Program Environmental Impact Report for the Vegetation Treatment Program

California State Board of Forestry and Fire Protection

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Draft Environmental Impact Report

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E. EXECUTIVE SUMMARY

E.1 INTRODUCTION

The California State Board of Forestry and Fire Protection (Board) is proposing to initiate the Vegetation Treatment Program (VTP). The VTP will become an integral part of the Board's comprehensive wildfire prevention strategy for the state responsibility area (SRA) lands of California, and will compliment fuel reduction projects being undertaken by federal and local governments. Under the VTP, the Department of Forestry and Fire Protection (CAL FIRE) will implement strategic fuel management projects as part of their mission to safeguard the people and protect the property and resources of California from the hazards associated with wildfire. This Program Environmental Impact Report (Program EIR) analyzes the potential environmental impacts that may occur from undertaking the VTP, and identifies project level limitations and mitigation measures that will minimize those impacts.

This Program EIR has been prepared according to the State CEQA Guidelines (California Code of Regulations (CCR) Section 15168). CEQA allows a lead agency, in this case the Board, to prepare a Program EIR to analyze the environmental impacts from a series of actions that can be characterized as one large project and are related to the issuance of general criteria to govern the conduct of a continuing program, or individual activities with similar scope or effects. The Board recognizes the need for a continuous fuel reduction program to ensure a high level of fire protection across the SRA in their Strategic Fire Plan, and has the statutory responsibility to establish policy for wildland resources in the SRA. The use of a Program EIR allows the Board to more exhaustively consider the environmental impacts than would be practical in separate project level EIRs and ensures consideration of cumulative impacts that might be missed in a project-by-project analysis.

E.2 PURPOSE AND NEED FOR THE VTP

Human population expansion into wildlands, increased fire suppression efforts, and a legacy of land use conversions has altered fire frequencies and fuel loading from historic patterns in California. The wildland-urban interface (WUI) – the transition between developed areas and the wildland – is of primary concern due to the high risk posed to life and property. In some forested portions of California fire suppression has created an uninterrupted accumulation of wildland fuels with resultant increases in fire hazard. Wildfire acreage in California increases with prolonged drought and extreme weather conditions (e.g., Santa Ana winds). The combination of manmade and natural factors has led to a situation where wildfire acreage, fire suppression cost,[1] and losses of residential structures have increased dramatically in the past three decades.

Climate change suggests a continuing and even accelerated risk from wildfire. Climate change scenarios suggest more frequent droughts (Diffenbaugh et al., 2015) and higher fire severity in some portions of the state (Fried et al., 2004). Increasing temperature has implications for vegetation distribution which may further increase future fire extent and fire intensity (Lenihan et al., 2003). Some ecosystems may not be able to adapt fast enough to increasing drought stress, resulting in large scale mortality from insects, fire, or disease (Grant et al., 2013). Increased fire extent, intensity, and severity can affect aquatic habitats (Bisson et al., 2003) and/or water quality (Ice et al., 2004). These future climate scenarios combined with continuing projections of residential growth into the wildland (Mann et al., 2014) suggest that existing wildfire-related problems are poised to become even larger in the near future.

An environmental problem of this magnitude goes beyond jurisdictional boundaries and requires a statewide strategy. The mission of the Board and CAL FIRE is to serve and safeguard the people and protect the property and resources of California (Board, 2010). An overarching goal of vegetation treatments is to alter fire behavior and reduce harmful effects. However, California displays astonishing diversity in plant, animal, and social systems. Without proper design, the statewide planning and implementation of vegetation treatments can potentially come with significant costs. To this end, the VTP Program EIR lays out a framework for accomplishing the fire hazard reduction goals of the Board and CAL FIRE in a manner that minimizes environmental impacts.

E.3 CONCEPTUAL BASIS OF THE VTP

CAL FIRE will implement the VTP with the intent of lowering the risk of damaging wildfire in the SRA by managing wildland fuels through the use of environmentally appropriate vegetation treatments. The VTP will only be applied to portions of the SRA that will best allow for the achievement of VTP objectives. These objectives are:

1. Modify wildland fire behavior to help reduce losses to life, property, and natural resources.
2. Increase the opportunities for altering or influencing the size, intensity, shape, and direction of wildfires within the wildland urban interface.

[1] CAL FIRE statistics indicate an exponential, more than six-fold increase in emergency fund fire suppression expenditures since 1979 after adjusting for inflation (CAL FIRE Emergency Fund Fire Suppression Expenditures, September 2014).

3. Reduce the potential size and total associated suppression costs of individual wildland fires by altering the continuity of wildland fuels.
4. Reduce the potential for high severity fires by restoring and maintaining a range of native, fire-adapted plant communities through periodic low intensity treatments within the appropriate vegetation types.
5. Provide a consistent, accountable, and transparent process for vegetation treatment monitoring that is responsive to the objectives, priorities, and concerns of landowners, local, state, and federal governments, and other stakeholders.

The first objective is the governing goal of the Program, and recognizes the link between fuels management, fire behavior, and fire effects. Modifying fuels influences fire behavior by reducing rate of spread and decreasing fire line intensity (i.e., heat release). This increases firefighter safety and the ability of firefighters to suppress or manage a fire. California's tremendous diversity in vegetation translates into a similar diversity in fuel types, with a resultant variation in fire behavior throughout the state. Considering statewide variations in fire behavior and the need to characterize it at a workable scale for a statewide environmental analysis, the vegetation of California is condensed into three main groups based on the distinct fire behavior each group exhibits. These groups can be classified as tree dominated, grass dominated, and shrub dominated vegetation formations.

Objectives two through four are related to the problem statement expressed in the previous section (E.2), and provide more specific links to values at risk and cost considerations.

To attain these objectives at the state-wide scale, the VTP organizes treatments into three general types:

- Wildland-Urban Interface (WUI): treatments will be focused in WUI-designated areas, and generally consist of fuel reduction to prevent the spread of fire between wildlands and structures, or vice versa.
- Fuel Breaks: strategically placed vegetation treatments that actively support fire control activities.
- Ecological Restoration: projects will generally occur outside the WUI in areas that have departed from the natural fire regime as a result of fire exclusion. Ecological restoration treatments will focus on restoring ecosystem resiliency by moderating uncharacteristic wildland fuel conditions to reflect historic vegetative composition and structure, including cultural landscapes.

This Program focuses fuel treatment projects in strategic areas to support the Board and CAL FIRE's mission to protect life, property, and natural resources by evaluating vegetation formations, expected fire behavior, values at risk, and treatment types. Further discussion of the VTP's conceptual basis is contained in Chapter 2.

Objective five promotes a consistent and collaborative process for identifying projects that meet the objectives of the VTP while avoiding significant impacts to the environment. An example of this would include working with private landowners of rangeland to meet the objectives of fuel hazard reduction while simultaneously improving forage production. This objective also supports integrating the VTP with broader, multi-jurisdictional fuel reduction efforts. Finally, it recognizes that project planning and implementation is best served through open communication with stakeholders and the public.

E.4 VEGETATION TREATMENT PROGRAM

The VTP allows for the implementation of specific vegetation treatment projects at appropriate locations and scales to meet program objectives for fire prevention, fire protection, and/or ecological restoration. Activities analyzed in and covered under the VTP Program EIR include: prescribed fire, manual activities (i.e., hand crew work), mechanical activities, prescribed herbivory (targeted beneficial grazing), and targeted ground application of herbicides. These activities will be used singularly or in combination depending upon the treatment type (i.e., WUI, fuel break, or ecological restoration) and environmental considerations.

Vegetation treatment activities will be implemented primarily on privately owned land within the SRA, and only on a voluntary basis**.** CAL FIRE will serve as the CEQA lead agency and oversee the implementation of vegetation treatment activities at the local CAL FIRE Unit or Contract County level for most VTP projects. The only exception would be in circumstances where proposed VTP projects are located on lands controlled by the California Department of Parks and Recreation (State Parks). In this case, State Parks may act as the lead agency and rely upon CAL FIRE's Program EIR in implementation of their vegetation treatment projects provided they fall within the objectives of the VTP. While CAL FIRE will serve as the CEQA lead agency in most circumstances, projects can be identified, funded (partially or fully), and implemented by private landowners, Fire Safe Councils, other public agencies, or non-profit groups. In these situations, the implementing entity will enter into a contract or agreement with CAL FIRE to carry out the VTP project.

The first step in the implementation process will be for each of CAL FIRE's Units or Contract Counties to identify proposed vegetation treatment projects consistent with the VTP during their annual update of the Unit Fire Management Plans (Unit Fire Plans) or Contract County Strategic Fire Plans. These strategic plans identify areas for fire prevention activities based on local conditions including values at risk, topography, predominant weather patterns, vegetation characteristics, likelihood of ignition sources, and response times. Proposed VTP projects will therefore become a component of fire prevention activities within the Unit or Contract County's jurisdiction. Projects are prioritized for implementation relative to how well they meet VTP and Unit/Contract County fire prevention objectives. In general, WUI treatments with the highest likelihood of protecting values at risk will receive the highest priority, and strategic fuel breaks or ecological restoration projects outside the WUI will be given moderate to low priority. The CAL FIRE Unit/Contract County staff will coordinate with private landowners and interested agencies to identify projects best suited to meet local priorities, funding limitations, and the VTP objectives. This provides the first opportunity for local stakeholders to engage in the VTP process.

Once a Unit Fire Plan/Contract County Strategic Fire Plan has identified proposed VTP projects, the CAL FIRE Unit/Contract County staff and the project proponent will begin the project evaluation process by completing the VTP Project Scale Analysis (see Chapter 7). The purpose of the Project Scale Analysis is to determine whether the environmental effects of the proposed project are addressed in this Program EIR. The Project Scale Analysis also requires CAL FIRE to consider whether all applicable standard project requirements and mitigation measures (see Chapter 2.5) identified in the Program EIR have been incorporated into the project. Standard project requirements are mandatory elements for every project in the VTP and ensure that significant adverse environmental impacts are avoided. Project requirements are prescriptive or procedural-based management practices (e.g., consultation with trustee agencies on resources of concern such as endangered species) that reduce or avoid potential environmental impacts. Some procedural-based project requirements allow for the development of project specific requirements to address project-scale site conditions that are not fully considered in the standard project requirements.

The Project Scale Analysis requires the applicant to contact agencies such as the California Department of Fish and Wildlife and Regional Water Quality Control Boards for consultation during the project evaluation process. Fuel Break and Ecological Restoration projects outside the WUI will require a public forum/workshop, which provides the public a venue to voice concerns over the potential for project specific environmental impacts or identify areas of concern not considered by the project proponent. Following the forum, the project proponent will be able to adjust the project to address any concerns. This is the second opportunity for the public to be part of the VTP process.

Once a Project Scale Analysis and all supporting documentation are complete, the project will be evaluated for approval on three levels: local CAL FIRE Unit/Contract County, CAL FIRE Region, and State Program levels. Projects will be approved under the VTP only once it has been found to be consistent with this Program EIR and all applicable project requirements and mitigation measures have been included. Any applicable project requirements and mitigation measures would then be incorporated into the project's contract requirements for implementation.

CEQA compliance and implementation will be coordinated through local CAL FIRE Units/Contract Counties. Implementation monitoring is required for all VTP-approved projects to ensure that all projects adhere to requirements and mitigation measures. Follow-up effectiveness monitoring and project reporting are also required elements of the VTP. A more formal cooperative adaptive management process is a long-term goal of the VTP. Additional details regarding the process for implementing the VTP are found in Chapter 2 and more information regarding monitoring, adaptive management, and Program communication is in Appendix I.

E.5 GEOGRAPHIC SCOPE OF THE VTP

Nearly all VTP projects will occur on privately owned lands. Of the over 101 million acres of land in California, approximately 31 million acres fall within CAL FIRE's SRA. The SRA is the area of the state where the State is financially responsible for the prevention and suppression of wildfires. SRA does not include lands within city boundaries or in federal ownership. However, not all of the SRA is appropriate for treatment given the constraints of the three general treatment types or the potential for damaging fire behavior. The total land area where the vegetation formation assemblages are appropriate for a WUI, fuel break, or ecological restoration treatment is approximately 22 million acres, or 71 percent of the SRA (Figure ES-1).

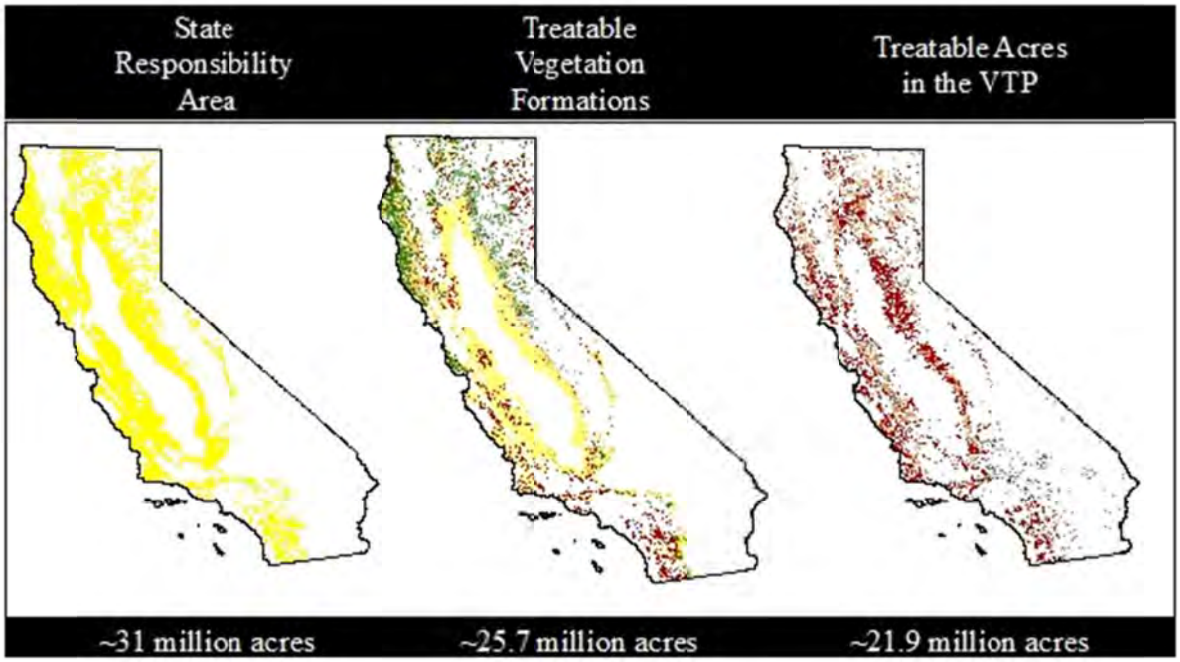

Figure ES-1. Identifying the Treatable Landscape within the Program.

Approximately 49 percent of the treatable acres are appropriate for the WUI treatment type, with the majority of the acres in the Sierra Nevada and Klamath/North Coast bioregions. Ecological restoration accounts for approximately 34 percent of the treatable acres; most of the ecological restoration acreage appears in the Klamath/North Coast, Modoc, and Sierra Nevada bioregions. Fuel breaks make up the smallest proportion of the treatments, accounting for only 18 percent of the area available for treatment. This is because fuel breaks are narrower and generally located along topographic ridgelines or roads. Further information on how the treatment types are delineated is contained in Chapters 2 (2.2.2) and 4 (4.1).

Within the approximately 22 million acres potentially subject to vegetation treatments, CAL FIRE plans to implement projects on approximately 60,000 acres per year, with a total of 600,000 acres treated over the 10-year period. This represents a doubling of vegetation treatment activity compared to the existing Vegetation Management Program. This proposed level of activity would treat approximately 0.2 percent of the SRA annually, or two percent of the SRA over a 10-year period. At an estimated project size of 260 acres, this amounts to approximately 230 projects per year or 2,300 projects over a ten-year period.

The above numbers are the basis for the analysis presented in this Program EIR. However, the actual acres treated annually in any portion of California will vary year-to-year based on several factors, such as the availability of cooperating landowners, funding, extended fire seasons, regional or statewide seasonal open burning suspensions, crew and equipment availability, unfavorable weather conditions, and access constraints. If the acreage proposed for treatment in a bioregion exceeds 110 percent of the projected yearly average for the bioregion, further project level analysis would be required to ensure that significant environmental effects do not occur. This determination will be made by the CAL FIRE Sacramento CEQA/Program Coordinator. Additional details about the geographic scope of the VTP are found in Chapters 2 and 3.

E.6 ALTERNATIVES ANALYZED

The following Program alternatives were developed for analysis:

No Project – This alternative is required by CEQA. If CAL FIRE took no further action, existing vegetation treatment programs, such as the Vegetation Management Program (VMP) and California Forest Improvement Program (CFIP), would continue to operate using their previously approved EIRs and departmental procedures to satisfy CEQA requirements. This alternative applies to an existing landscape that is larger than the landscape in the Proposed Program and below that for the Alternatives, since both existing programs apply to the entire SRA (i.e., approximately 31 million acres). This Alternative would continue to treat 30,000 acres annually.

Proposed Program – The proposed Vegetation Treatment Program limits vegetation treatment efforts to areas within the SRA where assets, both urban and natural, are at greatest risk from wildland fire. Treatment activities would be limited to three general project types, which include vegetation treatments to protect the WUI, fuel break installation and maintenance, and enhancing fire resiliency through ecological restoration. The available landscape to treat (approximately 22 million acres) would be smaller than the “No Project” Alternative because the scope is limited to areas that qualify for one or more of the specified project and vegetation types. This program proposes the treatment of 60,000 acres annually.

Alternative A: WUI Only – The WUI Only Alternative focuses on vegetation treatments planned specifically to protect assets within the WUI. Projects would primarily consist of community and infrastructure protection, establishing safe areas of refuge, and enhancing vegetation clearance proximate to structures. Vegetation management priorities and ecological restoration opportunities outside of the WUI would not be included under this proposed alternative. Wildland fire control success outside the WUI would rely primarily on initial attack and extended attack resources without the strategic benefit of pre-treated fuels or newly constructed/maintained fuel breaks. The project evaluation process, analysis procedures, treatment options, and mitigations would be the same as those for the Proposed Program. The available landscape to treat would be approximately 11 million acres in the SRA, but the projected average annual treatment acreage would be 60,000 acres.

Alternative B: WUI and Fuel Breaks – In addition to vegetation treatment efforts designed specifically to protect values within the WUI, fuel breaks would also be maintained or installed in favorable topographic locations to aid in wildland fire control efforts outside of the WUI. The project evaluation process, analysis procedures, treatment options, and mitigations would be the same as those for the Proposed Program. The available landscape to treat would be significantly larger than the “WUI Only” Alternative A due to the addition of fuel break-appropriate landscapes; however, it would remain less than the area for the Proposed Program. This alternative would also treat 60,000 acres annually.

Alternative C: Very High Fire Hazard Severity Zone – CAL FIRE is mandated by Public Resources Code § 4201-4204 and Government Code § 51175-89 to identify fire hazard severity zones statewide. These zones reflect areas of significant fire hazard based on fuels, terrain, weather, and other relevant factors. To reduce the wildland fire threat in high hazard areas, fuel treatments under Alternative C would focus specifically on areas that are classified as a "Very High Fire Hazard Severity Zone.” The project evaluation process, analysis procedures, treatment options, and mitigations would be the same as those for the Proposed Program. This alternative has the fewest available acres for treatment (~11.8 million acres) but it is still projected to treat 60,000 acres annually.

Alternative D: Treatments that Minimize Potential Impacts to Air Quality – Alternative D has limitations on the number of acres that could be treated with prescribed fire to reduce the potential health and environmental impacts from poor air quality. In this alternative, prescribed fire use would be considerably limited; however, some of those acres could be treated with hand or mechanical treatments. Overall, the landscape available for treatment with this alternative is the same as that for the Proposed Program, but the projected treated acres are fewer at 36,000 acres annually.

The Proposed Program would meet the objectives established for the VTP (see E.3) to a greater degree than the Alternatives and No Project (Status Quo) options. Specific details about each alternative and the environmental impacts associated with each alternative can be found in Chapters 3, 4, and 5.

E.7 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

This Program EIR evaluates the full range of potential environmental impacts identified in Appendix G of the CEQA Guidelines (Table ES-1). These impacts are discussed throughout Chapter 4 which identifies the Environmental Setting, Environmental Impacts, and Mitigation Measures for each resource of concern listed in Table ES-1 below. If a proposed project could not maintain project impacts at less than significant levels through the application of project requirements and mitigation measures, it would be disqualified from approval under the VTP and would have to be abandoned, re-designed, or use an alternative CEQA process (e.g., supplemental EIR) to proceed. This approach to limiting environmental impacts will preclude the creation of new significant impacts or considerable contributions to existing environmental problems. There are 87 standard project requirements identified within the Program EIR. These are repeated in three locations in the document: Chapter 2.5, Chapter 4, and Chapter 7. The determination of environmental impacts assumes projects will properly implement all standard project requirements.

Table ES-1. Comparison of the environmental impacts to resources implementing the Proposed Program or the Alternatives. SPRs are standard project requirements.

Resource of Concern	Significant and Unavoidable	Less than Significant with Mitigation Measures	Less than Significant with SPRs Implemented	Less Than Significant
Biological Resources			X	
Geology, Hydrology, and Soils			X	
Hazardous Materials, Public Health and Safety			X	
Water Quality			X	
Archeological, Cultural & Historic Resources			X	
Noise			X	
Recreation			X	
Utilities and Energy				X
Transportation and Traffic			X	
Population, Employment, Housing, & Socio-Economic Well-Being				X
Air Quality		X		
Aesthetics and Visual Resources			X	
Climate Change/Greenhouse Gas			X	

E.8 CUMULATIVE EFFECTS SUMMARY

The potential environmental impacts related to projects that qualify for approval under the VTP will be less than significant through the implementation of standard project requirements (SPRs) and any identified project specific requirements (PSRs). Where potentially significant impacts cannot be entirely avoided, mitigation measures will be required to compensate for resource impacts (see Chapter 4.12, Air Quality). If a proposed project cannot maintain project impacts and contributions to cumulative impacts at less than significant levels through the application of project requirements and mitigation measures, it will be disqualified from approval under the VTP and will be required to be abandoned, re-designed, or use an alternative CEQA process (e.g., supplemental EIR) to proceed. This approach to limiting environmental impacts will preclude the creation of new significant cumulative impacts or considerable contributions to existing cumulative environmental problems. Chapter 5 provides a detailed discussion of cumulative impact issues by environmental resources topic.

E.9 SIGNIFICANT AND UNAVOIDABLE ENVIRONMENTAL IMPACTS

No reasonably foreseeable significant irreversible environmental changes have been identified that would result from implementation of the VTP or the identified Alternatives. The VTP is projected to treat 0.2 percent of the SRA per year, or 2 percent of the SRA in a 10-year planning horizon. This relatively small spatial footprint along with a robust suite of project requirements and mitigation measures will make irreversible damage from environmental impacts of the VTP unlikely.

E.10 AREAS OF KNOWN CONTROVERSY

Section 15123(b) of the State CEQA Guidelines requires that an EIR identify areas of controversy known to the lead agency, including issues raised by agencies and the public. The following are areas of controversy known to CAL FIRE:

- Air quality impacts from prescribed burning
- Cumulative impacts to chaparral communities from program treatments and wildfires
- Impacts to water quality, biological resources, and human health
- Impacts to geological features and soil erosion
- Inclusion of herbicide applications as a Program activity
- Introduction or spread of invasive plants
- Potential for loss of life, property, and resource values due to escaped prescribed fire
- Impact to climate change and greenhouse gases Ability to address the ecological and social complexities of the state in a single Program
- Impacts to cultural resources

These areas of known controversy will be addressed through the implementation of the SPRs, PSRs, and mitigation measures outlined in Chapters 2 and 4.

E.11 SUMMARY

The Board recognizes the necessity for CAL FIRE to implement a robust program of vegetation treatments to fulfill its mission to safeguard the people and protect the property and resources of California. The VTP provides a framework for prioritizing, planning, implementing, and monitoring fuel treatments across the SRA. This Program EIR discloses to interested parties the scope of the VTP, potential foreseeable environmental impacts from implementing the VTP, and the proposed project limitations and mitigations designed to lessen or avoid environmental impacts. Through project monitoring and participation in adaptive management processes, it is anticipated that the VTP will be able to incorporate emerging science and the changing needs of the State as the Program matures.

ACRONYMS

ACOE	United States Army Corps of Engineers
ADT	Average Daily Traffic
APCD	Air Pollution Control District
AQMD	Air Quality Management District
ARB	Air Resource Board
BGEPA	Bald and Golden Eagle Protection Act
BIA	Bureau of Indian Affairs
BIOS	Biogeographic information & Observation System
BLM	Bureau of Land Management
BMP	Best Management Practice
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAD	Computer Aided Dispatch
CAISO	California Independent System Operator
CAL FIRE	California Department of Forestry and Fire Protection
Cal-IPC	California Invasive Plant Council
CalPIF	California Partners in Flight
CAP	Criteria Air Pollutants
CBD	Center for Biological Diversity
CCA	California Coastal Act

CCAA	California Clean Air Act
CCAS	California Climate Adaption Strategy
CCR	California Code of Regulations
CDCR	California Department of Corrections and Rehabilitation
CDFW	California Department of Fish and Wildlife
CDPR	California Department of Pesticide Regulation
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFIP	California Forestry Improvement Program
CFR	Code of Regulations
CGS	California Geological Survey
CIBA	California Indian Basketweavers Association
cm	Centimeters
CNDDB	California Natural Diversity Database
CNEL	Community Noise Equivalent Level
CNRA	California Natural Resources Agency
CPAD	California Protected Areas Database
CPUC	California Public Utilities Commission
CSS	Coastal Sage Scrub
CWA	Clean Water Act
CWPP	Community Wildfire Protection Pan
CZMA	Coastal Zone Management Act
dB	decibel

dBA	A-weighted decibel
dbh	Diameter breast height (4 ½ feet above ground)
DEM	Digital Elevation Model
DJJ	Division of Juvenile Justice
DoD	Department of Defense
DPR	California Department of Parks and Recreation
DTSC	California Department of Toxic Control
DWR	California Department of Water Resources
ECOS	Environmental Conservation Online System
EIR	Environmental Impact Report
ELZ	Equipment Limitation Zone
EPA	Environmental Protection Agency
ESA	Environmental Site Assessment
ESRI	Environmental Systems Research Institute
FESA	Federal Endangered Species Act
FHWA	Federal Highway Administration
FLPMA	Federal Land Policy Management Act
FOFEM	First Order Fire Effects Model
FPR	Forest Practice Rules
FRA	Federal Responsibility Area
FRAP	Fire and Resource Assessment Program
FRAQMD	Feather River Air Quality Management District
FRI	Fire Return Intervals

FSC	Fire Safe Council
GGRF	Greenhouse Gas Reduction Fund
GHG	Green House Gas
ha	Hectares
HAP	Hazardous Air Pollutants
HCP	Habitat Conservation Plans
HEPA	High Efficiency Particulate Air
HOA	Home Owner Association
Hz	Hertz
IAP	Incident Action Plan
IHRMP	Integrated Hardwood Range Management Program
IPM	Integrated Pest Management
IUCN	International Union for Conservation of Nature
L_{eg}	Energy-equivalent Noise Level
L_{dn}	Day-Night Average Noise Level
LRA	Local Responsibility Area
LSA	Lake and Streambed Alteration
LWD	Large Woody Debris
mm	Millimeters
MPH	Miles Per Hour

MPO	Metropolitan Planning Organization
MSDS	Material Safety Data Sheet
NAAQS	National Ambient Air Quality Standards
NCCP	Natural Community Conservation Plans
NEPA	National Environmental Protection Act
NFMA	National Forest Management Act
NOA	Naturally Occurring Asbestos
NOAA	National Oceanic and Atmospheric Agency
NOD	Notice of Determination
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPPA	Native Plant Protection Act
NPS	National Park Service
NTMP	Non-industrial Timber Management Plan
NWCG	National Wildfire Coordinating Group
OEHHA	Office of Environmental Health Hazard Assessment
OSHA	Occupation Safety and Health Administration
PCA	Pest Control Advisor
PEIR	Programmatic Environmental Impact Report
PFE	Pre-Fire Engineer
PG&E	Pacific Gas and Electric
PRC	Public Resource Code

PSA	Project Scale Analysis
PSR	Project Specific Requirements
PTHP	Program Timber Harvest Plan
PUC	Public Utilities Commission
RCD	Resource Conservation Districts
RMP	Resource Management Plans
ROG	Reactive Organic Gases
RPA	Rangeland Renewable Resource Planning Act
RPF	Registered Professional Forester
RTP	Regional Transportation Plan
RWQCB	Regional Water Quality Control Board
SCS	Sustainable Communities Strategy
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
SIP	State Implementation Plan
SJVAPCD	San Joaquin Air Pollution Control Districts
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMP	Smoke Management Plan
SNEP	Sierra Nevada Ecosystem Project
SNFPA	Sierra Nevada Forest Plan Amendment
SPR	Standard Project Requirements
SPRP	Spill Prevention and Response Plan
SRA	State Responsibility Area

SWPPP	Storm Water Pollution Prevention Plan
TAC	Toxic Air Contaminates
THP	Timber Harvest Plan
TMDL	Total Maximum Daily Loads
TNC	The Nature Conservancy
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VHFHSZ	Very High Fire Hazard Severity Zone
VMP	Vegetation Management Plan
VOC	Volatile Organic Compounds
VTP	Vegetation Treatment Program
WDR	Waste Discharge Requirements
WHR	Wildlife Habitat Relations
WLPZ	Watercourse and Lake Protections Zone
WUI	Wildland Urban Interface

Glossary

Broadcast burn

The controlled application of fire to wildland fuels in their natural or modified state over a predetermined area often conducted to reduce wildland fire fuel loads, restore the ecological health of an area, or to clear vegetation.

CalWat

The California Interagency Watershed Map of 1999 (Calwater 2.2, updated May 2004, "calw221") is the State of California's working definition of watershed boundaries. Previous Calwater versions (1.2 and 2.2) described California watersheds, beginning with the division of the State's 101 million acres into ten Hydrologic Regions (HR). Each HR is progressively subdivided into six smaller, nested levels: the Hydrologic Unit (HU, major rivers), Hydrologic Area (HA, major tributaries), Hydrologic Sub-Area (HSA), Super Planning Watershed (SPWS), and Planning Watershed (PWS). At the Planning Watershed (the most detailed level), where implemented, polygons range in size from approximately 3,000 to 10,000 acres. At all levels, a total of 7035 polygons represent the State's watersheds. The present version, Calwater 2.2.1, refines the watershed coding structure and documentation (database fields were added and some were renamed). There are significant watershed boundary, code, and name differences between Calwater versions 1.2 (1995), 2.0 (1998), and 2.2 (1999). The differences between versions 2.2 (1999) and 2.2.1 (2004) are attribute field names and some inserted lines that identify differences between State and federal watersheds.

Chaining

Consists of pulling heavy chains in a “U” or “J” shaped pattern behind two crawler-type tractors, or by one tractor pulling a chain with a heavy ball attached to the end. Chaining is most effective for crushing brittle shrubs, such as manzanita and chamise, and uprooting woody plants. Chaining can be done on irregular, moderately rocky terrain, with slopes of up to 50%. Although chaining may cause soil disturbance, the resultant plant debris can be left in place to minimize surface erosion, shade the ground surface, maintain soil moisture and provide nutrient recycling. Alternatively, the debris can be burned to facilitate grass seeding, improve aesthetic values, and eliminate potential rodent habitat. Chaining can be a cost effective means to incorporate grass seed into soil, especially in burned areas, as it provides a variety of seeding depths and microsites, which can improve ground cover and forage production.

Chipping

Chippers or “tub-grinders” are often used to chip the tops and limbs to generate mulch or biomass, which can be used onsite, sold to homeowners or garden supply stores, or used in power generation facilities.

Class I and II watercourses

The California Forest Practice Rules define a Class I watercourse at 14 CCR § 916.5 as 1) domestic supplies including springs on site and/or within 100 downstream of operations or 2) a stream where fish are always or seasonally present including habitat to sustain fish migration and passage. The definition of a Class II watercourse is a stream where fish are always or seasonally present within 1000’ downstream, and where there is aquatic habitat for nonfish aquatic species.

Community Noise Equivalent Level (CNEL)

A 24-hour average L_{eq} with no penalty added to noise during the day time hours between 7am and 7pm, a penalty of 5 dB added to evening noise occurring between 7pm and 10pm, and a penalty of 10 dB added to nighttime noise occurring between 10pm and 7am.

Contract Counties

CAL FIRE provides funding to six counties for fire protection services including wages of suppression crews, lookouts, maintenance of fire fighting facilities, fire prevention assistants, pre-fire management positions, dispatch, special repairs, and administrative services. Contract Counties are responsible for providing initial response to fires on SRA.

Critical Infrastructure

The nation's critical infrastructure provides the essential services that underpin American society and serve as the backbone of our nation's economy, security, and health. We know it as the power we use in our homes, the water we drink, the transportation that moves us, the stores we shop in, and the communication systems we rely on to stay in touch with friends and family.

Cultural Landscape

A geographic area,including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

dBA

An “A-weighted” decibel (dBA) is a decibel corrected for the variation in frequency response of the typical human ear at commonly encountered noise levels.

DFG 1600 permit

A permit issued by the California Department of Fish and Wildlife that, depending on permit conditions, allows a person, business, state or local government agency, or public utility to substantially modify a river, stream or lake by an activity that will, 1) divert or obstruct the natural flow of any river, stream or lake, 2) substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.

DPA

Federal DPA are lands that would normally receive fire protections services from CAL FIRE; however, due to efficiency of operations these lands receive fire protection from federal agencies according to written agreements with CAL FIRE.

Drainage facilities

Items constructed to control water, including, but not limited to, fords, inside ditches, waterbreaks, outsloping and rolling dips.

Drill Seeding/Drilling

Is often done in conjunction with tilling. The seed drills, which consist of a series of furrow openers, seed metering devices, seed hoppers, and seed covering devices, are either towed by or mounted on a tractor. The seed drill opens a furrow in the seedbed, deposits a measured amount of seed into the furrow, and closes the furrow to cover the seed. Seed may also be injected into the soil directly through direct “drilling” without creating furrows.

Ecological Restoration

Re-establishing the composition, structure, pattern, integrity and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions.

Feller-buncher

Are often used within a commercial or precommercial thinning or partial cutting for fuel hazard reduction projects such as shaded fuel breaks and wildlife habitat improvement. Feller-bunchers and harvester-forwarder-processors are usually used on slopes of less than 35%, and for handling trees that are between 4-22 inches in diameter. Feller-bunchers clamp the trunks of trees, cut them at the base, pick them up, and bundle them into piles or load them onto trucks.

Fuel Break

An area in which flammable vegetation has been modified to create a defensible space in an attempt to reduce fire spread to structures and/or natural resources, and to provide a safer location to fight fire. These treatments can be a part of a series of fuel modifications strategically located along a landscape.

Fire Safe Council

A group of concerned citizens organized to educate groups on fire safe programs, projects and planning. The Councils work closely with the local fire agencies to develop and implement priorities.

Fire Weather Watch

A term used by fire weather forecasters to notify using agencies, usually 24 to 72 hours ahead of the event, that current and developing meteorological conditions may evolve into dangerous fire weather.

Forested Landscape

As defined in Public Resources Code Section 754 means those tree dominated landscapes and their associated vegetation types on which there is growing a significant stand of tree species, or which are naturally capable of growing a significant stand of native trees in perpetuity, and is not otherwise devoted to non-forestry commercial, urban, or farming uses.

Fuel ladders

The live or dead vegetation that allows a fire to climb up from the forest floor into the tree canopy.

Grubbing/Ripping

This is usually done with a crawler-type tractor and a brush or root rake attachment. The rake attachment consists of a standard dozer blade adapted with a row of curved teeth projecting forward at the base of the blade. Shrubs are uprooted and roots are combed from the soil by placing the base of the blade below the soil surface.

Herbicide

A substance that is toxic to plants and is used to destroy or inhibit the growth of unwanted vegetation.

Integrated pest management

CA Healthy Schools Act of 2000 (AB2260) defines IMP as a pest management strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques such as monitoring for pest presence and establishing treatment threshold levels, using non-chemical practices to make the habitat less conducive to pest development, improving sanitation, and employing mechanical and physical controls. Pesticides that pose the least possible hazard and are effective in a manner that minimizes risks to people, property, and the environment, are used only after careful monitoring indicates they are needed according to pre-established guidelines and treatment thresholds.

Jackpot burning

This is tool used to reduce areas of heavy concentrations of surface fuels. This technique involves igniting concentrations or patches of dead and down fuel under specified conditions of fuels moisture, weather, and other variables. Sometimes called “spot burning” or “jackpotting”.

Landowner

Person or group who owns land that has volunteered to have vegetation treatments completed on their property.

L_{eq}

The energy-equivalent noise level (Leq), is the average acoustic energy content of noise, measured during a specific time period.

L_{dn}

The day-night average noise level (Ldn), is a 24-hour average Leq with a 10 dBA penalty added to noise occurring during the hours of 10pm and 7am to account for the greater nocturnal noise sensitivity of people.

Litter

The uppermost layer of the forest floor consisting chiefly of fallen leaves and other decaying organic matter.

Manual Activity

Use of hand tools and hand-operated power tools to cut, clear, or prune herbaceous and woody species.

Mastication

Equipment installed on small wheeled tractors, wheeled or crawler-type tractors, excavators, or other specialized vehicles, is used to cut shrubs and trees into small pieces that are scattered across the ground, where they act as mulch

Mechanical Activity

Use of motorized equipment designed to cut, uproot, crush/compact, or chop existing vegetation.

Mowing

Tools, such as rotary mowers on wheeled tractors or other equipment, or straight-edged cutter bar mowers, can be used to cut herbaceous and woody vegetation above the ground.

Periphyton

An assemblage of organisms (mostly algae) attached to and living on submerged solid surfaces in natural environments such as rivers.

Pesticide

A substance, or mixture of substances, intended to defoliate plants, regulate plant growth, or prevent, destroy, repel, or mitigate and insects, fungi, bacteria, weeds, rodents, predatory animal, or any other form of plant or animal life declared to be a pest detrimental to vegetation, man, animal, or households, or any environment. Also, in California only, a spray adjuvant.

Pile Burning

Technique involves gathering concentrations of fuel into a pile, igniting it and limiting the fire to each individual pile at a time.

Prescribe Fire

Application of fire to fuels to accomplish planned resource management objectives under specified conditions of fuels, weather, and other variables.

Prescribed Herbivory

Intentional use of domestic livestock to reduce a targeted plant population to an acceptable level and/or reducing the vegetative competition of a desired plant species.

Project coordinator

The individual who coordinates and supervises the project during the planning, implementation, and completion phases. This position is responsible for the overall project including the project scale analysis development, coordination of activities, resources, equipment and reporting information as required through contract with CAL FIRE. The project coordinator shall retain the responsibility and accountability to meet all contract needs.

Red Flag Warning

Term used by fire weather forecasters to alert forecast users to an ongoing or imminent critical fire weather pattern.

Riparian

The banks and other adjacent terrestrial environs of lakes, watercourses, estuaries, and wet areas, where transported surface and subsurface freshwaters provide soil moisture to support mesic vegetation.

Sensitive receptors

People that have an increased sensitivity to an environmental impact such as noise, air pollution, hazardous materials etc. Sensitive receptor locations include schools, parks and playgrounds, day care centers, nursing homes, hospitals, and residential dwelling unit(s).

Special Status Species

A plant or animal species that is listed as rare, threatened, or endangered under Federal law; or as rare, threatened, endangered, candidate, or fully protected under State law; or as sensitive species by the California Board of Forestry and Fire Protection.

Stakeholder

A person or group with an invested interest or concern in a vegetation treatment project proposed under the scope of this PEIR.

Tilling

Involves the use of angled disks (disk tilling) or pointed metal-toothed implements (chisel plowing) to uproot, chop, and mulch vegetation.

Underburn

Defined as a fire that is constrained to surface fuels to leave the canopy intact. Underburns are commonly prescribed for dry forest types such as ponderosa pine or mixed conifer to reduce fuel but leave the overstory intact. Underburns are usually classified as low-severity fires.

Unit Fire Plan

Plans developed by individual CAL FIRE Units to address wildfire protection areas, initial attack success, assets and infrastructure at risk, pre-fire management strategies, and accountability within their geographical boundaries.

Water Quality Requirements

A water quality objective (narrative or numeric), prohibition, TMDL implementation plan, policy, or other requirement contained in a water quality control plan adopted by the Regional Board and approved by the State Water Board.

Wet areas

Wet Meadows and Other Wet Areas-Those natural areas except cutover timberland which are moist on the surface throughout most of the year and support aquatic vegetation, grasses and forbs as their principal vegetative cover

Wetlands

An aquatic (water dominated) land cover class having greater than two percent vegetation cover and having less than 10 percent of the over story canopy occupied by trees or shrubs.

Wildland Urban Interface (WUI)

The geographical overlap of two diverse systems where the buildings and vegetation are sufficiently close that a wildland fire could spread to a structure or a structure fire could ignite wildland vegetation.

WUI treatments

Hazardous fuel reduction projects in the Wildland Urban Interface (WUI) designed to alter the vertical and horizontal continuity of vegetative fuels to reduce the likelihood of fire ignition, and reducing the rate of spread, duration and intensity of a wildfire.

1 INTRODUCTION

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1.1 PURPOSE

The California State Board of Forestry and Fire Protection (Board) is proposing to initiate the Vegetation Treatment Program (VTP). The VTP is part of a comprehensive fire prevention strategy from the Board (Board, 2010) that is implemented by the Department of Forestry and Fire Protection (CAL FIRE). This program intends to lower the risk of damaging wildfires on nonfederal lands by managing vegetation to modify and/or reduce hazardous fuels. The key objectives of this program are to prevent loss of lives and property, reduce fire suppression costs, and protect natural resources from damaging wildfire through the use of appropriate vegetation treatments. It is important to acknowledge that the VTP is not meant to resolve all hazardous fuel conditions but rather provide a tool to address them on a voluntary basis for all stakeholders within and associated with the SRA. The implementation of this program would be a discretionary action by CAL FIRE and would govern project-scale decision making. Therefore, approval of the VTP by the Board would be a “project” under the California Environmental Quality Act (CEQA), as defined in CEQA Guidelines Section 15378.

1.1.1 THE NEED FOR A VEGETATION TREATMENT PROGRAM

Fire is a natural process on the California landscape. Despite this, fire regimes in many California ecosystems have been altered by land use and other anthropogenic factors (Van de Water and Safford, 2011; Stephens, Martin & Clinton, 2007). It is estimated that approximately 4.45 million acres burned annually in California before the 1800s (Stephens, Martin & Clinton, 2007). Fire suppression and land use conversions have resulted in a buildup of fuels in some coniferous forest types (McKelvey et al., 1996; Miller et al., 2009). Unfortunately, human activities have increased ignitions and fire frequency in some chaparral vegetation types (Keeley and Fotheringham, 2003; Syphard et al., 2007). These types of anthropogenic alterations are some of the reasons why wildfire frequency in Northern California has increased 18 percent in the period from 1970 to 2003 (Westerling et al., 2006), and wildfire acreage in California has been steadily increasing since the mid-1990s (Figure 1.1-1). In a national-scale assessment, California was found to have three times the magnitude of wildfire-related risk for the most highly valued human and ecological resources (e.g., moderate/high density housing and municipal watersheds) than the next highest geographic area (Thompson et al., 2011). Risk due to wildfire is most acute in the wildland-urban interface (WUI), where housing losses have increased significantly during the past three decades (Figure 1.1-2; Stephens et al., 2009b). This problem is expected to grow, as modeling scenarios suggest that housing within the highest wildfire hazard severity zone (i.e., very high) will increase from 640,000 to 1.2 million units by the year 2050 (Mann et al., 2014).

Climate change is another mechanism that has been predicted to increase the size, timing, and severity of fires into the future (Lenihan et al., 2003; Fried et al., 2004; Westerling et al., 2008). Projected temperatures in California between 2000 and 2100 are expected to rise 1.7 to 3.0 degrees Celsius (^{o}C) in the lower range of projected warmings, 3.1 to 4.3 ^{o}C in the medium range, and 4.4 to 5.8 ^{o}C in the high range (Cayan et al., 2008). Most of the projected temperature increases will occur during the summer months (Cayan et al., 2008). Due to these temperature increases, predictive models forecast anywhere from a 12 to 53 percent increase in large fires between 2070 to 2099 (i.e., greater than approximately 500 acres) (Westerling et al., 2008), and a median increase of 41 to 69 percent for burned area by 2085 (Westerling et al., 2011). Large fire risk may increase or decrease in Southern California depending upon the change in precipitation magnitude, however, large fire risk increases in Northern California regardless of whether precipitation increases or decreases (Westerling et al., 2008). Regardless of the modeled scenario, the predicted trend is one of increasing fire season and fire size at the statewide scale. There is also considerable uncertainty about how climate change would affect vegetation composition and structure across the state (Lenihan et al., 2003). Aside from mitigating the probability (risk) of wildfire, and general threat to the environment from catastrophic wildfire, this VTP is intended to be utilized to increase fire resiliency and adaptation to climate change.

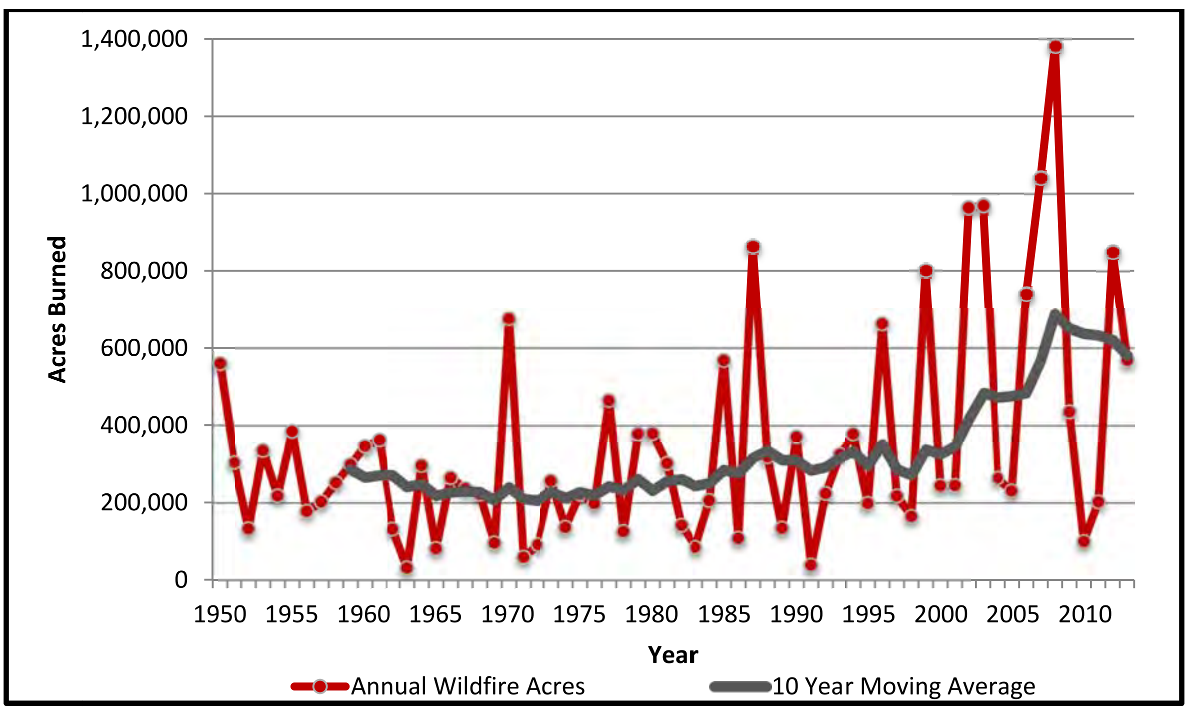

Figure 1.1-1 Annual area burned in California from 1950-2010 (CAL FIRE)

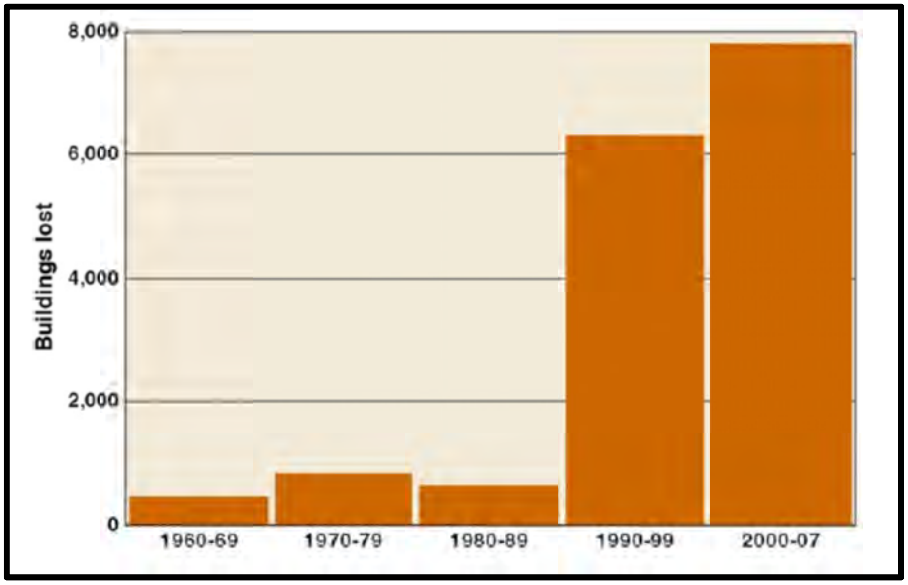

Figure 1.1-2 Number of buildings lost from the 25 most destructive WUI fires in California history from 1960-2007 (taken from Stephens et al., 2009).

Despite the uncertainties in future wildfire activity, what is known is that fire behavior in the wildland environment is influenced by the interaction between weather, topography, and fuels (Figure 1.1-3; Countryman, 1972). Of the three variables, fuels are the only one that can be feasibly manipulated through human activities. Vegetation treatments can influence fire behavior through the manipulation of the amount and arrangement of fuels. Properly implemented vegetation treatments have been shown to reduce fire severity and help to protect assets in the WUI (Safford et al., 2009). Vegetation treatments can improve the resistance and resiliency of some vegetation types to high-severity fire (Stephens et al., 2012), and strategically placed fuel breaks can help aid in fire suppression efforts (Syphard et al., 2011).

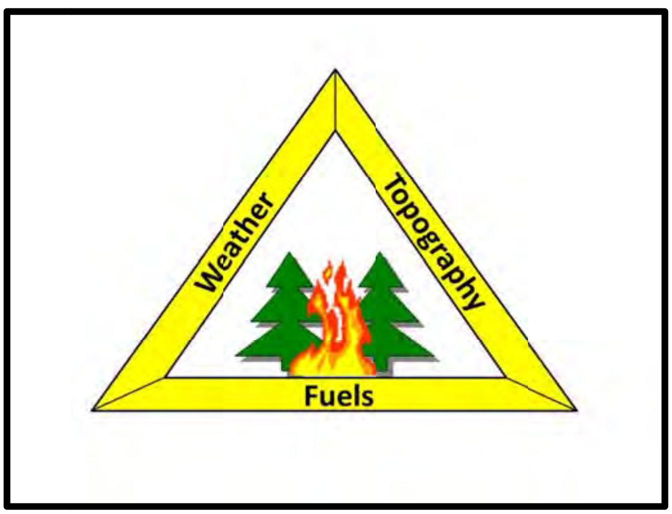

Figure 1.1-3 Fire Behavior Triangle Treating fuels is one of the only ways we can feasibly influence the rate of spread fire intensity and/or fire severity. (Graphic Credit CAL FIRE)

Regardless of the noted benefits, fuels treatments are not appropriate in all locations (Keeley, 2002), and can cause environmental impacts if not designed for site-specific conditions (Elliot et al., 2010). As such, the Board and CAL FIRE require a systematic process that guides the prioritization, selection, assessment, and mitigation of appropriate vegetation treatments in the diverse environments of California. The VTP would provide the framework that allows for the implementation of appropriate fuels treatments across nonfederal lands in California.

1.2 DECISIONS SUBJECT TO CEQA

CEQA applies only to discretionary projects by public agencies. A "project" is defined as a whole of an action which has the potential for resulting in either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. (State CEQA Guidelines Section 15378[a]; Public Resources Code [PRC] 21065).

A "project" under CEQA is considered to be an activity directly undertaken by a public agency, an activity that is supported, in whole or in part, through public agency contracts, grants, subsidies, loans, or other assistance from a public agency, or an activity involving the public agency issuance of a lease, permit, license, certificate, or other entitlement for use by a public agency. An agency is generally not permitted to treat each separate permit or approval under a program, such as the VTP, as a separate project segment, if the effect is to avoid full disclosure of environmental impacts. However, CEQA does encourage the application of a programmatic approach where a group or series of projects are similar in activities and impacts and where potential impacts can be avoided or mitigated in a similar manner. Section 1.3 describes the relationship between discretionary projects and the CEQA requirements for the VTP.

1.3 PURPOSE OF THIS PROGRAM ENVIRONMENTAL IMPACT REPORT

This Program Environmental Impact Report (Program EIR) has been prepared to evaluate the potential environmental effects of implementing the VTP. This Program EIR has been prepared in compliance with CEQA and the State CEQA Guidelines. CEQA requires that state and local government agencies consider the environmental effects of projects over which they have discretionary authority before taking action on those projects. CEQA requires that each public agency avoid or mitigate to less-than-significant levels, wherever feasible, the significant environmental effects of projects it approves or implements. The purpose of an EIR, under CEQA, is "to identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided" (PRC Section 21002.1 [a]). If a project would result in significant and unavoidable environmental impacts that cannot be feasibly mitigated to less-than-significant levels, the project can still be approved, but the lead agency's decision-maker (i.e., Board) must issue a "statement of overriding consideration" explaining, in writing, the specific economic, social, or other considerations that they believe make those significant effects acceptable (PRC Section 21002; 14 CCR 15093).

The Board is the Lead Agency for this Program EIR, as defined by CEQA and will provide policy direction and guidance to CAL FIRE in its implementation of the VTP. Other public agencies with jurisdiction over the project areas evaluated under the VTP are described below in Section 1.5 Responsible and Trustee Agencies.

The purpose, content, and procedures of a Program EIR are described in State CEQA Guidelines Section 15168 and summarized below. The relevant statute and resolution guiding the preparation of the Program EIR are:

- PRC Section 21000 et seq., the California Environmental Quality Act
- California Code of Regulations, Title 14, Division 6, Chapter 3, Section 15000 et seq., the State CEQA Guidelines

1.4 USE OF A PROGRAM ENVIRONMENTAL IMPACT REPORT

According to Section 15168 of the State CEQA Guidelines, a Program EIR may be prepared on a series of actions that can be characterized as one large project and are related to, among other things, the issuance of general criteria to govern the conduct of a continuing program or individual activities carried out under the same authorizing statutory or regulatory authority and having generally similar environmental effects that can be mitigated in similar ways. The VTP meets these criteria for use of a Program EIR.

Preparing a Program EIR allows for a more exhaustive consideration of effects than would be practical in separate EIRs on individual actions, and ensures consideration of cumulative impacts that might be missed on a case-by-case basis. It also avoids duplicative consideration of basic policy and program-wide mitigation measures.

As noted in Section 15168(c) of the State CEQA Guidelines, subsequent proposed projects that are consistent with the VTP (i.e., proposed treatment activities within units of CAL FIRE) would be examined in light of the information in this Program EIR to determine whether an additional environmental document must be prepared. This allows an opportunity for the public to provide comment on a project at an early stage of the CEQA process. If CAL FIRE finds that, pursuant to Section 15162 of the State

CEQA Guidelines, no new effects would occur or no new mitigation measures would be required on a subsequent project, the project can be considered as being “within the scope” this Program EIR, and no new EIR or negative declaration would be required. CAL FIRE would use this EIR for the project’s CEQA compliance and file a notice of determination (NOD) when the project is approved. Under this approach, CAL FIRE must incorporate all project requirements relevant to the proposed treatment activity and all feasible mitigation measures from this Program EIR into the project, as needed, to address significant or potentially significant effects on the environment.

If a proposed project would have effects that were not examined in this Program EIR, an initial study would be needed to be prepared to determine the appropriate environmental document. If another environmental document is needed, whether it is a notice of exemption, negative declaration, mitigated negative declaration, or Supplemental EIR, the Program EIR can be used to simplify the task of preparing the subsequent environmental document, as indicated in Section 15168(d) of the State CEQA Guidelines. For instance, regional influences, secondary effects, cumulative impacts, and broad alternatives that apply to the overall Process can be incorporated by reference, allowing the later environmental document to focus solely on the new effects that had not been previously considered. Any project-specific impacts that are too speculative to define at the program level would be resolved during CEQA review of individual projects. A detailed description of the implementation process is discussed in Chapter 2.1.1.

For the purposes of the VTP, the Program EIR offers the ability to factor State-level goals, values, and objectives into a framework for fuels management (Board, 2010; CAL FIRE, 2012). One of the goals of the 2010 Strategic Fire Plan is to develop a method to integrate fire and fuels management practices with landowner priorities and multiple jurisdictional efforts within local, state, and federal responsibility areas (Board, 2010). The Board supports the use of a programmatic approach to achieve this goal in a way that assists and streamlines the regulatory processes for site-specific projects, visualized below in Figure 1.4-1(Board, 2010).

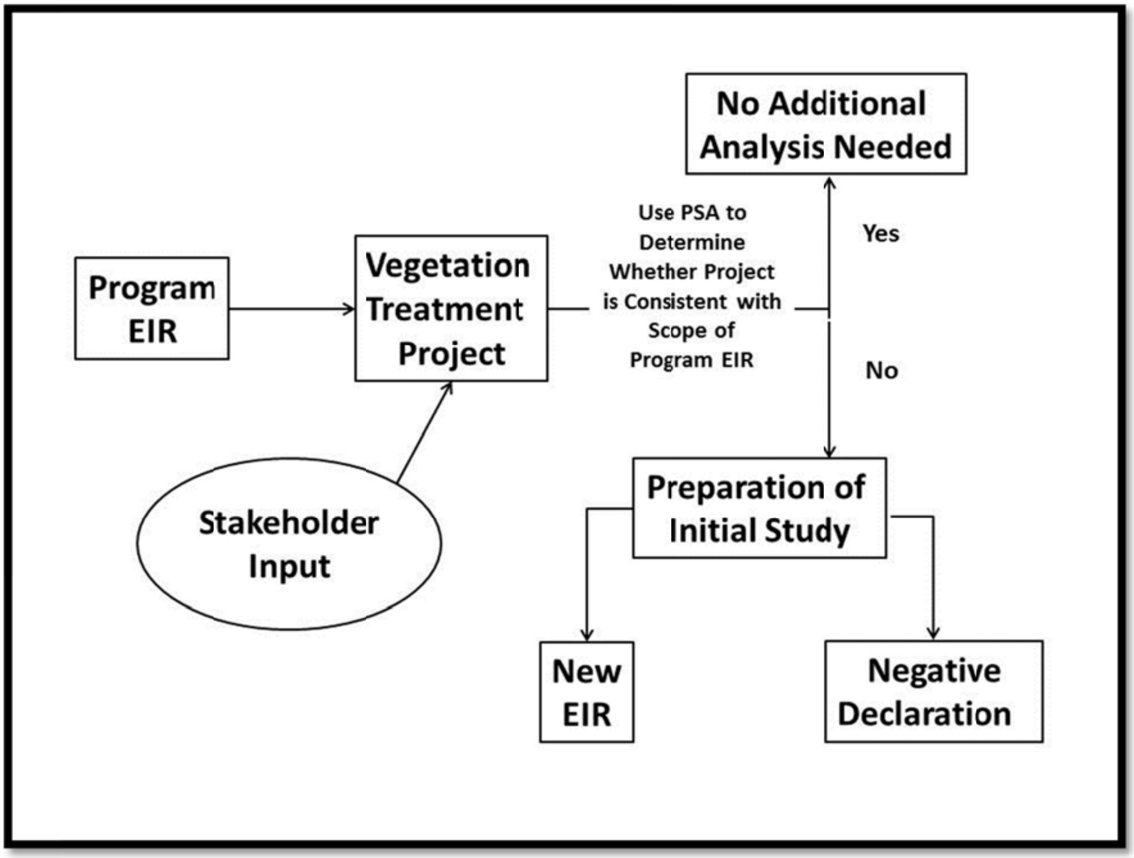

Figure 1.4-1 A simplified flowchart showing the linkage between the VTP Program EIR and site-specific projects. The program sets general goals, constraints, and a consistent process for developing individual VTP projects.

Utilization of a Program EIR for the VTP does not avoid site-specific environmental impact analysis, nor does it avoid public input into individual vegetation treatment projects. The VTP Program EIR sets forth the basic principles to prioritize, select, and analyze impacts and mitigate ecologically-appropriate vegetation treatments in a way that satisfies the goals of the VTP. These principles also provide the foundation for Project Scale Analysis (PSA). Through the implementation of the VTP communications plan, stakeholder input will be considered for various treatments during project scoping and relevant information will be used for site-specific analysis in preparing the PSA (See Figure 1.4-1).

1.5 RESPONSIBLE AND TRUSTEE AGENCIES

Responsible and trustee agencies are consulted by the Lead Agency to ensure they have the opportunity for input during the environmental review process. Under CEQA, a responsible agency is a public agency other than the lead agency that has legal responsibility for carrying out or approving a project or elements of a project (PRC 21069). Although other state and local agencies may have approval authority on individual vegetation treatment activities, these agencies do not have approval authority over implementing the VTP analyzed in this Program EIR, so there are no responsible agencies. However, CAL FIRE is interested in receiving comments and feedback on the VTP from other state and local agencies.

Under CEQA, a trustee agency is a state agency that has jurisdiction by law over the natural resources that are held in trust for the people of the State of California (PRC 21070). The California Department of Fish and Wildlife (CDFW) is a trustee agency with jurisdiction over fish and wildlife and their habitats that may be affected by the VTP. Other trustee agencies may have resources held in trust that are affected by future individual treatment activities.

The *2010 Strategic Fire Plan for California* and the California Department of Forestry & Fire Protection *2012 Strategic Fire Plan* identify the goals of cultivating and strengthening relationships with stakeholders, governing bodies, cooperators and the public (Board, 2010 & CAL FIRE, 2012). To further the goals of those plans, the Board and CAL FIRE have coordinated with a variety of stakeholders, including but not limited to federal, state and local government agencies and non-governmental organizations, to acknowledge the benefits of vegetation treatments. The proposed VTP will help to bridge the ground work and provide the ecological role of vegetation treatment on SRA land within future cooperating efforts.

1.6 REGULATORY SETTING

CAL FIRE is responsible for preventing and extinguishing wildland fires in State Responsibility Areas (SRA) (PRC Sections 4113 and 4125). The SRA is land that provides forest or range products, watersheds not owned or managed by the federal government or within the boundaries of incorporated cities, and where CAL FIRE has the primary financial responsibility for preventing and suppressing fires (Figure 1.6-1). Local Responsibility Areas (LRAs) are lands where local agencies have the primary financial responsibility for preventing and suppressing fires. Lands where federal agencies are responsible for preventing and suppressing wildland fires are called Federal Responsibility Areas (FRAs).

The Board is responsible for identifying very high fire hazard severity zones (VHFHSZ) in the SRA and areas protected by local fire agencies (LRAs). Local agencies are required to designate, by ordinance, VHFHSZ and to require landowners to reduce fire hazards adjacent to occupied buildings (Government Code Section 51179). The intent of identifying areas with very high fire hazards is to allow CAL FIRE and local agencies to develop and implement measures that would reduce the loss of life and property from uncontrolled wildfires (Government Code Section 51176).

PRC Sections 4114 and 4130 authorize the Board to establish a fire plan, which, among other things, establishes the levels of statewide fire protection services for SRA lands. The *2010 Strategic Fire Plan for California* (Board, 2010) was developed around the idea that there are certain central policies that are critical to reducing and preventing the impacts of fire, which revolve around both suppression efforts and fire prevention efforts. Major policy components of the plan are:

- Land use planning that ensures increased fire safety for new development
- Creation of defensible space for survivability of established homes and neighborhoods
- Improving fire resistance of homes and other constructed assets
- Fuel hazard reduction that creates resilient landscapes and protects the wildland and natural resource values
- Adequate and appropriate levels of wildland fire suppression and related services
- Commitment by individuals and communities to wildfire prevention and protection through local fire planning

CAL FIRE implements vegetation treatments under PRC Sections 4475 through 4495. PRC Sections 4461 through 4471 and 4491 through 4494 authorize CAL FIRE to implement its existing Chaparral Management Program (CMP) (CAL FIRE, 1981), now known as the Vegetation Management Program (VMP), and to enter into contracts with landowners or other persons to conduct vegetation treatments within defined vegetation types. In addition, with the 2005 passage of SB 1084 introduced by Senator Kehoe, the Legislature modified and in some cases added language to PRC Sections 4475 through 4480 which:

- Broadened CAL FIRE’s range of vegetation treatment practices beyond those described for the existing VMP
- Added a definition of “hazardous fuel reduction,”
- Made other changes to the major statutory provisions guiding CAL FIRE’s vegetation treatment authorities

PRC Sections 4790 through 4799.04 provides the regulatory authority for CAL FIRE to administer the California Forest Improvement Program (CFIP).

PRC Section 4562 mandates that the Board adopt fire protection zones where specific protection measures are to be identified, including vegetation treatments within and adjacent to timber operations.

Government Code Section 65302.5 gives the Board the regulatory authority to evaluate General Plan Safety Elements for their land use policies in SRA and VHFHSZs as well as methods and strategies for wildland fire risk reduction and prevention in those areas, which includes projects potentially covered by this Program EIR.

Finally, PRC Section 4291 give CAL FIRE the authority to enforce 100 feet of defensible space around all buildings and structures on non-federal SRA lands (PRC Section 4290); or non-federal forest-covered lands, brush-covered lands, grass-covered lands, or any land that is covered with flammable material (PRC Section 4291).

On October 30, 2015 Governor Jerry Brown proclaimed a State of Emergency related to the extensive tree mortality throughout the State of California. Governor Brown cited the current severe drought conditions, the susceptibility of forests to epidemic infestations of native bark beetles due to the lack of precipitation, and the unprecedented tree die-off in modern history as reasons for the proclamation. Under the proclamation Governor Brown directed specific tasks to CAL FIRE, while also acknowledging the partnerships that other agencies must have with CAL FIRE to achieve the goals set forth:

- The Department of Forestry and Fire Protection, the California Natural Resources Agency, and the California Department of Transportation, and the California Energy Commission shall immediately identify areas of the State that represent high hazard zones for wildfire and falling trees using best available science and geospatial data.
- State agencies, utilities, and local government, to the extent required by their existing responsibilities to protect the public health and safety, shall undertake efforts to remove dead or dying trees in these high hazard zones that threaten power lines, roads and other evacuation corridors, critical community infrastructure, and other existing structures. Incidental vegetation such as shrubs that restrict access for safe and efficient removal of dead and dying trees also may be removed. The Department of Forestry and Fire Protection shall issue emergency guidelines setting forth the relevant criteria, and the California Conservation Corps shall assist government entities in implementing this directive to the extent feasible.
- The California Air Resources Board and the California Department of Forestry and Fire Protection shall work together and with federal land managers and the United States Environmental Protection Agency to expand the practice of prescribed burns, which reduce fire risk and avoid significant pollution from major wildfires, and increase the number of allowable days on a temporary basis to burn tree waste that has been removed in high hazard areas.

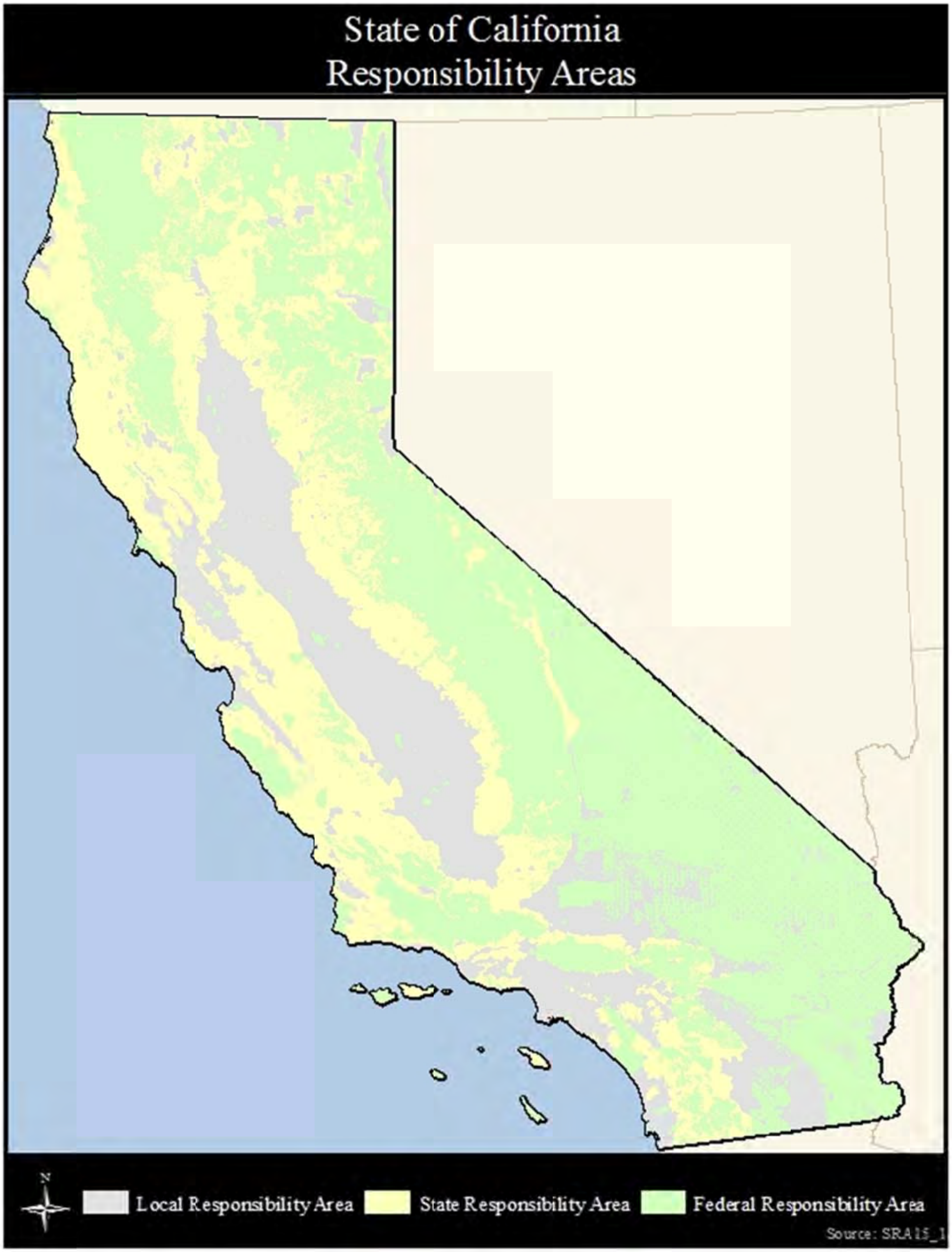

Figure 1.6-1: Responsibility Areas of California

1.7 CURRENT VEGETATION TREATMENT METHODS

1.7.1 OVERVIEW

CAL FIRE currently implements vegetation treatments through various programs including: the VMP, CAL FIRE's Fire Prevention Program, and the CFIP. In addition, CAL FIRE is involved with programs that support the *2010 Strategic Fire Plan for California* goals including:

- Land use planning: including projects such as general plans, new development, and existing developments
- Facilitating a shared vision among communities and the multiple fire protection jurisdictions, including the creation of county-based plans and community-based plans such as Community Wildfire Protection Plans (CWPP)
- Establishing fire resistance in assets at risk such as homes and neighborhoods (Board, 2010)

In 2004, CAL FIRE implemented a Fuels Reduction Program, funded by Proposition 40, the *California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002*. The goal of the Fuels Reduction Program, which ended in 2012, was to reduce wildland fuels that posed a threat to watershed resources and water quality on nonfederal lands in areas with high or moderate levels of watershed assets at risk within the fifteen Sierra Nevada counties. The program was implemented by partnering with non-profit organizations, such as Fire Safe Councils, and with non-federal government agencies, such as California State Parks and local Resource Conservation Districts, through funding under the Community Assistance Grants Program and CFIP.

Existing fuel management programs are briefly described below (see also Table 1.7-1). In addition, CAL FIRE regulates commercial timber harvesting on private lands, which manipulates fuel composition and arrangement. The timber harvest program is administered through a CEQA environmental review process that is separate from the proposed VTP.

1.7.2 CHAPPARAL MANAGEMENT PROGRAM (CMP) & VEGETATION MANAGEMENT PROGRAM (VMP)

In the early 1980s, the California State Legislature recognized that there had been an increase in the number of uncontrolled fires on wildlands of the state resulting in destruction of important natural resources, loss of recreation opportunities, and an unacceptable level of hazards to public safety. The California State Legislature subsequently passed Senate Bill (SB) 1704 (Keene) which was signed into law by the

Governor in 1980 and became effective in July 1981. The bill enabled the state to enter into a contract for prescribed burning with the owner or any other person who has legal control of any property which is included within any land classified by the state as "wildland."

In SB 1704, the California State Legislature established a program of fuel management to achieve the prevention of high-intensity wildland fires. The program allows CAL FIRE to enter into contracts with landowners for prescribed burning to prevent high-intensity wildland fires, and manage watersheds, rangeland, vegetation, forests, and wildlife habitat. Under SB 1704, the state may assume up to 90% of the costs of conducting a project, assume liability for the project, and suppress escaped fires.

CAL FIRE, in cooperation with federal, state, and county resource agencies and private landowners initiated the Chaparral Management Program (CMP) in 1981 to reduce the risk of wildfire and avoid negative impacts on humans, property, and the environment. CAL FIRE completed a programmatic environmental impact report (EIR) on the Chaparral Management Program in 1981. The intent of that program EIR was to implement SB 1704 and identify environmental effects, provide mitigation for potential adverse effects that could occur from management activities, and provide an environmental checklist for project-level actions. The CMP Programmatic EIR focused on assessing potential impacts of conducting prescribed burning on shrub lands. The CMP later became known as the Vegetation Management Program (VMP).

The current VMP reduces the potential for large wildfires and enhances natural resources by treating the following vegetation types primarily on SRA lands where CAL FIRE is responsible for fire protection:

- Coastal scrub habitat south of San Luis Obispo County
- Montane hardwood-conifer habitat north of Monterey County
- Mixed chaparral, montane chaparral, chemise-redshank, and valley foothill hardwood habitats throughout their range
- Annual and perennial grasslands that occur within the above vegetation types
- With the addition of a Negative Declaration, mixed conifer forests such as those found in the Coast Range, Sierra Nevada, and Cascade mountains are now included in the VMP

The VMP employs multiple mechanisms to treat vegetation, similar to the proposed VTP (prescribed fire, mechanical, manual, herbivory etc.), but the acreage treated with prescribed fire has decreased significantly since the program began in the 1980's. There are a number of reasons for this decrease, including an emphasis away from large range management burns to wildland urban interface projects that are smaller and less likely to use prescribed fire to obtain fuel reduction goals, increased air quality restrictions or restrictions for other environmental resources that limit the days available to conduct burning operations, budget and personnel constraints, and the re-tasking of VMP personnel to non-VMP work.

Although the VMP emphasizes treatment of rangelands, it also meets a wide variety of other objectives, including protecting human life and property, reducing fire suppression costs, enhancing wildlife habitat, improving commodity production (e.g., livestock grazing and water yield), and reducing the potential for long-term detrimental effects of wildfire (e.g., impacts from flooding, air and water quality, soil productivity). Approximately 10.9 million acres are available for treatment under the VMP and the VMP is authorized to treat a maximum of 120,000 acres annually (CAL FIRE, 1981). Because of funding limitations and other factors, (i.e., lack of suitable burn day conditions, cost and time to meet environmental review requirements, surveying for and mitigating treatment effects to threatened and endangered species, three year effective period for a VMP project, etc.), treatment has averaged less than 30,000 acres per year. Assistance for project funding is dependent on the availability of funds, staff, and consistency with the objectives of the VMP.

1.7.3 FIRE PREVENTION

CAL FIRE’s Fire Prevention Program consists of multiple activities, including wildland pre-fire engineering, vegetation treatments, fire planning, education, and law enforcement. Common projects include fire break construction and other hazardous fuel reduction activities that lessen the risk of wildfire to communities. This may include brush clearance around communities, roadways, and evacuation routes. Other important activities include emergency evacuation planning, fire prevention education, fire hazard severity mapping, implementation of the State Fire Plan, fire-related law enforcement activities (such as investigations to determine fire cause and origin, as well as arson cases), and support for local government fire safe planning in the SRA .

CAL FIRE’s fire prevention activities also include the education and enforcement of PRC 4291, commonly referred to as Defensible Space. PRC 4291 directs the creation and maintenance of 100 feet of defensible space around all buildings and structures on forest, brush, and grass-covered lands or any land that is covered with flammable material. The legislation also allows insurance companies, state law, and local ordinances, rules or regulations to require homeowners to maintain defensible space greater than 100 feet. PRC 4291 does not allow landowners to manage defensible space outside their property boundaries. The legislation also outlines the consequences for those found in violation of the requirements set forth by PRC 4291. PRC 4291 is implemented and made specific in regulation in CCR Title 14 Section § 1299.01 et seq.

Under PRC 4291 CAL FIRE is also directed to provide guidance for homeowners on how to manage their defensible space most efficiently. Therefore CAL FIRE provides guidelines to homeowners about their defensible space through readyforwildfire.org. Under these guidelines CAL FIRE advises that within the 30 feet nearest the structure, referred to as Zone 1, that homeowners:

- Remove all dead plants, grass and weeds (vegetation)
- Remove dead or dry leaves and pine needles from the yard, roof and rain gutters
- Trim trees regularly to keep branches a minimum of 10 feet from other trees
- Remove branches that hang over the roof and keep dead branches 10 feet away from your chimney
- Relocate wood piles into Zone 2
- Remove or prune flammable plants and shrubs near windows
- Remove vegetation and items that could catch fire from around and under decks
- Create a separation between trees, shrubs and items that could catch fire, such as patio furniture, wood piles, swing sets, etc

CAL FIRE then advises that within Zone 2, the whole defensible space area, homeowners:

- Cut or mow annual grass down to a maximum height of 4 inches
- Create horizontal spacing between shrubs and trees
- Create vertical spacing between grass, shrubs and trees
- Remove fallen leaves, needles, twigs, bark, cones, and small branches. However, they may be permitted to a depth of 3 inches

Figure 1.7-1 Defensible Space Zones

The exact number of acres treated under PRC 4291 is variable from year to year; however some assumptions about acreages can be made knowing that over 700,000 habitable structures are billed for the Fire Prevention Fee in the State Responsibility Areas each year. Assuming no overlapping defensible space, no property boundary restrictions, and a median habitable structure footprint of 2100 sq. ft.[1] in a perfect square, each habitable structure under the identified assumptions would treat approximate 1 acre or about

[1] 2010 Median and Average Square Feet of Floor Area in new Single-Family Houses, US Census

700,000 acres of vegetation statewide. However, many structures in rural areas do not have such large footprints, many habitable structures in the urban areas of the wildland urban interface are not one acre parcels, and many 100 foot zones overlap between parcels/homes. In addition, not all structures in the SRA require defensible space. Therefore it can be assumed that the vegetation modified under PRC 4291 is less than 700,000 acres.

1.7.4 CALIFORNIA FOREST IMPROVEMENT PROGRAM (CFIP)

CFIP is a cost-share program aimed at improving the economic value and environmental quality of private forestlands. The purpose of the program is to work cooperatively with private landowners, particularly smaller, non-industrial landowners, to upgrade the management of their lands and improve both the productivity of the land and the degree of protection and enhancement of the forest resource system as a whole. Fundable practices include:

- Preparation of forestland management plans
- Site preparation
- Planting and costs of seeds and seedlings
- Release from brush competition
- Young-growth stand improvement
- Forest land conservation measures
- Fish and wildlife habitat improvement
- Follow-up work

CFIP is a voluntary program that can fund up to 75 percent of an approved project or 90 percent of catastrophically-damaged lands. It applies to private landowners owning between 20 and 5,000 acres of commercial forest land. Forest landowners who own less than 20 acres can apply as part of a group. There is a 10-year requirement for maintenance of the land as timber, compatible with funded work.

Table 1.7-1 CAL FIRE Vegetation Treatment Program documents that guide the existing vegetation treatment programs carried out by CAL FIRE.

PROGRAM	RELEVANT DOCUMENTATION
Vegetation Management Program	Vegetation Management Program Handbook and Field Guide. June 16, 2001. California Department of Forestry and Fire Protection. Sacramento. 135p. Chaparral Management Program Final Environmental Impact Report. May 18, 1981. California Department of Forestry and Fire Protection, Sacramento.
Fire Prevention	• Defensible Space, http://www.readyforwildfire.org/, • Fire Planning http://osfm.fire.ca.gov/fireplan/fireplanning.php • Fire Engineering http://CAL FIREdata.fire.ca.gov/fire_er/fpp_engineering • Fire Safety Education http://calfire.ca.gov/communications/communications_firesafety.php • Law Enforcement http://calfire.ca.gov/communications/communications_firesafety.php • Office of the State Fire Marshall http://osfm.fire.ca.gov/ • Wildland Hazard & Building Codes http://calfire.ca.gov/fire_prevention/fire_prevention_wildland.php • Fire Engineering http://osfm.fire.ca.gov/strucfireengineer/strucfireengineer.php • SRA Fee http://www.firepreventionfee.org/
California Forest Improvement Program	California Forest Improvement Program User's Guide 2015 Edition, Vol 1. http://calfire.ca.gov/resource_mgt/downloads/CFIP/CFIP_User's_Guide_2015.pdf Procedural Guide for CAL FIRE Greenhouse Gas Reduction Fund Forest Management Projects CFIP Fuels Reduction Using the California Forest Improvement Program, For Carbon Sequestration Authorized by AB32 California Global Warming Solutions Act of 2006 http://calfire.ca.gov/resource_mgt/downloads/ProceduralGuide_FuelsReduction_GGRF_CFIP.pdf Final Environmental Impact Report for Proposed Administrative Regulations for the California Forest Improvement Program to be Adopted by the Director of Forestry and Approved by the Board of Forestry. June 1979. California Department of Forestry and Fire Protection, Sacramento. California Forest Improvement Program Environmental Impact Report: Supplement to the Final PEIR; State Clearinghouse #79050318. June 1990. California Department of Forestry and Fire Protection, Sacramento

1.7.5 THE PROPOSED VEGETATION TREATMENT PROGRAM

The California State Board of Forestry & Fire Protection (Board) and the California State Fish and Game Commission (FGC) initiated a review of the Departments VMP following the major wildfires in Southern California in the fall of 1993. Subsequently, a working group was formed in the spring of 1994 to recommend to the Board and FGC ways to improve the VMP to provide additional fire protection while meeting the concerns and needs of other agencies and the general public. These recommendations included:

- Expand the program and EIR to include all vegetation fuel types in California
- Expand the EIR to include all fuel management techniques that are currently available
- Include a more detailed discussion of the no action alternative in the EIR
- Modify the project-level environmental checklist
- Expand authorization for VMP projects from state responsibility areas to all hazardous areas

In 1996, the Board and the Department issued a new California Fire Plan, which placed an increased emphasis on “prefire” projects, such as vegetation treatment activities, to help reduce wildland fuels and thereby reduce the costs and losses associated with large, damaging wildfires, and the Department increased its activities in this area.

In June of 2000, CAL FIRE completed and certified a new programmatic EIR for the Department's Vegetation Management Program. In January of 2002, the Superior Court of San Francisco County ordered that the EIR be decertified for failure to adequately address the potential environmental impacts of the program. Herbicide use in association with VMP projects was specifically cited as inadequate (e.g., herbicides used as either a precursor step or a follow-up maintenance step to a VMP project).

In 2005, the Legislature passed and the Governor signed into law SB 1084 (Kehoe), which broadened the range of vegetation treatment practices specifically enumerated in the Public Resources Code, added a definition of “hazardous fuel reduction,” and made other changes to the major statutory provisions guiding the Department’s vegetation treatment authorities. See Public Resources Code Sections 4461 through 4494.

In 2006 the Board and Department began preparation of a draft Vegetation Treatment Program EIR that would address the issues raised by the court in the decertification of the 2000 EIR and also address the legislative modification to the Public Resources code. This effort lacked funding and staff support for completion of a Draft VTPEIR.

2010 brought a renewed effort by the Board and Department to complete a draft VTPEIR and circulate it to the public. A Draft VTP EIR was circulated in late 2012 and early 2013. The Board received extensive public comment on the draft EIR, particularly focused on the Program’s treatment of chaparral landscapes in Southern California. In 2013, the Board hosted a meeting and field tour in Ventura County to further examine this issue. The Board and Department then engaged stakeholders, scientists, and policymakers in several field tours in Southern California to discuss the current chaparral fuel conditions and stakeholders’ ecological concerns. As a result of these tours and discussions, the Board requested a critical scientific review of the Draft VTP EIR by specialists at the California Fire Science Consortium (CFSC).

The CFSC review was completed in fall 2014, and the Board and Department developed an internal workgroup to examine the review and the existing Draft VTP EIR and edit the document to reflect recommendations from the public and CFSC. This administrative draft of the revised VTP EIR was presented to the Board in mid-2015 and is currently in review and discussion by the Board.

1.8 BOARD OF FORESTRY AND CAL FIRE STRATEGIES

This VTP Program EIR is one component of an overall land use strategy by the Board. The goal of the VTP Program EIR is to conduct an environmental analysis of vegetation management tools that can be utilized to reduce the risk of damaging wildfires and any potential environmental impacts they may have. This goal is further outlined by the objectives detailed in Chapter 2.1.

1.8.1 STATEWIDE STRATEGIC PLANNING

There are three major strategic planning documents that establish the vision, goals, and objectives of the Board and CAL FIRE: 2010 Strategic Fire Plan for California, the 2012 Strategic Plan, and the Unit Fire Management Plans (See Figure 1.8-1). These three documents build upon one another and work in concert to improve the natural and built environment's resilience and resistance to wildfire.

Figure 1.8-1 The three major strategic planning documents that establish the vision, goals, and objectives.

The *2010 Strategic Fire Plan for California* lays out central goals for reducing and preventing the impacts of fire in the state. This Program EIR provides a framework for CAL FIRE Units to achieve the goals outlined in the 2010 Strategic Fire Plan via implementation of a variety of vegetation treatment projects. The goals of the 2010 Strategic Fire Plan are:

1. Identify and evaluate wildland fire hazards and recognize life, property, and natural resource assets at risk, including watershed, habitat, social, and other values of functioning ecosystems. Facilitate the sharing of all analyses and data collection across all ownerships for consistency in type and kind.
2. Articulate and promote the concept of land use planning as it relates to fire risk and individual landowner objectives and responsibilities.
3. Support and participate in the collaborative development and implementation of wildland fire protection plans and other local, county, and regional plans that address fire protection and landowner objectives.
4. Increase awareness, knowledge, and actions implemented by individuals and communities to reduce human loss and property damage from wildland fires, such as defensible space and other fuels reductions activities, fire prevention, and fire safe building standards.
5. Develop a method to integrate fire and fuels management practices with landowner priorities and multiple jurisdictional efforts within local, state, and federal responsibility areas.
6. Determine the level of fire suppression resources necessary to protect the values and assets at risk identified during planning processes.
7. Address post-fire responsibilities for natural resource recovery, including watershed protection, reforestation, and ecosystem restoration.

The goals articulated above are meant to establish a natural environment that is more resilient and human-made assets which are more resistant to the occurrence and effects of wildland fire through local, state, federal, and private partnerships. The VTP is one such strategy CAL FIRE and the Board employ to achieve those goals and vision.

The *2010 Strategic Fire Plan for California* considers the question “How do we utilize and live with [the] risk of wildfire?” and outlines a vision, goals, and objectives that lead to an answer to that question. CAL FIRE built upon the 2010 Plan and developed the 2012 Strategic Plan to identify and communicate CAL FIRE’s specific strategic goals and objectives through 2017 to meet their mission of serving and safeguarding the people and protecting the property and resources of California. Developing a Program EIR for the VTP, rather than project-level EIR’s for each fuel modification project, is a strategy by CAL FIRE to assist local Units in accomplishing the following four goals from the *2012 Strategic Plan*:

- Effectively communicate the Department’s mission and vision to employees, partners, and stakeholders
- Adapt and scale to changing budgetary, fiscal, and regulatory conditions

- Seek to improve operational efficiency and effectiveness by shaping, enhancing, and adapting to changing circumstances
- Cultivate and strengthen relationships with stakeholders, governing bodies, cooperators, and the public

This Program EIR sets a framework for local-level VTP projects to achieve these goals efficiently and successfully. The 2010 Strategic Fire Plan set forth the broad goals to improve resiliency and resistance to wildfire and the 2012 Strategic Plan helps establish Department-level goals to achieve such resiliency. Consequently, this Program EIR establishes a set of tools for VTP project managers within CAL FIRE Units to achieve these goals in their local area to create a fire resistant landscape across California.

The third major strategic document is the individual Unit Fire Plan. Updated yearly, Unit Fire Plans identify wildfire protection areas, initial attack success, assets, and infrastructure at risk, pre-fire management strategies, and accountability within their Unit's geographical boundaries. The Unit Fire Plan identifies strategic areas for pre-fire planning and fuel treatment as defined by the people who live and work locally. The plans include contributions from local collaborators and stakeholders and are aligned with other plans for the area such as CWPPs. This Program EIR helps Unit staff evaluate the potential projects in their communities and establish those projects to include in a Unit Fire Plan, which is a vital step to planning, funding, and implementing VTP projects on the ground.

1.8.2 LOCAL LAND USE PLANNING

In addition to the strategic documents mentioned above, there are other plans and programs that play a role in the Board's and CAL FIRE's protection of the SRA.

Local Fire Safe Councils and other nonprofits may decide to develop CWPPs. A CWPP helps a community use collaborative, coordinated community planning in order to refine its priorities for the protection of life, property, and critical infrastructure in the WUI. A CWPP helps a community identify its life, property, and critical infrastructure priorities and discuss land, watershed, and vegetation management options. It is required to have three components: 1) collaboration, 2) prioritized fuel reduction, and 3) treatment of structural ignitability. Many Unit Plans function as CWPPs or can assist as a baseline plan to establish the assets at risk, community vulnerabilities, and protection priorities. Fire Safe Councils are important partners in implementing projects under this Program EIR, because they help identify areas of high value and high risk in communities and can assist in finding funding and in-kind support for vegetation management projects.

In addition to CWPPs and Fire Safe Councils, Board and CAL FIRE review of General Plan Safety Elements is another tool to promote fire safe planning in the state. Under Government Code Section 65302.5, the Board is obligated to review Safety Elements for counties and cities with SRA or VHFHSZ designated areas for the following information:

- A detailed history of fire activity in the planning area, as well as fire hazard severity zone maps
- The planned land uses in VHFHSZ and SRA land
- Goals, policies, and objectives to protect the community from the unreasonable risk of wildfire
- Feasible implementation measures to carry out those goals, policies, and objectives

The Board and CAL FIRE maintain databases of information to assist in developing vegetation management projects, Unit Fire Plans, CWPPs, and other strategic fire planning documents. This data is utilized together with information from this Program EIR to establish, fund, and implement priority projects. It includes fire hazard severity zones; historic fire perimeters; land cover types and changes; LRA, SRA, and FRA; and priority landscapes throughout the state. By making this data available online through CAL MAPPER and the CAL FIRE website, the Board and CAL FIRE can provide data and analytical support to communities and organizations as they outline plans for vegetation projects and other fire protection planning strategies.

All of the above plans, data, and partnerships are tools utilized by the Board and CAL FIRE to reduce the risk of wildfire to landscapes across the state. They do not necessarily fall under this VTP Program EIR, but together create a suite of programs that implement the overall land use and fire protection strategies outlined in the *2010 Strategic Fire Plan for California* and the *2012 Strategic Plan*.

1.9 ORGANIZATIONAL STRUCTURE OF THE PROGRAM EIR

The content and format of this Program EIR is designed to meet the requirements of CEQA and the State CEQA Guidelines. The report is organized into the following chapters:

- Executive Summary summarizes the need for the program, the program objectives, the Proposed Program and the Alternatives, conclusions regarding impacts of the Proposed Program, and issues of concern.
- Chapter 1 describes the purpose of the Program EIR.
- Chapter 2 describes the proposed program description.
- Chapter 3 describes the alternatives to the proposed program.
- Chapter 4 describes the affected environment, effects, and mitigation.
- Chapter 5 contains the cumulative effects analysis.
- Chapter 6 describes the significant effects and growth-inducing impacts.

- Chapter 7 has the Project Scale Analysis documents.
- Chapter 8 lists the individuals involved in preparation of the Program EIR.
- Chapter 9 lists the works cited.

2. PROGRAM DESCRIPTION

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2.1 OVERVIEW OF THE VTP

CAL FIRE proposes to implement the VTP, which is a formal program that would comprehensively direct the management of wildland fuel sources within CAL FIRE's State Responsibility Area – an area comprised of over 31 million acres of private land. The VTP is projected to treat approximately 60,000 acres of this landscape annually, or 600,000 acres over a 10-year time frame. The VTP consists of a strategy that would implement vegetation treatment activities for the purpose of altering landscape fuels to reduce the size, number, or frequency of damaging fires and reduce losses to life, property, and natural resources. The process would generally involve the survey and monitoring of site conditions before, during, and after treatment to determine if objectives are being met and if program methods need to be revised.

The VTP must be consistent with CAL FIRE's mission to serve and safeguard the people and protect the property and resources of California. The VTP consists of specific vegetation treatment activities: prescribed fire, manual activities, mechanical activities, prescribed herbivory (beneficial grazing), and targeted ground application of herbicides. CAL FIRE has grouped the areas where vegetation treatment activities would occur by the following program treatment categories: wildland-urban interface (WUI), fuel break, and ecological restoration. These program treatment categories are summarized in Section 2.2.3 and described in greater detail in Chapter 4, Section 1 (4.1).

The VTP is intended to evaluate the potential vegetation management activities that would be implemented within individual CAL FIRE Units/Contract Counties. It is at the individual Unit/Contract County level where the initial review of those proposals will take place. As part of the VTP, CAL FIRE would utilize CEQA Coordinators at three levels for review (Unit/Contract County, Region, and Sacramento). The Unit/Contract County CEQA Coordinators would play a key role in reviewing VTP projects proposed by public or private entities and managing them for consistency with the VTP Program EIR. They would seek public input and engage with stakeholders to determine project priorities and fuel treatment strategies. The coordinators will also ensure each project properly implements Project Requirements and mitigation measures included in this Program EIR. Each vegetation treatment project proposed would require the preparation of a Project Scale Analysis (PSA) that would document the project's consistency with the requirements and findings of this Program EIR. The PSA would be submitted to the Region and Sacramento CEQA Coordinators for review and authorization prior to implementation of the project. If it is determined that the proposed project does not fall within the scope of the approved VTP and Program EIR, then that project would need to proceed with separate environmental analysis, documentation, and approval procedures.

Each VTP project will be required to do implementation monitoring, photo-point effectivness monitoring, and be entered into a geospatial database for program tracking purposes. More rigorous project and program monitoring will be implemented once key uncertainties are identified by the VTP Monitoring Working Group, and once funding is secured for a more formal adaptive management process. The Monitoring and Communication Plan (Appendix I) provides more information related to monitoring and adaptive management.

2.2 CONCEPTUAL FRAMEWORK OF THE VTP

CAL FIRE will implement the VTP with the intent of lowering the risk of damaging wildfire in the SRA by managing wildland fuels through the use of environmentally appropriate vegetation treatments. The VTP will only be applied to portions of the SRA that will best allow for the achievement of VTP objectives. The following conceptual framework for the proposed VTP is heavily influenced by recommendations from the California Fire Science Consortium (2014).

Given that California is the most bio-diverse state in the Union (Stein et al., 2000; Stein, 2002), the VTP must characterize the state in such a way that recognizes this diversity while still providing a tractable framework for analysis at the statewide scale. To do so, the Program groups the state's vegetation communities into three major vegetation formations: tree, grasslands, and shrublands. These major vegetation formations generally exhibit similar fire behavior and provide a good first basis for stratifying the state for programmatic assessment (Rothermel, 1983; Scott & Burgan, 2005; Anderson, 1982). Through the use of Standard Project Requirements (SPRs) and Project Specific Requirements (PSRs) (see Section 2.5 below), the process outlined in this VTP would address variability within these major vegetation communities and a variety of other environmental factors to ensure the appropriate application of treatments.

The VTP also stratifies treatments into three basic program treatment categories that are defined in Section 2.2.2: wildland-urban interface (WUI), fuel breaks, and ecological restoration. These three types of treatments would be selected based on the values at risk, surrounding fuel conditions, strategic necessity for fire suppression activities, and departure from natural fire regime. The actual prioritization of such projects would be made at the local CAL FIRE Unit/Contract County level, but the relative prioritization of projects would reflect concepts outlined in Figure 2.4-2.

The data in this Program EIR is generally summarized geographically through the use of California Bioregions. Bioregions are defined based on common geophysical characteristics and existing plant communities. They help describe common qualities, sensitivities, species, and natural processes within a region for purposes of resources management and environmental impact analysis. This chapter and the remaining portions of the Program EIR utilize the bioregions as modified from the California Biodiversity Council (Figure 2.2-1) to organize the projected VTP treatments in SRA around the state and provide information helpful to environmental impact analysis. Refer to Chapter 4.1 and Appendix A for more information on the Bioregions.

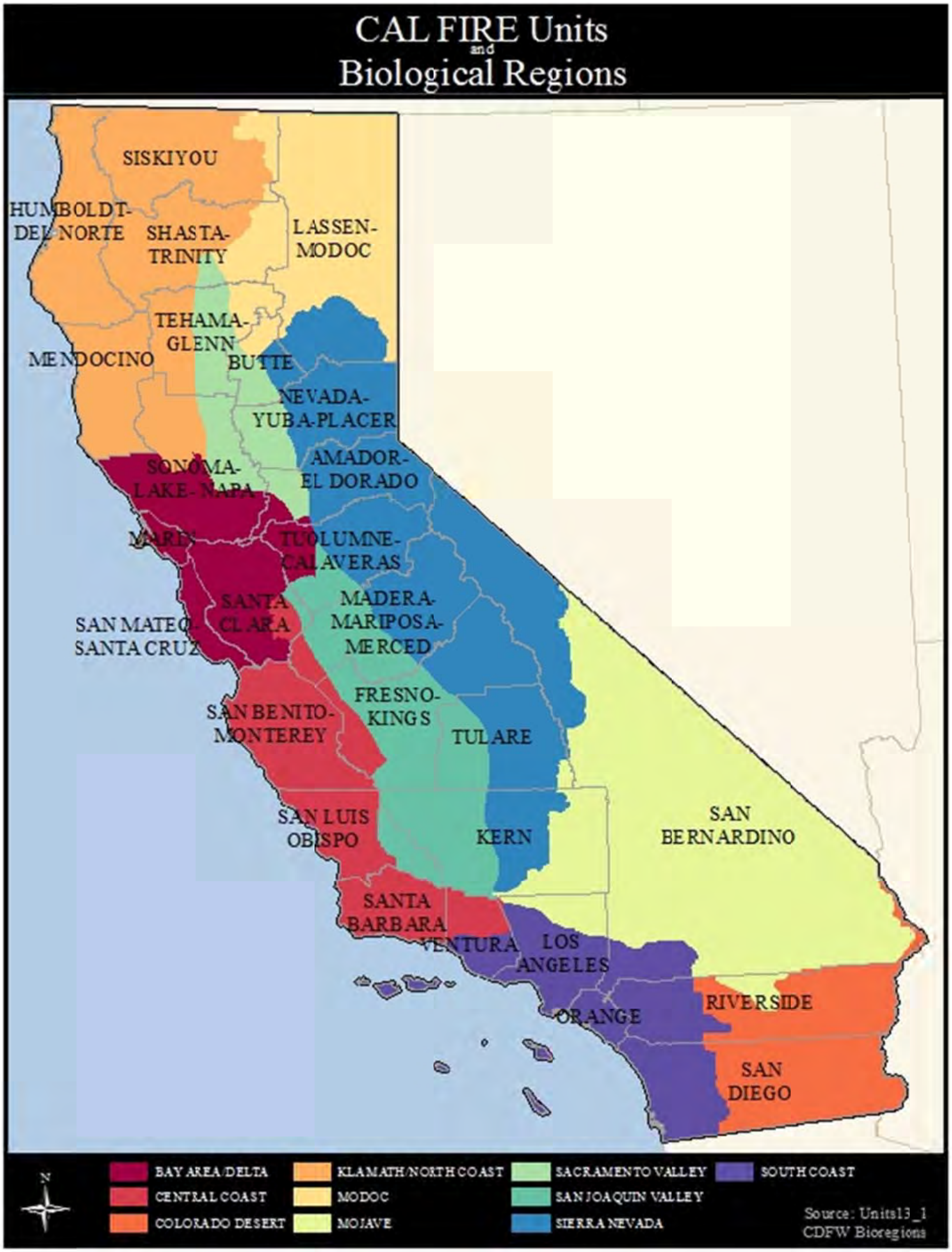


Figure 2.2-1 CAL FIRE Units and Biological Regions

2.2.1 OBJECTIVES OF THE VTP

The general objective of the proposed VTP is to implement vegetation treatment activities throughout California that would meet the goals outlined in the Board of Forestry and Fire Protection's *2010 Strategic Fire Plan for California* and CAL FIRE's *2012 Strategic Plan* in a manner that both reduces wildfire risk and severity and avoids significant environmental effects, to the extent feasible. The primary purpose of these documents and the VTP is to strategically implement actions to minimize the negative effects of wildfire in areas with high values at risk.

While existing modeling literature suggests that relatively large proportions of the landscape needs to be treated to achieve wildfire risk reduction at the landscape scale (Finney, 2001; Finney et al., 2007), these simulations model spatially averaged metrics of fire growth and behavior in response to landscape level treatments. The assumption behind the proposed VTP is that risk reduction can be achieved for targeted areas through strategic fuels treatments. Although the proposed annual acres of treatment may not affect all the potential landscape fuels, the Program will still be a valuable tool to allow landowners and stakeholders the opportunity to reduce risk in targeted locations. As such, the specific objectives of the proposed VTP are:

Vegetation Treatment Program Objectives
1. Modify wildland fire behavior to help reduce losses to life, property and natural resources.
2. Increase the opportunities for altering or influencing the size, intensity, shape, and direction of wildfires within the wildland urban interface.
3. Reduce the potential size and total associated suppression costs of individual wildland fires by altering the continuity of wildland fuels.
4. Reduce the potential for high severity fires by restoring and maintaining a range of native, fire-adapted plant communities through periodic low intensity treatments within the appropriate vegetation types.
5. Provide a consistent, accountable, and transparent process for vegetation treatment monitoring that is responsive to the objectives, priorities, and concerns of landowners, local, state, and federal governments, and other stakeholders.

OBJECTIVE 1: Modify wildland fire behavior to help reduce losses to life, property, and natural resources.

This is the governing objective of the program, and is consistent with the goals outlined in the *2010 Strategic Fire Plan for California* (Board, 2010). Fire behavior is the manner in which fire reacts to weather, topography, and fuels (NWCG, 2014). Of the three variables, only fuels can be feasibly altered by humans. The primary assumption of the VTP is that appropriate vegetation treatments can affect wildland fire behavior through the manipulation of wildland fuels. Since human activity cannot influence weather or topography, reducing the continuity of wildland fuels would result in lower fuel hazard and more favorable fire behavior. In turn, this would allow for more effective fire suppression and, therefore, reduce the likelihood of wildfire adversely affecting values at risk. Values at risk include, but are not limited to, public and firefighter health and safety, structures, infrastructure, timber and environmental services (e.g., biodiversity, clean water, carbon sequestration, etc.) rangelands and other natural resources. Through the strategic placement of WUI, fuel break or ecological restoration treatments, projects implemented under the VTP will help to reduce losses to life, property, and natural resources.

OBJECTIVE 2: Increase the opportunities for altering or influencing size, intensity, shape, and direction of wildfires within the wildland urban interface.

This objective places emphasis on increasing the strategic and tactical effectiveness of fire suppression within the WUI through the use of appropriate vegetation treatments. The WUI is the geographical overlap of two diverse systems: wildland and structures. At this interface, the buildings and vegetation are sufficiently close that a wildland fire could spread to a structure or a structure fire could ignite wildland vegetation. Focusing vegetation treatments in the WUI is critical, because losses in the WUI are on the rise (Stephens et al., 2009) and are expected to get worse (Mann et al., 2014). This objective only relates to fuel treatments within the WUI; influences or changes to local land use planning associated with the WUI is outside the scope of this VTP, but is part of a larger strategy being implemented by CAL FIRE and the Board (Board, 2010).

Figure 2.2-2: CAL FIRE's "Wildland Urban Interface Operating Principles" outlines some of the Department's WUI operating policies.

Achieving this objective is dependent on integration with CAL FIRE WUI operating policies, as existing when a VTP project is planned and implemented (Figure 2.2-2). CAL FIRE's current operating principles in the WUI include an emphasis on pre-incident planning and prioritizing perimeter control before the fire reaches structures (CAL FIRE, 2014). The need for vegetation treatments will be evaluated during the pre-incident planning process, and strategically placed vegetation treatments can offer a more effective means of perimeter control.

OBJECTIVE 3: Reduce the potential size and overall associated suppression costs of individual wildland fires by altering the continuity of wildland fuels.

Wildfire suppression costs borne by California taxpayers have risen significantly in the past 35 years (Figure 2.2-3). Figure 1.1-1 (Chapter 1) and Figure 2.2-3 suggest a steady increase in both acres burned and suppression costs since the year 2000. This objective seeks to reduce the size of fires through the use of appropriate vegetation treatments. The assumption is that decreasing fire size will have a resulting decrease on overall fire suppression costs (Figure 2.2-4). While wildfire acreage is not the only variable that drives suppression costs (Gude et al., 2013[1]), increasing the likelihood that fires would be contained to relatively small areas should also relate to lower cumulative fire suppression costs.

There is strong scientific agreement that the use of fuel treatments helps to reduce the impact and damage from wildfires (Reinhardt et al., 2008; Safford et al., 2009; Schoennagel and Nelson, 2011), but there is a lack of quantifying data to directly relate treatment methods to a reduction in damage and costs relative to the WUI.

Benefits from projects can be realized in the initial attack phase because more fires can be controlled at very small sizes, when ignitions and projects intersect. As fires escape initial attack they grow more complex, with many factors contributing to the costs of fire suppression and damage. Individual treatments within these larger fire areas can systematically realize extended attack benefits outside their actual boundaries if the collection and pattern of treatment areas has been developed using landscape level strategies (Finney, 2005). Targeted fuel treatments aimed at reducing the vulnerability of houses in the WUI can make a difference for individual structures, entire subdivisions, or even towns and villages in the path of an approaching wildfire. Vegetation treatment has other benefits (range improvement, biomass fuels, watershed integrity), but it is from the reduction of fire hazards where the largest share of economic benefits would be derived.

The initial attack phase is the most critical for controlling overall wildfire related costs and losses. CAL FIRE's goal for wildland fire protection is to contain 95 percent of vegetation fires at 10 acres or less. Statewide, approximately 97 percent of all vegetation fires are contained within the first few hours after they are reported. Some of

[1] Gude et al. (2013) suggests that fire proximity to homes is a significant driver of suppression costs.

the three percent that escape initial attack may eventually become large and complex campaign fires which require a formal base camp and management functions including logistics, communication, finance, food services, and other functions. A typical campaign fire can cost one million dollars or more per day at full staffing. Several large fires burning at one time can quickly draw down fire suppression resources, increasing the chances of new starts quickly growing out of control. Stopping fires before they become large is a key to limiting total wildfire related costs, damage, and loss of life. Projects implemented under the VTP will be incorporated into local CAL FIRE Unit Fire Plans and Contract County Strategic Fire Plans, which allows for the best use of available fire suppression resources to help minimize fire spread while allowing safe areas for firefighter deployment. Consequently, the strategic placement of vegetation treatments may help reduce the overall fire size and the associated fire suppression cost.

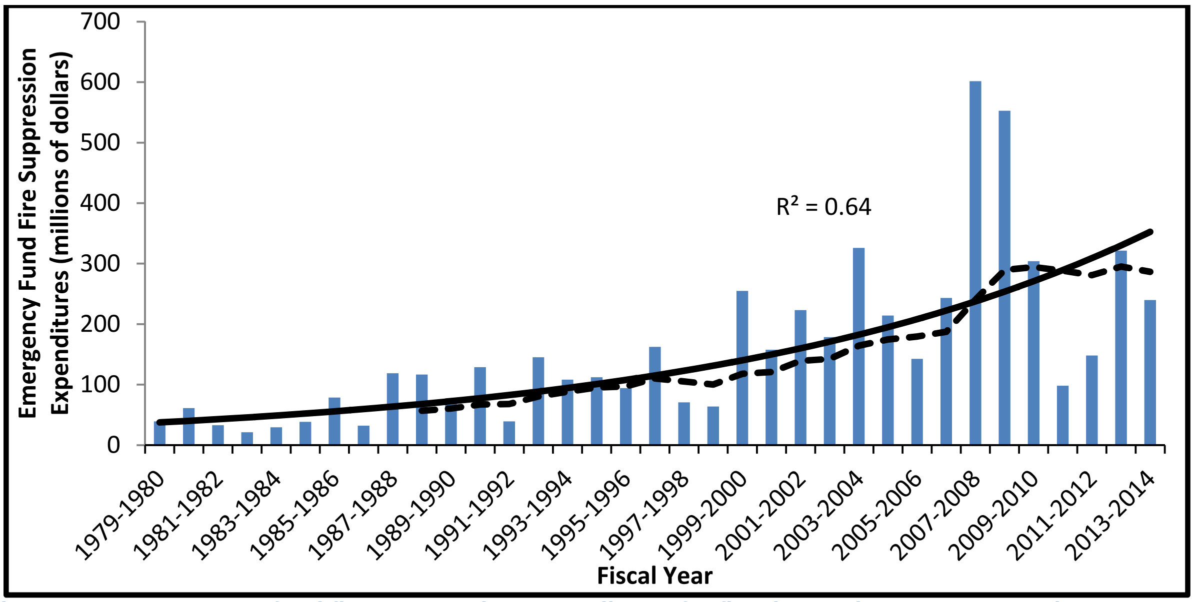


Figure 2.2-3: Emergency fund fire suppression expenditures for fiscal years between 1979 and 2014 Expenditures corrected for inflation using the Consumer Price Index. Data taken from CAL FIRE Emergency Fund Suppression Expenditures, September 2014.

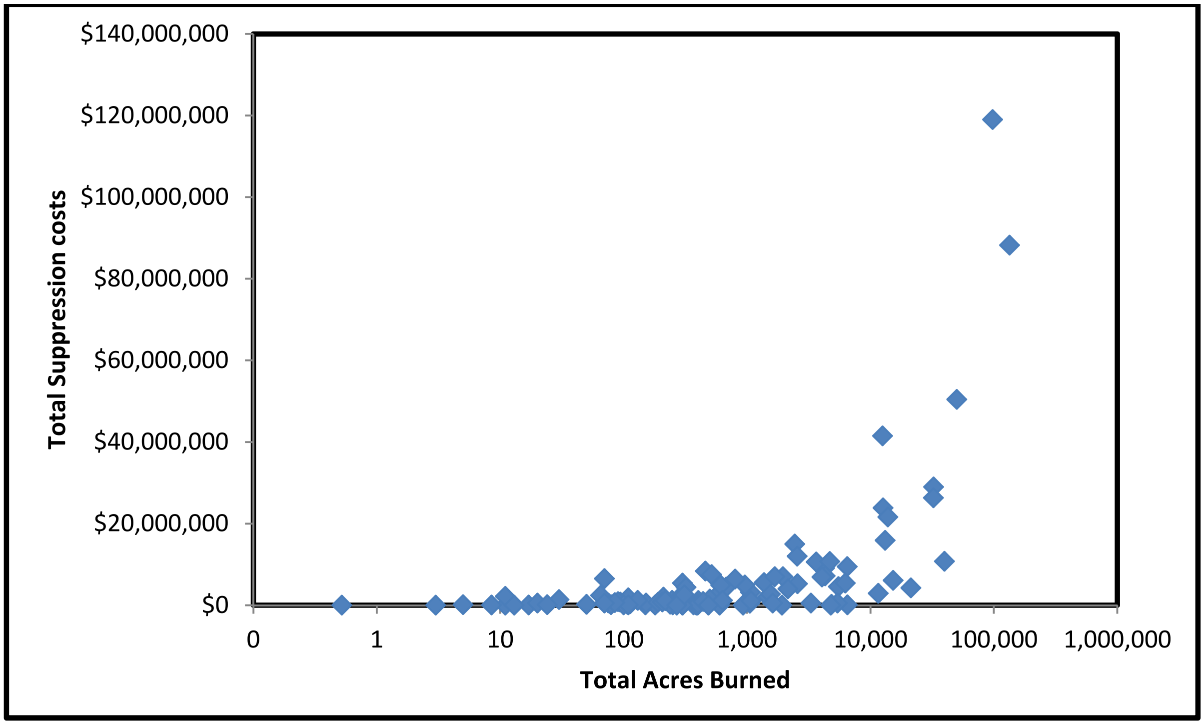


Figure 2.2-4: Suppression costs versus fire size for CAL FIRE incidents during the 2014 calendar year ending on October 25, 2014. Costs and acreage extracted from ICS-209 forms.

OBJECTIVE 4: Reduce the potential for high severity fires by restoring and maintaining a range of native, fire-adapted plant communities through periodic low intensity treatments within the appropriate vegetation types.

Before the twentieth century, many forests within California were generally open and park-like due to the thinning effects of recurrent fire. Decades of fire suppression and other forest management have left a legacy of increased fuel loads and ecosystems dense with an understory of shade-tolerant, late-succession plant species. The widespread level of dangerous fuel conditions is a result of highly productive vegetative systems accumulating fuels and/or reductions in fire frequency from fire suppression. In the absence of fire, these plant communities accrue biomass and alter the arrangement of it in ways that significantly increase fuel availability and expected fire intensity. As such, many ecosystems are conducive to large, severe fires, especially during hot, dry, windy periods in late summer through fall. Additionally, the spatial continuity of fuels has increased with fewer structural breaks to retard fire spread and intensity. The increased accumulations of live and dead fuels may burn longer and more completely, threatening the integrity and sustainability of the ecosystems.

Species composition within these forests is also rapidly changing. Plant and animal species that require open conditions and/or highly patchy edge ecotones are declining and streams are drying as evapotranspiration increases due to increased stocking. Additionally, streams are subject to sedimentation following high severity fires and unnaturally severe wildfires have destroyed vast areas of forest (Bonnicksen, 2003). Some insects and disease have reached epidemic proportions in parts of the state and current forest conditions are conducive to more outbreaks. The understory of these once open forests is now dominated by smaller shade tolerant trees that would have previously been thinned and/or consumed by fire.

Like many disturbances, fire may promote the invasion of nonnative plant species by providing canopy openings, reducing cover of competing vegetation, and creating favorable soil conditions such as newly exposed soil surfaces and increased nutrient availability. Invasive plants may affect fire behavior and fire regimes, often by increasing fuel bed flammability, which increases fire frequency. Cheatgrass, a winter annual which grows rapidly during late winter and early spring, provides a continuous fuel bed of light flashy fuel once cured in early summer and serves as a classic example of an exotic which has significantly altered the fire ecology in the Western United States and Canada.

Other than direct residential development, one of the more important changes in shrubland ecosystems has been the anthropogenic alteration of the natural fire regime. Despite a long-standing policy of fire suppression, the primary impact to these ecosystems has been a dramatic acceleration of human-caused fire occurrence. Because anthropogenic ignitions tend to be concentrated near human infrastructure, more fires now occur at the urban fringe than in the backcountry. Too-frequent fire can result in habitat loss and fragmentation, shifting vegetative composition, and unfavorable impacts to small-mammal populations.

The restoration of lower fuel amounts is a critical need across portions of the western United States (Agee and Skinner, 2005). In California, fuel treatments have been shown to reduce fire severity (Skinner et al., 2004; Stephens et al., 2009). It is also recognized that fuel reduction projects within forested settings appear to be more effective in reducing burn severity as compared to some southern California chaparral ecosystems. Nevertheless, this objective recognizes that appropriately designed vegetation treatments can mimic the disturbance processes that historically controlled plant community composition and structure. In addition, reduced fuel loading in appropriate vegetation types can increase ecosystem resiliency to wildfire, drought, and potentially climate change.

OBJECTIVE 5: Provide a consistent, accountable, and transparent process for vegetation treatment monitoring that is responsive to the objectives, priorities, and concerns of landowners, local, state, federal governments and other stakeholders.

Adopting a programmatic approach to vegetation treatment can assure that a consistent process is applied to the prioritization, evaluation, and implementation of vegetation treatment projects. There is also assurance that projects consider stakeholder commentary, increasing the emphasis on coordination with county or bioregional groups such as fire safe councils. Outreach with private landowners, particularly the ranching community, such as occurred under the Chaparral Management Plan is a vital component of successfully implementing the proposed VTP. In addition, a programmatic approach allows CAL FIRE to determine whether the desired program and/or project outcomes are being achieved, and whether elements of the program should be iteratively changed in response to emerging data (i.e., adaptive management). This objective recognizes that the chosen alternative should foster consistency, accountability, and transparency in a way that satisfies the needs of vested stakeholders.

2.2.2 TREATABLE LANDSCAPE

The VTP's treatable landscape was established by grouping the California Wildlife Habitat Relation (WHR) vegetation classifications into treatable vegetation formations. Treatable vegetation formations are those WHR classifications that can be manipulated or altered to change the wildfire environment. Treatable acreage estimates for the VTP were then created by intersecting treatable vegetation formations with modeled treatment areas, using FVEG15_1 compiled by CAL FIRE FRAP, CDFW, and USDA Forest Service Region 5 Sensing Laboratory (RSL). FVEG15_1 is the best available land cover data available for California in single comprehensive dataset, incorporating the most recent and accurate vegetation classifications from 1990 to 2014. See Appendix A for a more detailed discussion of FVEG15_1. Vegetation formations are divided into three categories: tree-dominated, shrub dominated, and grass-dominated. These are commonly referred to throughout the EIR as tree, shrub, and grass. Treatment areas are divided into three categories: Wildland Urban Interface (WUI), Fuel Breaks, and Ecological Restoration. The following figure shows how the landscape was pared down from 31 million acres within the SRA, to approximately 25 million acres within the treatable vegetation formations, to the final 21.9 million acres that fall within the treatment areas and are referred to as the treatable acreage within the VTP.

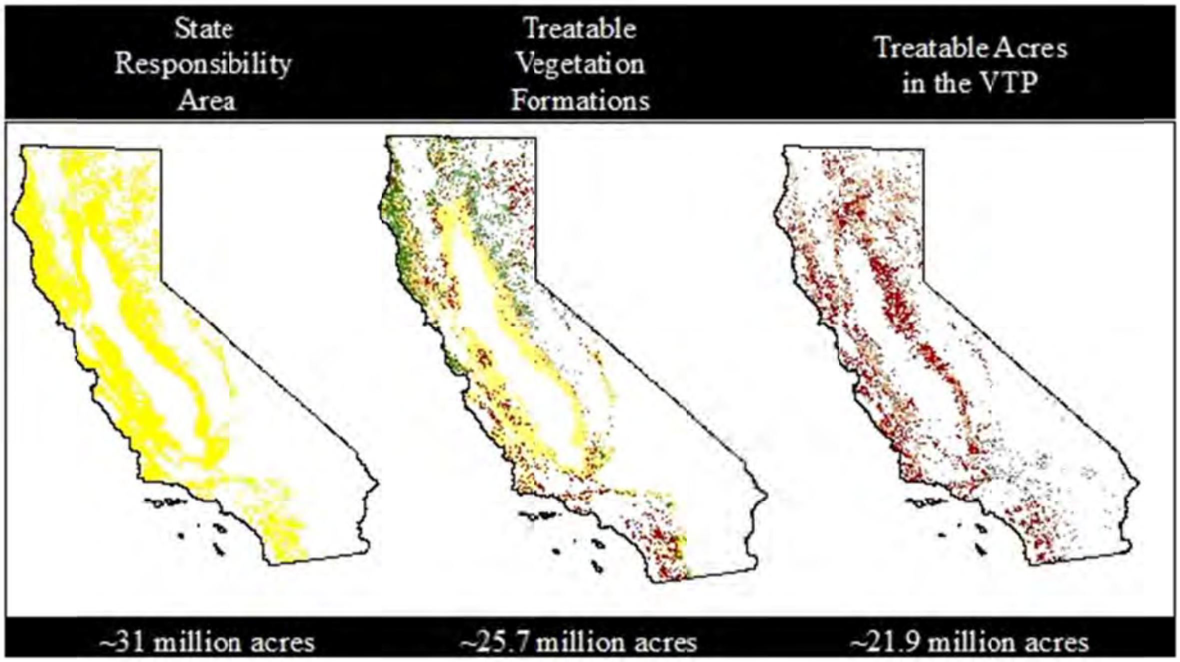


Figure 2.2-5: Identifying the Treatable Landscape within the Program

2.2.2.1 Vegetation Formations

The WHR system, managed by CDFW, is a system which classifies vegetation types important to wildlife and was developed to recognize and logically categorize major vegetative complexes at a scale sufficient to predict wildlife-habitat relationships. Some WHR vegetation types were excluded from the potential vegetation types that could be treated under this program because their wildfire risks are negligible (i.e. agriculture, wet meadow, estuarine, etc.). Table 2.2-1 Vegetation Status in VTP breaks down each WHR life form by treatability within the Program.

A multitude of factors in the wildland fire environment contribute to fire behavior. One of the most important factors that can influence fire behavior is the fuel type. Fuel type represents an identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause resistance to control under specified weather conditions (NWCG, 2014; Anderson, 1982). While California is home to a tremendous range of fuel types, these fuel types can be condensed into three main groups based on the sufficiently distinct fire behavior each group exhibits (Bishop, 2007; Anderson, 1982). These groups can be classified as tree dominated, grass dominated, and shrub dominated vegetative formations. Within these three main formations, subtypes still remain that allow for acknowledgement of variations. The vegetation formation, subtypes, and WHR classifications for each grouping within the SRA is summarized in Figure 2.2-6.

Table 2.2-1 Vegetation Status in VTP

WHR LIFE FORM VEGETATION TYPE	TREATABLE	WHR LIFE FORM VEGETATION TYPE	TREATABLE
Annual Grassland	Likely	Valley Foothill Riparian	Likely
Aspen	Likely	Valley Oak Woodland	Likely
Bitterbrush	Likely	White Fir	Likely
Blue Oak Woodland	Likely	Alkali Desert Scrub	Unlikely
Blue Oak-Foothill Pine	Likely	Alpine-Dwarf Shrub	Unlikely
Chamise-Redshank Chaparral	Likely	Desert Scrub	Unlikely
Closed-Cone Pine-Cypress	Likely	Desert Succulent Shrub	Unlikely
Coastal Oak Woodland	Likely	Joshua Tree	Unlikely
Coastal Scrub	Likely	Subalpine Conifer	Unlikely
Douglas Fir	Likely	Agriculture	Excluded
Eastside Pine	Likely	Barren	Excluded
Eucalyptus	Likely	Cropland	Excluded
Hardwood	Likely	Deciduous Orchard	Excluded
Jeffrey Pine	Likely	Desert Riparian	Excluded
Juniper	Likely	Desert Wash	Excluded
Klamath Mixed Conifer	Likely	Dryland Grain Crops	Excluded
Lodgepole Pine	Likely	Estuarine	Excluded
Low Sage	Likely	Evergreen Orchard	Excluded
Mixed Chaparral	Likely	Fresh Emergent Wetland	Excluded
Montane Chaparral	Likely	Irrigated Grain Crops	Excluded
Montane Hardwood	Likely	Irrigated Row and Field Crops	Excluded
Montane Hardwood-Conifer	Likely	Lacustrine	Excluded
Montane Riparian	Likely	Orchard - Vineyard	Excluded
Perennial Grassland	Likely	Palm Oasis	Excluded
Pinyon-Juniper	Likely	Pasture	Excluded
Ponderosa Pine	Likely	Rice	Excluded
Red Fir	Likely	Riverine	Excluded
Redwood	Likely	Saline Emergent Wetland	Excluded
Sagebrush	Likely	Urban	Excluded
Sierran Mixed Conifer	Likely	Vineyard	Excluded
Undetermined Conifer	Likely	Water	Excluded
Undetermined Shrub	Likely	Wet Meadow	Excluded

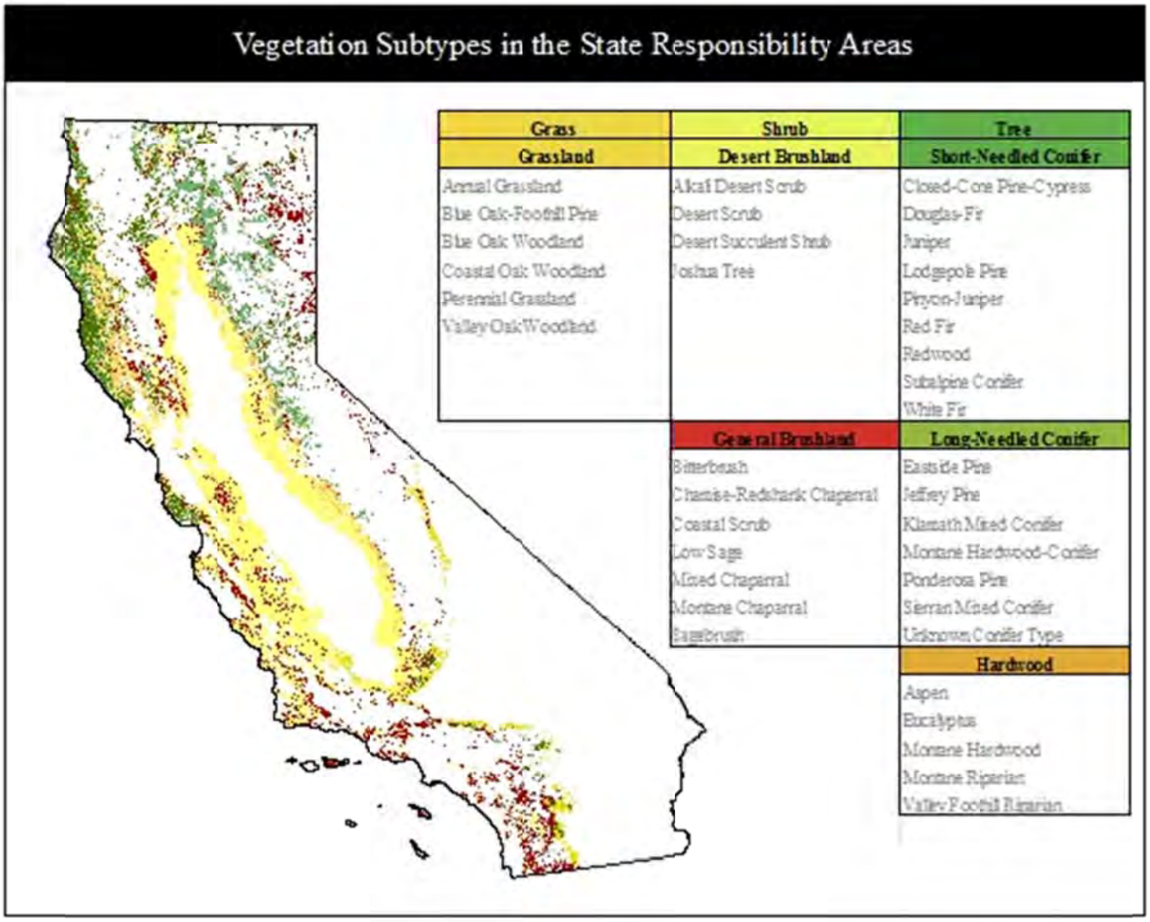


Figure 2.2-6: Vegetation Subtypes in the SRA

In grass dominated groups, fire spread is governed by fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires are typically surface fires that move very rapidly through the cured grass and associated material. Generally, less than one-third of the area is comprised of shrub or timber. Where shrub or timber formations exist, fire intensity generally increases along with an increase in firebrand production. Grass dominated groups are typically characterized as a replacement severity regime with a 0-35 year fire frequency.

Fire in shrub dominated groups is generally carried in the surface fuels comprised of litter cast by the shrubs as well as the grasses or forbs in the understory. Fire intensity is variable in this group, however; fuel and weather conditions can produce intense fast-spreading fires as a result of the available live and dead fine woody material in the crowns of a nearly continuous secondary overstory. Besides flammable foliage, dead woody material in the stands significantly contributes to the fire intensity as well as a deep litter layer. Shrub dominated groups are typically characterized as a replacement severity regime with a 35-200 year fire frequency.

Tree dominated groups generally see slow-burning ground fires with low flame lengths, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. However, under severe weather conditions involving high temperatures, low humidity, and high winds, fuels can pose significant fire hazards as surface fires transition into crown fires. Closed canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. Dead/down fuels include greater quantities of 3-inch or larger limb-wood resulting from over-maturity or natural events can create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties. Tree dominated groups are typically characterized as a mixed severity regime with a 0-35 year fire frequency but can be much greater depending on forest type and location.

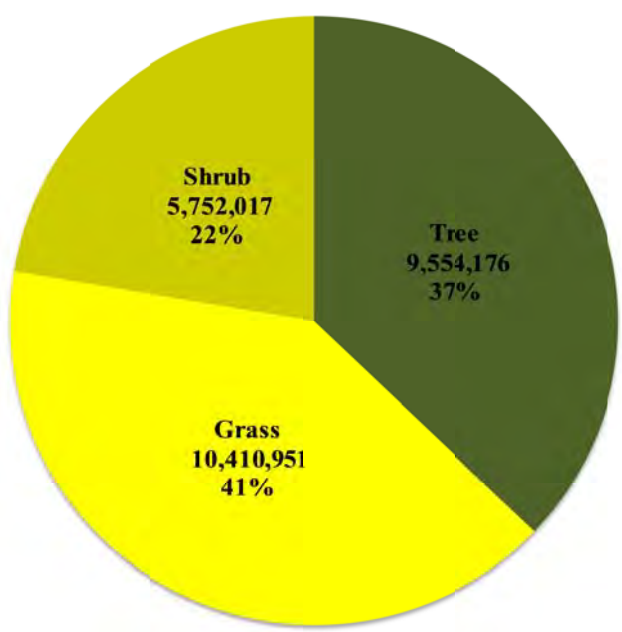


Figure 2.2-7 Acreage estimates for vegetation formations in SRA

Within the primary vegetation formations, the grass dominated vegetation formation occupies approximately 41 percent of the state responsibility landscape and is the largest of the three groups. Tree dominated and shrub dominated formations occupy approximately 37 percent and 22 percent of the total acreage, respectively. Figure 2.2-7 summarizes the acreages associated with each of the three vegetation formations.

2.2.2.2 Program Treatments

Fuels management at the landscape scale is focused on treating fuels to either help suppression forces more easily contain fire or reduce the area burned by high-intensity fire. This is accomplished by modifying fire behavior through strategic placement and arrangement of fuel reduction treatments on the landscape (Finney and Cohen, 2003; Graham et al., 2004). To address the fuel conditions throughout the SRA, projects conducted under this VTP have been organized into three general treatments or project types.

1) **Wildland-Urban Interface:** projects would be focused in WUI-designated areas, would generally consist of fuel reduction to prevent the spread of fire between structures and wildlands.
2) **Fuel Breaks:** projects would consist of converting the vegetation along strategically located areas to support fire control activities.
3) **Ecological Restoration:** projects would generally occur outside of the WUI in areas that have departed from the natural fire regime, would generally consist of restoring the fire resiliency by promoting native fire-adapted plant communities.

Within each of these treatment categories, a menu of treatment activities (see Section 2.4) would be implemented to modify the fuels within the landscape. Participation in the VTP is completely voluntary and the placement of treatments will depend on the public's involvement. The location and type of project must be included in the local Unit Fire Plan to be considered under the VTP EIR. Unit Fire Plans can also function as Community Wildfire Protection Plans (CWPP), and may contain all or some of projects outlined in smaller CWPPs throughout the Unit/Contract County. CWPPs have several requirements to guarantee public participation and sign-off in the creation of the plans, which ensures public input into the selection of VTP projects. Additional VTP projects may also be proposed through Fire Safe Councils or other community groups in coordination with the local Unit/Contract County. Consequently, public feedback helps shape the location and type of vegetation treatment within the Wildland Urban Interface.

Case Study Examples – Throughout the remaining chapter there are nine case studies examining vegetation treatments that were used to help control the impacts of wildfires. There are two additional case studies that discuss the utilization of pre-planning and community involvement as a wildland firefighting strategies and their impacts.

2.2.2.2.1 Wildland-Urban Interface (WUI)

The WUI is the geographical overlap of two diverse systems, wildland and structures. At this interface, the buildings and vegetation are sufficiently close that a wildland fire could spread to a structure or a structure fire could ignite wildland vegetation. WUI treatments would focus on modifying fire behavior by breaking up the horizontal and vertical continuity of fuels while also considering flame size, ignition sources, potential spread rate, and public and firefighter safety.

Geospatially, the WUI was identified through a complex modeling process undertaken by FRAP and the California Fire Alliance in 2001 and was completed in 2003. The modeling process consisted of three main components: ranking fuel hazard, assessing the probability of wildfire, and defining areas of suitable housing density that lead to Wildland-Urban Interface protection strategy situations (FRAP 2003). Further discussion on spatial modeling of the WUI can be found in Chapter 4.1 and Appendix A. Modeled WUI Treatment Areas can be found in Figure 2.2-9.

Projects implemented under the WUI treatment type would take place outside of the 100 foot defensible space requirements under PRC 4291 and within the outer edge of the defined WUI area as described in Chapter 4.1. The location and type of project must be included in a local Unit Fire Plan. If a WUI pre-incident plan exists as per CAL FIRE's Wildland Urban Interface Operating Principles (CAL FIRE, 2014), projects shall be consistent with:

- The strategy and tactics employed in the target area (e.g., perimeter control adjacent to structures)
- Likely scenarios (e.g., evacuation, road access, protecting critical infrastructure, etc.)
- Likely fire behavior

The focus of WUI treatments is to modify fuels in order to directly protect communities and assets at risk from potential damage from wildfires originating in the adjacent wildlands as well as to protect the wildlands from fires transitioning to the wildlands from human infrastructure. Treatment prioritization within the WUI would be based on concepts illustrated in Figure 2.2-8.

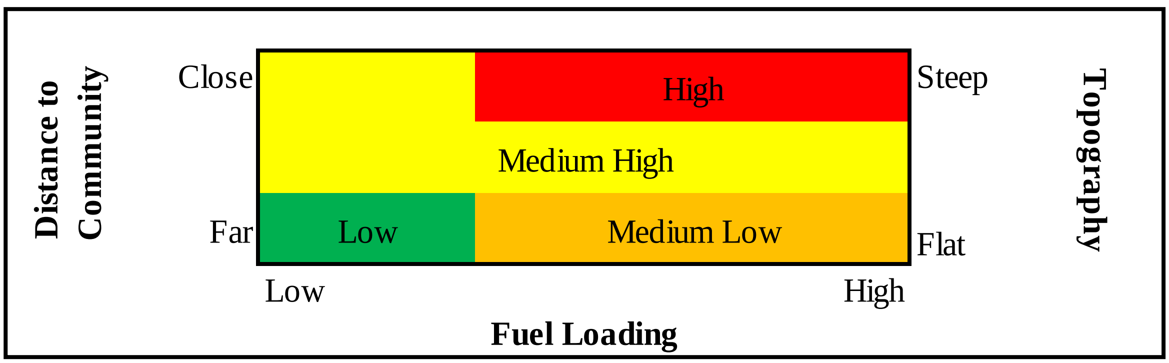


Figure 2.2-8: Treatment prioritization for WUI treatments.

The distribution of the vegetation formations within the modeled WUI treatment areas is summarized in below:

Table 2.2-2: Treatable Acres within the WUI treatment area by Vegetation Formation.

Bioregion	Tree Dominated	Shrub Dominated	Grass Dominated	Total by Bioregion
Bay Area/Delta	345,235	152,571	794,135	**1,291,941**
Central Coast	53,983	410,122	1,162,785	**1,626,890**
Colorado Desert	357	109,459	3,849	**113,664**
Klamath/North Coast	872,897	226,236	505,615	**1,604,748**
Modoc	377,423	235,956	120,292	**733,671**
Mojave	3,348	185,511	37,398	**226,257**
Sacramento Valley	15,173	3,136	494,494	**512,804**
San Joaquin Valley	4,959	52,595	270,582	**328,136**
Sierra Nevada	1,090,662	323,025	1,470,973	**2,884,660**
South Coast	101,424	958,039	284,868	**1,344,332**
Total by Veg Type	**2,865,462**	**2,656,649**	**5,144,991**	**10,667,101**

An example of a WUI treatment is presented in the Ranch Fire Case Study and a more detailed discussion of WUI treatments can be found in Chapter 4.1.

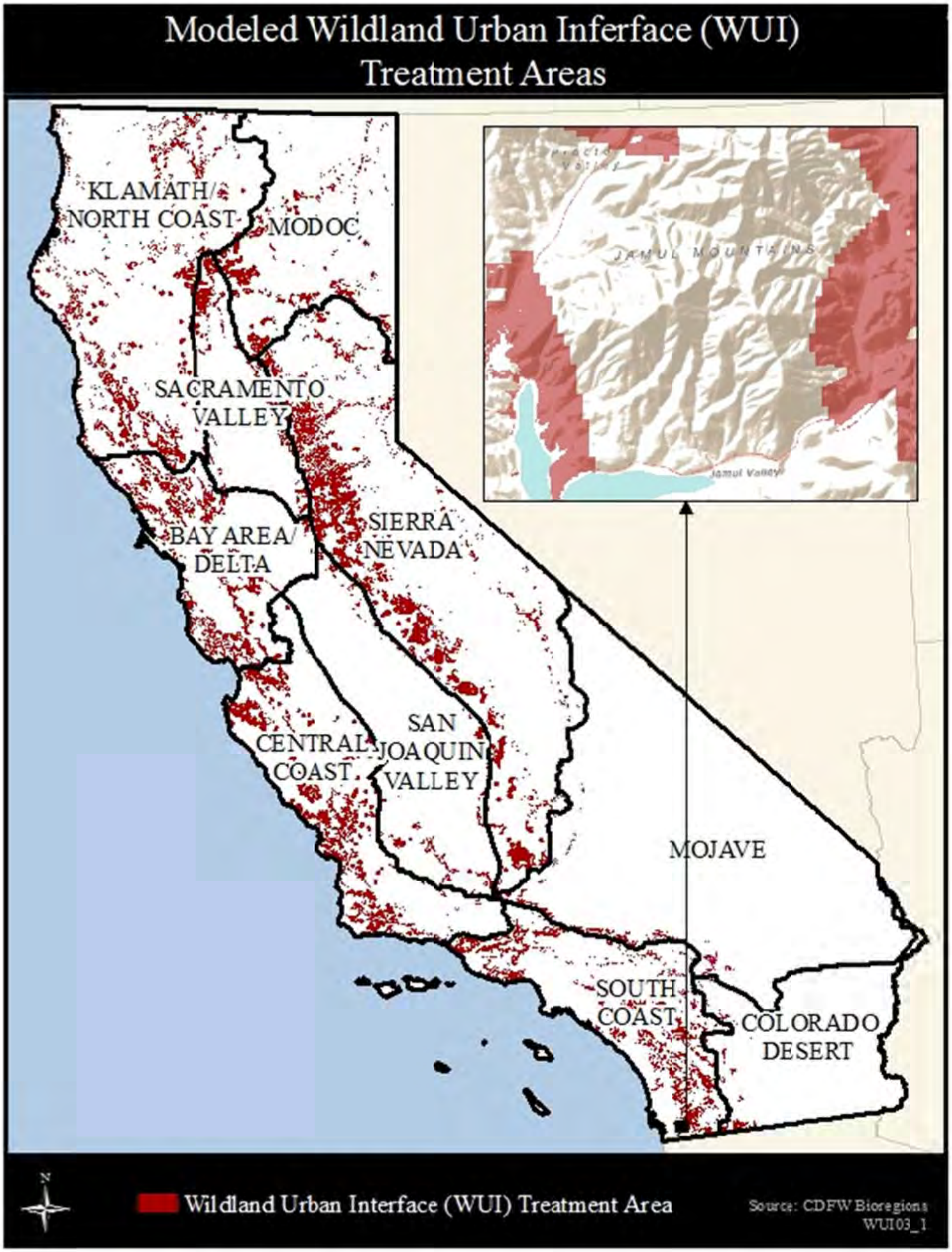


Figure 2.2-9: Wildland Urban Interface within the SRA.

Example of a WUI project:

This project area consists of oak woodlands, low elevation pockets of Ponderosa Pine, and chaparral vegetation with a large number of homes scattered throughout. The Auburn Lake Trails subdivision is situated on a plateau that rests along the south rim of the American River Canyon over the location that was to be a lake created by the Auburn Dam. This subdivision was planned to be a lake side development. At this time, the Auburn Dam project is likely to never be completed, and even if it were, vegetation treatment would still be necessary due to the ignition potential posed by lake side access by recreational users.

The areas directly below the subdivision are covered with heavy vegetation on slopes that are extremely steep. To complicate things, the area is a State Recreation Area with heavy use by river rafting enthusiasts, hikers, bikers, and horse back riders. The ignition potential below the subdivision is extreme as evidenced by the approximately 600 acre Mammoth Bar fire of July 16, 2009. The area has been identified by the local CAL FIRE Battalion Chief as a high priority for fuels management in the Unit Fire Plan.

A primary goal of this project is to maintain and continue to create a Shaded Fuel Break on private and publicly owned lands along the rim of the American River Canyon along topographic features that will allow fire suppression operations to safely occur in the event of wildfire. The Bureau of Reclamation, California Department of Parks and Recreation, and the California Department of Forestry and Fire Protection (CAL FIRE) will be cooperating on the development of this project. CAL FIRE is preparing this VMP to address CEQA on the privately owned lands that will be included in this project. Those lands that are managed or owned by other agencies will be covered by that agencies respective environmental planning process.

A minimum 300' wide shaded fuel break will be maintained and constructed along the edge of the subdivision, utilizing topography as the primary criteria for determining the final location of the fuel break. CAL FIRE inmate crews will be utilized from the Growlersburg Camp to complete the work. Fuel break maintenance and construction will be done by hand and any resulting material will be pile burned or chipped on site by the hand crew.

The Objectives of this WUI project:

1. To reduce wildfire hazard.
2. Maintain & construct a perimeter shaded fuel break on private lands at a location that will provide the maximum safety and benefit to fire suppression operations in the event of wildland fire.
3. Protect residential structures from the wildland fire threat that exists in the area.

CASE STUDY– WUI

Ranch Fire

December 21, 1999

Ventura County's Ojai Valley has long been considered an area especially susceptible to wildland fire. The valley is known for its high winds and dense vegetation. These conditions were made worse in the winter of 1999 when a lack of rainfall made high intensity wildland fire even more likely.

On the night of December 21, 1999 firefighters got the call that they had long been expecting: fireworks had ignited the Ranch Fire in the upper Ojai Valley and in its path lay homes, schools, and agriculture. As Santa Ana winds roared through the valley, the situation looked dire and left many local residents expecting a terrible disaster to be left in the Ranch Fire's wake.

However, almost seven years earlier a process was started that would ultimately save the community and save the taxpayers millions of dollars. The Ventura County Fire Protection District's Vegetation Officer started a five-year plan to reduce the threat in areas with the greatest potential for costly damaging wildfires. A large percentage of the cost of the project was provided by the Federal Emergency Management Agency after severe firestorms ravaged areas of Southern California in 1993.

The upper Ojai Valley had specifically been included in the plan, and by the spring of 1993 a comprehensive action plan was put together with the cooperation of landowners, the U.S. Forest Service, CAL FIRE, local schools, businesses, and residents.

Cooperators used prescribed burns to create defensible space between vegetation and homes. Further vegetation was cut and stacked in many areas and was burned in low intensity prescribed fires during the winter. Maintenance of this new community protection fuel break was the next issue. Property owners fenced the area and used livestock to eat the chaparral regrowth. Almost all of the homeowners in the community pitched in by cleaning flammable vegetation from around their homes. Fire department inspectors reported 99 percent compliance with local and state fire hazard clearance laws.

During the first few hours of the incident many success stories unveiled themselves. The weed abatement and pre-fire work made the disaster much less damaging than it otherwise would have been. While 4,400 acres and one home had burned, crews were successful at saving the other 67 homes in the area. Efforts by this committee freed up fire fighting forces to attack the fire before it could enter the community of Ojai. This is an example of how insightful planning and interagency teamwork can save communities from certain destruction by wildland fire.

2.2.2.2.2 Fuel Breaks

Fuel breaks are an area in which flammable vegetation has been modified to create a defensible space in an attempt to reduce fire spread to structures and/or natural resources, and to provide a safer location to fight fire. This treatment category could be a part of a series of fuel modifications strategically located along a landscape.

The wildland fuels of California occur mainly on mountainous terrain, which increases the difficulty in controlling wildfires. Typical fuel break locations include ridgelines, along roads, or in other favorable topographic situations. Fuel breaks can provide safe access for quickly staffing fire control lines and are a common place where forward progress of a fire can be slowed or stopped. Aerial attack may be used in conjunction with fuel breaks to contain the lateral spread of an advancing wildfire.

Strategic fuel breaks may vary in character depending on their specific location, vegetation type, expected fire behavior in the immediate location, and other land management objectives relative to the area under consideration. Under critical fire weather conditions, strategically placed fuel breaks can assist with containing lateral fire spread. Strategic fuel breaks, in this context, are designed to protect assets with national, state, or regional significance or value. Where possible, fuel breaks will be planned to provide essential linkages between fire control systems across the landscape. Potential fuel break treatments must address a clear fire prevention need and be based on local activity such as ignition patterns and fire spread history. Additional principles for fuel break treatment planning include:

- Be constructed to mitigate the loss of high value assets
- Significantly increase the chance of reducing the occurrence and impact of landscape-scale fires
- Be based on clear objectives, including acceptable fire size within a landscape unit
- Be located at the most effective position on the landscape
- Use or link to, if appropriate, existing roads and fuel break networks
- Be constructed to minimize and/or avoid environmental impacts
- Be constructed to increase firefighter safety
- Sufficiently reviewed and adopted as a component of a Unit Fire Plan

Geospatially, fuel breaks were identified by modeling the dominate ridgelines and identifying roads within the WUI. A 150 foot buffer was placed on the identified ridgelines, which created a 300 foot wide modeled fuel break treatment area. The road modeling component of the fuel break was further constrained to only include areas where Condition Class 2 or 3 were present. Condition Class is defined as the “relative risk of losing key components that define an ecosystem” (Hardy et al., 2001). Condition

Classes 2 and 3 can identify areas where fire behavior is uncharacteristic due to the loss of the key components of an ecosystem. Condition Class and Fuel Break modeling is discussed in further detail in Chapter 4.1. Modeled Fuel Break Treatment Areas can be found in Figure 2.2-10.

Projects implemented under the fuel break treatment category would consist of converting the vegetation along strategically located areas for fire control through mowing, mastication, herbicide application, and other methods. Treatments will focus on reducing fuels in areas exhibiting condition class 2 and 3.

The distribution of vegetation formations within the modeled Fuel Break Treatment areas is summarized below:

Table 2.2-3: Treatable Acres within the Fuel Break treatment area by Vegetation Formation.

Bioregion	Tree Dominated	Shrub Dominated	Grass Dominated	Total by Bioregion
Bay Area/Delta	72,525	47,126	203,365	**323,016**
Central Coast	12,248	132,588	354,799	**499,634**
Colorado Desert	1,403	198,732	1,737	**201,872**
Klamath/North Coast	343,006	89,875	184,560	**617,441**
Modoc	199,678	154,778	51,095	**405,551**
Mojave	5,968	591,422	39,460	**636,850**
Sacramento Valley	5,762	2,022	165,764	**173,548**
San Joaquin Valley	1,279	40,560	186,512	**228,350**
Sierra Nevada	154,834	96,448	253,995	**505,276**
South Coast	25,248	252,806	68,969	**347,023**
Total by Veg Type	**821,951**	**1,606,357**	**1,510,255**	**3,938,563**

An example of a Fuel Break treatment is presented in the Peterson Fire and Toro Creek Case Studies. A more detailed discussion of Fuel Break treatments can be found in Chapter 4.1.

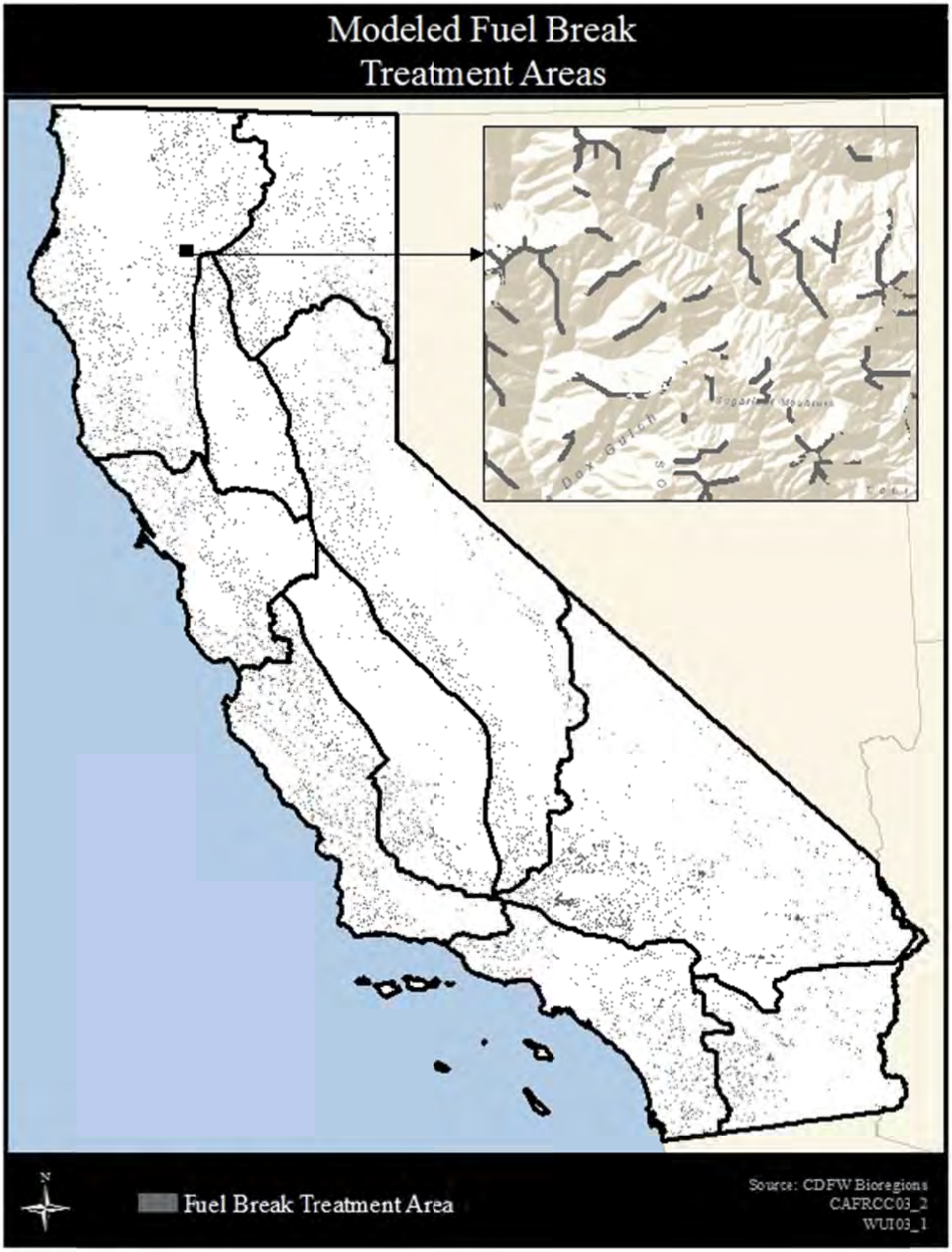
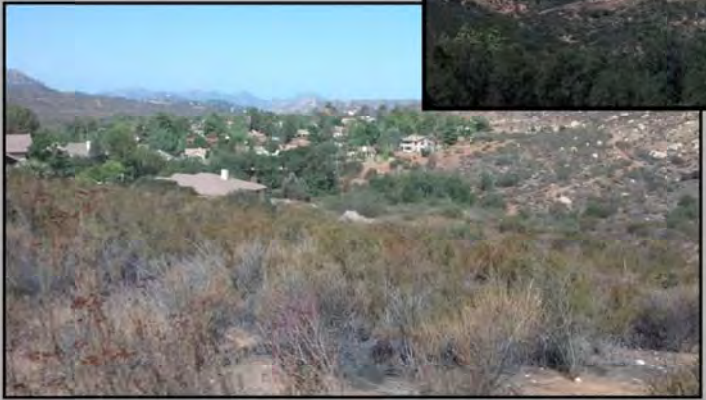


Figure 2.2-10: Fuel Breaks within the SRA.

Western end of San Diego Country Estates (SDCE) Community Defense Zone, location is near Wikiup Road. View is looking west. San Diego Country Estates, Ramona, CA. Photo taken 03/25/15.



Before:
Eastern end of San Diego Country Estates (SDCE) Community Defense Zone. USFS Cleveland National Forest's San Vicente Community Defense Zone parallels (as shown on right side of photo) a portion of SDCE Community Defense Zone. View is looking west. San Diego Country Estates, Ramona, CA. Photo taken 07/31/14.

After:
Eastern end of San Diego Country Estates (SDCE) Community Defense Zone. USFS Cleveland National Forest's San Vicente Community Defense Zone parallels (as shown on right side of photo) a portion of SDCE Community Defense Zone. View is looking west. San Diego Country Estates, Ramona, CA. Photo taken 03/25/15.

San Diego Country Estates Fuel Break

The purpose of this project was to provide enhanced defensible space to homes and properties along the northern perimeter of the San Diego Country Estates (SDCE), located in the San Vicente Valley, six miles southeast of the unincorporated community of Ramona in San Diego County. The intent of this project was to reduce a potential fire's intensity, and decrease the threat of fire originating from the adjacent urban area. Requiring a collaborative approach due to the array of property ownerships the fuel break would be constructed on, the project incorporated lands owned by the Bureau of Land Management (BLM), San Diego Country Estates Association, and private landowners. Width of the proposed zone varied from 150 feet to 400 feet wide and is approximately six miles in length. The average width of the of the defense zone is approximately 200 feet wide, and increases to 400 feet wide for a distance of approximately 1,500 feet at the eastern boundary where it parallels the Cleveland National Forest's San Vicente/Barona Mesa Community Defense Zone.

CASE STUDY-Shaded Fuel Break

Peterson Fire

Before Treatment

After Treatment

Before Treatment

After Treatment

July 12, 2004

On July 12, 2004 in eastern Fresno County a wildland fire was reported. The initial attack Incident Commander arrived at the scene and found the fire rapidly spreading uphill, threatening structures above and on each flank. Reported temperature was 89 degrees Fahrenheit, wind was from the southwest at 5-11 mph, with 17% relative humidity, and fuel moistures were 4.7%. In addition, the fire was rapidly spreading towards the recently completed Cressman Road Fuel Modification Zone (FMZ), a shaded fuel break.

CAL FIRE, in cooperation with the Pine Ridge Property Owners Association, the Highway 168 Fire Safe Council, and the California Department of Corrections, developed the Cressman Road FMZ. A FMZ is an area where selected vegetation has been removed in such a way as to break the horizontal and vertical continuity of forest fuels. The Cressman Road FMZ involved 60 parcels and 57 different landowners.

The purpose of this project was to try to increase the level of safety for both residents and firefighters that may be entering and/or leaving the Cressman Road area under wildfire conditions. This increased level of safety has been achieved through the selective removal of vegetation along Cressman Road. The Cressman Road area was selected for this project because of several reasons:

1. The Fresno/Kings Unit of CAL FIRE had identified the Pine Ridge area as a priority area for fuel reduction projects. This area was selected as a priority because of its high fuel loading, its potential for a large damaging fire, and its high population density intermixed within the wildland.
2. The Highway 168 Fire Safe Council had identified the Pine Ridge area as a priority area for fuel reduction projects for similar reasons.
3. Cressman Road is a single lane road, open to the public, which accesses approximately 113 parcels and 75 residences.
4. At the initial discussion stages of this project, the Pine Ridge Property Owners Association expressed interest in and support of the proposed project.

The Incident Commander on the Peterson Fire states that the Cressman Fuel Modification Project provided him with:

- The confidence that the head of the fire would be stopped or slowed when it reached the FMZ;
- That it would serve as a safe point of attack for firefighters even at the head of the fire;
- That firefighters could "anchor-in" at the FMZ and safely make a downhill hose lay along the flank of the fire;
- Significantly reducing the number of firefighting resources ordered for the incident;
- Significantly reduced fire intensities and subsequent resource damage in the FMZ compared to the non-treated areas in the fire perimeter.

CASE STUDY-Fuel Break

Toro Creek Fire - Fuel Break Utilization

November 8, 2013

At 10:30am on November 8, 2013, CAL FIRE San Luis Obispo Unit (SLU) dispatched a full-scale wildfire response to a 20 acre fire near Toro Creek Road and Highway 41, west of Atascadero in San Luis Obispo County. This area is characterized as mountainous terrain that is heavily covered in brush, set within the northwestern tip of the Los Padres National Forest.

During the operational planning of this fire, the West Atascadero Wildland Fire Pre-Plan map created by the SLU Pre-Fire Division was utilized. The Incident commander successfully utilized this map and explained that the map helped in "gathering situational awareness on the same operating plan."

Another equally important component in this success story was the presence of the West Atascadero Fuel Break which was completed in 2012 just north of the Toro Fire location. This fuel break was created under the CAL FIRE HFT2 grant program funded by the USFS. The fuel break was constructed using mastication equipment and a limited amount of hand crew work. This fuel break was used exactly as it was designed, to offer a strategic location from which to conduct aggressive control operations. Fortunately, the fire was stopped prior to reaching the fuel break, because the fuel break providing easier access to the fire location. Consequently, suppression resources, especially dozers, could quickly access the ridge on the east side of the fire and build a control line down the gas line. The local knowledge gained from building the fuel break and having accurate maps and firsthand knowledge of exactly how to safely and quickly access this area was why the fire was held to just 51 acres. Were it not for the existence of the fuel break and the knowledge of the local road system, the dozer line would not have been constructed nearly as quickly and the fire would have likely grown substantially larger.

2.2.2.2.3 Ecological Restoration

Ecological Restoration is the process of re-establishing the composition, structure, pattern, integrity and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions.

Geospatially, Ecological Restoration treatment areas were identified by excluding all areas identified as WUI and intersecting the remaining area with areas identified as Condition Class 2 or 3. Condition Class is defined as the "relative risk of losing key components that define an ecosystem" (Hardy et al., 2001). Condition Classes 2 and 3 identify areas where fire behavior is uncharacteristic and vegetation composition is altered due to the loss of the key components of an ecosystem. Condition Class and Ecological Restoration modeling is discussed in further detail in Chapter 4.1. Modeled Ecological Restoration Treatment Areas can be found in Figure 2.2-12.

Projects implemented under the Ecological Restoration treatment type would attempt to restore the fire resiliency associated with the specified fire-adapted plant community by renewing degraded, damaged, or destroyed ecosystems and habitats in the environment through active intervention. Ecological restoration could be implemented through grazing, thinning, understory burning, and other methods.

Ecological Restoration treatments include the removal of invasive or non-native species from a Condition Class 2 and 3 in order to promote native fire adapted plant communities. The conceptual basis for ecological restoration is that for fire-adapted ecosystems, much of their ecological structure and processes are driven by fire, and the disruption of fire regimes leads to changes in plant composition and structure, uncharacteristic fire behavior and other disturbance agents (such as pests), altered hydrologic processes, and increased smoke production. This conceptual basis is illustrated in Figure 2.2-11. This treatment may also be used to enhance rangeland landscapes to facilitate terrestrial and aquatic ecosystem sustainability. Under the VTP, median Fire Return Intervals (FRIs) are used to gauge the appropriate frequency of prescribed burns occurring within Ecological Restoration project types. Some vegetative communities, such as mixed chaparral and coastal scrub, are sensitive to short intervals between burns and pose a higher risk for long-term impacts such as type conversion.

An example of an Ecological Restoration project is presented in the Big Creek VMP Project Overview. A more detailed discussion of Ecological Restoration treatment areas can be found in Chapter 4.1.

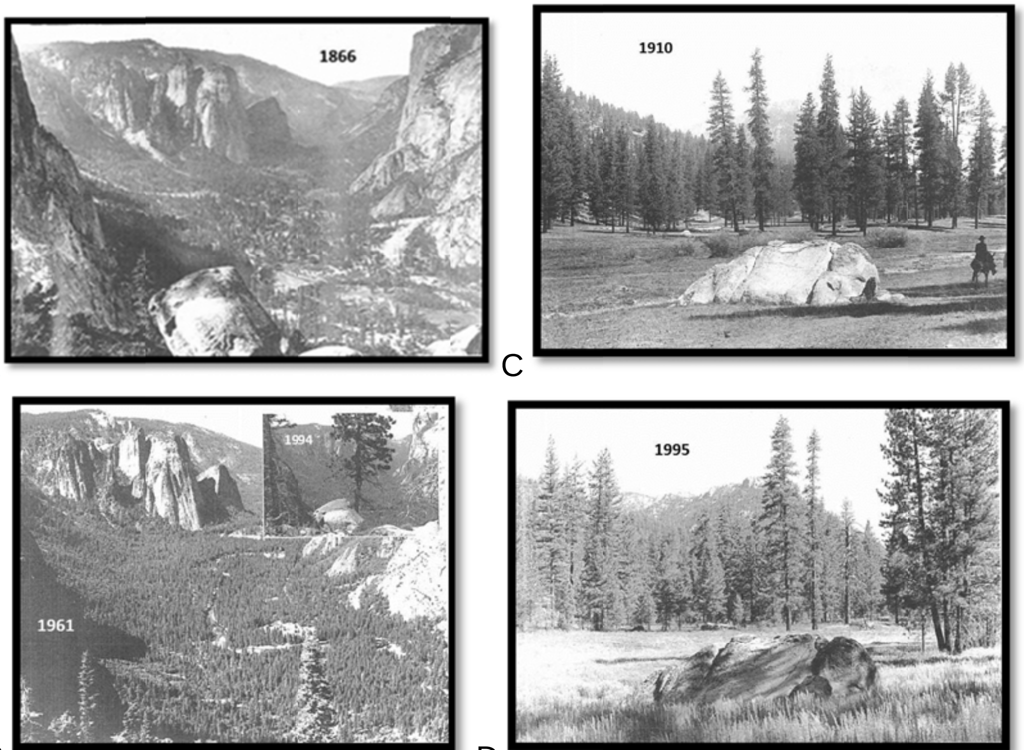


Figure 2.2-11: Photos demonstrating the concept of ecological restoration (taken from Gruell, 2001). The historic photos of Yosemite Valley (a) and Trout Meadows/Tulare County (c) indicate a condition analogous to Condition Class I, whereas the modern photos (B and D) reflect Condition Classes 2 or 3. Ecological restoration treatments would attempt to restore stand densities, fuel loading, and species composition to a condition that more closely resemble the historic photos (A and C).

The distribution of vegetation formations within the model Ecological Restoration treatment areas is summarized below:

Table 2.2-4: Treatable Acres within Ecological Restoration treatment area by Vegetation Formation.

Bioregion	Tree Dominated	Shrub Dominated	Grass Dominated	Total by Bioregion
Bay Area/Delta	191,386	85,988	253,805	**531,178**
Central Coast	41,347	362,589	733,272	**1,137,209**
Colorado Desert	408	45,536	597	**46,541**
Klamath/North Coast	1,443,053	135,324	469,769	**2,048,146**
Modoc	827,087	538,995	124,530	**1,490,612**
Mojave	12,566	40,227	27,062	**79,855**
Sacramento Valley	10,071	6,236	163,818	**180,126**
San Joaquin Valley	1,922	36,231	93,497	**131,651**
Sierra Nevada	722,877	178,085	624,761	**1,525,722**
South Coast	22,850	157,476	35,875	**216,202**
Total by Veg Type	**3,273,567**	**1,586,688**	**2,526,987**	**7,387,242**

Figure 2.2-12: Ecological Restoration within the SRA.

Example of an Ecological Restoration Project:

The Big Creek VMP is an ongoing cooperative effort between CAL FIRE and the landowner to reduce fuel adjacent to the community of Hayfork. Big Creek VMP is being conducted on the Big Creek Ranch and includes a total of 542 acres of proposed fuel treatments. The treatment for the portion of the VMP was prescribed fire. Prescribed fire is the use of live fire to modify vegetation under carefully specified conditions of moisture content, weather conditions, and fire behavior (the prescription) to achieve definite management objectives. Control lines are pre-planned and constructed prior to burning operations. An Incident Commander (IC) will be identified by the Unit Chief to oversee all aspects of the prescribed burn. The firing method and firing device to be used is at the discretion of the IC.

Before treatment...

After treatment...

The Objectives for this Ecological Restoration Project:

- Cooperate with the landowner to meet their goals. Landowner goals include:
    - Protect existing oak stands by reducing understory fuel loads.
    - Encourage return of native grasses by reducing non-native invasive grasses and brush.
    - Improve grazing for livestock and wildlife.
- Reduce the fuel loading in the burn units to limit the spread of future wildfires, thus reducing the threat to life and property.
- Conduct project operations in such a manner as to protect the environmental and cultural values of the landscape.
- Train fire personnel in the safe application of prescribed burning methods and techniques.
- Reduce the threat of sediment delivery to fisheries in Big Creek and Hayfork Creek by reducing the threat of large wildfire.
- Conduct the prescribed burns in a manner to minimize smoke impacts to population centers, specifically Hayfork.

2.2.3 PROGRAM ACTIVITIES

The WUI, Fuel Break, and Ecological Restoration treatment categories include the removal, rearrangement, or conversion of vegetation using various treatment "activities." These activities may be applied singularly or in any combination needed for a particular vegetation type to meet specific resource management objectives. The method or methods used would be those that are most likely to achieve the desired objectives while protecting natural resource values and meeting the overall program objectives. During the planning phase of a VTP project, the appropriate activity would be selected that is best matched to the operational needs and treatment constraints on the landscape (Graham et al., 2010). The activities to be implemented under the VTP are identified in Table 2.2-5.

Table 2.2-5: Proposed VTP Activities

Treatment Activities	Description	Methods of Application
Prescribed Fire: Pile Burn	Application of fire to an intentionally concentrated pile of fuels to accomplish planned resource management objectives.	Pile and burn fuels.
Prescribed Fire: Broadcast Burn	Application of prescribed fire to fuels to accomplish planned resource management objectives under specified conditions of fuels, weather, and other variables.	Understory burn within timber or oak woodlands, or broadcast treatment using fire with a control line along the perimeter.
Mechanical	Use of motorized equipment designed to cut, uproot, crush/compact, or chop existing vegetation.	Masticating, chipping, brush raking, tilling, mowing, roller chopping, chaining, skidding and removal, piling, often combined with pile burning.
Manual	Use of hand tools and hand-operated power tools to cut, clear, or prune herbaceous and woody species.	Hand pull and grub, thin, prune, hand pile, lop and scatter, hand plant, often combined with pile burning.
Prescribed Herbivory	Intentional use of domestic livestock to reduce a targeted plant population to an acceptable level and/or reducing the vegetative competition of a desired plant species.	Grazing or browsing by cows, sheep or goats.
Herbicides	Chemical applications designed to inhibit growth of vegetation.	Ground applications only, such as backpack spray, hypo-hatchet, pellet dispersal, etc.

The activities described above are techniques or tools rather than end results. Projects implemented under the VTP would use prescriptions incorporating the appropriate vegetation activities and methods described above in order to create specific project results, such as shaded fuel breaks, fuel reduction zones, or improvement of browse or forage for wildlife or domestic stock. The VTP would allow herbicide treatments on the landscape, subject to the landscape constraints and the specific project requirements pertaining to herbicide application described below. Detailed descriptions of Program Activities are found in Chapter 4.1.5.

The number and type of vegetation activities would be selected based on a number of parameters, which may include but are not limited to:

- Potential for significant adverse impacts
- Ability and willingness of landowner to maintain treated area
- Management program requirements or objectives for the site
- Historic and current conditions
- Opportunities to prevent future problems
- Opportunities to conserve desirable vegetation and wildlife habitat
- Effectiveness and cost of the treatment methods and follow-up maintenance treatments
- Available funding
- Success of past treatments, or treatments conducted under similar conditions
- Recommendations by local experts
- Input from local community
- Characteristics of the target plant species, including size, distribution, density, life cycle, and life stage during which the plants are most susceptible to treatment
- Non-target plant species potentially impacted by the treatment
- Fuel configuration (amount, arrangement, and size classes)
- Primary land use (e.g., WUI, forestry, range, and open space)
- Accessibility of the treatment area
- Soil characteristics of the treatment area
- Weather conditions at the time of treatment, particularly wind speed and direction, precipitation prior to or likely to occur during or after application, and time of year
- Proximity of the treatment area to sensitive areas, such as wetlands, streams, or habitat for plant or animal species of concern, rare plants and habitat structure vital to species survival and reproduction, air and water quality, soil productivity and cultural resources
- Need for subsequent re-treatment
- Maintenance of prior treated area
- Size of the target area
- Topography, slope, and aspect of the treatment area

These parameters would be considered before activity methods are selected. In addition, prior to any vegetation activities or ground disturbance occurring, CAL FIRE would verify that any specialists and/or databases for sensitive areas/species are consulted and reviewed regarding the project area. These notifications would be identified as part of the PSA. Furthermore, the project sites would be surveyed for listed, state-candidate, state/federal threatened or endangered species, rare plants, and for evidence of cultural, or prehistoric sites. The results of these surveys would also be included within the VTP PSA (Chapter 7).

Initial activities and follow up maintenance within specific vegetation types would vary depending on the ecological characteristics of the vegetation types, the objective(s) of the treatment, and funding. In general, all vegetation types require follow up maintenance to meet long-term vegetation management goals. The type of follow up treatment and interval between treatments would depend on site conditions and project objectives. Treatment maintenance is further discussed in Section 4.1.5.7.

A proposed project should identify the time frame to complete the expected project level objectives. Once either the time frame has been met or the contractual agreements in place between CAL FIRE and the project applicant expire, another project may need to be submitted for future maintenance activity. Maintenance of a VTP project may not always require a new project proposal after the contractual obligation expires or is concluded. If the maintenance activity will have similar impacts as evaluated under this PEIR then a new project will need to be submitted for review. However, if the impacts are not covered by this PEIR then another CEQA process may be required.

2.3 SCOPE OF THE VTP

The environmental setting of the fuel landscape that could be modified by VTP activities is diverse, from conifer and hardwood forest and woodlands in mountain and coastal areas; to shrub and herbaceous rangelands in the south coast, north interior, and central valley; to desert habitats in the southeast (FRAP, 2010). Covering such an extensive and heterogeneous region, VTP projects would need to reflect the treatment needs of the vegetation at the local and regional levels. Over a ten year period, CAL FIRE would implement vegetation treatment activities on approximately 60,000 acres per year with a total of 600,000 acres treated over the ten-year period. Within a ten-year period it is estimated that there would be approximately 2,301 projects implemented – approximately 231 projects per year at an average project size of 260 acres.

The above annual rate of treament and total acres treated is the basis for the analysis presented in this Program EIR. However, the actual acres treated annually in any region will vary year-to-year based on several factors, such as: the number of willing landowners, funding ability, and access constraints. In addition, it is expected that the ten-year total acreage treated would never occur all within one year or all within any one bioregion, but would be distributed across several years and several bioregions. Finally, if the acreage being treated in a bioregion exceeded 110 percent of the projected yearly average by bioregion (Table 2.3-1), then further analysis would be required at the project level to ensure that significant environmental effects do not occur. This determination would be made by the Sacramento CEQA Program Coordinator (ADM-7).

It should also be noted that the VTP is not proposed as the solution to California's vegetation management and fire problem. Although the proposed annual acres of treatment may not impact all the potential landscape fuels, the Program is still a valuable tool to allow landowners and stakeholders the opportunity to impact their community's fire risk. Each VTP project requires implementation monitoring and photo-point effectivness monitoring, and all treatments will be entered into a geospatial database for program tracking purposes. As more rigorous project and program monitoring becomes available through funding, the VTP Monitoring Working Group can evaluate key uncertainities and develop a more formal adaptive management program.

2.3.1 SCALE OF PAST TREATMENTS

Annual records of treated acreage by Unit/Contract County from the 1996/1997 to 2013/2014 fiscal years indicate an average of approximately 14,000 acres of lands are treated per year under CAL FIRE's current VMP. The annual treated acreage statewide ranged from a low of 3,246 acres in the 2013/2014 fiscal year to a high of 50,867 acres in the 1996/1997 fiscal year and indicates a significant decrease in treated acreage over time. However, the dataset suffers from possible quality control/quality assurance issues, as 40 percent of the tabulated data are listed as zeros or are blank, and it is unclear whether the reported acreage was for prescribed burning only or included additional vegetation management projects. Years with more complete reporting (e.g., 1996-2004) indicate an annual average of approximately 23,000 treated acres.

Unit and Contract County pre-fire engineers (PFEs) were contacted via email to determine their capacity for conducting vegetation treatment activities given current staffing levels and constraints (e.g., available burn days). A sample of nine PFEs responded to the information request, with estimated annual treated acreage ranging from 600 to 2,905 acres per year. The average annual treated acreage reported by Unit or Contract County PFEs was approximately 1,500 acres. If this average value is multiplied by the 27 Units and Contract Counties, the estimated annual statewide acreage that could reasonably be treated is approximately 40,000 acres per year.

2.3.2 PROJECTED SCALE OF VTP

It is reasonable to expect CAL FIRE would increase the annual acreage treated under the VTP by 100 percent when compared to historic treatment acreages under the existing VMP for a number of reasons. First, the limited scope of the existing VMP, which is the primary CEQA mechanism CAL FIRE uses for implementing fuels management projects in shrub and grass fuel types, excludes forested landscapes. As a result, fuel reduction projects occurring within forested fuel types have not been represented under the historic VMP annual treatment acreage figures. Because the proposed VTP scope includes all vegetative fuel types within SRA, including forested fuel types, fuels management projects occurring beyond the scope of the current VMP program can now be accounted for under the proposed VTP. Functionally, the VTP will perform as the primary CEQA mechanism for the VMP. Although the terminology or specific phasing of the goals differs between the two programs, the VTP corresponds with the same goals outlined in the VMP. Secondly, replacing the costly, time consuming, and repetitive process of preparing multiple CEQA documents for projects located in forested fuel types with this Program EIR would result in a more efficient use of staff time and finances, leading to CAL FIRE's ability to treat additional acres.

Thirdly, treatment options such as mechanical mastication and the use of herbicides are options now included under the VTP which were not available to CAL FIRE under existing EIRs. For example, CAL FIRE routinely engages in mastication projects by utilizing Mitigated Negative Declarations or Supplemental EIRs. Mechanical fuel reduction projects, which treat large areas and are favorable when the risk of an escaped prescribed fire may exist, would now be evaluated under the VTP. Additionally, herbicide use, which is a cost effective fuel management option that can be used for a variety of applications, has been largely unavailable under existing CAL FIRE environmental protocols. The inclusion of new treatment options would add flexibility and improve efficiency, which ultimately translates to a greater ability to treat additional acres compared to existing conditions.

Fourth, there are new funding sources available that would allow CAL FIRE to increase treated acres. A variety of grant programs have developed in recent years that specifically fund fuels management. The significant increase in available grant funding statewide combined with the increase in CAL FIRE staffing would provide additional resources to implement VTP projects.

Considering the levels of historic annual treatment acreage through the CAL FIRE's VMP (i.e., approximately 23,000 acres) and the information submitted by CAL FIRE Units regarding the expected increase in project acres utilizing this VTP (i.e., approximately 40,000 acres), the average between the two values is approximately 30,000 acres per year. With the combination of an expanded VTP scope, the inclusion of project acreage historically outside the scope of the existing VMP, the addition of treatment options, and an increase in both funding and staff, it is reasonable to assume that the annual acreage treated would increase by a factor of two. The average annual treated acreage for the VTP is projected to be 60,000 acres, and the estimate of acres treated would be approximately 600,000 acres over a 10-year period.

The spatial distribution of the projects implemented by the proposed VTP is likely to follow the spatial distribution of available acres. As such, the total treated acreage would likely be highest in the Sierra Nevada, Central Coast, and Klamath/North Coast bioregions, respectively. Treated acres would likely be lowest in the Mojave, San Joaquin Valley, and Colorado Desert bioregions, respectively. However, the absolute magnitude of treatments by bioregion is not expected to remain static over time, and would change in response to emerging priorities and environmental constraints.

Table 2.3-1: Proposed program treatment acreage by Bioregion

Bioregion	Total Landscape Acres for Treatment	Approximate 10-Year Acreage	Approximate Annual Acreage	% of Treatable Landscape Treated per Decade	% of SRA Treated per Decade
Bay Area/Delta	2,146,135	58,550	5,855	0.27%	0.19%
Central Coast	3,263,733	89,040	8,904	0.40%	0.29%
Colorado Desert	362,077	9,878	988	0.04%	0.03%
Klamath/North Coast	4,270,334	116,501	11,650	0.53%	0.37%
Modoc	2,629,835	71,746	7,175	0.33%	0.23%
Mojave	942,962	25,725	2,573	0.12%	0.08%
Sacramento Valley	866,478	23,639	2,364	0.11%	0.08%
San Joaquin Valley	688,137	18,773	1,877	0.09%	0.06%
Sierra Nevada	4,915,658	134,107	13,411	0.61%	0.43%
South Coast	1,907,557	52,041	5,204	0.24%	0.17%
Total by Treatment	**21,992,906**	**600,000**	**60,000**	**2.73%**	**1.93%**

Although the annual treated acres are projected to be 60,000 acres, this number should not be considered an upper limit to the number of acres that might be treated over an annual timeframe. Rather, these annual and ten-year acreage estimates are used to determine the individual and cumulative impacts of the proposed program. If the acreage treated within any bioregion exceeds 110 percent of the yearly amounts in Table 2.3-1, then additional analysis would be required at the project level to assess whether there are additional significant effects (ADM-7).

The relative distribution of projects by activity type (e.g., prescribed fire, mechanical) is based on trends from the available recorded data and is generally expected to be distributed as follows:

- 50% prescribed fire
- 10% hand treatments
- 20% mechanical treatments
- 10% herbicide treatments
- 10% prescribed herbivory

Because each of these activity types can have a characteristic impact on the environment, this allows for more focused impact assessment later in the document. It is anticipated that the percentage of treatments utilizing prescribed fire would decline over time due to the environmental constraints associated with burning. Also, additional funding sources would help to subsidize the less cost-effective treatments such as mechanical and hand treatments, and this increased funding would likely result in a higher proportion of non-burning activities than indicated by the historic data. Consequently, the percent distribution is not a threshold that the Program must maintain. This is expected to change over time as interest in each activity adapts to environmental and political needs. As stated earlier, the assumption in this analysis is that CAL FIRE can increase the number of treated acres by 100 percent, thereby doubling the treated area to approximately 60,000 acres annually on average. Figure 2.3-1 shows the projected acreage by treatment and vegetation subtype. Figure 2.3-2 shows the estimated number of projects by treatment and vegetation subtype. The data in these tables show that the majority of projected VTP treated acres and projects would be WUI treatments. Ecological Restoration and Fuel Breaks treatments would comprise 34 and 18 percent of the treated acreage, respectively. The figures also show that 41 percent of treatments would be in the grass-dominated vegetation subtype, 24 percent in the shrub dominated subtype, and 35 percent in the tree dominated subtype.

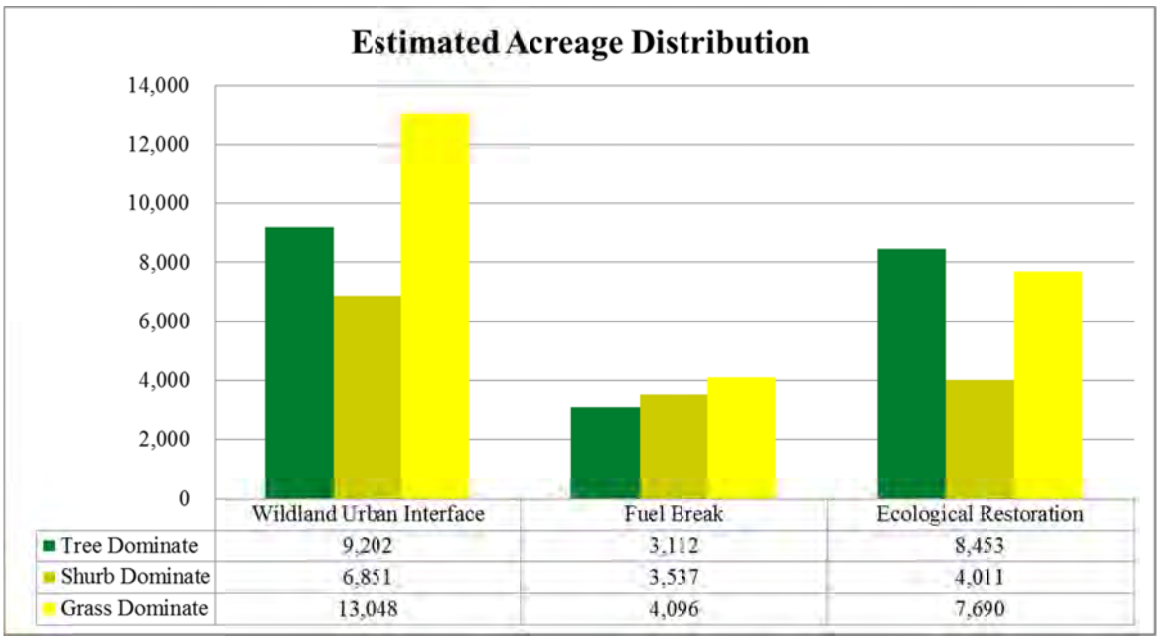


Figure 2.3-1 Estimated Acreage Distribution by Treatment and Vegetation Formation per Year

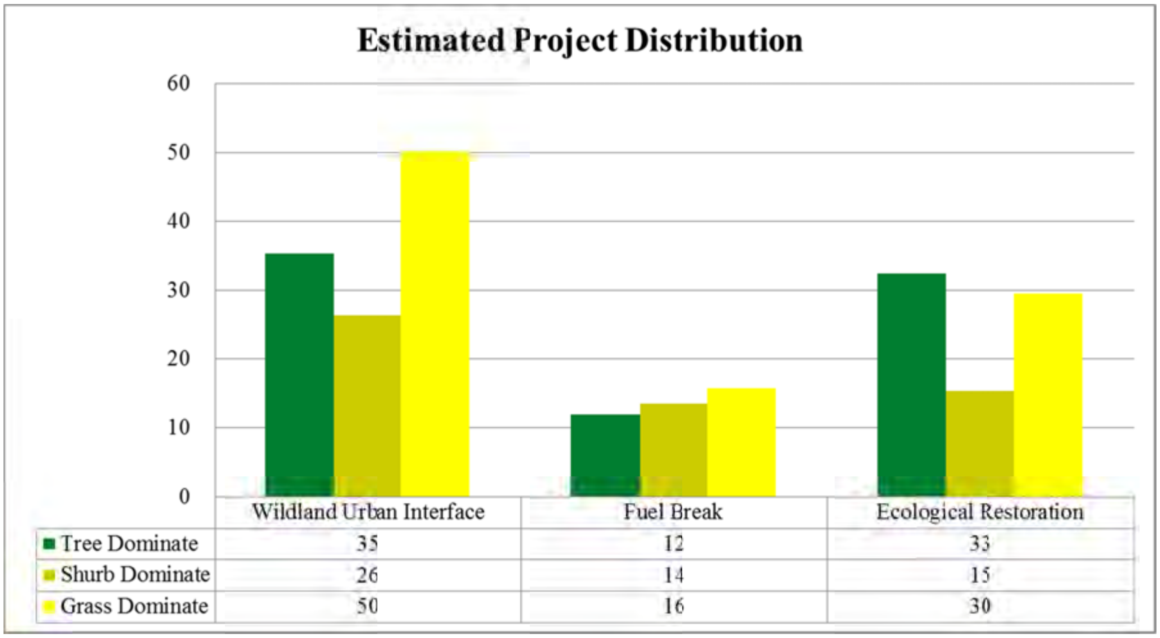


Figure 2.3-2 Estimated Project Distribution by Treatment and Vegetation Formation per Year

2.4 IMPLEMENTATION FRAMEWORK

2.4.1 IMPLEMENTATION PROCESS

As described earlier, the VTP is a formal program that would comprehensively direct the management of fuel sources within CAL FIRE's SRA landscape. The VTP consists of a strategy that would implement vegetation treatment activities on primarily privately owned land for the purpose of altering fuels to reduce the size, number, or frequency of damaging fires and reduce losses to life, property, and natural resources. The implementation process is explained in Figure 2.4-1. VTP treatments will be prioritized using concepts illustrated in Figure 2.4-2. In general, WUI treatments will receive the highest priority.

On private property, VTP projects would only be implemented in cooperation with willing landowners. Efforts should be made to include private, local, state and federal stakeholder involvement where vegetation treatments may connect previous fuel reduction projects. In addition, planning and collaboration for various landscape treatments are encouraged when they directly benefit local communities. During the project planning phase, the project proponent will provide a public meeting for projects outside of the WUI, advertised in a local newspaper and through other means (see Appendix I – Monitoring and Communication Plan). The public meeting will be used to inform stakeholders about the project and to solicit information on the potential for significant environmental impacts during the project planning phase (See SPR ADM-8 and Figure 2.4-1). Although a significant portion of the Project Scale Analysis (PSA) should be complete enough to address public concerns and provide a detailed discussion regarding the project's benefits, the PSA will be completed after the public meeting. For all projects implemented under the VTP, CAL FIRE would serve as the CEQA lead agency and would oversee the implementation of vegetation treatment activities at the CAL FIRE Unit level. The only exception would be in circumstances where proposed VTP projects are located on lands controlled by the California Department of Parks and Recreation (State Parks). In this case, State Parks may act as the lead agency and may rely upon CAL FIRE's Program EIR in implementation of their vegetation treatment projects.

While CAL FIRE would serve as the CEQA lead agency under most circumstances, most projects would be funded, at least partially, and implemented by private landowners, Fire Safe Councils, other public agencies or non-profit groups. In these situations, the implementing entity would enter into a contract or agreement with CAL FIRE to carry out the VTP project. If the project qualifies for this Program EIR, SPRs and mitigation measures would be included in the contract requirements and the project's CEQA compliance and implementation would be coordinated through local CAL FIRE Units/Contract Counties.

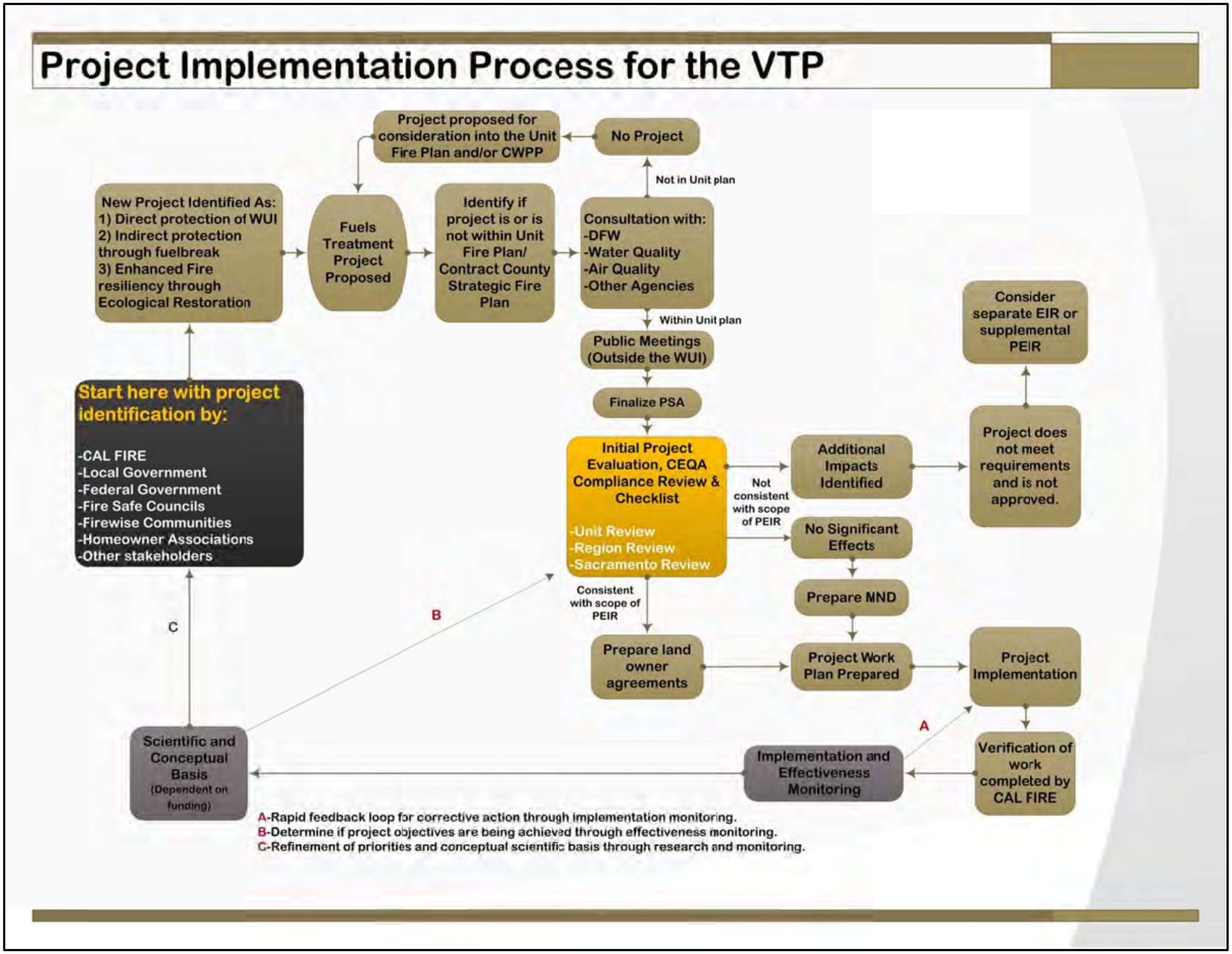


Figure 2.4-1: Project Implementation Process for the VTP

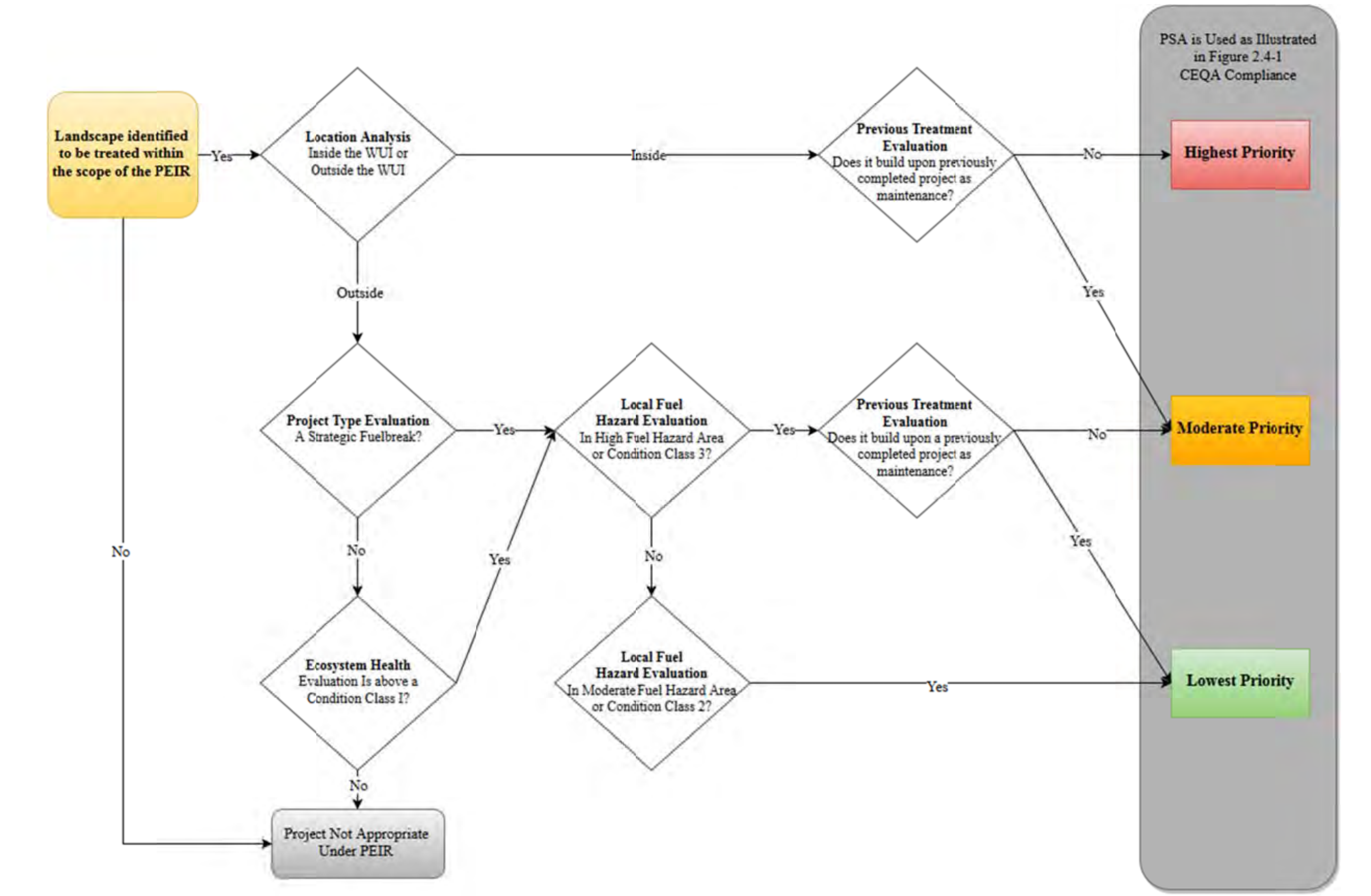


Figure 2.4-2: A relative ranking of project priority based on fuel hazard and values at risk. Using this conceptual framework, the WUI will receive the highest priority for treatment in the Vegetation Treatment Program.

CASE STUDY– Community Pre-planning

Firewise Community in San Luis Obispo 2010-2013

2010

In 2010, CAL FIRE began discussions with the Oak Shores Community Association (OSCA) General Manager about the hazardous fuel situation in and around the community. After assessing the situation, it was agreed that OSCA should apply to become a Fire Safe Council Focus Group in order to use San Luis Obispo County Community Fire Safe Council (FSCSLO) resources to help implement a fuel management program in cooperation with CAL FIRE. In early 2011 OSCA was accepted as a Focus Group in accordance with Fire Safe Council policies. OSCA immediately began working with CAL FIRE to establish priorities for the Hazardous Fuel Reduction Program, which was then successfully incorporated into the annual FSC Clearinghouse Grants process. 140 acres consisting primarily of OSCA open space parcels and the 2 ½ mile entry road (Oak Shores Drive) were identified as high risk areas in need of fuel removal or reduction.

Before Treatment

In 2011, the OSCA Focus Group, through the efforts of the Fire Safe Council, received a grant to begin fuel modification work adjacent to the 2 ½ mile main entry road and within a 16 acre portion of the main drainage that divides the community into two areas. The work was performed by CAL FIRE Hand Crews from Cuesta Camp in San Luis Obispo. This initial phase of the project lasted 9 months.

After Treatment

In 2012, the OSCA Focus Group received additional funding to continue the second phase of the fuel reduction program priorities outlined in 2011. This work was also was done by CAL FIRE Hand Crews from Cuesta Camp. The methods used consisted of cutting/chipping and cutting/piling/burning. Concurrently, OSCA also started a yard waste disposal program allowing owners to bring their trimmings and debris to a common location with the intent of creating a burn pile. This effort was so successful and so much material accumulated that chipping was used to reduce the size of the pile while waiting for fire season to end.

In 2013, additional funding was awarded to complete the third phase of the projects outlined in 2011. As of January 2014, fuel treatment on 120 of the 140 acres identified by CAL FIRE as high fire hazard areas has been completed. This work was done on OSCA property and on adjacent property outside of the community. The support of CAL FIRE with the Cuesta Camp Crews and the financial support from the Fire Safe Council have allowed the Community to be able to continue with follow-up maintenance of this area now and into the future.

CASE STUDY– Pre-Attack Planning

The benefits of Pre-Attack Planning

July 16, 2012

On July 16, 2012 a wildfire started around 11:35 am at the intersection of Highway 58 and Pozo Road, 5-8 miles east of the town of Santa Margarita. The CAL FIRE San Luis Obispo Unit dispatched a full wildland fire response to the incident. The fire, which was burning in very rough terrain making access difficult for firefighters, eventually grew to 640 acres. Evacuations took place along Parkhill Road between Highway 58 and Seven Oaks Road. During the fire, the Parkhill Area pre-attack plan (developed by the San Luis Obispo County Fire Department, GIS Department) was used to efficiently deploy resources around the fire.

According to the Incident Commander, Battalion Chief Phil Veneris, the pre-attack plan allowed for everyone involved to be looking at the same operating plan. The pre-attack plan allowed firefighters to easily locate safety zones, staging areas, water sources, proposed dozer lines, hazards, and other important features. Additionally, all of the residences in the area had been checked and verified prior to the fire during the creation of the pre-attack plan allowing for a timely evacuation. The pre-attack plan enabled the IC to focus firefighting efforts in areas where control lines could easily and safely be held. Lastly, the ICS symbology of the maps allowed everyone to easily read and locate points of interest on the maps.

For firefighters stationed in the area, everyone had seen and gone over the pre-attack map, as well as having double-checked to ensure the map was correct. This allowed for faster deployment when the fire did start and created a safer operating area. Not only was the pre-attack plan useful in the fire, it has also been useful in search and rescue operations and vegetation management plans. The pre-attack plan has also been given to other agencies that are stationed in the area, in order for them to learn the best points around the area for holding a fire.

2.4.2 SUBSEQUENT REVIEW UNDER THE VTP

If the VTP is approved by the Board, CAL FIRE would begin the implementation and roll-out of the program. The first step in the implementation process would be for each of the CAL FIRE Units/Contract Counties to update their annual Unit Fire Management Plans/Contract County Strategic Fire Plans ("Unit Fire Plans") to identify vegetation treatment projects that are proposed for implementation and would be covered under the VTP. In general, the CAL FIRE Unit/Contract County staff would coordinate with private landowners and interested agencies to identify which projects would be implemented. While participation in the Vegetation Treatment Program is completely voluntary, the successful placement of projects will depend on the public's involvement. Unit Fire Plans also function as Community Wildfire Protection Plans (CWPP), and may contain all or some of projects outlined in smaller CWPPs throughout the Unit/Contract County. CWPPs have several requirements to guarantee public participation and sign-off in the creation of the plans, which ensures public input into the selection of VTP projects. Additional VTP projects may also be proposed through Fire Safe Councils or other community groups in coordination with the local Unit/Contract County. Consequently, the public feedback helps shape the location and type of vegetation treatment projects.

By incorporating proposed VTP projects into the Unit Fire Plans, the proposed project would be appropriately linked to the comprehensively planned fire prevention activities within the Unit's jurisdiction, providing enhanced fire suppression capabilities.

Once a Unit Fire Plan has identified proposed VTP projects, the CAL FIRE Unit/Contract County staff and the project proponent, together, would begin the project evaluation process by completing the VTP Project Scale Analysis (PSA). The purpose of the PSA would be to determine whether the environmental effects of the proposed VTP project were addressed in this Program EIR. The PSA also requires CAL FIRE to consider whether all applicable SPRs and mitigation measures identified in the Program EIR have been incorporated into the VTP project and whether additional mitigation would be necessary. This is also an opportune time for the project proponent to initiate the public workshop previously discussed for projects outside the WUI. The PSA will be completed after the public meeting. If the VTP project is being carried out by contract through a private landowner or other public or non-profit entity, the contract terms would require implementation of the applicable SPRs and mitigation measures and any Project Specific Requirements (PSRs) identified after completing the PSA. The PSA would document whether any specific permits from responsible and trustee agencies would be required. A copy of the VTP PSA is included in Chapter 7.

Once completed, the PSA would be submitted for three levels of review: Unit/Contract County review, Regional review, and Sacramento CEQA Coordinator review. The

Unit/Contract County review would focus on the project objectives, project scope, and proper use of the VTP PSA; the feasibility of the activities proposed; and whether the project has been appropriately included in the Unit Fire Plan. The CAL FIRE Region representative would review the PSA, confirm the project is within the scope of the Program EIR, and would determine if there are any areas where shared use of resources between Units could be coordinated. Finally, the Sacramento CEQA Coordinator review would provide the final determination of whether the proposed project is consistent with the Program EIR, whether supplemental environmental review in compliance with CEQA would be required, or whether the project does not qualify under the VTP Program EIR and separate environmental documentation would need to be prepared. If it is determined that the project falls within the scope of the Program EIR then no additional CEQA documentation would be required. The project would be implemented subject to the applicable SPRs, mitigation measures, PSRs, and permitting requirements identified for the project. At the conclusion of the project, a completion inspection would be completed by CAL FIRE staff. The completion inspection (i.e., monitoring) would evaluate if the vegetation management activities were completed in accordance with the authorized project plan. Follow up effectiveness or validation monitoring might also be performed on the project area after project implementation (See Figure 2.4-1 and Appendix I for additional information).

If it is determined that the proposed VTP project includes activities or chemicals that are substantially different from those evaluated in the Program EIR or that the VTP project may result in one or more new significant impacts not addressed in the Program EIR, the following actions may be taken:

- The project may be changed to avoid the potential impact.
- The project may be cancelled.
- Additional CEQA analysis, in the form of a mitigated negative declaration or supplemental or subsequent EIR, may be conducted to address the impacts and identify any feasible mitigation measures.
- An alternate environmental process may be engaged.

2.4.3 MONITORING AND ADAPTIVE MANAGEMENT

The VTP requires program elements that will aid in program implementation, help assess program effectiveness, and will provide feedback for adaptive decision-making. Required elements under the VTP include but are not limited to:

- A mechanism for introducing independent science into the VTP
- A requirement to geospatially track project implementation over time
- Implementation monitoring to provide a rapid feedback loop for corrective action at the project scale

- Qualitative project effectiveness monitoring to communicate “lessons learned” during VTP implementation
- Post-incident effectiveness monitoring
- An annual workshop in each CAL FIRE Region to communicate Program implementation, effectiveness, and “lessons learned” to stakeholders and provide this information to the State Board of Forestry & Fire Protection
- A process that will allow for stakeholder involvement in scoping for non-WUI related projects in southern California
- A goal to implement “active” adaptive management by securing dedicated funding for research effectiveness and validation monitoring

Implementing informal adaptive management will be a required element of the VTP until funding can be secured to employ more formal adaptive management strategies (ADM-3 and ADM-4). Further details on monitoring requirements and adaptive management are contained in Appendix I Monitoring and Communication.

CASE STUDY– Prescribed Fire Fuel Reduction

Winton Fire

September 9, 1999

California is prone to dry lightning in the late summer months. Lightning-caused fires can cost taxpayers millions of dollars because lightning often ignites multiple fires at one time in remote mountainous areas.

Lightning started the Winton Fire outside of the Stanislaus National Forest in Calaveras County on September 9,1999. When fire crews responded to the call, they already knew that as many as 40 homes could be threatened if they were unable to quickly contain it.

The work of those crews was made easier because of logging and prescribed fire projects that had been done in 1996 by Sierra Pacific Industries. Due to reduced fuel on the northwestern side of the fire, where a prescribed burn had been completed, the flames burned at a much lower intensity and spread slower. In addition, the main road used by fire personnel to access the head of the fire ran through this treated area. This allowed fire crews safe access and an escape route should they need one. Because of these factors, the Winton Fire Incident Commander was able to concentrate crews and equipment on more actively burning areas of the fire.

While one home and 115 acres were burned, fire commanders estimated that 40 homes and 300 acres of timber were saved due to the ability of the crews to quickly contain the fire. This is an example of how pre-fire planning and treatment saves homes, resources and money. One of the major benefits of the pre-fire efforts taken in this area was improved firefighter safety. Crews were able to safely access the Winton Fire from the west due to the prescribed fire done earlier. It was not safe for crews to access the flames from any other side due to the high fire intensity in those areas.

2.4.4 FUNDING

Guidelines for the development of, and participation in, VTP projects would be similar to those used for CAL FIRE's existing Vegetation Management Program (VMP) (see Section 1.5.2 for a discussion) and CFIP (see Section 1.5.4 for a discussion) processes. CAL FIRE may share the costs of the project, accept liability in the case of an escaped fire, and suppress escaped fires. As described above, CAL FIRE, acting on behalf of private landowners, State Parks, and a variety of regional and local agencies, such as RCDs, local fire protection agencies, or Fire Safe Councils, may initiate VTP projects. Participants must be willing to:

- Enter into a contract with CAL FIRE to implement the project.
- Assume and guarantee payment of a proportionate share of the project in cases where cost sharing is required.
- Develop or direct completion of a treatment plan.
- Assume any monitoring requirements for a specific VTP project.

Assistance for project funding would be dependent on the availability of funds and consistency with the objectives of the VTP. It is expected that projects utilizing this Program EIR would be funded through grants or other cost-share agreements. CAL FIRE would evaluate the relationship between public and private benefits to determine the basis for any cost-sharing agreement. Projects that benefit only individual private landowners would receive the least assistance, while projects that emphasize public benefits would receive the most assistance. For instance, CAL FIRE would not fund the portion of a fuel reduction project that is required by regulation (e.g., PRC 4291 to provide defensible space around dwellings) and which would not provide protection to a community at large or other high-value resources. Conversely, CAL FIRE would provide a larger proportion of funding for projects that benefit the public, such as reducing fuel hazards to protect communities and high-value resources or areas that CAL FIRE has designated as high priority areas in Unit Fire Plans.

The *2010 Strategic Fire Plan for California* and the California Department of Forestry & Fire Protection *2012 Strategic Fire Plan* both identify the goals of cultivating and strengthening relationships with stakeholders, governing bodies, cooperators and the Public (Board, 2010 & CAL FIRE, 2012). As a result, there has been coordinating efforts to acknowledge the benefits of vegetation treatments with a variety of stakeholders including but not limited to federal, state and local government agencies and non-governmental organizations. Through the use of MOUs or other mechanisms such as grants, funding may be provided from other cooperating stakeholders. Depending on the project types and funding restrictions, the VTP may help bridge the ground work and provide an ecological evaluation of vegetation treatment on SRA land.

The VTP does not include projects that would cut or remove timber or other solid wood products from timberlands for commercial purposes (as defined by PRC 4527). These projects require a Timber Harvesting Plan (THP), Non-industrial Timber Management Plan (NTMP), or other Program Timber Harvesting Plan (PTHP).

Regardless of the funding, all projects would be reviewed with the same level of detail as described above. (Section 2.4.2 Subsequent Review under the VTP)

2.5 PROJECT REQUIREMENTS

The VTP provides a reasonable and environmentally protective approach to prioritizing, assessing, designing, and implementing vegetation treatment projects. Requirements (e.g., best management practices) related to program and project design and implementation would be based on constraining biotic and abiotic factors, landowner goals, and the types of vegetation manipulation activities needed to implement the three treatment types, and applicable environmental laws and regulations. Requirements common to all projects are known as Standard Project Requirements (SPRs), whereas site-specific requirements are known as project specific requirements (PSRs).

2.5.1 STANDARD PROJECT REQUIREMENTS AND MITIGATIONS

Standard project requirements (SPR) are program design elements for reducing or avoiding adverse environmental effects of the treatment activities that are set by the VTP and applied to individual projects. SPRs apply to all projects governed by the VTP. SPRs are a collection of standard operating procedures, Best Management Practices, and known regulatory requirements related to project implementation and oversight that help protect the environment. The analysis within Chapter 4 identified the following SPRs:

Table 2.5-1 Standard Project Requirements Reference Location

Standard Project Requirements (SPR) Reference Location					
SPR	Reference Section	SPR	Reference Section	SPR	Reference Section
ADM-1	4.2.3.1, 4.6.3.1	CC-1	4.14.3	HYD-1	4.3.3.1, 4.2.3.1
ADM-2	4.2.3.1, 4.6.3.1	CC-2	4.14.3	HYD-2	4.3.3.1, 4.2.3.1
ADM-3	2.4.3	CC-3	4.14.3	HYD-3	4.3.3.1, 4.2.3.1
ADM-4	2.4.3	CC-4	4.14.3	HYD-4	4.3.3.1, 4.2.3.1
ADM-5	4.1.5.2	CUL-1	4.6.3.1	HYD-5	4.3.3.1, 4.2.3.1
ADM-6	4.3.3.1	CUL-2	4.6.3.1	HYD-6	4.3.3.1, 4.2.3.1
ADM-7	2.3, 4.1.2	CUL-3	4.6.3.1	HYD-7	4.3.3.1, 4.2.3.1
ADM-8	2.4.1	CUL-4	4.6.3.1	HYD-8	4.3.3.1, 4.2.3.1
AES-1	4.13.3	CUL-5	4.6.3.1	HYD-9	4.3.3.1, 4.2.3.1
AIR-1	4.12.3	FBE-1	4.36.2.2, 4.4.2.3	HYD-10	4.3.3.1, 4.2.3.1
AIR-2	4.12.3		4.6.2.5, 4.14.2.3	HYD-11	4.3.3.1, 4.2.3.1
AIR-3	4.12.3	FBE-2	4.3.2.2, 4.14.2.2	HYD-12	4.3.3.1, 4.2.3.1
AIR-4	4.12.3	FBE-3	4.3.2.2, 4.6.2.5	HYD-13	4.3.3.1, 4.2.3.1
AIR-5	4.12.3	FBE-4	4.4.2.3	HYD-14	4.3.3.1, 4.2.3.1
AIR-6	4.12.3	GEO-1	4.3.3	HYD-15	4.3.3.1, 4.2.3.1
AIR-7	4.12.3	GEO-2	4.3.3	HYD-16	4.3.3.1, 4.2.3.1
AIR-8	4.12.3	HAZ-1	4.4.3	HYD-17	4.3.3.1, 4.2.3.1
AIR-9	4.12.3	HAZ-2	4.4.3	NSE-1	4.7.3
AIR-10	4.12.3	HAZ-3	4.4.3	NSE-2	4.7.3
AIR-11	4.12.3	HAZ-4	4.4.3	NSE-3	4.7.3
AIR-12	4.12.3	HAZ-5	4.4.3	NSE-4	4.7.3
MM AIR-1	4.12.3	HAZ-6	4.4.3	NSE-5	4.7.3
BIO-1	4.2.3.1	HAZ-7	4.4.3	TRA-1	4.10.3
BIO-2	4.2.3.1	HAZ-8	4.4.3	TRA-2	4.10.3
BIO-3	4.2.3.1	HAZ-9	4.4.3		
BIO-4	4.2.3.1	HAZ-10	4.4.3		
BIO-5	4.2.3.1	HAZ-11	4.4.3		
BIO-6	4.2.3.1	HAZ-12	4.4.3		
BIO-7	4.2.3.1	HAZ-13	4.4.3		
BIO-8	4.2.3.1	HAZ-14	4.4.3		
BIO-9	4.2.3.1				
BIO-10	4.2.3.1				
BIO-11	4.2.3.1				
BIO-12	4.2.3.1				
BIO-13	4.2.3.1				

Administrative Standard Project Requirements

ADM-1: Prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using standard project requirements (SPRs). If burning operations are done with CAL FIRE personnel, the Battalion Chief and/or their Company Officer designee shall meet with the project coordinator onsite prior to operations to discuss resource protection measures. Additionally, the project coordinator shall specify the resource protection measures and details of the burn plan in the incident action plan (IAP) and shall attend the pre-operation briefing to provide further information.

ADM-2: All protected resources shall be flagged, painted or otherwise marked prior to the start of operations by someone knowledgeable of the resources at risk, their location, and the applicable protection measures to be applied. This work shall be performed by a Registered Professional Forester (RPF), or his/her supervised designee, for any project in a forested landscape as defined in PRC § 754.

ADM-3: The project coordinator or designee shall monitor SPR implementation (and effectiveness in some cases) as an adaptive management tool. If a SPR does not perform adequately to protect the specified resource, the project coordinator will determine adaptation strategies, in coordination with the contractor and/or CAL FIRE personnel, and require their implementation.

ADM-4: If monitoring is necessary (e.g., effectiveness monitoring), the project coordinator or designee shall notify the party responsible for monitoring a minimum of three weeks in advance of operations. More advanced notification is encouraged from project coordinators to parties responsible for more rigorous monitoring activities.

ADM-5: All ground disturbing treatment activities, including land clearing and bull dozer line construction, shall be suspended when a red flag warning is issued by the local National Weather Service office.

ADM-6: The project coordinator or designee shall consult with the USFS, CAL FIRE, or other public agencies as appropriate to develop a list of past, current, and reasonably foreseeable probable future projects within the planning watershed of the proposed project. If the total combined acreage disturbed in the planning watershed exceeds 20% in a 10-year period, compliance with HYD-16 must be met prior to any ground disturbing operations. Projects that may combine with VTP projects to create the potential for significant effects include, but are not limited to, controlled burning, fuel reduction, and commercial timber harvesting.

ADM-7: The Sacramento Program manager shall track the annual and 10-year average annual acreage treated by the VTP, by bioregion. If the acreage treated within any bioregion exceeds 110 percent of the yearly amounts as identified in Table 2.3-1, the Program manager will notify the affected CAL FIRE Units that any additional projects submitted within that bioregion fall outside of the scope of analysis by this PEIR and additional CEQA analysis will be required. Additional CEQA analysis, such as a mitigated negative declaration, shall assess the cumulative impacts of the proposed project and identify any additional project constraints that may be necessary to mitigate these to less than significant. Additional CEQA analysis may be tiered off this PEIR when the proposed project is otherwise consistent with the VTP.

ADM-8: During the project planning phase, the project proponent will provide a public workshop for projects outside of the WUI. A public notice will be advertised in a local newspaper. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

Aesthetics-Related Standard Project Requirements

AES-1: See **BIO-5** for shrublands in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, and San Bernardino counties.

Air Quality-Related Standard Project Requirements

AIR-1: The project shall comply with all local, state, and federal air quality regulations and ordinances. The local Air Pollution Control District (APCD) or Air Quality Management District (AQMD) will be contacted to determine local requirements.

AIR-2: Prior to approval of an CAL FIRE Unit project under the VTP, the project coordinator shall model the project's Criteria Air Pollutant (CAP) emissions and compare the projected emissions levels to the thresholds identified by the local air district. If emissions levels exceed air district thresholds, consultation of the air district will occur.

AIR-3: In accordance with CCR Section 80160(b), all burn prescriptions shall require the submittal of a smoke management plan for all projects greater than 10 acres or are estimated to produce more than 1 ton of particulate matter. Burning shall only be done in compliance with the burn authorization program of the local air district having jurisdiction over the project area. Example of a smoke management plan is in Appendix J.

AIR-4: Fire emissions and fire behavior shall be planned, predicted, and monitored in accordance with SPRs FBE-1, FBE-2, and FBE-3 with the goal of minimizing air pollutant emissions.

AIR-5: Dust control measures shall be implemented in accordance with SPRs Hyd-9 with the goal of minimizing fugitive dust emissions.

AIR-6: The speed of activity-related trucks, vehicles, and equipment traveling on dirt areas shall be limited to 15 miles per hour (mph) to reduce fugitive dust emissions.

AIR-7: In areas where sufficient water supplies and access to water is available, all visible dust, silt, or mud tracked-out on to public paved roadways as a result of project treatment activities shall be removed at the conclusion of each work day, or at a minimum of every 24 hours for continuous fire treatment activities.

AIR-8: Ground-disturbing treatment activities, including land clearing and bull dozer lines, shall be suspended when there is a visible dust transport outside the project boundary.

AIR-9: Ground-disturbing treatment activities shall not be performed in areas identified as “moderately likely to contain naturally occurring asbestos (NOA)” according to maps and guidance published by the California Geological Survey (CGS), unless an Asbestos Dust Control Plan is prepared by the Operational Unit and approved by the air district(s) with jurisdiction over the project site. This determination would be based on a CGS publication titled *A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos* (Churchill and Hill 2000), or whatever more current guidance from CGS exists at the time the VTP project is evaluated. Any NOA-related guidance provided by the applicable local air district shall also be followed. If it is determined that NOA could be present at the project site, then an Asbestos Dust Control Plan shall be prepared and implemented in accordance with Title 17 of the Public Health CA Code of Regulations of Section 93105.

AIR-10: Operation of each large diesel- or gasoline-powered activity equipment (i.e., greater than 50 horsepower [hp]) shall not exceed 16 equipment-hours per day, where an equipment-hour is defined as one piece of equipment operating for one hour (daily CAPs, TACs, GHGs).

AIR-11: All diesel- and gasoline-powered equipment shall be properly maintained according to manufacturer's specifications, and in compliance with all state and federal emissions requirements. Maintenance records shall be available for verification.

AIR-12: A CAL FIRE Unit shall not conduct more than five simultaneous VTP activities on any day within an air district when multiple units reside within the same air district boundary. When a single CAL FIRE Unit resides within an air district boundary, one day total activity emission estimates will not exceed the current air district’s Threshold of Significance. No more than one of these projects shall be a prescribed burn, unless additional prescribed burns have been approved by the local air district having authority over the project area.

Mitigation Measure AIR-1

To achieve compliance with local air district emission thresholds in the San Joaquin Valley Unified Air Quality Management District, simultaneous projects within that air district will be constrained to an appropriate number as not to exceed air quality standards. As a result, the Program shall implement the following:

- CAL FIRE shall not allow more than seven simultaneous treatment activities to occur in the San Joaquin Valley Unified Air Quality Management District, regardless of the number of CAL FIRE units in the district.

Biological Standard Project Requirements

BIO-1: Projects shall be designed to avoid significant effects and avoid take of special status species as defined in the glossary as a plant or animal species that is listed as rare, threatened, or endangered under Federal law; or rare, threatened, endangered, candidate, or fully protected under State law; or as a sensitive species by the California Board of Forestry and Fire Protection.

BIO-2: The project coordinator shall run a nine-quad search or larger search area (may be required if a project is on the boundary of two USGS quad maps) of the area surrounding the proposed project for special status species, using at a minimum, the California Natural Diversity Database (CNDDB) or its successor (e.g., DFW's Vegetation Classification and Mapping Program, VegCAMP).

BIO-3: The project coordinator shall write a summary of all special status species identified in the biological scoping including the CNDDB search with a preliminary analysis, identifying which species would be affected by the proposed project. A field review will then be conducted by the project coordinator to identify the presence or absence of any special status species, or appropriate habitat for special status species, within the project area.

BIO-4: The project coordinator shall ensure that a CAL FIRE Environmental Coordinator analyze impacts to any species identified in a CNDDB or BIOS search and shall submit the summary and preliminary analysis to the CDFW, USFWS, and [if applicable] NOAA Fisheries for consultation. The preliminary analysis shall be accompanied with a standard letter containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning; mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- The output from the CNDDB run, including a map of any special status species located during the field review, and the SPRs that will be implemented to minimize impacts on the identified special status species.
- A request for information regarding the presence and absence of special status species, including any applicable HCPs, in the project vicinity, and potential take

avoidance measures to be implemented as PSRs.
- An offer to schedule a day to visit the project area with the project coordinator.

BIO-5: Vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties shall:

- Be designed to prevent vegetation type conversion.
- Not take place in vegetation that has not reached the age of median fire return intervals.
- Not re-enter treatment areas for maintenance in an interval shorter than the median fire return interval outside of the wildland urban interface and excluding fuel break maintenance.
- Not take place in old-growth chaparral without consultation regarding the potential for significant impacts with the CDFW and the CNPS.
- Take into account the local aesthetics, wildlife, and recreation of the shrub-dominated subtype during the planning and implementation of the project.
- During the project planning phase provide a public workshop or public notice in a newspaper that is circulated locally describing the proposed project during the project planning phase for projects outside of the WUI. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

BIO-6: In shrublands containing native oaks, treatments may incorporate retention of older, acorn producing oaks to create deer forage. CAL FIRE or applicants may plant other vegetation to promote species diversity and improve wildlife habitat when such practices are not in conflict with program goals.

BIO-7: Unless otherwise directed by CDFW, a minimum 50 foot avoidance buffer shall be established around any special status animal, nest site, or den location and a minimum 15 foot avoidance buffer shall be established around any special status plant within the project area. Additional buffer distances may be required through consultation with the appropriate State or Federal agencies, or a qualified biologist to avoid significant effects to special status species (see BIO-4).

BIO-8: In order to reduce the spread of new invasive plants, only certified weed-free straw and mulch shall be used.

BIO-9: During the planning phase, if the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures shall be developed using principles outlined in the document “Preventing the Spread of

Invasive Plants: Best Management Practices for Land Managers (3rd edition)" or other relevant documents. Coordination of mitigation measures will also include consultation with CDFW.

BIO-10: If water drafting becomes a necessary component of the proposed project, drafting sites shall be planned to avoid adverse effects to special status aquatic species and associated habitat, in-stream flows, and depletion of pool habitat. Screening devices shall be used for water drafting pumps, and pumps with low entry velocity shall be used to minimize removal of aquatic species, including juvenile fish, amphibian egg masses, and tadpoles, from aquatic habitats.

BIO-11: Aquatic habitats and species shall be protected through the use of watercourse and lake protection zones (WLPZ), as described in California Forest Practice Rules (14 CCR Chapters 4, 4.5, and 10). Other operational restrictions may be identified through consultation with CDFW and RWQCB (see BIO-4). See HYD-3 for these standard protection measures.

BIO-12: For projects that require a non-construction-related CDFW Streambed Alteration Agreement, any BMPs identified in the agreement shall be developed and implemented.

BIO-13: If any special status species are identified within the project area, an onsite meeting shall occur between the project coordinator and operating contractor. At this meeting the project manager shall conduct a brief review of life history, field identification, and habitat requirements for each special status species, their known or probable locations in the vicinity of the treatment site, project specific requirements or avoidance measures, and necessary actions if special status species or sensitive natural communities are encountered.

Climate Change-Related Standard Project Requirements

CC-1: Prior to approval of a Unit project under the VTP, the project coordinator shall run the FOFEM, and/or other GHG-emissions models, as appropriate to the treatment activity, to confirm that GHG emissions will be the minimum necessary to achieve risk reduction objectives.

CC-2: Carbon sequestration measures shall be implemented per SPRs BIO-5 and BIO-6 to reduce total carbon emissions resulting from the treatment activity.

CC-3: Treatment activity-related air pollutant emission control measures for prescribed burns shall be implemented in accordance with SPRs AIR-3 and AIR-4.

CC-4: Treatment activity-related air pollutant emission control measures for equipment operation hours, practices, and maintenance shall be implemented in accordance with SPRs AIR-11 and AIR-12.

Archaeology and Cultural Resources-Related Standard Project Requirements

CUL-1: The project coordinator or designee shall order a current records check as per the most current edition of "Archaeological Review Procedures for CAL FIRE Projects" (CAL FIRE, 2010, see Appendix H). The project coordinator may contact landowners within the project area who might have already conducted a records check for a Timber Harvest Plan or other project on their land to limit costly redundant records searches. Records checks must be less than five years old at the time of project submission.

CUL-2: Using the latest Native Americans Contact List from the CAL FIRE website, the project coordinator or designee shall send all Native American groups in the counties where the project is located a standard letter notifying them of the project. The letter shall contain the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- A request for information regarding potential cultural impacts from the proposed project.

CUL-3: The project coordinator or designee shall contact a CAL FIRE Archaeologist or CAL FIRE Certified Archaeological Surveyor to arrange for a survey of the project area if necessary. The specific requirements need to comply with the most current edition of "Archaeological Review Procedures for CAL FIRE Projects" (CAL FIRE, 2010).

CUL-4: Protection measures for archaeological and cultural resources shall be developed through consultation with a CAL FIRE archeologist. If new archaeological sites are discovered, the project coordinator or designee shall notify Native American groups of the resource and the protection measure with the standard second letter (see Appendix H). Locations of archaeological resources should not be disclosed on a map to the members of the public, including Native American groups.

CUL-5: If an unknown site is discovered during project operations, operations within 100 feet of the identified boundaries of the new site shall immediately halt, and the project will avoid any more disturbances. A CAL FIRE Archaeologist shall be contacted for an evaluation of the significance of the site. In accordance with the California Health and Safety Code, if human remains are discovered during ground disturbing activities, CAL FIRE and/or the project contractor(s) shall immediately halt potentially damaging activities in the area of the burial and notify the County Coroner and a qualified professional archaeologist to determine the nature and significance of the remains.

Fire Behavior-Related Standard Project Requirements

FBE-1: The prescribed fire burn prescription shall be designed to initiate a surface fire of sufficient intensity that will only consume surface and ladder fuels. The prescribed fire burn prescription shall be designed and implemented to protect soil resources from direct soil heating impacts. Soil damage will not occur as a result of this project.

FBE-2: A burn plan shall be created using the burn plan template. The burn plan shall include a fire behavior model output of BEHAVE or other fire behavior modeling simulation and performed by a fire behavior technical specialist (S-490 qualified). The burn plan shall be created with input from the vegetation project's Battalion Chief and a fire behavior technical specialist (S-490 qualified).

FBE-3: The project coordinator shall run a First Order Fire Effects Model (FOFEM) to analyze fire effects. The results of the analysis shall be included with the Burn Plan. FOFEM calculates consumption of fuels, tree mortality, predicted emissions, GHG emissions, and soil heating.

FBE-4: Approximately two weeks prior to commencement of prescribed burning operations the project coordinator shall 1) post signs along the closest major road way to the project area describing the project, timing, and requesting for smoke sensitive persons in the area to contact the project coordinator; 2) publish a public interest notification in a local newspapers describing the project, timing, and requesting for smoke sensitive persons in the area to contact the CAL FIRE project coordinator; 3) send the local county supervisor a notification letter describing the project, its necessity, timing, and summarize the measures being taken to protect the environment and prevent escape; and 4) develop a list of smoke sensitive persons in the area and contact them prior to burning.

Geologic Standard Project Requirements

GEO-1: An RPF or licensed geologist shall assess the project area for unstable areas and unstable soils as per 14 CCR 895.1 of the California Forest Practice Rules. Guidance on identifying unstable areas is contained in the California Licensed Foresters Association *Guide to Determining the Need for Input From a Licensed Geologist During THP Preparation* and California Geological Survey (CGS) Note 50 (see Appendix C). Priority will be placed on assessing watercourse-adjacent slopes greater than 50%. If unstable areas or soils are identified within the project area, are unavoidable, and are potentially directly or indirectly affected by the project operations, a licensed geologist (P.G. or C.E.G.) shall conduct a geologic assessment to determine the potential for project-induced impacts and mitigation strategies. Project shall incorporate all of the recommended mitigations. Geologic reports should cover the topics outlined in CGS Note 45 (see Appendix C).

GEO-2: The potential impacts of prescribed fire on geologic processes shall be reduced by following the Fire Behavior-related SPRs FBE-1, FBE-2, and FBE-3.

Hazards and Hazardous Material-Related Standard Project Requirements

HAZ-1: Prior to the start of vegetation treatment activities, the project coordinator shall conduct an Envirofacts web search to identify any known contamination sites within the project area. If a proposed vegetation treatment project occurs in areas located on the DTSC Cortese List, no activities shall occur within 100 feet of the site boundaries.

HAZ-2: Prior to the start of vegetation treatment activities, the project coordinator or contractor shall inspect all equipment for leaks and regularly inspect thereafter until equipment is removed from the site.

HAZ-3: Prior to the selection of treatment activities, CAL FIRE shall determine if there are viable, cost-effective, non-herbicide treatment activities that could be implemented prior to the selection of herbicide treatments.

HAZ-4: Prior to the start of herbicide treatment activities, the project coordinator shall prepare a Spill Prevention and Response Plan (SPRP) to provide protection to onsite workers, the public, and the environment from accidental leaks or spills of herbicides, adjuvants, or other potential contaminants. This plan shall include (but not be limited to):

- A map that delineates VTP staging areas, where storage, loading, and mixing of herbicides will occur
- A list of items required in a spill kit onsite that will be maintained throughout the life of the project
- Procedures for the proper storage, use, and disposal of any herbicides, adjuvants, or other chemicals used in vegetation treatment

HAZ-5: If remediation of hazardous contamination is needed, the project coordinator shall hire a licensed contractor with expertise in performing such work. The contractor shall comply with all laws and regulations governing worker safety and the removal and disposal of any contaminated material.

HAZ-6: All pesticide use shall be implemented consistent with Pest Control recommendations prepared annually by a licensed Pest Control Advisor.

HAZ-7: All appropriate laws and regulations pertaining to the use of pesticides and safety standards for employees and the public, as governed by the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, and local jurisdictions shall be followed. All applications shall adhere to label directions for application rates and methods, storage, transportation, mixing, and container disposal. All contracted applicators shall be appropriately licensed by the state. The project coordinator shall coordinate with the County Agricultural Commissioners, and all required licenses and permits shall be obtained prior to pesticide application.

HAZ-8: Projects shall avoid herbicide treatment in areas adjacent to water bodies and riparian areas. Application of herbicides shall be outside the WLPZ and ELZ as specified in HYD-3, or at the distances set forth in the herbicide label requirements, whichever is greater. No aerial spraying of herbicides shall occur under this Program EIR.

HAZ-9: The following general application parameters shall be employed during herbicide application:

- Application shall cease when weather parameters exceed label specifications, when sustained winds at the site of application exceeds seven miles per hour (MPH), or when precipitation (rain) occurs or is forecasted with greater than a 40 percent probability in the next 24-hour period to prevent sediment and herbicides from entering the water via surface runoff
- Spray nozzles shall be configured to produce a relatively large droplet size
- Low nozzle pressures (30-70 pounds per square inch [PSI]) shall be observed
- Spray nozzles shall be kept within 24 inches of vegetation during spraying

Drift avoidance measures shall be used to prevent drift in locations where target weeds and pests are in proximity to special status species or their habitat. Such measures can consist of, but would not be limited to, the use of plastic shields around target weeds and pests and adjusting the spray nozzles of application equipment to limit the spray area.

HAZ-10: All herbicide and adjuvant containers shall be triple rinsed with clean water at an approved site, and the rinsate shall be disposed of by placing it in the batch tank for application per 3 CCR § 6684. Used containers shall be punctured on the top and bottom to render them unusable, unless said containers are part of a manufacturer's container recycling program, in which case the manufacturer's instructions shall be followed. Disposal of non-recyclable containers will be at legal dumpsites. Equipment would not be cleaned and personnel would not bathe in a manner that allows contaminated water to directly enter any body of water within the treatment areas or adjacent watersheds. Disposal of all pesticides shall follow label requirements and local waste disposal regulations.

HAZ-11: Storage, loading and mixing of herbicides shall be set back at least 150 feet from any aquatic feature or special status species or their habitat or sensitive natural communities.

HAZ-12: Appropriate non-toxic colorants or dyes shall be added to the herbicide mixture where needed to determine treated areas and prevent over-spraying.

HAZ-13: For treatment activities located within or adjacent to public recreation areas, signs shall be posted at each end of herbicide treatment areas and any intersecting trails notifying the public of the use of herbicides. The signs shall consist of the following information: signal word, product name, and manufacturer; active ingredient; EPA registration number; target pest; treatment location; date and time of application; date which notification sign may be removed; and contact person with telephone number. Signs shall be posted at the start of treatment and notification will remain in place for 72 hours after treatment ceases.

HAZ-14: All heavy equipment shall be required to include spark arrestors or turbo chargers that eliminate sparks in exhaust and have fire extinguishers onsite.

Hydrologic and Water Quality-Related Standard Project Requirements

HYD-1: The project shall comply with all applicable water quality requirements adopted by the appropriate Regional Water Quality Control Board and approved by the State Water Board (i.e., Basin Plan).

HYD-2: During the planning phase the project coordinator shall submit a standard letter to the appropriate RWQCB containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- Notification of whether the project drains directly into an impaired water body, and the type of water quality constituent(s) that is impairing the water body.
- A request for information and recommendations regarding the potential for significant water quality impacts from the proposed project and an offer to schedule a day to visit the project area with the project coordinator. The project shall incorporate the recommendations that prevent significant impacts to water quality as PSRs.

HYD-3: A WLPZ shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current California Forest Practice Rules (Table 2.5-2). Fifty foot equipment limitation zones (ELZs) shall be established for

Class III watercourses. Vegetation within the WLPZ or ELZ will not be disturbed by project activities, with the exception of backing prescribed fire. Class IV watercourse protections shall be PSRs specified in the PSA, and designed in conjunction with any recommendations from RWQCB staff.

Table 2.5-2 Watercourse and lake protection zone buffer widths by watercourse classification and hill slope gradient (See HYD -3)

Note: ELZ-Equipment Limitation Zone, PSR-Project Specific Requirement

Water Class Characteristics or Key Indicator / Beneficial Use	1)Domestic supplies, including springs, on site and/or within 100 feet downstream of the project area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning	1) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for non-fish aquatic species. 3) Excludes Class III water that are tributary to Class I waters	No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II water under normal high water flow conditions of timber operations	Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use
Water Class	Class I	Class II	Class III	Class IV
Slope Class (%)	Width (ft.)	Width (ft.)	Width (ft.)	Width
<30	75	50	50 (ELZ)	PSR
30-50	100	75	50 (ELZ)	PSR
>50	150	100	50 (ELZ)	PSR

HYD-4: No direct ignition shall be allowed within the WLPZ or ELZs. However, it is acceptable for a fire to enter or back into a WLPZ's or ELZ's.

HYD-5: Compacted and/or bare linear treatment areas (e.g., fire breaks, roads, or trails) capable of generating storm runoff shall be drained via water breaks using the spacing guidelines contained in Sections 914.6, 934.6, and 954.6(c) of the California Forest Practice Rules.

HYD-6: Compacted and/or bare treatment areas shall be drained such that they are hydrologically disconnected from watercourses or lakes. Measures to hydrologically disconnect these areas shall be guided by consulting with Technical Rule Addendum #5 of the California Forest Practice Rules – Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings

HYD-7: No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or damage to soil structure. Saturated soil means that soil and/or surface material pore spaces are filled with water to such an extent that runoff is likely to occur. Indicators of saturated soil conditions may include, but are not limited to: (1) areas of ponded water, (2) pumping of fines from the soil or road surfacing material during timber operations, (3) loss of bearing strength resulting in the deflection of soil or road surfaces under a load, such as the creation of wheel ruts, (4) spinning or churning of wheels or tracks that produces a wet slurry, or (5) inadequate traction without blading wet soil or surfacing materials.

HYD-8: For remaining hydrologically connected areas of compacted or bare linear treatment areas, disturbed areas will be mulched with onsite native vegetative material (e.g., cut material).

HYD-9: During dry, dusty conditions, unpaved roads shall be wetted using water trucks or treated with a non-toxic chemical dust suppressant (e.g., emulsion polymers, organic material). Any dust suppressant product used shall be environmentally benign (i.e., non-toxic to plants and shall not negatively impact water quality) and its use shall not be prohibited by the ARB, U.S. Environmental Protection Agency (EPA), or the State Water Resources Control Board. Exposed areas shall not be over-watered such that water results in runoff. The type of dust suppression method shall be selected by the contractor based on soil, traffic, site-specific conditions, and local air quality regulations.

HYD-10: Prior to the start of onsite activities, all equipment will be inspected for leaks and regularly inspected thereafter until equipment is removed from the project area. All contaminated water, sludge, spill residue, or other hazardous compounds will be contained and disposed of outside the boundaries of the site, at a lawfully permitted or authorized destination.

HYD-11: Staging areas shall be designated and located to prevent leakage of oil, hydraulic fluids, or other chemicals into watercourses or lakes.

HYD-12: All heavy equipment parking, refueling, and service shall be conducted within designated areas outside of the WLPZ or ELZ.

HYD-13: No new roads (including temporary roads) shall be constructed or reconstructed (reconstruction is defined as cutting or filling involving less than 50 cubic yards/0.25 linear road miles). Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice Rules.

HYD-14: Heavy equipment is prohibited on slopes exceeding 65 percent or on slopes greater than 50 percent where the erosion hazard rating is high or extreme. Heavy equipment is prohibited on slopes greater than 50 percent that lead without flattening to watercourses.

HYD-15: Burn piles shall not exceed 20 feet in length, width, or diameter, except when on landings, road surfaces, or on contour.

HYD-16: At the CalWater Planning Watershed scale, if the combined, appropriately-weighted acreage subjected to fuels treatments and logging exceed 20% of the watershed area within a 10-year timespan (see Appendix K for calculation procedures); an analysis will be performed to determine the potential for hydrologically-induced significant impacts of the proposed activity.

HYD-17: If herbivory is proposed to treat vegetation in a project area containing watercourses, then the following items must be addressed as PSRs:

- The project will require water on site in the form of an on-site stock pond outside the WLPZ or ELZ, or a portable water source located outside the WLPZ or ELZ.
- The project will specify animal containment measures in the PSA to prevent animals from entering the WLPZ and/or ELZs. These might include the use of fencing (i.e., fixed or portable), the use of guard or herd dogs, or the use of an on-site herder.

Noise-Related Standard Project Requirements

NSE-1: All powered equipment shall be used and maintained according to manufacturer's specifications.

NSE-2: Equipment engine shrouds shall be closed during equipment operation.

NSE-3: All heavy equipment and equipment staging areas shall be located as far as possible from nearby noise-sensitive land use (e.g., residential land uses, schools, hospitals, places of worship).

NSE-4: All motorized equipment shall be shut down when not in use. Idling of equipment or trucks shall be limited to 5 minutes.

NSE-5: Public notice of the proposed project shall be given to notify noise-sensitive receptors of potential noise-generating activities.

Traffic-Related Standard Project Requirements

TRA-1: Public road ways leading into project area shall be signed to warn traffic of the project activities that are taking place. Road signage shall be posted the morning prior to the commencement of burning operations and shall remain until all operations are completed.

TRA-2: Direct smoke and dust impacts to roadway visibility and the indirect distraction of operations shall be considered during burning operations. Traffic control operations shall be implemented if weather conditions inhibiting smoke and dust dispersion have the potential to impact roadway visibility to motorists.

2.5.2 PROJECT SPECIFIC REQUIREMENTS

Projects may require additional measures to protect the environment based on site-specific conditions and consultation with affected regulatory agencies and/or stakeholders. These additional measures are known as Project Specific Requirements (PSRs) mitigations, and will be discussed narratively in the body of the VTP PSA. PSRs will also be placed into contract language so that they are properly implemented during project operations.

2.6 AREAS OF CONTROVERSY

Section 15123(b) of the State CEQA Guidelines requires that an EIR identify areas of controversy known to the lead agency, including issues raised by agencies and the public. The following are areas of controversy known to CAL FIRE:

- Air quality impacts from prescribed burning
- Cumulative impacts to chaparral communities from program treatments and wildfires
- Impacts to water quality, biological resources, and human health
- Impacts to geological features and soil erosion
- Inclusion of herbicide applications as a Program activity
- Introduction or spread of invasive plants
- Potential for loss of life, property, and resource values due to escaped prescribed fire
- Impact to climate change and greenhouse gases Ability to address the ecological and social complexities of the state in a single Program
- Impacts to cultural resources

These areas of known controversy will be addressed through the implementation of the SPRs, PSRs, and mitigation measures.

CASE STUDY– Shaded Fuel Break

West Fire and Critical Defensible Space Lessons

July 28, 2010

The West Fire started on July 28, 2010 at 14:14 hours in Kern County. The fire was human caused and started along Blackburn Canyon Road 3 miles south of Highline Road. First arriving units reported a fast moving vegetation fire 1-2 acres in size with an immediate structure threat. Within the first 15 minutes the fire was exhibiting extreme fire behavior, with moderate duration crown runs and spotting a ½ mile ahead of the main fire and around several structures. The fire was burning in a north direction down-canyon which is not typical for this area, as the typical wind pattern is west to east.

Vegetation management projects within the community of Old West Ranch started in 2004 when the Fire Safe Council receiving their first grant for vegetation management work to develop the Blackburn Canyon Escape Route. Kern County Fire crews spent the next two summers clearing overgrown vegetation. The project consisted of removing dead and overgrown vegetation, limbing up existing live trees, and removing dead trees within 25 feet of both sides of the road. The purpose of this project was to reduce the fuel build up along the side of the access roads to allow the residents a safe way to evacuate the community and allow emergency vehicles a safe way into the community. In 2010 additional project work consisting of a 150 foot wide shaded fuel break along Wildhorse Ridge to the south of the Old West Ranch community. Kern County fire crews utilized a masticator and were able to complete the majority of the work in three months.

These projects were used effectively in the efforts to control the West Fire. The shaded fuel break along Wildhorse Ridge stopped the southern progression of the fire with no re-enforcement and the escape route project proved to be invaluable in the evacuation and safety of the residents and the safety of emergency equipment accessing the fire.

Defensible space was the key to structure survivability during this fire. During initial attack firefighters were battling an intensely burning, fast moving wildfire, with flame lengths in excess of 150 feet and numerous spot fires ¼- ½ mile ahead of the main fire. Kern County Fire Department enforces the 100 feet defensible space requirement in PRC 4291. In this case the minimum provided to be inadequate in areas due to the intensity of this fire. The 100 feet did suffice in some areas, but in the areas of extreme fire behavior larger clearances were needed to insure survivability.

CASE STUDY– Shaded Fuel Break

Goat Fire

July 18, 2000

The Goat Fire was caused by a campfire on July 18, 2000. Located in steep, rocky terrain along State Highway 44 in Lassen County, the fire spread rapidly toward the community of Lake Forest Estates. Because of extreme fire conditions, and as a precaution, evacuations were started.

Over 1,100 fire fighting resources were called in to battle the flames which were racing through heavy timber, jumping from treetop to treetop in the form of a crown fire. The land had been owned by Roseburg Resources timber company before purchase by Sierra Pacific Industries. Roseburg had completed a thinning and chipping project in the area back in 1991. When the Goat Fire reached this thinned area flames dropped from the crown of the trees to the ground where firefighters were able to attack it.

In addition to the thinned area, Roseburg had completed a 1,000 foot shaded fuel break along one side of Lake Forest Estates in 1990. The fire reached within a mile of the community. Firefighters were able to safely stop the fire in the thinned forest keeping the flames out of Lake Forest Estates.

3 SUMMARY OF ALTERNATIVES

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The California Environmental Quality Act (CEQA) Guidelines (State CEQA Guidelines) Section 15126.6[a] requires an Environmental Impact Report (EIR) to “describe a range of reasonable alternatives to the project, ... [that] would feasibly attain most of the basic project objectives but would avoid or substantially lessen any of the significant effects, and evaluate the comparative merits of the alternatives.” The purpose of the alternatives analysis is to determine whether or not an alternative to the proposed Program would feasibly reduce or eliminate significant project impacts, while still attaining the basic objectives of the project.

The range of alternatives studied in an EIR is governed by the “rule of reason,” requiring evaluation of only those alternatives “necessary to permit a reasoned choice” (State CEQA Guidelines Section 15126.6[f]). Further, an agency “need not consider an alternative whose effect cannot be reasonably ascertained and whose implementation is remote and speculative” (State CEQA Guidelines Section 15126.6[f][3]). The analysis should focus on alternatives that are feasible (i.e., that may be accomplished in a successful manner within a reasonable period of time, taking economic, environmental, social, and technological factors into account). Alternatives that are remote or speculative or that do not feasibly meet most of the project objectives need not be discussed. Furthermore, the alternatives analyzed for a project should focus on reducing or avoiding significant environmental impacts associated with the project, as proposed. The CEQA Guidelines provide the following direction for analysis of the alternatives:

- Describe a range of reasonable and feasible alternatives to the project, or to the location of the project.
- Evaluate the comparative merits of the alternatives.

- If there is a specific proposed project, explain why other alternatives were rejected in favor of the proposal.
- Focus on alternatives capable of avoiding or substantially lessening significant adverse environmental effects or reducing them to a level of less than significant, even if these alternatives would impede to some degree the attainment of the project objectives or would be more costly.
- If an alternative would cause one or more significant effects in addition to those that would be caused by the project as proposed, the significant effects of the alternative shall be discussed, but in less detail than the significant effects of the project as proposed.

The objectives of the proposed Program are listed below. The evaluation of alternatives is conducted in the context of seeking to meet most of these objectives. They are:

- To modify wildland fire behavior to help reduce losses to life, property, and natural resources
- To increase the opportunities for altering or influencing the size, intensity, shape, and direction of wildfires within the wildland urban interface
- To reduce the potential size and associated suppression costs of individual wildland fires by altering the continuity of wildland fuels
- To reduce the potential for high severity fires by restoring and maintaining a range of native fire-adapted plant communities through periodic low intensity treatments within the appropriate vegetation types
- To provide a consistent, accountable, and transparent process for vegetation treatment that is responsive to the objectives, priorities, and concerns of landowners, local, state, and federal governments, and other stakeholders

3.1 ALTERNATIVES EVALUATED IN THIS PROGRAM EIR

As a result of the above requirements, the following alternatives have been developed. Each is listed below and described in more detail in following sub-sections. A more detailed analysis of the impacts of all alternative are discussed in Chapter 4 and 5.

No Project – This alternative represents the “No Project” alternative required by CEQA. If CAL FIRE took no further action, existing vegetation treatment programs, such as the Vegetation Management Program (VMP) and California Forest Improvement Program (CFIP), would continue to operate using previously approved EIRs and departmental procedures to satisfy CEQA requirements. The guidance documents for each of the CAL FIRE programs would apply to an existing landscape that is larger than the proposed Program or the Alternatives because both apply to the entire State Responsibility Area (SRA).

Proposed Program – The proposed Program would limit vegetation treatment efforts to areas within the SRA where assets, both urban and natural, are at greatest risk from wildland fire. Treatment activities would be limited to three general “project types” which include vegetation treatments to protect the Wildland Urban Interface (WUI), fuel break installation and maintenance, and enhancing vegetative fire resiliency through Ecological Restoration. The available landscape to treat would be smaller than the “No Project” Alternative because the scope would be limited to areas that fall under one or more of the specified project and vegetation types.

Alternative A: WUI Only- The WUI Only Alternative would focus vegetation treatments specifically in areas that would protect assets within the WUI. Projects would primarily consist of community and infrastructure protection, establishing safe areas of refuge, and enhancing vegetation clearance proximate to structures. Vegetation management priorities and ecological restoration opportunities outside of the WUI would not be included under this proposed alternative. Wildland fire control success outside the WUI would rely primarily on initial attack and extended attack resources without the strategic benefit of pre-treated fuels or existing fuel breaks. The project evaluation process, analysis procedures, treatment options, and mitigations would be the same as the proposed Program. The available landscape to treat would be significantly smaller than the “Proposed Program” because only a portion of the SRA is comprised of the WUI.

Alternative B: WUI and Fuel Breaks- In addition to vegetation treatment efforts designed specifically to protect values within the WUI, fuel breaks would also be maintained or installed in favorable topographic locations to aid in wildland fire control efforts outside of the WUI. The project evaluation process, analysis procedures, treatment options, and mitigations would be the same as the proposed Program. The available landscape to treat would be significantly larger than the “WUI Only” due to the addition of fuel breaks, however, it would remain less than the “Proposed Program.”

Alternative C: Very High Fire Hazard Severity Zone- CAL FIRE is mandated by Public Resources Code 4201-4204 and Government Code 51175-51189 to identify fire hazard severity zones statewide. These zones reflect areas of significant fire hazard based on fuels, terrain, weather, and other relevant factors. To reduce the wildland fire threat in high hazard areas, fuel treatments under Alternative C would focus specifically on areas that are classified as a "Very High Fire Hazard Severity Zone.” The project evaluation process, analysis procedures, treatment options, and mitigations would be the same as the proposed Program. This alternative includes the least available acreage for treatment relative to the other alternatives.

Alternative D: Treatments that Minimize Potential Impacts to Air Quality- Minimize Potential Impacts to Air Quality has limitations on treatments, specifically the number of acres that could be treated with prescribed fire, and the landscape available for treatment is substantially less than the Proposed Program.

3.2 NO PROJECT

Under the No Project Alternative, CAL FIRE would continue to implement vegetation treatments through existing programs. Treatments would continue to emphasize changing vegetative structure to modify wildland fire behavior and improve non-industrial forestland quality on private forestlands within the State. Treatments would also meet a wide variety of other objectives, including protecting human life and property, reducing fire suppression costs, enhancing habitat, improving resource production (e.g. rangeland forage and water yield), and reducing the potential for long-term detrimental effects of wildland fire.

CAL FIRE would continue to rely on a broad range of environmental analysis tools to satisfy CEQA requirements as Lead Agency. Projects located in shrubland and grass vegetation types could rely on the 1981 Chaparral Management Program EIR for environmental compliance. Vegetation management projects in timber vegetation types, which are outside the scope of the Chaparral Management Program EIR, would rely on either the completion of a Negative Declaration or could fall under the California Forest Improvement Program EIR. Projects which are small in scope and would result in no impacts from the proposed activities could fall under a Categorical Exemption.

3.2.1 DETAILED DESCRIPTION OF TREATMENTS

Vegetation management activities include the disposal, rearrangement, or conversion of vegetation using various treatments. Treatment methods and actions include:

- Prescribed fire (underburn, jackpot burn, broadcast burn, pile burn, establishment of control lines)
- Mechanical (chaining, tilling, mowing, roller chopping, brush raking, skidding and removal, chipping, piling, pile burning)
- Manual (hand pull and grub, thin, prune, hand pile, pile burning, lop and scatter, hand plant)
- Prescribed herbivory (grazing by domestic animals, such as cattle, sheep, goats, horses)

Under the No Project Alternative, herbicide treatments are limited solely to applications funded or regulated under the CFIP program. Vegetation management treatment techniques may be applied singularly or in any combination for a particular vegetation type to meet specific objectives of resource management. Within existing physical, environmental, ecological, social, and legal constraints on the area to be treated, the method or methods used will be those that are most likely to achieve the desired objectives while protecting environmental quality. Historically, treatment acreage has averaged about 27,000 acres per year, with approximately 200,000 to 300,000 acres treated in any ten-year period. Based on recent trends, average project size is expected to be around 260 acres. A detailed description of the vegetation treatments that would be applied under the No Project Alternative is described in Section 2.4.

3.2.2 LANDSCAPE AVAILABLE TO BE TREATED

Unlike the other alternatives, the No Project Alternative already takes place throughout SRA. Because a vegetation treatment project could theoretically take place at any location within the SRA, the landscape available to be treated occurs on a much larger landscape than what the proposed Program and other Alternatives would take place on. Table 3.2-1, visualized in Figure 3.2-1, provides a summary of the available landscape acreage, approximate distribution of treatment activities, approximate acreage treated per decade, approximate annual acreage treated, and percent of the available landscape treated per decade.

Table 3.2-1 No Project treatable landscape (SRA) and approximate acres treated per decade

Bioregion	SRA Acres	Distribution of Treatments	Approx. 10 Year Acreage Treated	Approx. Annual Acreage Treated	% of Modeled Acres (10 years)
Bay Area/Delta	2,990,699	7.39%	20,020	2,002	0.67%
Central Coast	4,953,917	14.26%	38,640	3,864	0.78%
Colorado Desert	509,668	3.25%	8,800	880	1.73%
Klamath/North Coast	7,335,482	17.74%	48,060	4,806	0.66%
Modoc	3,082,183	13.56%	36,730	3,673	1.19%
Mojave	729,740	4.12%	11,160	1,116	1.53%
Sacramento Valley	1,293,669	11.68%	31,650	3,165	2.45%
San Joaquin Valley	1,548,885	7.02%	19,030	1,903	1.23%
Sierra Nevada	6,436,569	14.72%	39,900	3,990	0.62%
South Coast	2,216,829	6.27%	16,980	1,698	0.77%
Total by Treatment	**31,097,639**	**100.00%**	**270,970**	**27,097**	**0.87%**

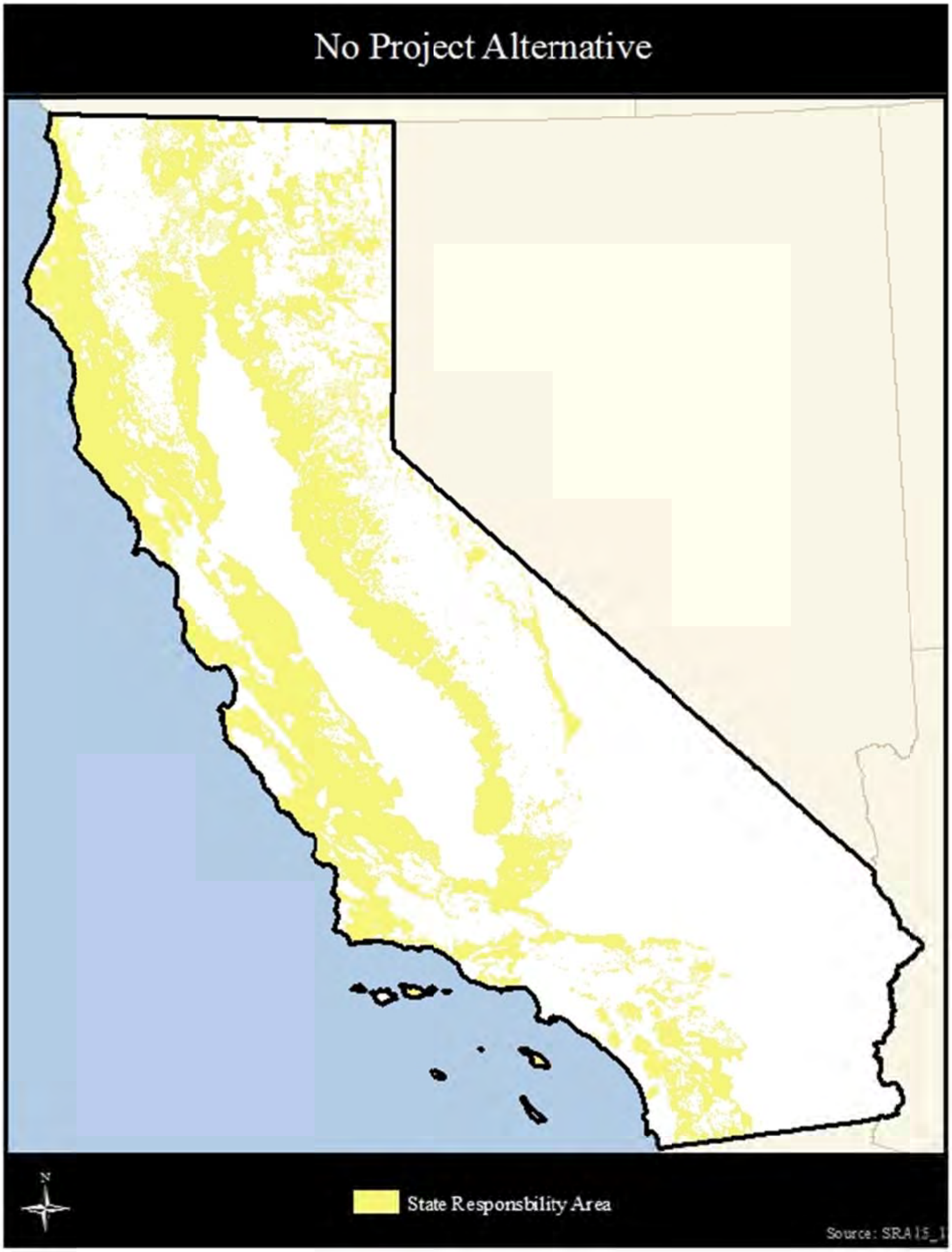

Figure 3.2-1 No Project Alternative

3.2.3 ACHIEVMENT OF BASIC PROJECT OBJECTIVES

The No Project Alternative would not achieve many of the basic objectives of the proposed Program. While wildland fire behavior could be modified to reduce impacts to life, property, and natural resources, the existing VMP scope is limited to only shrubland and grass fuel types and leaves out timber fuel types. Projects initiated in timber fuel types would rely on other programmatic vehicles such as the CFIP EIR or the preparation of a Mitigated Negative Declaration. The CFIP process, however, is largely developed between the landowner and a consulting RPF outside of the Department and generally excludes CAL FIRE from project planning. Preparation of a Mitigated Negative Declaration is costly, time consuming, repetitive, and unsustainable from a personnel standpoint. Because the No Project Alternative does not apply equally to all vegetative fuel types throughout the SRA, opportunities for altering wildfire size, intensity, shape, and ultimately reducing suppression costs within the WUI is largely limited to areas located in shrubland and grass fuel types. Although projects could be initiated under alternative CEQA means, the time consuming nature of preparing projects in this manner would result in fewer projects initiated and fewer acres treated.

Projects under the No Treatment Alternative would continue to be evaluated and approved on a project by project basis through multiple CEQA processes. This alternative does not adequately focus projects to strategic locations within the SRA to achieve the objectives of the proposed Program. Also, because of the multiple CEQA processes involved, the No Treatment Alternative lacks a large-scale coordinated analysis of a series of closely related and reasonably predictable vegetation treatment projects being undertaken throughout the State. Vegetation treatment projects would still be carried out in a manner consistent with CAL FIRE policy, relevant EIRs and CEQA processes, handbooks, and legal requirements which include many features intended to reduce or eliminate potential significant environmental impacts. Adherence to a comprehensive and consistent set of Standard Project Requirements (SPRs) to mitigate potentially significant impacts from vegetation treatment projects would not occur. Adaptive management techniques could be employed, but their application would likely vary from one CAL FIRE Unit to another.

Recognizing that each project would receive its case-by-case review without the opportunity for consistent application of SPRs and mitigation measures from a comprehensive Program EIR, the CEQA documentation would likely be repetitive from one project to the next and the potential for variability in mitigation approaches to offset impacts from one CAL FIRE Unit to the other would exist. The openness and transparency of the case-by-case project evaluation process, while complying with all legal requirements, could also be variable, depending on the nature of the proposal and the approaches of each administrative Unit.

3.3 PROPOSED PROGRAM

The Program stratifies treatments into three basic types: (1) wildland-urban interface (WUI), (2) fuel breaks, and (3) ecological restoration. These three types of treatments will be selected based on the values at risk, surrounding fuel conditions, strategic necessity for fire suppression activities, and departure from natural fire regime. The actual prioritization of such projects will be made at the local CAL FIRE Unit level.

Projects implemented under the WUI treatment type would take place outside of the 100 foot defensible space requirements under PRC 4291, and within the outer edge of the defined WUI area as described later in this section. These projects would focus on directly protecting communities and assets at risk from potential damage from wildfires originating in the adjacent wildlands as well as protecting the wildlands from fires transitioning to the wildlands from human infrastructure by modifying the fuels. Projects conducted in the designated WUI would utilize any of the treatment activities (prescribed herbivory, mechanical, etc) to reduce risk in the WUI.

Projects implemented under the Ecological Restoration treatment type would attempt to restore the fire resiliency associated with many of the fire-adapted plant communities by renewing degraded, damaged, or destroyed ecosystems and habitats in the environment through active intervention. The conceptual basis is that for fire-adapted ecosystems, much of their ecological structure and processes are driven by fire, and the disruption of fire regimes leads to changes in plant composition and structure, uncharacteristic fire behavior and other disturbance agents (pests), altered hydrologic processes, and increased smoke production. This treatment may also be used on working landscapes such as rangeland to facilitate terrestrial and aquatic ecosystem sustainability. Ecological Restoration projects would predominantly occur outside of the WUI in areas that have departed from the natural fire regime; however, these practices may have value in the WUI.

Projects implemented under the Fuel Break treatment type would consist of converting the vegetation along strategically located areas for fire control. The wildland fuels of California occur mainly on mountainous terrain, which adds greatly to the problem of controlling wildfires. Typical fuel break locations include ridgelines, along roads, or in other favorable topographic locations. Fuel breaks can provide safe access for quick manning of fire control lines. Low-volume fuels, especially flammable grass, can be fired out quickly to widen a fire line under conditions where backfiring would be impossible in heavy fuels that have a high heat output. Aerial attack can also be used effectively in conjunction with fuel breaks to contain the lateral spread of an advancing wildfire.

3.3.1 DETAILED DESCRIPTION OF TREATMENTS

Vegetation management activities include the disposal, rearrangement, or conversion of vegetation using various treatments. Treatment methods and actions include:

- Prescribed fire (underburn, jackpot burn, broadcast burn, pile burn, establishment of control lines)
- Mechanical (chaining, tilling, mowing, roller chopping, masticating, brushraking, skidding and removal, chipping, piling, pile burning)
- Manual (hand pull and grub, thin, prune, hand pile, pile burning, lop and scatter, hand plant)
- Prescribed herbivory (grazing by domestic animals, such as cattle, sheep, goats, horses)
- Herbicides (ground applications only, such as backpack spray, hypohatchet, pellet dispersal)

Vegetation management treatment techniques would be applied singularly or in any combination for a particular vegetation type to moderate the fire behavior of the targeted area. Within existing physical, environmental, ecological, social, and legal constraints on the area to be treated, the method or methods used would be those that are most likely to achieve the desired objectives while protecting environmental quality. A detailed description of the vegetation treatment activities that could be applied under the Proposed Program is described in Section 4.1.5.

3.3.2 LANDSCAPE AVAILABLE TO BE TREATED

SRA accounts for over 31 million acres in California, but not all of the area is appropriate for the three basic treatment types outlined in Section 2.3. The total land area capable of undergoing a WUI, fuel break, or ecological restoration treatment is approximately 21 million acres, or 70 percent of the SRA. Just under 50 percent of the acreage is within the proposed WUI treatment type, with the majority of the WUI acreage occurring in the Sierra Nevada and Klamath/North Coast bioregions, respectively. Ecological restoration accounts for approximately 33 percent of the available acreage; most of the ecological restoration acreage occurs in the Klamath/North Coast, Modoc, and Sierra Nevada bioregions, respectively. Fuel breaks make up the smallest proportion of the treatments, accounting for only 17 percent of the area available for treatment. Table 3.3-1 provides a summary of the available landscape acreage, approximate distribution of treatment activities, approximate acreage treated per decade, approximate annual acreage treated, and percent of the available landscape treated per decade under the proposed VTP. Figure 3.3-2 provides a map of the available WUI and ecological restoration treatment areas in the state. An example of a fuel break is pictured in Figure 3.3-1.

Table 3.3-1 Proposed Program treatable landscape and approximate acres treated per decade

Bioregion	Acres Modeled as the VTP	Distribution of Treatments	Approx. 10 Year Acreage Treated	Approx. Annual Acreage Treated	% of Modeled Acres (10 years)
Bay Area/Delta	2,146,135	9.76%	58,550	5,855	0.27%
Central Coast	3,263,733	14.84%	89,040	8,904	0.40%
Colorado Desert	362,077	1.65%	9,878	988	0.04%
Klamath/North Coast	4,270,334	19.42%	116,501	11,650	0.53%
Modoc	2,629,835	11.96%	71,746	7,175	0.33%
Mojave	942,962	4.29%	25,725	2,573	0.12%
Sacramento Valley	866,478	3.94%	23,639	2,364	0.11%
San Joaquin Valley	688,137	3.13%	18,773	1,877	0.09%
Sierra Nevada	4,915,658	22.35%	134,107	13,411	0.61%
South Coast	1,907,557	8.67%	52,041	5,204	0.24%
Total by Treatment	**21,992,906**	**100.00%**	**600,000**	**60,000**	**2.73%**

Figure 3.3-1 Example of a maintained landscape fuel break (arrow). Calf Canyon fuel break, San Luis Obispo County

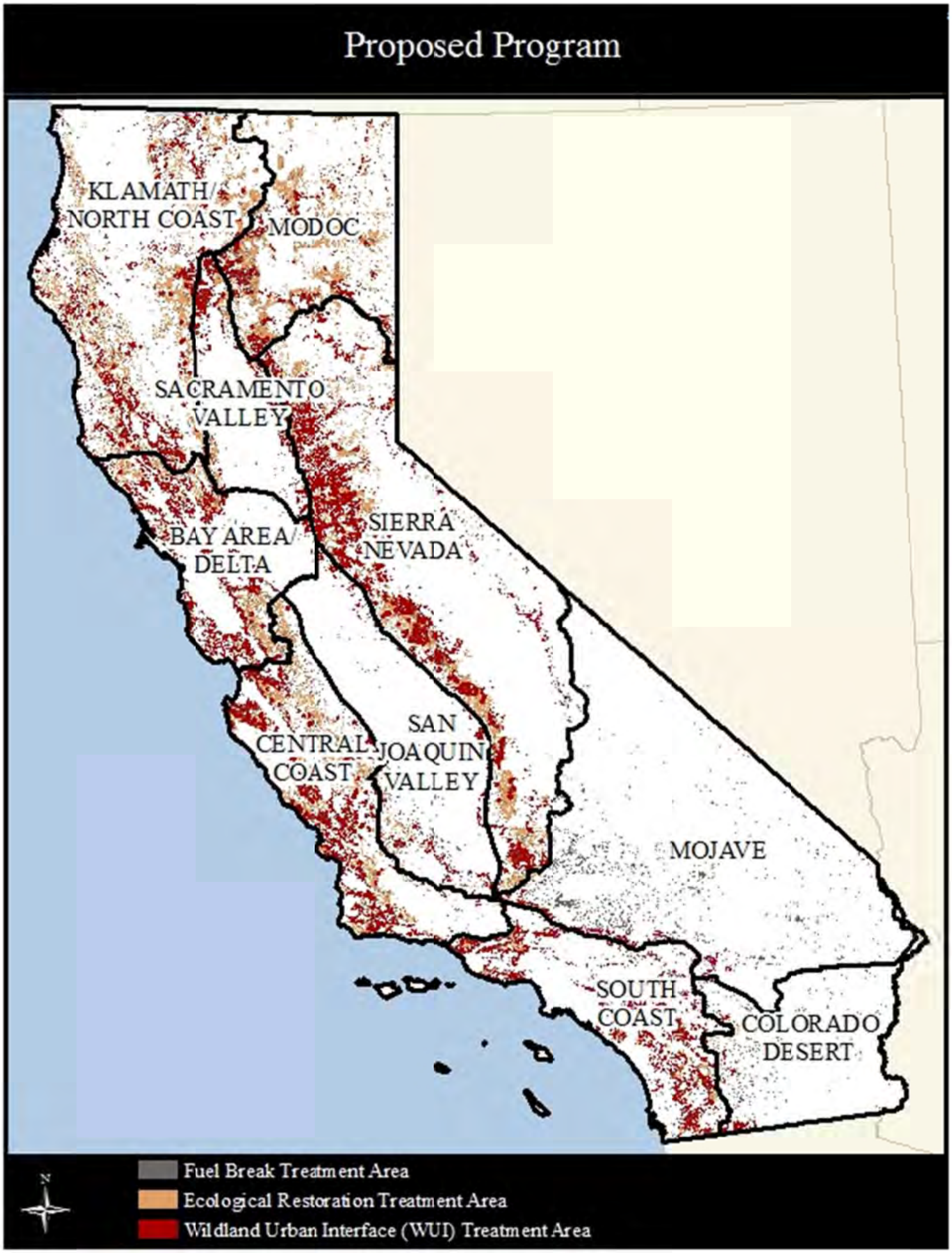

Figure 3.3-2 Proposed Program

3.3.3 ACHIEVEMENT OF BASIC PROJECT OBJECTIVES

The proposed Program would address all of the Program objectives. Wildland fire behavior would be modified, through the use of strategic fuel treatments, to help reduce losses to life, property, and natural resources. This is the governing objective of the program, and is consistent with Goals 1, 5, and 6 of the *2010 Strategic Fire Plan* (Board, 2010). Fire behavior is the manner in which fire reacts to weather, topography, and fuels (NWCG, 2001). Of the three variables, only fuels can be feasibly altered by humans. The primary assumption of the VTP is that appropriate vegetation treatments can affect wildland fire behavior through the manipulation of wildland fuels. With all other factors held constant, reducing the continuity of wildland fuels will result in lower fuel hazard and more favorable fire behavior. In turn, this will theoretically allow for more effective fire suppression and therefore reduce the likelihood of wildfire adversely affecting values at risk.

Opportunities for altering the intensity, shape, and direction of wildfires within the wildland urban interface would occur under the proposed Program. This objective places emphasis on increasing the strategic and tactical effectiveness of fire suppression within the WUI through the use of appropriate vegetation treatments. The WUI is the geographical overlap of two diverse systems, wildland and structures. At this interface, the buildings and vegetation are sufficiently close that a wildland fire could spread to a structure or a structure fire could ignite wildland vegetation. Focusing vegetation treatments in the WUI is critical, as losses in the WUI are on the rise (Stephens et al., 2009a) and are expected to get worse (Mann et al., 2014). The WUI component of the proposed Program is a tool to combat these predictions and engage in fuel reduction projects within the WUI.

The proposed Program would reduce the potential size and associated suppression costs of wildland fires by altering the continuity of wildland fuels. Wildfire suppression costs borne by California taxpayers have risen significantly in the past 35 years (Figure 2.2-3). Figure 1.1-1 and Figure 2.2-4 suggest a concomitant increase in both acres burned and suppression costs around the year 2000. The assumption is that decreasing fire size will have a resulting decrease on fire suppression costs (Figure 2.2-4). While wildfire acreage is not the only variable that drives suppression costs (Gude et al., 2013), increasing the likelihood that fires will be contained to relatively small areas through the use of fuel breaks and ecological restoration should also relate to lower cumulative fire suppression costs.

The potential for high-severity fires would be reduced by restoring a range of native fire-adapted plant communities through periodic low intensity treatments within appropriate vegetation types. The restoration of lower fuel amounts is a critical need across portions of the western United States (Agee and Skinner, 2005). In California, fuel treatments have been shown to reduce fire severity (Skinner et al., 2004; Stephens et al., 2009a). It is also recognized that fuel reduction projects within forested settings appear to be more effective in reducing burn severity, as compared to some southern California chaparral ecosystems. Appropriately designed ecological restoration treatments can mimic the disturbance processes that historically controlled plant community composition and structure. In addition, reduced fuel loading in appropriate vegetation types can increase ecosystem resiliency to wildfire.

Adopting a programmatic approach to vegetation treatment can assure that a consistent process is applied to the prioritization, evaluation, and implementation of vegetation treatment projects. There is also recognition that projects can be improved through the consideration of stakeholder commentary. Also, there is a need to demonstrate whether the desired program and/or project outcomes are being achieved, and whether elements of the program should be iteratively changed in response to emerging data (i.e., adaptive management). The proposed Program recognizes that the chosen alternative will foster consistency, accountability, and transparency for the VTP in a way that satisfies the needs of vested stakeholders.

3.4 ALTERNATIVE A: WUI ONLY

Although wildfire behavior is driven by fuels, weather, and topography, human influences on wildfire are largely restricted to intentional or unintentional effects on fuels. Human geography, as it relates to the increased settlement of wildland landscapes, further complicates fire control efforts. The density of houses and other private structures in formerly wildland landscapes of the West is increasing rapidly (Field and Jensen, 2005). The extent of California's WUI, the area where homes are located in or near undeveloped wildland vegetation, grew almost 9 percent from 1990 to 2000 while the number of houses in new WUI grew by almost 700 percent over the same period (Hammer et al., 2007). Development in the WUI is leading both to increasing fire ignition and to increasing losses of property and life and as such, California is the focus of much of the nation's WUI issues (Radeloff et al., 2005).

Fires occurring in the WUI inherently pose multiple challenges. The mix of threats to life, homes, infrastructure, critical watersheds, and other high-value resources all contribute to the complexity of engaging WUI wildfires. Yet, response and management options available to fire managers are limited in areas of such multiple threats and complexity. Because WUI fires typically represent an immediate threat to life and property, fires of this type require immediate and aggressive action with a full complement of crews, equipment, and aircraft. The multiple resources needed to quickly and effectively suppress WUI fires drive costs upward relative to similar sized fires burning in non-WUI areas. Strategically focusing on wildland fuel reduction within the WUI would increase public safety while reducing potential damage to assets within the WUI.

Under Alternative A, projects would limit fuel reduction projects to the WUI only. State resources and funding would focus on protecting or enhancing strategic fire control features within or adjacent to communities primarily through fuel reduction. Vegetation management treatment techniques would be applied singularly or in any combination for a particular vegetation type to meet specific objectives of WUI protection. Within existing physical, environmental, ecological, social, and legal constraints on the area to be treated, the method or methods used would be those that are most likely to achieve the desired objectives while protecting environmental quality.

3.4.1 DETAILED DESCRIPTION OF TREATMENTS

Vegetation management activities include the disposal, rearrangement, or conversion of vegetation using various treatments. Treatment methods and actions include:

- Prescribed fire (underburn, jackpot burn, broadcast burn, pile burn, establishment of control lines)
- Mechanical (chaining, tilling, mowing, roller chopping, masticating, brushraking, skidding and removal, chipping, piling, pile burning)
- Manual (hand pull and grub, thin, prune, hand pile, pile burning, lop and scatter, hand plant)
- Prescribed herbivory (grazing by domestic animals, such as cattle, sheep, goats, horses)
- Herbicides (ground applications only, such as backpack spray, hypohatchet, pellet dispersal)

Vegetation management treatment techniques would be applied singularly or in any combination for a particular vegetation type to moderate the fire behavior within and adjacent to the WUI. Within existing physical, environmental, ecological, social, and legal constraints on the area to be treated, the method or methods used would be those that are most likely to achieve the desired objectives while protecting environmental quality. A detailed description of the vegetation treatments that could be applied under the WUI Alternative is described in Section 4.1.5.

3.4.2 LANDSCAPE AVAILABLE TO BE TREATED

Vegetation treatment projects under this Alternative would occur only in areas within the defined WUI landscape. To summarize Chapter 2, the WUI landscape was developed using a cost distance function in which urban areas and areas of “little” or “no threat” have higher costs while all other areas have lower cost. A maximum 1.5 mile buffer around areas where all costs are low was developed in accordance with the 2001 California Fire Alliance definition of “vicinity,” which is an approximate distance that embers and flaming material (firebrands) can be carried from a wildland fire to the roof of a structure. For areas where the buffer takes on higher cost values, the maximal buffer distance is approximately 0.5 miles. Areas with mixed costs have buffer distances within this range. This concept reflects the greater resistance that urban areas and areas of little or no threat (such as agriculture lands) offer to the spread of wildland fire. Thus, areas of greater threat class take precedence over areas with lesser or no threat class. Refer to Chapter 2.3.2 for greater detail regarding WUI landscape development.

Vegetation management projects outside the defined WUI would be considered beyond the scope of the VTP Program EIR and would need to satisfy CEQA requirements through external processes. It is assumed that work capacity would be the same as that of the proposed Program. Table 3.4-1 provides a summary of the available landscape acreage, approximate distribution of treatment activities, approximate acreage treated per decade, approximate annual acreage treated, and percent of the available landscape treated per decade. Figure 3.4-1 shows the spatial distribution of treatable WUI land under this Alternative. A closer look at an example WUI area is presented in Figure 3.4-2.

Table 3.4-1 Alternative A treatable landscape (WUI) and approximate acres treated per decade

Bioregion	Acres Modeled as WUI	Distribution of Treatments	Approx. 10 Year Acreage Treated	Approx. Annual Acreage Treated	% of Modeled Acres (10 years)
Bay Area/Delta	1,291,941	12.11%	72,669	7,267	0.68%
Central Coast	1,626,890	15.25%	91,509	9,151	0.86%
Colorado Desert	113,664	1.07%	6,393	639	0.06%
Klamath/North Coast	1,604,748	15.04%	90,263	9,026	0.85%
Modoc	733,671	6.88%	41,267	4,127	0.39%
Mojave	226,257	2.12%	12,726	1,273	0.12%
Sacramento Valley	512,804	4.81%	28,844	2,884	0.27%
San Joaquin Valley	328,136	3.08%	18,457	1,846	0.17%
Sierra Nevada	2,884,660	27.04%	162,256	16,226	1.52%
South Coast	1,344,332	12.60%	75,616	7,562	0.71%
Total by Treatment	**10,667,101**	**100.00%**	**600,000**	**60,000**	**5.62%**

Figure 3.4-1 Alternative A

3.4.3 ACHIEVMENT OF BASIC PROJECT OBJECTIVES

Alternative A would achieve some of the basic objectives of the proposed Program. Fire behavior modification would occur to help reduce loss to life, property, and natural resources. Beyond the WUI however, the results would be limited. SRA lands provide a broad array of ecological benefits including critical habitat for protected species, drinking water, wood products, carbon storage, and scenic and recreational opportunities to name a few. Large, destructive wildfires are a growing threat to these values, and it's clear that landscape scale changes in vegetative structure and fuel loadings must be accomplished to significantly alter wildfire behavior, reduce wildfire losses, and achieve longer term fire resiliency in the wildlands (Agee et al., 2000; Finney, 2001; Peterson et al., 2003; Graham et al., 2004). Limiting fuel treatments to only the WUI would ignore larger opportunities to restore or maintain fire-adapted ecosystems beyond the WUI.

It should be noted that there are several key differences between fuel treatment priorities and outcomes in the WUI versus in wildlands. WUI fuel treatments are intended primarily to protect lives and private property, and to create safe zones for direct attack tactics based on mechanized support. Wildland treatments are typically designed to slow fire spread so as to provide time for indirect efforts to succeed in creating favorable conditions ahead of the fire that are more likely to result in its control. As such, WUI fuel treatments ultimately serve as the last line of defense for asset protection and are subject to more intense levels of fuel removal (Safford et al., 2009).

Alternative A, because it is WUI-centric, would likely out-perform other Alternatives with regard to increasing opportunities for altering or influencing the size, intensity, shape and direction of wildfires within the WUI. With few exceptions, fuel treatments substantially moderate fire severity and reduce tree mortality under typical weather conditions. Focusing fuel treatment efforts to the WUI will increase opportunities to reduce fire behavior and provide firefighters with safer options to protect homes and infrastructure.

Alternative A would marginally reduce the potential for high severity fires by restoring a range of native, fire-adapted plant communities through periodic low intensity treatments within appropriate vegetation types. Prescribed burning elicits a host of ecological interactions potentially important to restoration, including release from plant competition, greater access to light and water, nutrient enrichment, destruction of germination retardants, and the beneficial effects of smoke on plant germination (Keeley and Fotheringham, 1998).

The risk of potential fire escape and the generation of nuisance smoke often outweigh the benefits of applying fire for fuel reduction proximate to communities. Because of social, operational, and ecological constraints, mechanical treatments are often easier to implement than prescribed fire, and are often used in its place. However, mechanized and hand treatment effects on ecological function are usually subtle, short-lived, and do not serve as a surrogate for fire. Fire has unique effects on ecosystems and most favorable effects cannot be successfully emulated with any other treatment (McIver et al., 2013). Restoring native, fire-adapted plant communities would be less likely under this Alternative because prescribed fire would be available in fewer applications than alternative treatments.

Limiting projects only to the WUI is not in total alignment with the Department's overall mission to protect natural resources. In addition to providing fire protection, the Department also engages in projects to protect watershed values and restore fire-adapted ecosystems to preserve biological integrity. Engaging in ecological restoration projects to protect watersheds and address chronic departures from natural fire regimes outside the WUI would not occur, leading to increased fire behavior and hazard risk.

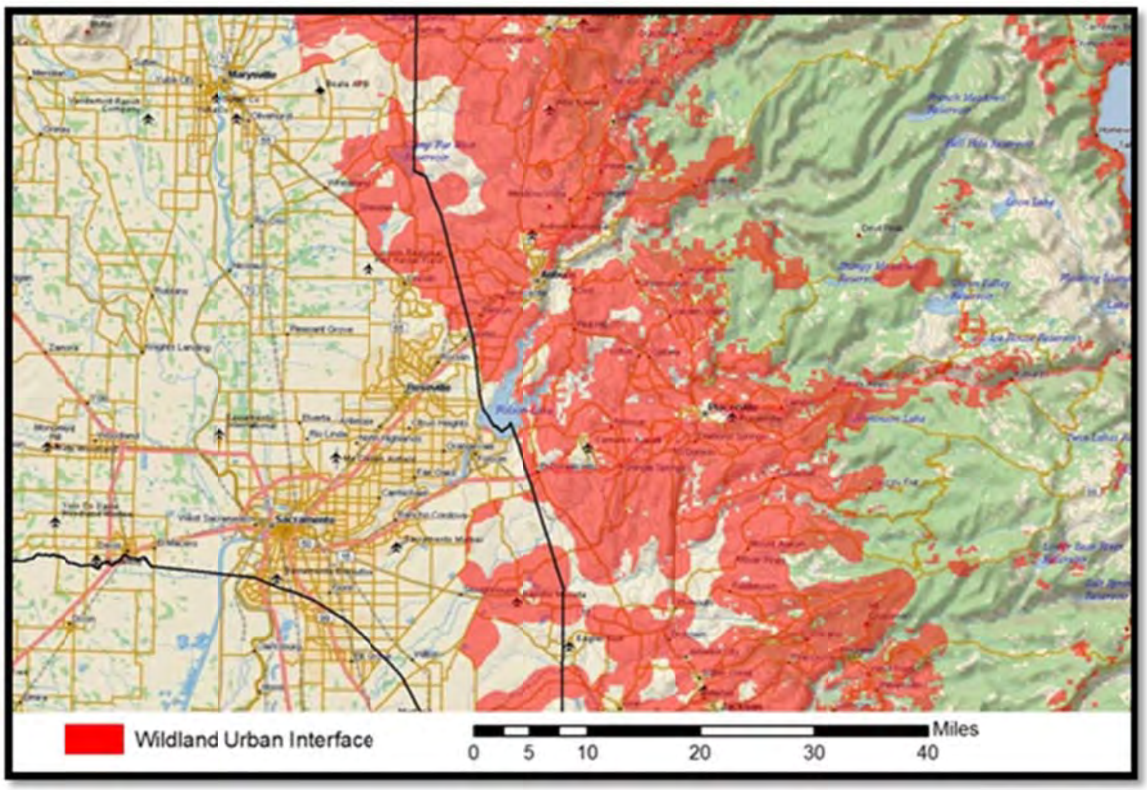

Figure 3.4-2 Example of designated WUI within SRA in the central Sierra Nevada Mountains

Similar in structure to the proposed Program, projects conducted under Alternative A would benefit from a consistent statewide evaluation process. Proposed projects would be evaluated for implementation using a standardized system and subject to a single CEQA process. Adherence to a comprehensive set of statewide mitigations would occur. CAL FIRE would still require compliance with CEQA for all project proposals equally, regardless of whether it is conducted in a systematic and comprehensive manner or on a case-by-case basis. Projects conducted outside of the designated WUI, however, would require additional CEQA analysis on a case-by-case basis without the benefit of consistently applied Standard Project Requirements (SPRs). It is reasonable to conclude that the risk of environmental impacts may be greater as a practical matter for case-by-case proposals outside of the WUI.

3.5 ALTERNATIVE B: WUI AND FUEL BREAKS

Alternative B would combine Alternative A (WUI only) with the option to implement fuel breaks outside the WUI. Fuel breaks are an area in which flammable vegetation has been modified to create a defensible space in an attempt to reduce fire spread to structures and/or natural resources, and to provide a safer location to fight fire. These treatments can be a part of a series of fuel modifications strategically located along a landscape.

Projects implemented under the fuel break designation would consist of converting the vegetation along strategically located areas for fire control. The wildland fuels of California occur mainly on mountainous terrain, which adds greatly to the problem of controlling wildfires. Typical fuel break locations include ridgelines, along roads, or in other favorable topographic situations. Fuel breaks can provide safe access for quick manning of fire control lines. As stated previously, protective firefighter clothing and equipment has limitations on how much convection and conduction heat energy they can take. These types of vegetation treatments can provide necessary firefighter safety zones or immediate access to escape wildfire burn injuries. Low-volume fuels, especially flammable grass, can be cleared quickly to widen a fire line under conditions where backfiring would be impossible in heavy fuels having high heat output. Aerial attack can also be used effectively in conjunction with fuel breaks to contain the lateral spread of an advancing wildfire.

3.5.1 DETAILED DESCRIPTION OF TREATMENTS

Vegetation management activities include the disposal, rearrangement, or conversion of vegetation using various treatments. Treatment methods and actions include:

- Prescribed fire (underburn, jackpot burn, broadcast burn, pile burn, establishment of control lines)
- Mechanical (chaining, tilling, mowing, roller chopping, masticating, brushraking, skidding and removal, chipping, piling, pile burning)
- Manual (hand pull and grub, thin, prune, hand pile, pile burning, lop and scatter, hand plant)
- Prescribed herbivory (grazing by domestic animals, such as cattle, sheep, goats, horses)

- Herbicides (ground applications only, such as backpack spray, hypohatchet, pellet dispersal)

Vegetation management treatment techniques would be applied singularly or in any combination for a particular vegetation type to moderate the fire behavior associated within the WUI as well as fuel break maintenance or installation. Within existing physical, environmental, ecological, social, and legal constraints on the area to be treated, the method or methods used would be those that are most likely to achieve the desired objectives while protecting environmental quality. A detailed description of the vegetation treatments that would be applied under the Alternative B is described in Section 4.1.5.

3.5.2 LANDSCAPE AVAILABLE TO BE TREATED

Vegetation treatment projects under this EIR would occur only in areas designated within the WUI or as a fuel break outside of the WUI. Fuel break acreage estimates were compiled using a modelling exercise which combines key topographic features with roadside fuel clearance along designated roads. See Chapter 4.1 for model description and parameters. Vegetation management projects which are outside the WUI and not associated with a fuel break would be considered outside the scope of the VTP Program EIR and would need to rely on alternative means to address CEQA requirements. Table 3.5-1 provides a summary of the available landscape acreage, approximate distribution of treatment activities, approximate acreage treated per decade, approximate annual acreage treated, and percent of the available landscape treated per decade. WUI and fuel break treatable areas are modeled spatially in Figure 3.5-1.

Table 3.5-1 Alternative B treatable landscape (WUI and Fuel Breaks) and approximate acres treated per decade

Bioregion	Acres Modeled as WUI & Fuel Breaks	Distribution of Treatments	Approx. 10 Year Acreage Treated	Approx. Annual Acreage Treated	% of Modeled Acres (10 years)
Bay Area/Delta	1,614,957	11.06%	66,342	6,634	0.45%
Central Coast	2,126,524	14.56%	87,358	8,736	0.60%
Colorado Desert	315,536	2.16%	12,962	1,296	0.09%
Klamath/North Coast	2,222,188	15.21%	91,287	9,129	0.63%
Modoc	1,139,222	7.80%	46,799	4,680	0.32%
Mojave	863,107	5.91%	35,456	3,546	0.24%
Sacramento Valley	686,352	4.70%	28,195	2,820	0.19%
San Joaquin Valley	556,486	3.81%	22,860	2,286	0.16%
Sierra Nevada	3,389,936	23.21%	139,258	13,926	0.95%
South Coast	1,691,355	11.58%	69,481	6,948	0.48%
Total by Treatment	**14,605,664**	**100.00%**	**600,000**	**60,000**	**4.11%**

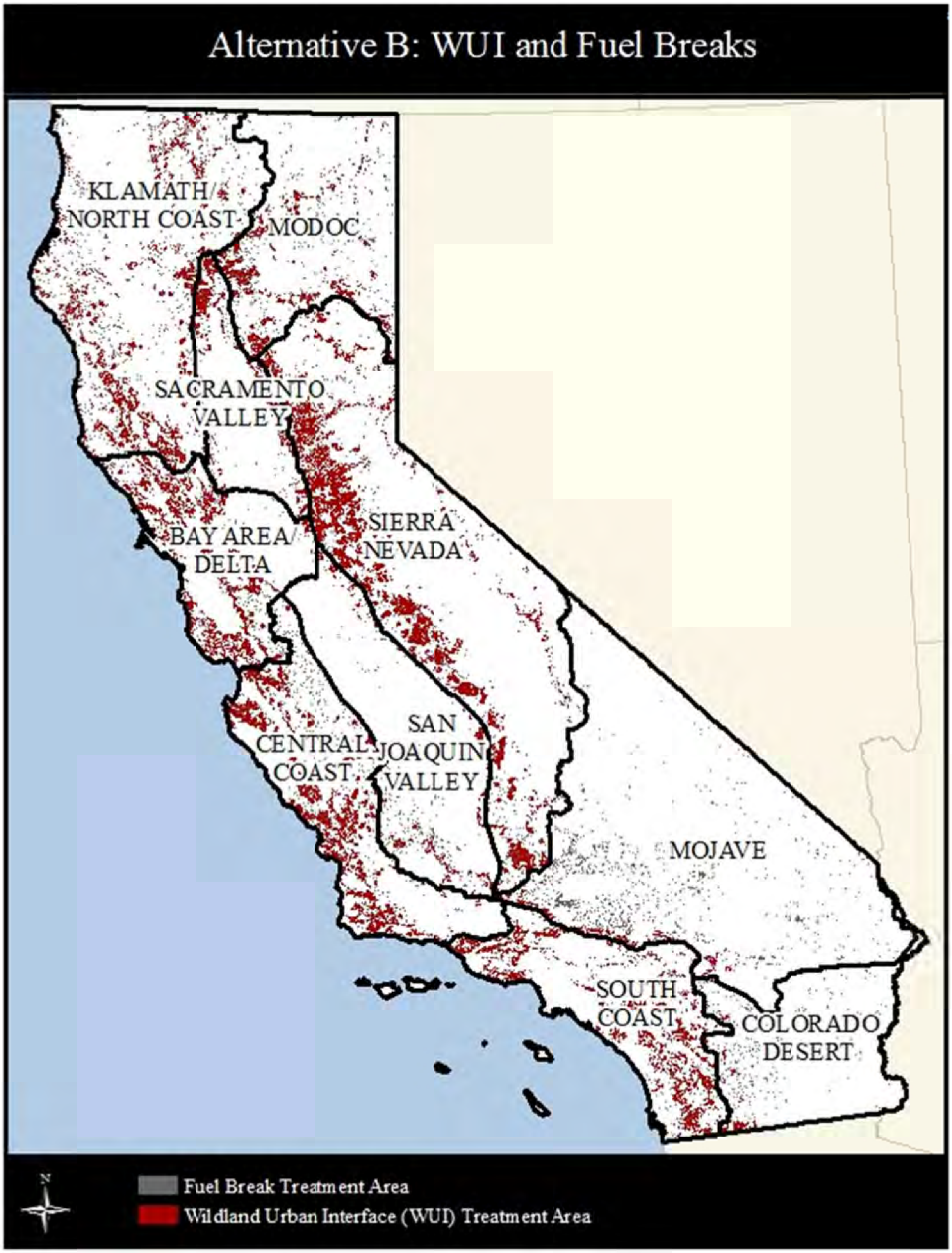

Figure 3.5-1 Alternative B

3.5.3 ACHIEVMENT OF BASIC PROJECT OBJECTIVES

Alternative B would achieve most of the objectives of the proposed Program. Similar to the other Alternatives, wildland fire behavior would be modified to help reduce losses to life, property, and natural resources. Because the WUI is a major component of this Alternative, there exists opportunities to alter the size, intensity, shape, and direction of fires specific to the WUI. Also within the WUI, and beyond, to a lesser degree, the reduction of potential size and associated suppression costs is achievable due to the fuel break component of this Alternative. Fuel breaks are designed to reduce the potential for fire spread and allow for the safety of suppression personnel to engage a fire.

An obvious limitation of fuel break system effectiveness is the heavy, flammable vegetation which normally remains on much of the adjacent untreated lands. Fires that occur on adjacent, untreated lands with heavy fuels are extremely difficult to control. Even with improvements in firefighting equipment and techniques which provide quicker, larger suppression responses during windy weather, smoky conditions, and during darkness, control of fires in heavy fuels will continue to be difficult and perhaps impossible under severe conditions.

Reducing the potential for high severity fires by restoring a range of native, fire-adapted plant communities through periodic low intensity treatments is unlikely to occur outside of the WUI under this alternative. Prior to human-influenced changes to the characteristic fire regime, the composition, structure, and spatial pattern in frequent-fire ecosystems (FRI of less than 35 years) were maintained by frequent, low-severity fire through a functional relationship between pattern and process; that is, frequent low-severity fires resulted in ecosystem structures that facilitated continued low-severity fire.

Fuel breaks serve as a defensive feature and are typically implemented through mechanical means. Ecosystem resiliency is the ability of an ecosystem to absorb and recover from disturbances without altering its inherent function (Reynolds et al., 2013). Fire has unique effects on ecosystems and most favorable effects cannot be successfully emulated with any other treatment (McIver et al., 2013). Restoring native, fire-adapted plant communities beyond the WUI would be less likely under this Alternative because the option to engage in landscape scale restoration efforts would be beyond its scope.

Similar in structure to the proposed Program, projects conducted under Alternative B would benefit from a consistent statewide evaluation process. Proposed projects would be evaluated for implementation using a standardized system and be subject to a single CEQA process. Adherence to a comprehensive set of statewide Standard Project Requirements (SPRs) would occur. CAL FIRE would still require compliance with CEQA for all project proposals equally, regardless of whether it is conducted in a systematic and comprehensive manner or on a case-by-case basis. Projects conducted outside of the designated WUI and not associated with a fuel break, however, would require additional CEQA analysis on a case-by-case basis without the benefit of consistently applied SPRs. It is reasonable to conclude that the risk of environmental impacts may be greater as a practical matter for case-by-case proposals outside of the scope of Alternative B.

3.6 ALTERNATIVE C: PROJECTS LIMITED TO VERY HIGH FIRE HAZARD SEVERITY ZONES

The Bates Bill, which became law January 1, 1993, added Sections 51175 et seq. to the Government Code and amended Health and Safety Code Section 13108.5. The bill requires CAL FIRE to identify and classify fire hazards as they relate to communities. The classification resulted in the identification of moderate, high, and very high fire hazard severity zones (VHFHSZ) and is based on a number of factors including fuels, weather, topography, and ember production. The program is administered by CAL FIRE's Fire and Resource Assessment Program (FRAP). The zones are illustrated on maps and distributed to cities and counties by CAL FIRE, and available to the public on the FRAP website.

Fire hazard, in this case, is a method to measure the physical fire behavior to predict the damage a fire is likely to cause. Fire hazard measurement includes the speed at which a wildfire moves, the amount of heat the fire produces, and the burning fire brands that the fire sends ahead of the flaming front.

Fire hazard is evaluated using five key elements. Vegetation serves as fuel for a wildfire and it changes over time. Fire hazard considers the potential vegetation over a 50 year planning horizon. Topography influences fire hazard by providing opportunities for convective heating. Fires typically burn faster as they progress up steep slopes because the convective heating allows pre-drying and heating prior to the passage of the flaming front. Weather is a critical fire hazard element because fires burn faster and with more intensity when the ambient air temperature is high, relative humidity is low, and winds are strong. Crown fire potential measures the risk of a fire transitioning from a surface fire to the crowns of trees and tall shrubs. The last fire hazard element includes ember production and movement. Fire brands generated from the flaming front are blown ahead of the main fire resulting in increased fire spread as well as opportunities for embers to penetrate openings in structures and ignite the interior.

Under Alternative C, CAL FIRE would focus vegetation treatment to areas representing the highest hazard, classified as VHFHSZ. The purpose would be to moderate the potential fire hazard of these very high hazard areas by modifying the fuels to reduce the potential for extreme fire behavior and ultimately reducing the fire risk to communities adjacent to the VHFHSZ area if an ignition occurs. Because the treatment areas are clearly defined and represent the highest hazard, CAL FIRE could specifically focus efforts to these high priority areas.

3.6.1 DETAILED DESCRIPTION OF TREATMENTS

Vegetation management activities include the disposal, rearrangement, or conversion of vegetation using various treatments. Treatment methods and actions include:

- Prescribed fire (underburn, jackpot burn, broadcast burn, pile burn, establishment of control lines)
- Mechanical (chaining, tilling, mowing, roller chopping, masticating, brushraking, skidding and removal, chipping, piling, pile burning)
- Manual (hand pull and grub, thin, prune, hand pile, pile burning, lop and scatter, hand plant)
- Prescribed herbivory (grazing by domestic animals, such as cattle, sheep, goats, horses)
- Herbicides (ground applications only, such as backpack spray, hypohatchet, pellet dispersal)

Vegetation management treatment techniques would be applied singularly or in any combination for a particular vegetation type to moderate the fire behavior associated with VHFHSZs. Within existing physical, environmental, ecological, social, and legal constraints on the area to be treated, the method or methods used would be those that are most likely to achieve the desired objectives while protecting environmental quality. A detailed description of the vegetation treatments that would be applied under the VHFHSZ Alternative is described in Section 4.1.5. There would be less total acres available for treatment under this Alternative.

3.6.2 LANDSCAPE AVAILABLE TO BE TREATED

Vegetation treatment projects under this Program EIR would occur only in areas designated as VHFHSZ. Vegetation management projects which are beyond VHFHSZs would be considered outside the scope of the VTP Program EIR and would need to rely on either the completion of a Negative Declaration or could fall under the CFIP EIR. Projects which are small in scope and would result in no impacts from the proposed activities could fall under a Categorical Exemption. It should be noted that the presence of a significant WUI hazard or the designation of communities-at-risk does not influence fire hazard severity zone classification. As stated earlier, fire hazard severity zones are evaluated based on the impacts they could produce without regard to the physical vulnerability of structures proximate to the zone. Table 3.6-1 provides a summary of the available landscape acreage, approximate distribution of treatment activities, approximate acreage treated per decade, approximate annual acreage treated, and percent of the available landscape treated per decade. VHFHSZ are mapped in Figure 3.6-1.

Table 3.6-1 Alternative C treatable landscape (VHFHSZ) and approximate acres treated per decade

Bioregion	Acres Modeled as VHFHSZ	Distribution of Treatments	Approx. 10 Year Acreage Treated	Approx. Annual Acreage Treated	% of Modeled Acres (10 years)
Bay Area/Delta	567,799	4.82%	28,903	2,890	0.25%
Central Coast	1,350,997	11.46%	68,770	6,877	0.58%
Colorado Desert	255,248	2.17%	12,993	1,299	0.11%
Klamath/North Coast	3,689,075	31.30%	187,787	18,779	1.59%
Modoc	1,663,045	14.11%	84,655	8,465	0.72%
Mojave	152,109	1.29%	7,743	774	0.07%
Sacramento Valley	287,841	2.44%	14,652	1,465	0.12%
San Joaquin Valley	46,117	0.39%	2,348	235	0.02%
Sierra Nevada	2,338,827	19.84%	119,054	11,905	1.01%
South Coast	1,435,957	12.18%	73,095	7,310	0.62%
Total by Treatment	**11,787,015**	**100.00%**	**600,000**	**60,000**	**5.09%**

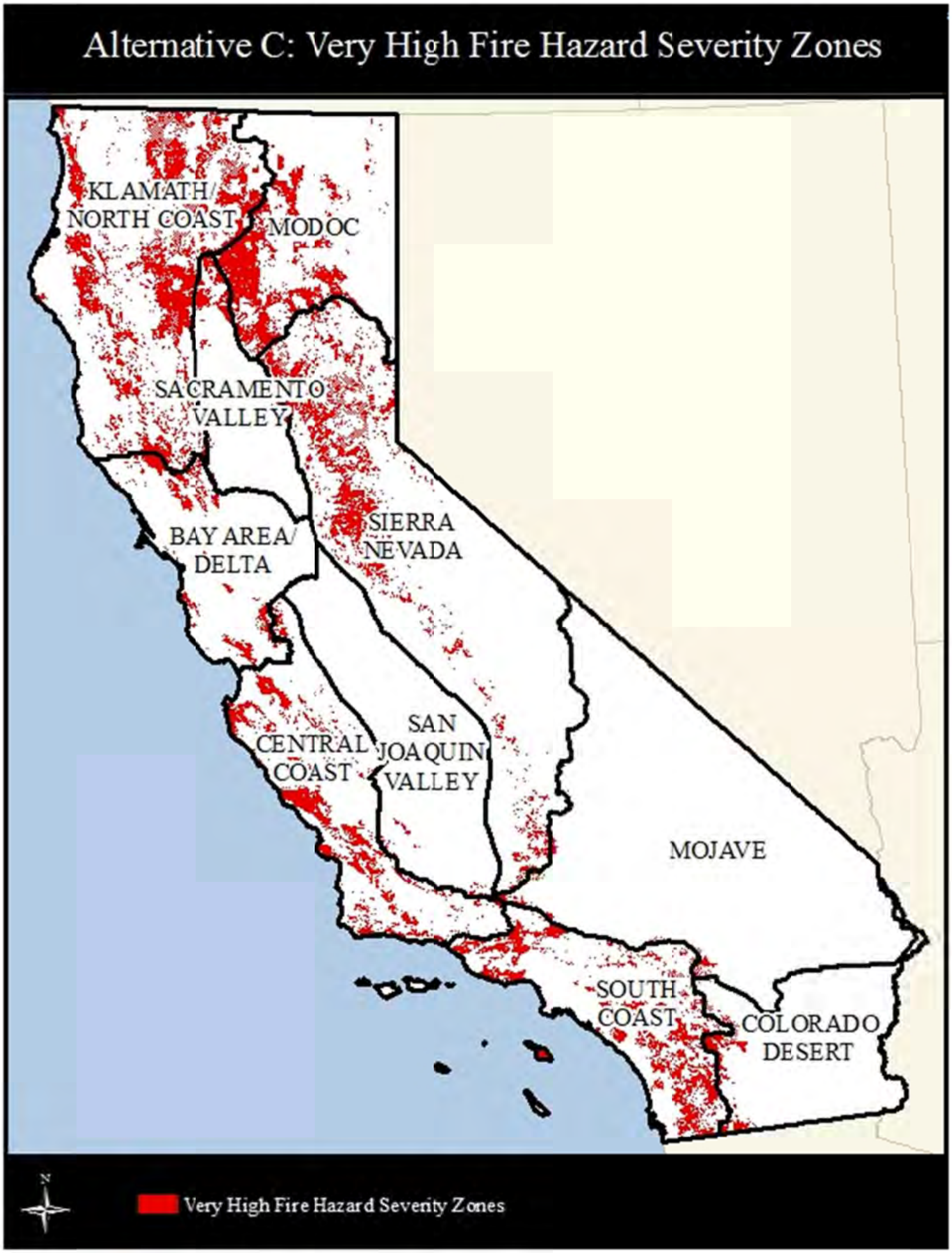

Figure 3.6-1 Alternative C

3.6.3 ACHIEVMENT OF BASIC PROJECT OBJECTIVES

The VHFHSZ Alternative would achieve some of the basic objectives of the proposed Program. While it’s true that wildland fire behavior could be modified, in part, to help reduce losses to life, property, and natural resources, destructive wildfires can be supported by high and moderate fire hazard severity zones as well. Although the most hazardous fuel systems would be targeted under this Alternative, local opportunities to protect specific assets that may be located outside the VHFHSZ would be excluded, resulting in reduced treatment location flexibility and a decreased program utility.

To help protect people and their property from potential catastrophic wildfire, the National Fire Plan directs funding to be provided for projects designed to reduce the fire risks to communities. A fundamental step in achieving this goal was the identification of communities that are at high risk of damage from wildfire. These high risk communities identified within the wildland-urban interface, the area where homes and wildlands intermix, were published in the Federal Register in 2001. At the request of Congress, the Federal Register notice only listed those communities neighboring federal lands. The list represents the collaborative work of the 50 states and five federal agencies using a standardized process, whereby states were asked to submit all communities within their borders that met the criteria of a structure at high risk from wildfire. With California's extensive WUI situation, the list of communities extends beyond just those adjacent to Federal lands. A significant inadequacy under Alternative C is the inability to engage in fuel reduction projects in areas that are outside of the VHFHSZ but within other identified high-risk areas. Many high risk communities exist within areas designated under more moderate hazard severity zones (see Figure 3.6-2). Beneficial projects that may directly protect WUI assets or communities in need of fuel reduction efforts which occur outside a VHFHSZ would not be eligible for treatment.

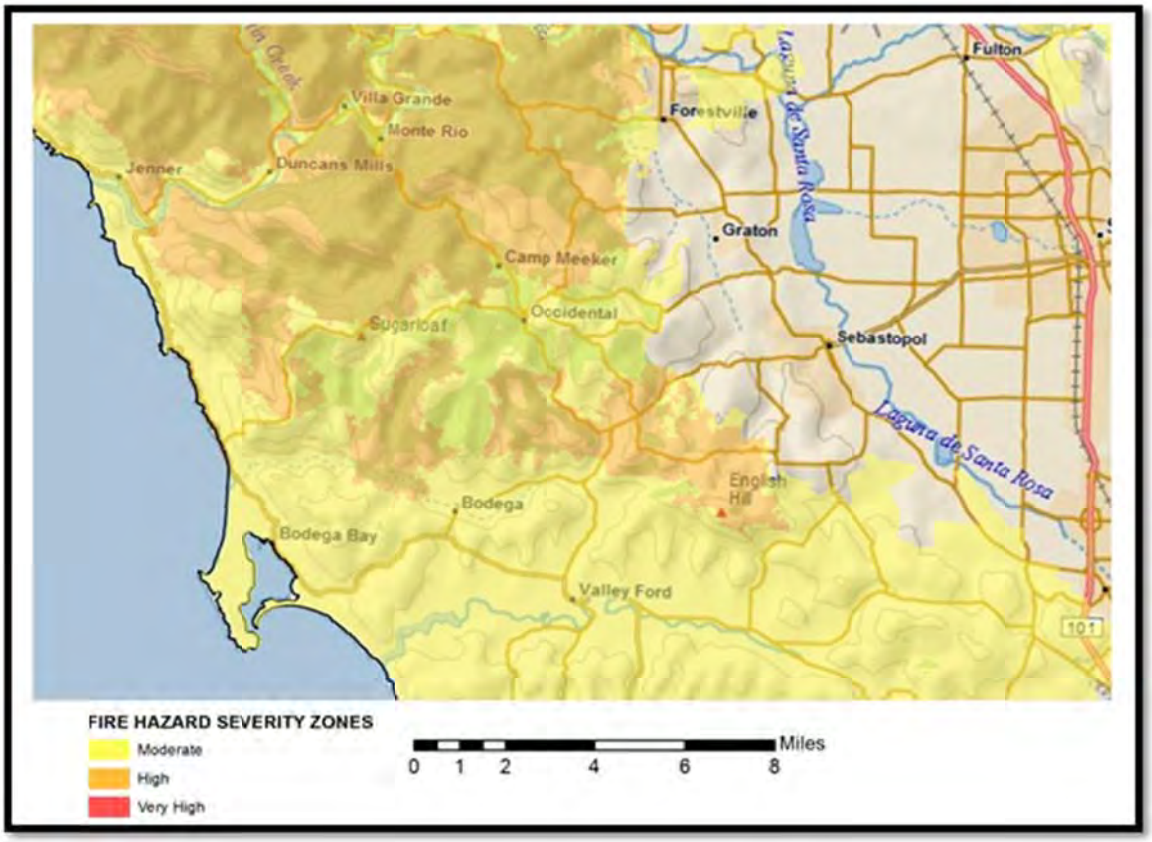

Figure 3.6-2 Western portion of Sonoma County. Monte Rio, Duncan Mills, Jenner, Camp Meeker, Occidental, Bodega Bay, Bodega, and Valley Ford are all registered as "communities-at-risk" from the threat of wildfire (source: ofsm.fire.ca.gov). The absence of a VHFHSZ classification proximate to the communities would exclude them from future wildfire hazard mitigation efforts.

While restoring fire-adapted plant communities may be an indirect outcome for some of the fuel reduction projects implemented under this alternative, ecological restoration would not be an emphasis like that of the proposed Program. Hazard mitigation would serve as the primary purpose for the VHFHSZ Alternative and as such, would utilize all available resources to reduce the wildland fire threat specific to those very high hazard areas. Opportunities to adjust the potential fire behavior in hazard zones represented as "high" or "moderate," and where landowners are willing to participate, would not exist. Operating primarily in VHFHSZ would reduce the Unit's overall flexibility and could result in the forfeiture of key fire control features (i.e. truck trails, fuel breaks).

Limiting projects only to VHFHSZ is not in total alignment with the Department's overall mission to protect natural resources. In addition to providing fire protection, the Department also engages in projects to protect watershed values and restore fire-adapted ecosystems to preserve biological integrity. VHFHSZ designations do not take into account ecological aspects related to fire control, resulting in missed opportunities to restore ecological function, protect watersheds, and address chronic departures from natural fire regimes (see Figure 3.6-3).

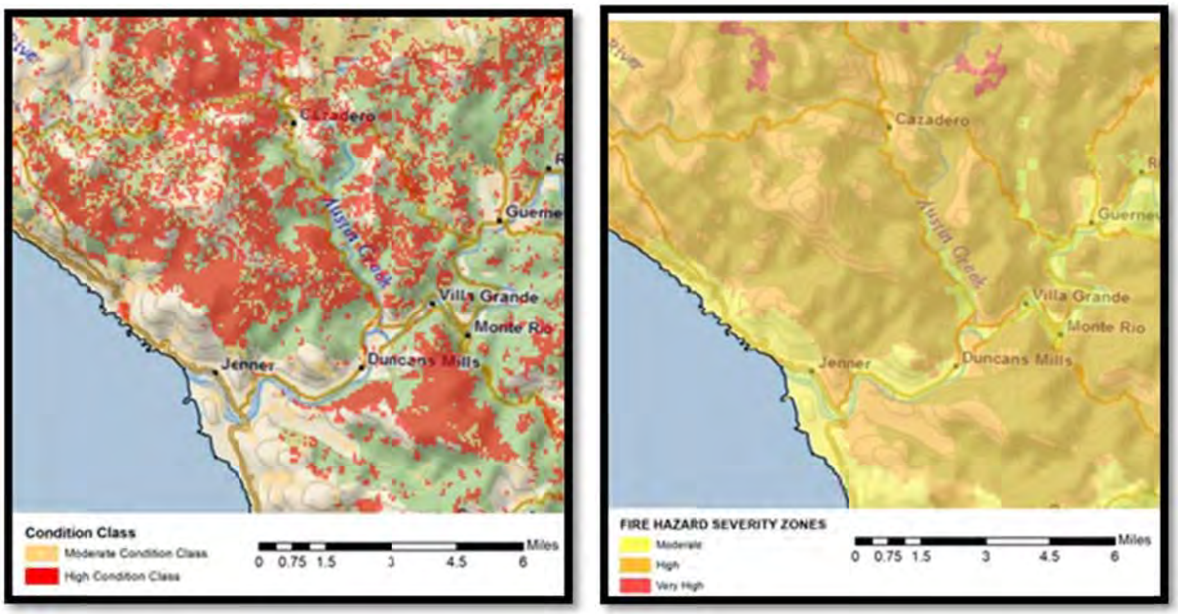

Figure 3.6-3 While most of western Sonoma County is classified as a Moderate and High FHSZ, the majority of the same area is also classified as a High Condition Class (Condition Class 3). High Condition Classes have departed from the natural fire regime and typically results in significantly different vegetation composition, structure and fuels, highly uncharacteristic fire behavior and severity, high smoke production. Opportunities to moderate the High Condition Class would not be available under the VHFHSZ Alternative.

Similar in structure to the proposed Program, projects conducted under this alternative would benefit from a consistent statewide evaluation process. Proposed projects would be evaluated for implementation using a standardized system and subject to a single CEQA process. Adherence to a comprehensive set of statewide Standard Project Requirements would occur. CAL FIRE would still require compliance with CEQA for all project proposals equally, regardless of whether it is conducted in a systematic and comprehensive manner or on a case-by-case basis. Projects conducted outside of VHFHSZs however, would require additional CEQA on a case-by-case basis without the benefit of consistently applied SPRs. It is reasonable to conclude that the risk of environmental impacts may be greater as a practical matter for case-by-case proposals outside of VHFHSZs.

3.7 ALTERNATIVE D: REDUCTION OF PRESCRIBED FIRE TREATMENTS TO REDUCE AIR QUALITY IMPACTS

Burning wildland vegetation causes emissions of many different chemical compounds such as small particles, nitrogen oxide (NO_x), carbon monoxide (CO), and organic compounds. The components and quantity of emissions depends in part on the types of fuel burned, its moisture content, and the temperature of combustion. Complex organic materials may be absorbed into or onto condensed smoke particles. Tests indicate that, on average, 90 percent of smoke particles from wildland and prescribed fires are PM_{10}, and 70 percent are $PM_{2.5}$.

The primary air pollutants that are detrimental to public health or ecosystems or that impair visual quality include particulates, oxides of sulfur and nitrogen, elemental carbon and carbon oxides, ozone, and toxic air pollutants. Air pollution affects human health and welfare, including damage to vegetation, injury to animals, effects on soil and water, and visibility impairment. Health effects include respiratory problems and decreased lung function, heart disease, and premature death. Chronic injury to plants often results from intermittent or long-term exposure to relatively low pollutant concentrations with chlorophyll destruction or chlorosis as the principal symptom of injury (Neary, 2005). Nitrates and sulfates contribute to acid rain and dry deposition of acid compounds. Lower elevation aquatic systems tend to be less sensitive to acid rain than higher elevation systems. Current levels of acidity are not high enough to cause mortality of amphibians or to fish but may have other subtle effects, particularly during the spring snowmelt period (Neary, 2005).

Atmospheric conditions that create temperature inversions and permit air masses to remain stagnant for long periods allow the airborne concentrations of smoke and other pollutants to increase. These conditions aggravate air pollution over urban, industrial, and agricultural areas. Air pollution is occasionally aggravated by daily and seasonal wind patterns. Sea-to-land breezes remove pollution from coastal areas during the day as cold, dense air moves onshore, but push it back during the night as the land breeze gently flows offshore.

The potential to ignite prescribed fire is dependent on whether the particular day is a permissive burn day and whether the project area is available to burn. An analysis of the number of permissive burn days by the California Air Resources Board, Planning and Technical Support Division, Meteorology Section of burn day information in 2005 showed that on average, the number of permissive burn days varies from a low of only 15 days per month in July to a high of 28 days per month in February. On the other hand, the average number of permissive burn days varies by AQMD location; the South Central Coast AQMD, for instance only averages about 21 permissive burn days per month. The Lake Tahoe AQMD has the lowest number of permissive burn days, at 19 days per month. Permissive burn days during the critical prescribed burn months of February through June average about 28 days per month statewide.

Mechanical treatments can serve as a reasonable replacement to prescribed fire when management objectives are to reduce fuel density to reduce a wildfire hazard. However, mechanical treatments are normally limited to accessible areas, terrain that is not excessively rough, slopes of 40 percent or less, sites that are not wet, areas not designated as national parks or wilderness, areas not protected for threatened and endangered species, and areas without cultural or paleontological resources.

An alternative that specifically addressed air quality is considered in this Program EIR because most of the state's counties are in a non-attainment status for PM_{10}, $PM_{2.5}$, and ozone (Table 4.12-3). Treatments would be modified so that prescribed fire in non-attainment basins would only take place on burn days, with no variances allowed. Eliminating the use of variances would ensure that air quality would not be degraded beyond that allowed under the State Implementation Plan (SIP). A SIP is a plan prepared by states and submitted to the U.S. EPA describing how each area will attain and maintain National Ambient Air Quality Standards (AAQS). AAQS serve as health and welfare-based standards for outdoor air which identify the maximum acceptable average concentrations of air pollutant during a specified period of time.

Under Alternative D, live-fire vegetation treatment techniques (broadcast burning, pile burning) would be reduced by 55 percent statewide when compared to the No Project Alternative to meet air quality thresholds. Under the No Project Alternative, annual live-fire projects account for approximately 13,500 acres annually; under Alternative D the annual acreage figure would be reduced to 6,000 acres. Other vegetation treatment options would remain unaffected. Total output of PM_{10} and CO would be limited to the statewide total allowed in the SIP. This restriction would drastically limit the amount of acreage that could be burned and ultimately treated. Other available vegetation treatments are assumed to slightly increase due to the reduction in prescribed fire projects, but because of the significantly higher costs and significantly lower production rates associated with the other available treatment techniques, the acreage increase would be largely insignificant.

3.7.1 DETAILED DESCRIPTION OF TREATMENTS

Vegetation management activities include the disposal, rearrangement, or conversion of vegetation using various treatments. Treatment methods and actions include:

- Prescribed fire (underburn, jackpot burn, broadcast burn, pile burn, establishment of control lines)
- Mechanical (chaining, tilling, mowing, roller chopping, masticating, brushraking, skidding and removal, chipping, piling, pile burning)
- Manual (hand pull and grub, thin, prune, hand pile, pile burning, lop and scatter, hand plant)
- Prescribed herbivory (grazing by domestic animals, such as cattle, sheep, goats, horses)

- Herbicides (ground applications only, such as backpack spray, hypohatchet, pellet dispersal)

Vegetation management treatment techniques may be applied singularly or in any combination for a particular vegetation type to meet specific objectives of resource management. Within existing physical, environmental, ecological, social, and legal constraints on the area to be treated, the method or methods used will be those that are most likely to achieve the desired objectives while protecting environmental quality. A detailed description of the vegetation treatments that would be applied under Alternative D is described in Section 4.1.5. Historically, treatment acreage has averaged about 27,000 acres per year, with approximately 200,000 to 300,000 acres treated in any ten-year period. Based on recent trends, average project size is expected to be around 260 acres.

3.7.2 LANDSCAPE AVAILABLE TO BE TREATED

Alternative D would take place within the same footprint as the Proposed Program and utilize the same scope. However, in order to reduce air quality impacts under Alternative D, the annual live-fire acres would be reduced from approximately 13,500 prescribed fire acres under the No Project Alternative to 6,000 acres. Approximately 36,000 acres would be treated on an annual basis statewide by prescribed fire and the other available vegetation treatment options. With the significant decrease in the annual prescribed fire acreage, other vegetation treatment options would occupy a larger percentage of the total, but are not expected to compensate for the reduction in live-fire acres with any significance. Of the total 36,000 annual acres proposed to be treated under Alternative D, approximately 17 percent of all treatments are expected to be prescribed fire, 32 percent are expected to be hand treatments, 17 percent are expected to be mechanical treatments, 17 percent are expected to be chemical treatments and 17 percent are expected to be treatments using prescribed herbivory. Table 3.7-1 provides a summary of the available landscape acreage, approximate distribution of treatment activities, approximate acreage treated per decade, approximate annual acreage treated, and percent of the available landscape treated per decade.

Table 3.7-1 Treatable landscape and approximate acres treated per decade

Bioregion	Acres Modeled as the VTP	Distribution of Treatments	Approx. 10 Year Acreage Treated	Approx. Annual Acreage Treated	% of Modeled Acres (10 years)
Bay Area/Delta	2,146,135	9.76%	35,130	3,513	0.16%
Central Coast	3,263,733	14.84%	53,424	5,342	0.24%
Colorado Desert	362,077	1.65%	5,927	593	0.03%
Klamath/North Coast	4,270,334	19.42%	69,901	6,990	0.32%
Modoc	2,629,835	11.96%	43,048	4,305	0.20%
Mojave	942,962	4.29%	15,435	1,544	0.07%
Sacramento Valley	866,478	3.94%	14,183	1,418	0.06%
San Joaquin Valley	688,137	3.13%	11,264	1,126	0.05%
Sierra Nevada	4,915,658	22.35%	80,464	8,046	0.37%
South Coast	1,907,557	8.67%	31,225	3,122	0.14%
Total by Treatment	**21,992,906**	**100.00%**	**360,000**	**36,000**	**1.64%**

3.7.3 ACHIEVMENT OF BASIC PROJECT OBJECTIVES

Alternative D would address some of the Program objectives. Wildland fire behavior could be modified, through the use of strategic fuel treatments, to help reduce losses to life, property, and natural resources. This is the governing objective of the program, and is consistent with Goals 1, 5, and 6 of the *2010 Strategic Fire Plan* (Board, 2010). Larger landscape level treatments, where prescribed fire is the only reasonable option, would be limited. Burning out fuels between past wildfire scars, which is an effective technique to reduce opportunities for wind driven fires to breach areas with lower fuel loading, would be largely unavailable. Range improvement burning would also be limited.

Opportunities for altering the intensity, shape, and direction of wildfires within the wildland urban interface would occur under Alternative D. This objective places emphasis on increasing the strategic and tactical effectiveness of fire suppression within the WUI through the use of appropriate vegetation treatments. Although the use of prescribed fire would be limited, all of the other treatment options would still be available for use within the WUI environment. With the inherent risk of escape from prescribed fire, live-fire operations within the WUI would not be expected to change as a result of Alternative D.

With the limited use of prescribed fire, which can be used to treat landscape level hazardous fuel conditions, the reduction of fire size and associated suppression costs would be limited under Alternative D. Prescribed fire is a logical option to treat larger areas in need of fuel reduction. Other treatment options alone could not be expected to compensate for lack of prescribed fire acres due to the topographic and access limitations associated with mechanical treatment options and the slow production rates associated with hand treatments. Alternative D would also be impractical from an ecological standpoint because mechanical and hand treatments alone do not serve as ecological substitutes for fire. Fire adapted vegetative systems, which occupy the majority of California, require the infrequent application of fire to stimulate growth, scarify seedbeds, reduce resource competition, and ultimately maintain a balanced and healthy ecosystem.

Alternative D would not reduce the potential for high severity fires by restoring a range of native, fire-adapted plant communities through periodic low intensity treatments within appropriate vegetation types. Prescribed burning elicits a host of ecological interactions potentially important to restoration, including release from plant competition, greater access to light and water, nutrient enrichment, destruction of germination retardants, and the beneficial effects of smoke on plant germination (Keeley and Fotheringham, 1998). The risk of potential fire escape and the generation of nuisance smoke often outweigh the benefits of applying fire for fuel reduction proximate to communities. Because of social, operational, and ecological constraints, mechanical treatments are often easier to implement than prescribed fire, and are often used in its place. However, mechanized and hand treatment effects on ecological function are usually subtle, short-lived, and may not serve as a surrogate for fire. Fire has unique effects on ecosystems and most favorable effects cannot be successfully emulated with any other treatment (McIver et al., 2013). Restoring native, fire-adapted plant communities would be less likely under this Alternative because prescribed fire would be available in fewer applications than alternative treatments.

Similar to the other Alternatives, adopting a programmatic approach to vegetation treatment can assure that a consistent process is applied to the prioritization, evaluation, and implementation of vegetation treatment projects. Also, there is a need to demonstrate whether the desired program and/or project outcomes are being achieved, and whether elements of the program should be iteratively changed in response to emerging data (i.e., adaptive management). The proposed Program recognizes that the chosen alternative will foster consistency, accountability, and transparency for the VTP in a way that satisfies the needs of vested stakeholders.

3.8 ACREAGE SUMMARY FOR PROPOSED PROGRAM AND ALTERNATIVES

Below is a summary of the available landscape where projects could occur relative to the geographic constraints associated with each Alternative. The proposed Program would take place within the WUI, fuel breaks outside of the WUI, and in the Condition Classes 2 and 3 outside the WUI (Ecological Restoration). Fuel treatments under the No Project Alternative can take place anywhere within SRA. Alternative A (WUI only) occurs only in the WUI. Projects initiated under Alternative B (WUI and fuel break) could occur anywhere within the designated WUI as well as fuel break features outside of the

WUI. Alternative C (VHFHSZ) would only address VHFHSZs regardless of whether WUI assets are present. Alternative D would significantly reduce the available acreage for prescribed fire while maintaining the acreage devoted to other treatment types. Tables are presented in acres by bioregion

Table 3.8-1 Treatable landscape under the Proposed Program, No Project, and Alternatives

Bioregion	VTP	No Project	Alt A: WUI Only	Alt B: WUI and Fuel Breaks	Alt C: VHFHSZ	Alt D: Air Quaility
Bay Area/Delta	2,146,135	2,991,166	1,291,941	1,614,957	567,799	2,146,135
Central Coast	3,263,733	4,954,495	1,626,890	2,126,524	1,350,997	3,263,733
Colorado Desert	362,077	509,424	113,664	315,536	255,248	362,077
Klamath/North Coast	4,270,334	7,335,781	1,604,748	2,222,188	3,689,075	4,270,334
Modoc	2,629,835	3,080,269	733,671	1,139,222	1,663,045	2,629,835
Mojave	942,962	731,382	226,257	863,107	152,109	942,962
Sacramento Valley	866,478	1,310,640	512,804	686,352	287,841	866,478
San Joaquin Valley	688,137	1,539,938	328,136	556,486	46,117	688,137
Sierra Nevada	4,915,658	6,439,257	2,884,660	3,389,936	2,338,827	4,915,658
South Coast	1,907,557	2,209,622	1,344,332	1,691,355	1,435,957	1,907,557
Total by Project	**21,992,906**	**31,101,975**	**10,667,101**	**14,605,664**	**11,787,015**	**21,992,906**

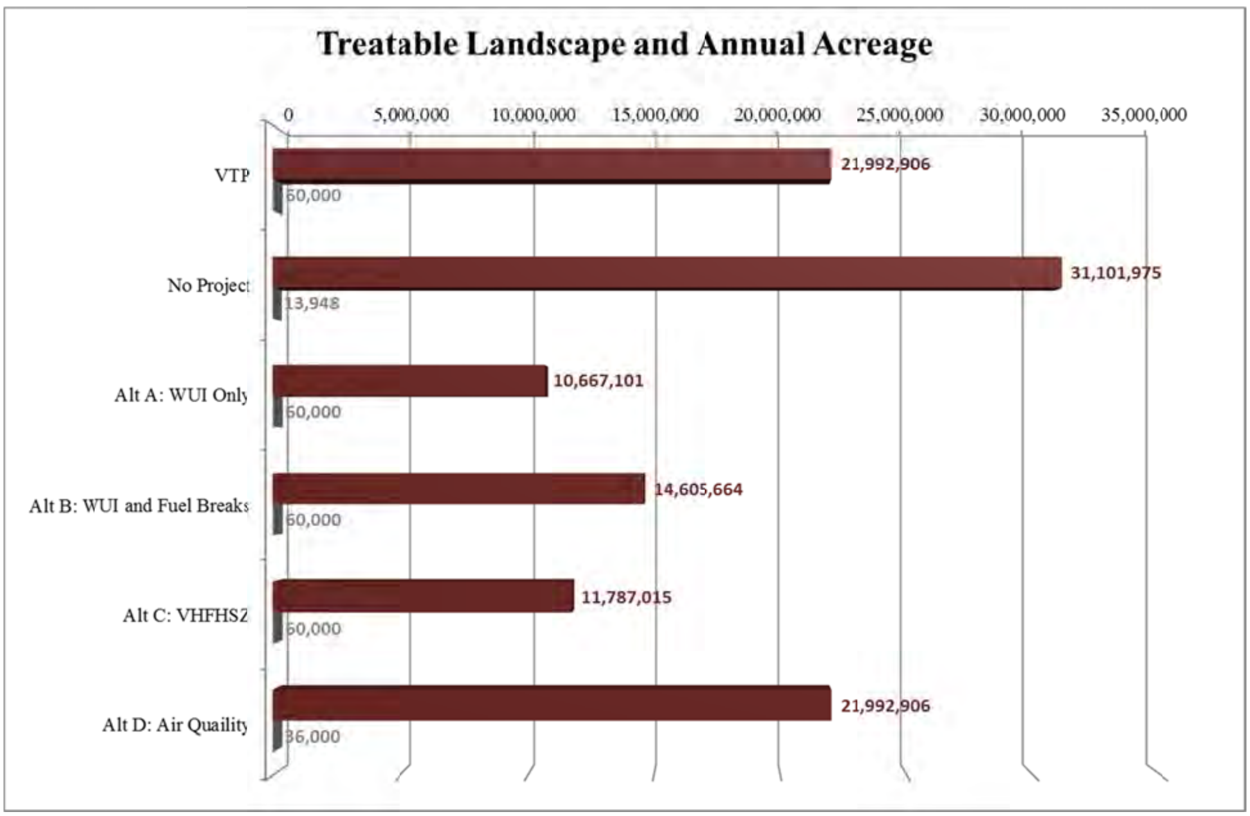

Figure 3.8-1 Treatable Landscape and Annual Acreage under the Proposed Program, No Project and Alternatives

3.9 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

Alternatives considered but eliminated from detailed analysis are described below.

3.9.1 REDUCED ACREAGE

An alternative was developed similar to the proposed Program but which only treated about 30,000 acres instead of the 60,000 acres proposed under the proposed Program. This alternative projected that treatment acreages would increase at a rate consistent with current program treatment accomplishments over the past 20 years. However, this alternative was eliminated from detailed analysis because it would fall short of the objectives of the proposed Program from a fuel treatment and fire behavior standpoint. Effectively this option deviates very little from Alternative D, although prescribed fire would not be specifically limited. The existing VMP treats on average 23,000 acres each year; with such a small increase in treated acres, this option would not provide sufficient additional acreage over existing programs to adequately address the objectives of the proposed Program.

3.9.2 HIGHLY CONSTRAINED – WUI AND VHFHSZ

Another “highly constrained” alternative was also considered but eliminated from detailed analysis. This alternative would have been similar to Alternative A: WUI, but would have further constrained treatments to VHFHSZs only. This alternative was rejected because it too would not have been able to meet the objectives of the program from a fuel treatment and fire behavior standpoint. Too many acres would have been constrained out of treatment to allow such a program to be successful in achieving the stated objectives. In addition, this alternative is not consistent with *2010 Strategic Fire Plan for California* or the *2012 Strategic Plan*.

3.9.3 LIMITING TREATMENT TO AREAS WITH HIGH INCIDENCE OF WILDFIRES

The third alternative considered but eliminated from detailed analysis would have placed most of the treatments in areas where there currently is a high incidence of wildfire (i.e. ignition sources). As a result, this alternative would have placed the majority of the annual acreage of treatments into the South Coast and Sierra Nevada bioregions. This alternative was eliminated from detailed analysis because the likely consequences of treating such a small proportion of the state were expected to outweigh the benefits in the two bioregions. In addition, treating only two bioregions would have resulted in no benefits to other bioregions from treatments to reduce wildland fire, improve forest and range conditions, etc. This alternative would also not allow the majority of California residence in the SRA the opportunity to benefit from vegetation treatments in areas that may reside in Condition Class 2 or 3 but are considered infrequent areas for wildfires. In addition, this alternative is not consistent with *2010 Strategic Fire Plan for California* or the *2012 Strategic Plan*.

3.9.4 HIGH ACRES IN THE WUI ONLY

The fourth alternative eliminated from detailed analysis proposes treatment activity within the WUI only and would propose to treat 10 percent of the WUI landscape over a 10 year time frame. Projects would primarily consist of community and infrastructure protection, establishing safe areas of refuge, and enhancing vegetation clearance proximate to structures. Fuel breaks and ecological restoration opportunities outside of the WUI would not be included under this proposed alternative. Wildland fire control success outside the WUI would rely primarily on initial attack and extended attack resources without the strategic benefit of pre-treated fuels or existing fuel breaks. The project evaluation process, analysis procedures, treatment options, and SPRs would be the same as the proposed Program. The available landscape to treat would be significantly smaller than the proposed Program because only a portion of the SRA is comprised of the WUI, but to reach the threshold of treating 10 percent of the landscape over a decade, the total acres treated under this alternative would be greater than the proposed Program. Modeling this approach identifies 11.7 million acres of WUI within the SRA, which equates to 117,243 acres being treated each year. As discussed in Section 2.3.2, CAL FIRE does not have the capacity to treat this many acres.

Although this option focuses treatments on high value resources (life safety and property) and would be expected to make WUI communities more resilient to wildfire, there would be significant impacts to air quality, greenhouse gasses, and watershed resources as the treatments are concentrated on only 11.7 million acres. Furthermore, this Alternative excludes the option to implement hazardous fuel reduction treatments (fuel break or ecological restoration) on a landscape level. Consequently, this Alternative may lead to more fires entering and being fought in the WUI and is not consistent with *2010 Strategic Fire Plan for California* or the *2012 Strategic Plan*.

3.9.5 FOCUSING ON AREAS OF HISTORICAL USE OF TREATMENTS

A fifth alternative eliminated from detailed analysis would limit vegetation treatments to areas of the State that already practice these activities. Portions of California would not be eligible for fuel treatments based on historical treatment applications. The effects of California’s drought continue to show in conifer mortality throughout the State, but communities that have not conducted fuel treatments previously would not be eligible to take advantage of this Vegetation Treatment Program. There is a current estimate that about 12.5 million trees have died in areas of extreme and exceptional drought stricken areas of California (USFS, 2015). Drought impacts have also lead to a buildup of bark beetle infestations throughout the State (USDA, 2015). This Alternative does not allow CAL FIRE to respond to changing environmental conditions over time. Consequently, this Alternative would not meet the first four objectives including increasing the opportunities for altering or influencing the size, intensity, shape, and direction of wildfires within the wildland-urban interface. In addition, this alternative is not consistent with *2010 Strategic Fire Plan for California* or the *2012 Strategic Plan*.

3.9.6 1,000 FOOT WUI AND FUEL BREAKS ONLY

Another alternative considered but eliminated from detailed analysis focused vegetation treatments within a 1,000 foot WUI area and maintaining existing pretreated areas only. However, there are several road blocks to develop an analysis of this Alternative. A review of scientific literature found no scientific basis to support limiting WUI treatments to 1,000 feet. The most relevant research from the Sierra Nevada Forest Plan Amendment (Part 3.5) split the WUI into two components, a 0.25 and a 1.25 mile wide area, for a total of a 1.5 mile wide WUI zone, but a scientific basis for a smaller WUI zone could not be established.

Further literature review examined the potential for a tiered WUI alternative based on ember cast from timber, shrubs, and grass. Spotting and spotting ignition are a significant mechanism for fire spread. The hypothesis was that a timber ember would travel farther than a shrub or grass ember. There are three primary mechanisms for ember ignition potential: generation, transport, and ignition of recipient fuel. However, weather conditions (specifically wind and humidity) are the most critical factors in spotting (Koo et al., 2010). There are several models that predict the potential spotting distance from a fire. Factors such as height of the flame above a canopy, wind speed, plume height and ember size play individual roles that collectively specify the total distance of travel (Albini et al., 2012). Another study evaluated wind speed and firebrand distance and concluded that the distance a firebrand reaches is dependent on wind speed and not in relation to a fire’s pyrolysis temperature and diameter of the ember (Kim et al., 2009). Comparisons of these factors have provided encouraging results but additional studies on ember casts have been recommended (Koo et al., 2010; Albini, et al. 2012; Linn et al., 2010). Consequently, there was no strong basis to support this approach with this Program EIR. See Chapter 2.3 and Chapter 4.1 for additional WUI evaluation under this Program EIR.

Maintaining existing fuel breaks does not allow a community to respond to changing environmental conditions, especially emergency environmental conditions such as drought. This alternative would not offer opportunities for altering or influencing the size, intensity, shape or directions of wildfires within the WUI as fuel loading changes occur over time. Consequently, this alternative is not consistent with *2010 Strategic Fire Plan for California* or the *2012 Strategic Plan*.

3.9.7 FIRE RETURN INTERVAL DEPARTURE

Comprehensive fuels management programs traditionally depend on the characterization of a reference condition which can provide management targets and a means to measure management success. The most commonly used reference condition to reconstruct historical fire regimes is fire return interval (FRI), or the length of time between fire occurrences on a specific area of land (Agee, 1993; Brown, 1995). Drawing comparisons between past and current fire frequencies can assist resource managers in prioritizing fuel treatments by providing a template for assessing ecosystem conditions and evaluating landscapes for ecosystem need (Hann and Bunnell, 2001). Under this alternative, only landscapes that have met or exceeded their FRI would be available for vegetation treatment.

Using a landscape's FRI as a strategic planning guide has many benefits. Landscapes that have exceeded their FRI are more susceptible to fire, pests, disease, and water stress (Schmidt et al., 2002) and the FRI alternative could also address the ecological consequences of fire suppression such as altered species composition. Landscapes within their mean FRI will generally have less severe fire behavior should an ignition occur (Hardy et al., 2001).

However, committing to focus treatment efforts based on one metric has many shortcomings. Changes in the environmental baseline resulting from climate change, human land use, or invasive species make the uncritical use of historical data as a guide to the future less defensible. Most landscapes already exhibit substantial variability in fire occurrence (Schmidt et al., 2002). Modeled or inferred fire intervals over the next 50 to 100 years nearly unanimously project increasing potential for wildfire above pre-settlement levels (Safford and Van de Water, 2014) which makes relying on a historical FRI questionable.

Areas in the WUI already suffering from potentially damaging fires would also continue to be threatened from potentially damaging fires under this Alternative. Unless the FRI is met or exceeded, fuel treatments could not be initiated. This poses significant challenges as California's urban areas continue to stretch out into the wildlands. Delaying the opportunity to address critical fuel conditions until an arbitrary point in time has been reached ignores the immediate threat to life and property.

Considering most fire-dependent ecosystems in California never reach their FRI because of an abundance of human and natural ignition sources, this alternative would not meet any of the Program Goals. By utilizing a one-dimensional metric such as FRI as a guide to focus fuel treatment efforts would likely result in future loss to life and property. Fewer opportunities to alter the size of potential fires would be available because treatments would not commence until the FRI was met or exceeded. Although the potential for high-severity fires could be reduced by restoring a range of native and fire-adapted plant communities through treatment efforts, these reductions would only be met in areas meeting the FRI requirement and would ignore landscapes of slightly younger fuels that are still capable of supporting high severity fires. Consequently, this alternative is not consistent with *2010 Strategic Fire Plan for California* or the *2012 Strategic Plan*.

3.10 PREFERRED ALTERNATIVE

After considering all of the environmental consequences of implementing the proposed Program and the Alternatives, the proposed Program is considered the Preferred Alternative relative to the Objectives.

Overall, the proposed Program is the environmentally superior alternative as it has a combination of the most benefits and least effects when considering all of resources. Alternative B is close to the proposed Program, but while it treats the same number of acres per decade as the proposed Program, it would not have nearly as large of a treatable land base open to prescribed fire in terms of ecological restoration. This reduced landscape would not initially be constraining, but over time the acreage that could be treated with prescribed fire would be limited. In addition, limitations on what could be treated at the project level could create a more complex mosaic of treated and untreated vegetation that might not reduce wildfire behavior to as great an extent as the proposed Program. A detailed description of the potential impacts to various resources, as well as any mitigation measures prescribed to reduce their impacts, is discussed in Chapter 4. Cumulative impacts are discussed in Chapter 5.

The proposed Program would meet the objectives established for the VTP in Section 2.2.1 to a greater degree than the Alternatives and No Project (Status Quo). Again, Alternative B would come almost as close to meeting the objectives for the VTP as the proposed Program. However, the opportunity to engage in vegetation treatment projects throughout the SRA that have been designated as Condition Classes 2 or 3 would not be available. As stated earlier, SRA lands provide a broad array of ecological benefits including critical habitat for protected species, drinking water, wood products, carbon storage, and scenic and recreational opportunities. Large, destructive wildfires are a growing threat to these values, and it’s clear that landscape scale changes in vegetative structure and fuel loadings must be accomplished to significantly alter wildfire behavior, reduce wildfire losses, and achieve longer term fire resiliency in the wildlands (Agee et al., 2000; Finney, 2001; Peterson et al., 2003; Graham et al., 2004). Limiting fuel treatments as proposed in Alternative B would ultimately ignore broad-scale opportunities to restore or maintain landscape-level fire-adapted ecosystems.

4 AFFECTED ENVIRONMENT, EFFECTS AND MITIGATIONS

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4.1 INTRODUCTION AND IMPACT ANALYSIS

The environmental setting of the Vegetation Treatment Program (VTP) is diverse; from conifer and hardwood forest and woodlands in the mountain and coastal areas, to shrub and herbaceous rangelands in the south coast, north interior and central valley, to desert habitats in the southeast (FRAP, 2010). Covering such an extensive and heterogeneous region, VTP projects will reflect the needs of the vegetation at the local and regional levels.

Individuals, laws and public agencies through ownership, management direction, and interaction with private landowners play a strong role in shaping natural systems. Nearly all VTP projects will occur on private ownership. Federal management activities influence the environmental setting on neighboring forest and rangelands adjacent to those under the jurisdiction of CAL FIRE. Approximately 31 million acres are within CAL FIRE's fire protection and fuels treatment jurisdiction. These lands are managed for a variety of purposes, including recreation, open space, and ecological services and goods.

A multitude of factors in the wildland fire environment contribute to fire behavior. One of the most important factors that can influence fire behavior is the fuel type. Fuel type represents an identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause resistance to control under specified weather conditions (NWCG, 2014). California is home to a tremendous range of fuel types which can be condensed into three main groups based on the sufficiently distinct fire behavior each group exhibits (Bishop, 2007). These groups can be classified as **Tree-dominated**, **Grass-dominated**, and **Shrub-dominated** vegetative formations. Figure 2.2-6 identifies the associated vegetative subtypes by these three dominate vegetation formations and illustrates how these three groups lay across the California landscape within the SRA.

As previously stated in Chapter 2, there is a critical need for widespread fuel reduction across the West. Fuels come in various shapes, sizes, and arrangements. There are live and dead fuels, herb and shrub fuels, litter, twigs and branches, ladder fuels (small trees), and canopy fuels (larger trees) (Agee and Skinner 2005). Fuels management at the landscape scale is focused on treating fuels to help suppression forces more easily contain fire, reduce the area burned by high-intensity fire, or reduce the risk of fire ignitions. This is accomplished by modifying fire behavior through strategic placement and arrangement of fuel reduction treatments on the landscape (Finney and Cohen 2003; Graham et al. 2004). To address the fuel conditions throughout the SRA, projects conducted under this Program EIR have been organized into three general treatments or project types: **Wildland-Urban Interface**, **Ecological Restoration** and **Fuel Breaks.**

4.1.1 ANALYSIS OVERVIEW

Environmental impacts are a function of both the extent and the intensity of the effects. *Intensity* of effects refers to the degree of change in biological and physical characteristics that are likely to result from carrying out the treatment. *Extent* of effects refers to the quantity of acres treated and their distribution across the landscape.

As previously described in Chapters 2 and 3, treatments would be applied across each bioregion by willing landowners implementing practices designed to accomplish one or more of the objectives outlined in Section 2.2. An individual treatment by itself or multiple treatments might take place all in one year, or might be spread out over several years. Most treatments would be applied in order to achieve desired future conditions such as reducing the severity and extent of wildland fire. In every bioregion, treatments would focus on one or more components of the purpose and objectives.

For analysis purposes, the number of acres treated yearly is assumed to be $1/10^{th}$ of the ten-year totals shown in Chapter 2. However, the actual acres treated annually in any bioregion will vary substantially year-to-year based on several factors, such as availability of cooperating landowners, funding, and access constraints. In addition, it is assumed that the 10-year total acreage treated would never all occur within one year or any one bioregion, but would be distributed across several years and several bioregions. Finally, if the acreage being treated in a bioregion exceeded 110% of the yearly average, then further analysis would be required at the project level to ensure that significant effects did not take place (ADM-7). Table 4.1-1 is a summary of the analysis identifying the areas with significance criteria and any mitigations or SPRs.

Table 4.1-1 Impact Summary Analysis and Reference Locations

Impact Summary Analysis and Reference Locations.			
	Reference Location		
Environmental Review Resource Area	Resource impacts determined to be Significant	Significance & Threshold Criteria	Mitigation / SPR
Biological Resources	N	4.2.2.1	4.2.3.1
Geology, Hydrology, and Soils	N	4.3.2.1	4.3.3
Hazardous Materials	N	4.4.2.1	4.4.3
Water Quality	N	4.5.2.1	4.3.3 & 4.4.3
Archeological, Cultural and Historic Resources	N	4.6.2.1	4.6.3.1
Noise	N	4.7.2.1	4.7.3
Recreation	N	4.8.2.1	NM
Utilities and Energy	N	4.9.2.1	NM
Transportation and Traffic	N	4.10.2.1	4.10.3
Population, Employment, Housing, & Socio-economic Wellbeing	N	4.11.2.1	NM
Air Quality	N*	4.12.2.1	4.12.3
Aesthetics and Visual Resources	N	4.13.2.1	4.13.3
Climate Change	N	4.14.2.1	4.14.3
* - No significance after mitigation is applied NM - No mitigations were needed.			

4.1.2 LAND MANAGEMENT REGULATION

LAWS AND PUBLIC AGENCIES

The body of laws regulating California's forest and rangelands is complex. At least 50 federal laws, 20 executive orders or other federal policy directives, and nearly 40 state laws provide the legal framework for these landscapes (FRAP, 2003). A number of county, state and federal agencies are charged with enforcing statutes and regulating resource use and extraction activities on these lands. The result is an often overlapping system of jurisdictions and regulations of land management, which can make it difficult for private land managers to meet all standards and laws and develop economically.

Federally managed lands come under the jurisdiction of federal laws and regulations, whereas management of private and state-controlled land needs to comply with state, county and local laws and regulations, as well as some federal statutes.

FEDERAL AGENCIES

The federal agencies managing substantial forest and rangeland areas of California are the U.S. Department of Agriculture's Forest Service, the U.S. Department of the Interior's Bureau of Land Management (BLM), National Park Service (NPS), Bureau of Indian Affairs (BIA), U.S. Fire and Wildlife Service (USFWS), and the Department of Defense (DoD).

Land management activities on California's 18 national forests are guided by Land and Resource Management Plans ("forest plans") developed by and for each forest in compliance with the Forest and Rangeland Renewable Resources Planning Act (RPA) and the National Forest Management Act (NFMA), as well as the National Environmental Protection Act (NEPA) and all other federal and state laws that apply. Forest plans are the official documents that describe the full spectrum of program-level management activities scheduled to occur in that national forest's jurisdiction within the planning cycle. These include timber harvest levels and locations, any road building and/or removal, forest wildfire fuels mitigations, invasive weed control, livestock grazing allotments, recreational facilities maintenance and improvement, etc. Forest plans are normally updated on a 10-year cycle.

Section 202 of the Federal Land Policy Management Act (FLPMA), enacted in 2002, provides the principles that guide BLM land management plans and activities. The BLM employs an ad hoc approach to proposing and implementing Resource Management Plans (RMPs) governing its use of the 262 million acres it administers in the western United States. These plans describe lands that can be used for livestock grazing and the parameters under which grazing can occur. In mid-2006, BLM issued amended rules regarding aspects of its rangeland program (United States Bureau of Land Management et al., 2006).

All U.S. Fish and Wildlife refuges with burnable acreage are required to have fire management plans. There are 470,000 acres of refuges in California.

The National Park Service (NPS) has 27 parks, monuments, recreation areas, and seashores across all regions of California. Lands in these parks cover a wide variety of forest and range ecosystems. The National Park Service manages lands primarily to provide recreational opportunities, preserve historical and cultural areas, and enhance ecological services. All national parks with burnable acres have current fire management plans. Some parks have plans which detail specific resource management activities, such as Yosemite National Park's recent Fire Management Plan (2009). As timber extraction and grazing (and related activities) are usually prohibited in National Parks, only those NPS plans related to vegetation management and fuels mitigation have bearing on the proposed VTP.

STATE AGENCIES

The California Department of Fish and Wildlife (CDFW) manages over 600,000 acres of land with forest and rangeland settings and includes bighorn sheep habitat, deer habitat, grassland/upland habitats, special habitats, and threatened and endangered habitats. These lands are managed primarily for habitat, recreation, and ecological services. Just over half of the lands managed by California Department of Parks and Recreation can be considered to have settings associated with forest and rangeland ecosystems. The California Department of Forestry and Fire Protection (CAL FIRE) manages eight demonstration forests covering over 71,000 acres. These are primarily forestland habitats, but do contain some range. State forests are managed for a variety of purposes. Conservancies covering the largest land acreage are the Sierra Nevada Conservancy, Coachella Mountains Conservancy, and San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy. The main focuses of all these conservancies are to protect, preserve, and enhance natural habitat corridors while providing public access and recreational opportunities (FRAP, 2003).

LOCAL AGENCIES

A portion of these lands, especially city parks, are developed settings with irrigated grass and other developed facilities. Wildland local parks are predominately found in the Bay/Delta, Central Coast, and South Coast bioregions and are particularly prevalent in areas adjacent to the Bay Area, Los Angeles, Orange, and San Diego County urban areas. Local parks with wildland settings and forest and rangeland vegetation are only a part of the total acres of local parks. Local park acreage is considerably less extensive in the more rural regions of California that already have large areas of federal land.

4.1.3 RANGELAND BASE AND OWNERSHIP

The majority of California's working landscapes are rangelands. These lands are primarily managed for commodity production and/or services. "Rangelands" or "primary rangelands" include the area of all rangelands, regardless of availability, with suitable vegetation for grazing livestock, excluding conifer forests and upland hardwood forests associated with conifer forests. Included in these lands, however, are some conifer woodland types – typically semi-arid highland areas with very open canopies dominated by pinyon pine and/or juniper and sagebrush. In California, there are substantial areas of forest land, particularly within U.S. Forest Service (USFS). Though these allotments are often used for grazing, they are not shown in the estimate because forage output is transient, often only related to areas with little tree cover following harvesting or fire. These lands are termed "secondary rangeland" and limited information on grazing activities and other measures related to condition are provided.

A majority of rangelands are in public ownership, with the Bureau of Land Management being the largest public land managing agency. Approximately forty-two percent of rangeland habitats within California are privately owned, while fifty-eight percent are publicly owned (see Table 4.1-2 below). This ownership pattern varies among the bioregions of the State.

MANAGEMENT BY PRIVATE LANDOWNERS

The largest group of private landowners managing rangeland is the range-livestock community. This class of owners may include land owners who have conservation easements or similar arrangements. Data comes from the USDA National Agricultural Statistics Service as part of their five-year national census.

Characteristics of rangeland owners seem to be approximated best by the category of "beef cattle (except feedlots)." In 1997, there were over 11,500 beef cattle farms (excluding feedlots) in California. Nearly 72 percent of these farms statewide are less than 500 acres in size.

Sole proprietorship is by far the most common form of ownership in all farms, including those with cattle, sheep, and goats. Partnerships are the second most common ownership, with family-held corporations next. In 1997, about three quarters of all farms were in sole proprietorship (National Agricultural Statistic Service, 2001). About 85 percent of farms reported as beef cattle (except feedlots) are sole proprietorships.

FORAGE USE

The range livestock industry utilizes cropland, woodland, and pasture/range for forage. Both private and public lands may be grazed. Ranches may use some or all of these resources. Farms greater than 2,000 acres had a greater dependence on pasture/range other than cropland or woodland for grazing than smaller farms (National Agricultural Statistics Service, 2001).

About 60 percent (34.1 million acres) of all available rangeland is grazed by livestock in California. Ninety percent of total range forage grazed each year by livestock comes from private lands (where the VTP will function), with the remainder coming from federally managed lands such as the BLM. Although private lands are much more productive (due to grasslands, better growing conditions, low elevation, year-round grazing), they comprise less than half (41 percent) of the total rangeland grazed by livestock as shown in Table 4.1-2.

Table 4.1-2: California rangeland area by management (thousands of acres) (FRAP, 2010).

Rangeland Vegetation Type	Private	USFS	BLM	NPS	Other Public	NGO	Total*
Shrublands (chaparral, sagebrush)	4,842	5,806	2,353	282	1,180	60	14,522
Grasslands	9,525	376	433	82	831	159	11,407
Desert types	3,540	137	10,450	4,772	4,325	27	23,251
Conifer Woodland	466	989	469	317	137	21	2,399
Hardwood Woodland	4,296	284	193	19	456	45	5,292
Hardwood Forest	2,828	1,305	194	104	151	12	4,594
Total	**25,497**	**8,897**	**14,092**	**5,576**	**7,080**	**324**	**61,465**

*Totals may not add up due to rounding

Grassland vegetation provides the most important source of forage for grazing livestock. Other important vegetation types for grazing are Hardwood Woodland and Hardwood Forests, which often occur adjacent to grasslands and have an understory of grasses. Livestock grazing occurs on land subject to private and public permits or leases. In the last decade, the amount of authorized grazing has declined on federal land (FRAP, 2010).

4.1.3.1.1 Environmental Factors on Rangeland

RIPARIAN AREAS

While only a portion of total precipitation falls on California rangelands, almost all surface water in California passes through rangeland at some point in its cycle. In addition, two-thirds of the major reservoirs are located on rangeland. Therefore, rangeland hydrology greatly influences the quality of California's surface waters (George et al., 1998). The grazing activities conducted on rangelands and their effects on soil and water quality are of particular concern for maintaining hydrological function.

The impact grazing has on surface hydrologic condition depends primarily on the behavior of the livestock, including feeding, drinking, waste production, and traveling.

The timing and the intensity of grazing also have an impact. The resultant effects of these behaviors can lead to excessive vegetation removal (over-grazing), potential erosion due to soil baring, accelerated channel bank erosion due to trampling, stream temperature increase due to removal of riparian vegetation, water pollution from direct nutrient and pathogen deposits, and habitat degradation in wet meadow areas (Dahlgren et al., 2001). Key issues related to water quality are cost effective management of riparian zone grazing practices.

PLANT COMMUNITY COMPOSITION

Plant community composition is the species type, structure (size and density), and diversity of vegetation on rangeland. The ability of a rangeland site to support these characteristics, resist loss of function and structure, and recover help define rangeland condition from a vegetative perspective. Major changes have occurred to rangeland plant composition since the late 1800s with society's increasing demand on resources (Menke et al., 1996). Historic changes in rangeland vegetation, primarily for the Sierra bioregion, were marked by substantial over-grazing, introduction of large fires for forage improvement and unrestricted livestock foraging in riparian areas. Substantial changes have taken place to recover the Sierra rangelands during the last two decades, including a slow recovery of upland wet meadows and re-vegetation of riparian areas following improvements in grazing practices. Rangeland Management can continue to be improved through the ecological restoration presented in this PEIR.

HARDWOOD RANGE CONDITION CHANGES

California's hardwood rangelands are the nearly 10 million acres of hardwood forests and woodlands that are composed primarily of oak tree species but may also contain other hardwood tree species as well. The annual and perennial grasses found within California's hardwood rangelands are an important source of rangeland forage for California's livestock industry (Gordon and Rice, 2000). These lands are generally located adjacent to the Sacramento Valley, San Joaquin Valley, and smaller coastal valleys within the Coast Range. While mapping efforts directed at California's hardwood rangelands are useful for translating vegetation condition into wildlife habitat values, they are less useful as assessment tools when measuring variable conditions such as rangeland forage, soil, and water quality. As such, soil and water quality conditions and trends are poorly quantified across hardwood rangelands.

Livestock grazing has both positive and negative influences on hardwood rangeland condition that can be controlled through the timing, duration and intensity of livestock use. Positive influences include reduction in moisture competition between oak seedlings and annual grass species as well as reduction in fine fuels that influence fire spread rates. Negative influences on hardwood rangelands include potential for increased soil compaction, alteration of stream hydrologic function, and direct impact on oak seedling regeneration. Some findings by Integrated Hardwood Range Management Program (IHRMP) on sustainable practice research include canopy management of oak for improved forage yields and appropriate methods measuring the utilization of rangelands.

Historically, ranchers removed oaks as a means to increase forage production by reducing competition for limited amounts of moisture and sunlight. Most studies on this topic have demonstrated that increased forage production is possible in rangelands dominated by blue oak (*Quercus douglasii*) if precipitation exceeded 20 inches per year and tree canopy cover exceeded 25 percent of total area. In areas with less than 20 inches of rainfall and less than 25 percent canopy cover, forage yields were greater than adjacent open grassland areas. Moderate blue oak canopy cover (25 to 60 percent) had a variable effect on forage production.

Current research on this topic concludes that the benefits of oak removal generally decline within 15 years due to the loss of an organic matter source sustaining soil quality and the disruption of the nutrient cycling processes. Conversely, there has been little impact on soil quality under light to moderate grazing pressures given organic matter inputs from grazing livestock. In addition, during periods of drought, the shading provided by an oak canopy results in longer retention of soil moisture, thus maintaining green forage for a longer period into the dry season.

CONDITION OF NON-FEDERAL ANNUAL GRASSLANDS

Annual grasslands provide approximately 84 percent of the forage used for domestic livestock grazing on California's forests and rangelands (FRAP, 2003). This percentage includes annual grassland as well as the annual grass understory component of valley and foothill woodland, coastal scrub, and chaparral land cover types. Early assessments mandated by Congress (e.g., Renewable Resources Planning Act, Soil and Water Resource Conservation Act) reported California's annual rangelands to be in "poor" condition. This conclusion was based on an evaluation of California's grasslands according to perennial grassland standards. In these standards, assessment criteria and methods place annual-dominated plant communities into lower condition classes. The plant succession concepts and application methods developed for perennial grassland (such as Midwestern prairies) are not sufficiently similar to the annual grassland ecosystem function to allow comparison (FRAP, 2003).

DEVELOPMENT ON RANGELANDS

Rangelands have faced disproportionate development and conversion pressure relative to other vegetation and land cover types in the state (FRAP, 2010). Outside of the less-productive desert and other arid regions, rangeland is often found on easily developed rolling terrain near sea level or at low elevations, and frequently surrounds what have become urban and suburban areas. Moreover, the majority of areas that now comprise the great metropolitan areas in the state, such as in and around Los Angeles, San Diego, the Inland Empire and San Francisco's south and east bay, were nearly all originally covered in rangeland vegetation types.

The trend of rangeland at risk from development has continued. A study of ecosystems determined that rangeland types appears as the top two (and five out of the top six) WHR types at risk from development (FRAP, 2010). The study overlaid spatially-explicit population projection data from the EPA with WHR and tree seed zone delineations to rank areas as low medium or high. The areas most at-risk were determined to be at the periphery of the main metropolitan areas, where the large urban and suburban growth is most likely going to occur. In addition to residential development, rangelands are also under pressure from conversion to more intensive agricultural uses, such as orchards and vineyards (Cameron et al., 2014)

ECONOMIC IMPORTANCE

Despite rangelands covering approximately 54 percent of California, agriculture and its livestock sub-sector have declined in relative importance within the state's economy. The declining relative importance of goods production and a rise in services, trade, finance and other non-goods producing activities are characteristic of the structural change that swept the nation and the region in latter half of the twentieth century. Even with this structural transformation California has been the nation's largest dairy producer since 1993, and accounted for 21 percent of the nation's milk supply in 2009.

In 2009, total cash receipts for sheep and lambs were about $37 million, representing an increase from 2007 levels, but an overall downward trend of close to 40 percent from the 2000 levels. In 1990, 39 California counties had cattle and calf production values (beef and dairy) within their top five agricultural commodities. In 2009, 31 counties listed cattle and calf production by value as among their top five agricultural products. California's cattle and calf commodity was the fifth leading agricultural production commodity by gross value for the state in 2009, surpassed by milk and cream, grapes, nursery products, and almonds. The five leading counties for cattle and calf production and their percent of state total were Tulare (17.9%), Fresno (13%), Imperial (12.4%), Merced (9.3%), and Kern (7.5%). The five leading counties for sheep and lamb production and their percent of state total included Fresno (19.6%), Solano (12.2%), Kern (12%), Imperial (10.4%), and Merced (5.2%). While each of these counties contains open rangeland, a large portion of their contribution comes from production in feedlots.

Sales of beef cattle comprise over 90 percent of the income generated from livestock operations. However, prices for sheep, cattle, meat, wool, and other products tend to reflect global markets, trade factors, and other conditions. There is a high degree of integration in the North American cattle market. U.S. cattle inventories exceed Canadian inventories by almost ten-fold; inventory highs and lows tend to parallel each other. U.S. and Canadian fed steer prices generally run closely together. In general, prices follow a cycle that is related to biological and market factors. Long-term cattle prices are determined in the U.S. market, but increasingly American producers compete with foreign imports of beef. For example, several large hamburger and restaurant chains in the United States import significant portions of their meat. At the same time, growth of foreign producers such as Australia and New Zealand has increased competition for American producers who wish to export. This adds downward pressure on prices received for American cattle. This trend is likely to continue for the near future as prices in California largely reflect these kinds of factors. They, too, are cyclical and have varied greatly in the last decade.

4.1.4 MAJOR TREE, BRUSH & GRASS VEGETATION FORMATION REVIEW

This section expands on the creation of the Treatable Landscape discussion that was presented in Chapter 2, Section 2.2.2.

Data for vegetation typing in the VTP is based on various data sets representing the “best available” land cover data, which was then typed using the California Wildlife Habitat Relationships (WHR) classification system and provided as a single statewide vegetation layer by CAL FIRE’s Fire Resource and Assessment Program to be used in this analysis (see Appendix A for a complete discussion of the vegetation data layer). In the VTP the treatable landscape was identified by grouping the WHR vegetation classifications into treatable vegetation formations. Treatable vegetation formations are those WHR classifications that can be manipulated or altered to change the fire environment. Vegetation formations are divided into three categories: tree-dominated, shrub dominated, and grass-dominated. The following sections discuss in detail the vegetation formations and their subtypes. Figure 4.1-1 provides an overview of the vegetation formations and their subtypes.

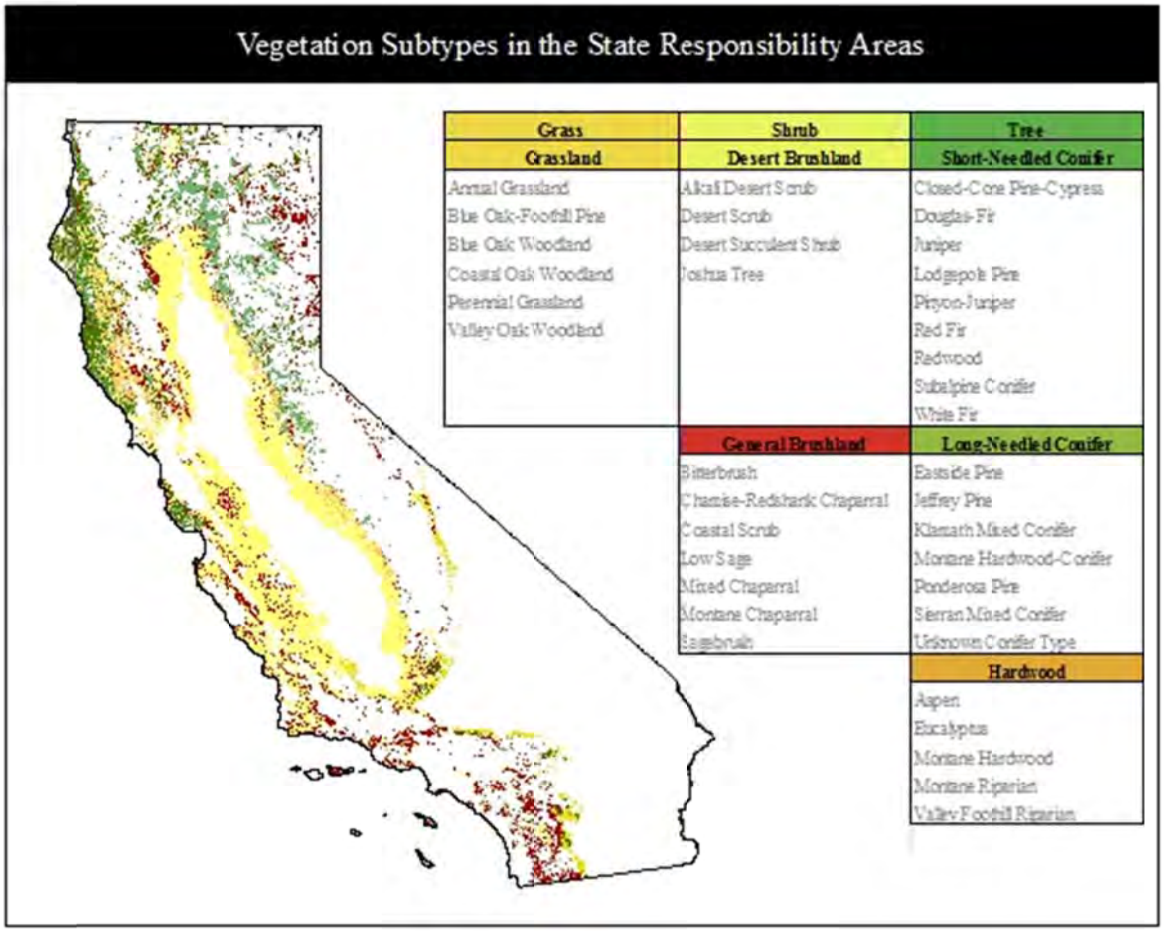


Figure 4.1-1 Vegetation Subtypes in the State Responsibility Areas

4.1.4.1 Life History Features for Tree-dominated Subtypes

Hardwood forests are California-wide within the Mediterranean climate zone, largely in foothill areas of the Coast Range and the Sierra Nevada. The forest overstory is typically dominated by deciduous hardwood species that result in a herbaceous surface fuel complex dominating fuel/fire behavior. The typical regime is frequent, low-severity fire that likely exerts a positive influence on overstory productivity and canopy resilience to fire damage. The WHR vegetation classes compiled under the hardwood forest subtype for California include aspen, eucalyptus, montane hardwood, montane riparian, and valley foothill riparian.

Mature stands of quaking aspen usually have relatively open canopies, often shared with other deciduous trees and a few conifer species, typically pines. Average canopy closures of stands in eastern California range from 60 to 100 percent in young and intermediate-aged stands and from 25 to 60 percent in mature stands (DFG, 1988). Quaking aspens often attain a height of 60 feet and a diameter of 2 feet. Extraordinary trees may reach a height of 100 feet and a diameter of about 3 feet. The open nature of the stands results in substantial light penetration to the ground. Therefore, all stands have a herbaceous understory with about half maintaining a tall shrub layer. Following disturbance, succession proceeds rapidly from a herbaceous layer to shrubs and trees, which invade together. The successional status of aspen stands is unsettled. Most authorities regard it as an early seral stage that invades after fire or other disturbances. Consequently, successful, long-term suppression of fires or excessive grazing and browsing by ungulates may result in the eventual disappearance of quaking aspen from an area (DFG, 1988).

Eucalyptus habitats range from single-species thickets with little or no shrubby understory to scattered trees over a well-developed herbaceous and shrubby understory. In most cases, eucalyptus forms a dense stand with a closed canopy. Stand structure for this habitat may vary considerably because most eucalyptus has been planted into either rows for wind protection or dense groves for hardwood production and harvesting. Eucalyptus is often found in monotypic stands. The genus is composed of over 150 species with high morphological diversity. Thus, habitat structure may be affected if more than two or three species coexist. Tree size may vary considerably depending on spacing and species. Overstory composition is typically limited to one species of the genus or mixed stands composed of other species of the same genus; few native overstory species are present within eucalyptus planted areas, except in small cleared pockets. Most species of eucalyptus are characterized by adaptations that allow them to survive and recover quickly from disturbances like fire. Even if totally killed by some disturbance, many eucalyptus species produce subsurface ground shoots from lignotubers. For non-lignotubers eucalyptus, the ability to seed heavily and produce heavy natural regeneration suggests that this genus has adapted to a constant environment of fire (DFG, 1988).

Montane hardwood, in particular, occupies the largest spatial component of the hardwood forest subtype in California and is perhaps the most variable of any California forest type. The dominant oak species vary by topography, soils, and elevation. Montane hardwood forests typically lack blue oaks and valley oaks. The characteristic oaks are canyon live oak, interior live oak, California black oak, and Oregon white oak. Once established, the four dominant oaks - canyon live, interior live, California black, and Oregon white - can sprout vigorously from stumps, allowing rapid re-establishment after a fire. Frequent fires over relatively small areas result in a variety of age classes across the landscape (DFG, 1988). A large number of hardwood and conifer species allows this type to occupy many environments and locations.

The vegetation of montane riparian zones is quite variable and often structurally diverse. Usually, the montane riparian zone occurs as a narrow, often dense grove of broad-leaved, winter deciduous trees up to 98 feet tall with a sparse understory. In northwest California along streams west of the Klamath Mountains, black cottonwood is a dominant hardwood. In some areas, it is codominant with big leaf maple. In either case, black cottonwood can occur in association with dogwood and boxelder. At high elevations black cottonwood occurs with quaking aspen and white alder. In northeastern California, black cottonwood, white alder and thin leaf alder dominate the montane riparian zone. Oregon ash, willow and a high diversity of forbs are common associates. In the Sierra Nevada, characteristic species include thin leaf alder, aspen, black cottonwood, dogwood, wild azalea, willow and water birch (southern Sierra east of the crest), white alder and dogwood. In the southern Coast Range as well as Transverse and Peninsular ranges, big leaf maple and California bay are typical dominants of montane riparian habitat. Fremont cottonwood is the most important cottonwood in the Sierra below 5000 feet, much of the Coast Ranges and the Transverse and Peninsular ranges (DFG, 1988).

Dominant species in the canopy layer of valley foothill riparian are cottonwood, California sycamore and valley oak. Sub-canopy trees are white alder, boxelder and Oregon ash. Typical understory shrub layer plants include wild grape, wild rose, California blackberry, blue elderberry, poison oak, button brush, and willows. The herbaceous layer consists of sedges, rushes, grasses, miner's lettuce, Douglas sagewort, poison-hemlock, and hoary nettle. Valley-foothill riparian habitats are found in valleys bordered by sloping alluvial fans, slightly dissected terraces, lower foothills, and coastal plains. They are generally associated with low velocity flows, flood plains, and gentle topography. Valleys provide deep alluvial soils and a high water table (DFG, 1988).

Table 4.1-3: Hardwood forest WHR types representative fuel models, and median fire return intervals (FRI) in State Responsibility Areas (SRA) (*Anderson, 1982)(Scott and Burgan, 2005)**

WHR Type	Acres	Anderson* Fuel Model	Scott & Burgan Fuel Model**	Median FRI (Years)
Aspen	5,143	8	TL2	20
Eucalyptus	21,776	9	TL9	5
Montane Hardwood	2,805,625	9	TL6	13
Montane Riparian	94,599	8	TL2	13
Valley Foothill Riparian	111,830	9	TL6	12
Total Acres	**3,038,973**			

The long-needled conifer subtype includes vegetative formations widely distributed throughout California. Where stands are relatively dense and sufficient fuels are available, the typical fire regime includes frequent (less than 15 years), low severity fires. The WHR vegetation classes compiled under the long-needled conifer subtype for

California include eastside pine, Jeffrey pine, Klamath mixed conifer, montane hardwood-conifer, ponderosa pine, Sierran mixed-conifer.

The eastside pine habitat is characterized by short to moderate height, 65-115 feet tall pine trees at maturity. Without disturbance, except for naturally occurring fire, a mosaic of even-aged patches develops, with open spaces and dense sapling stands. Oaks or junipers may form an understory, but pure stands of pine also are found. An open stand of low shrubs, less than 6.5 feet, and a grassy herb layer are typical. Crowns of pines are open, allowing light, wind and rain to penetrate, whereas other associated trees provide more dense foliage. Logging, bark beetles, root diseases and fire are the major disturbances in the eastside pine type. The understory typical of the specific site increases following disturbance, depending on the nature of the disturbance, season in which it occurred and weather patterns. In general, disturbance favors brush, particularly manzanita and ceanothus. But some kinds of disturbance may eliminate antelope bitterbrush, a desirable deer forage plant that may not be as robust a competitor with trees as are some other shrubs. Open tree stands generally support more vigorous brush or grass understories which may prevent additional tree regeneration for many years. Fire tends to maintain pine stands on sites that will support other conifers. The following understory dominants may be used to identify different eastside pine communities: western juniper, manzanita, several species of ceanothus, big sagebrush, antelope bitterbrush, grass dominance and forb dominance (DFG, 1988).

The structure of the Jeffrey pine forest varies over its distribution. A single tree layer is characteristic of Jeffrey pine stands on moderately dry sites, giving an impression of openness, limited leaf area, light, and heat. On moist and mesic sites a second tree layer exists which is composed of deciduous hardwood species, whereas on dry sites evergreen hardwood species form the second tree layer. Conifer species provide the second tree layer on xeric sites. Jeffrey pine is the dominant species found in the upper tree layer. It usually forms pure stands but may have as its associates ponderosa pine, Coulter pine, sugar pine, lodgepole pine, timber pine, white fir, red fir, incense-cedar, and black cottonwood (DFG, 1988). Jeffrey pine stands are self-perpetuating under a regime of periodic surface fires. Old-growth Jeffrey pine stands exhibit an uneven-aged structure. Analysis of fire scars and age structure suggests that prehistoric fires played an important role in regeneration without destroying the overstory; however, in southern California fires have recently eliminated large areas of Jeffrey pine forest overstory because of accumulated surface fuels. The successional pattern following these fires involves an initial fireweed stage, followed by a shrub stage dominated by ceanothus and manzanita (DFG, 1988).

Klamath mixed conifer habitat is typically composed of tall, dense to moderately open, needle-leaved evergreen forests with patches of broad-leaved evergreen and deciduous low trees and shrubs. On favorable mesic sites with little disturbance, the habitat is dominated by tall evergreen conifers up to 200 feet in height with a rich shrub layer and well-developed herbaceous layer. On more xeric sites, the habitat is generally open, but very diverse forest land having a well-developed shrub layer. The mixed conifer communities of the eastern Klamath region are stable, with frequent light fires. The mixed conifer communities of the western Klamath region are usually burned enough to revert to the montane chaparral type (DFG, 1988).

Montane hardwood-conifer habitat includes both conifers and hardwoods, often as a closed forest. To be considered, at least one-third of the trees must be conifer and at least one-third must be broad-leaved. The habitat often occurs in a mosaic-like pattern with small pure stands of conifers interspersed with small stands of broad-leaved trees. This diverse habitat consists of a broad spectrum of mixed, vigorously growing conifer and hardwood species. This habitat is climax in most cases; however, it can occur as a seral stage of mixed conifer forests. Vegetation response following disturbance, such as fire or logging, begins with a dense shrubby stage dominated by taller broad-leaved species. The stand gradually increases in height, simultaneously developing into two canopy strata with faster growing conifers above and broad-leaved species below. On mesic sites the conifer component overtakes the hardwood component more rapidly than on xeric sites, where the hardwood component is dominant longer (DFG, 1988).

The ponderosa pine habitat includes pure stands of ponderosa pine as well as stands of mixed species in which at least 50% of the canopy area is ponderosa pine. Associated species vary depending on location in the state and site conditions. Typical tree associates include white fir, incense-cedar, Coulter pine, Jeffrey pine, sugar pine, Douglas-fir, bigcone Douglas-fir, canyon live oak, California black oak, Oregon white oak, Pacific madrone and tanoak. Most ponderosa pine stands that include other coniferous trees probably are maintained by periodic ground fires. In many of these stands, crown fires result in dense montane chaparral communities. Young, dense stands, as in plantations, exclude most undergrowth once trees attain a closed canopy. Prior to that, dense brush is typical, but an herbaceous layer may develop on some sites (DFG, 1988).

Five conifers and one hardwood typify the Sierran mixed conifer forest white fir, Douglas-fir, ponderosa pine, sugar pine, incense-cedar, and California black oak. White fir tends to be the most ubiquitous species (though most often a minor overstory component) because it tolerates shade and has the ability to survive long periods of suppression in brush fields Douglas-fir dominates the species mix in the north, but is absent south of the Merced River. Ponderosa pine dominates at lower elevations and on south slopes. Jeffrey pine commonly replaces ponderosa pine at high elevations, on cold sites, or on ultramafic soils. Red fir is a minor associate at the highest elevations. Sugar pine is found throughout the mixed conifer type. Black oak is a minor, but widespread, component in mixed conifer stands. Though black oak does best on open sites, it is maintained under adverse conditions such as shade, ridge tops, and south slopes where conifers may regenerate in its shade (DFG, 1988). In the central and particularly southern Sierra Nevada, giant sequoia is a striking associate of the mixed conifer type. White fir, incense-cedar and sugar pine are associated with the mesic giant sequoia sites.

Table 4.1-4: Long-needled conifer WHR types in State Responsibility Areas (SRA)

WHR Type	Acres	Anderson Fuel Model	Scott & Burgan Fuel Model	Median FRI (Years)
Eastside Pine	346,453	9	TL8	7
Jeffrey Pine	68,751	9	TL8	7
Klamath Mixed Conifer	364,093	9	TL8	12
Montane Hardwood-Conifer	1,369,115	9	TL8	13
Ponderosa Pine	591,307	9	TL8	7
Sierran Mixed Conifer	991,864	9	TL8	9
Total Acres	**3,731,583**			

The short-needled conifer subtype includes most true-fir formations and short-needled pines. Disturbance patterns for this subtype range from frequent, low severity fires like that of the white fir, to very infrequent mixed-severity fires that are typical of higher elevation lodgepole pine stands. The WHR vegetation classes compiled under the short-needled conifer subtype for California include closed-cone pine/cypress, Douglas-fir, lodgepole pine, juniper, Pinyon-juniper, red fir, redwood, subalpine conifer, and white fir.

Closed-cone pine-Cypress habitat includes a number of different series of evergreen, needle-leaved trees. The height and canopy closure of these series are variable and depend upon site characteristics, soil type, the age of the stand and the floristic composition. The closed-cone pine habitats are similar to each other and will be described separately from the cypress habitats, although some of the series within this habitat contain both pine and cypress. After fire, particularly on good sites, both cypress and pine habitats form dense, even-aged stands. As the stand matures, the stocking density decreases, but single species site dominance is common. Closed-cone Pine-Cypress habitats found along the extreme coast or on very shallow infertile soils contain stunted wind-pruned individuals. Closed-cone pines and cypress retain their seeds in serotinous cones which remain on the branches. These habitats are true fire climax or fire-dependent vegetation types, but fire may occur at any phase of the community. The heat of the fire causes the cones to release seeds which fall on the bare mineral soils. The full sunlight provided in early successional stages is excellent for seedling establishment and promotes the dense even-aged stands typical of all types of closed-cone pine and cypress habitats. Numerous "fire following" herbaceous species are abundant in the early successional stages following fire.

Douglas-fir habitat forms a complex mosaic of forest expression due to the geologic, topographic, and successional variation typical within its range. Typical aggregations include a lower overstory of dense, sclerophyllous, broad-leaved evergreen trees (tanoak, Pacific madrone) up to 114 feet tall, with an irregular, often open, higher overstory of tall needle-leaved evergreen trees (Douglas-fir) up to 295 feet. A small number of pole and sapling trees occur throughout stands. On wet sites, shrub layers are well developed, often with 100 percent cover. Cover of the herbaceous layer under the shrubs can be up to 10 percent. At higher elevations, the shrubs disappear and the herb layer is often 100 percent. Because of frequent fires, typical climax Douglas-fir habitat is rare. In the absence of disturbance, such stands develop in 80 to over 250 years, depending on site quality. Individual Douglas-fir trees can live to 1250 years; ages in excess of 750 years are common. Following disturbance, the seedling tree class persists for 5 to 20 years, depending on site quality (DFG, 1988).

Lodgepole pine typically forms open stands of similarly sized specimens in association with few other species and with a sparse understory. On fertile sites, trees can reach a height of 130 feet, but typically a stand consists of groups averaging 40 to 65 feet in height. Three major disturbances affect lodgepole pine in California: fire, insects, and logging. These disturbances create openings of various sizes that lodgepole pines rapidly recolonize. The stages of vegetation change are primarily the result of increased tree density, canopy cover, and size. Beetle infestation creates large quantities of fuel that increase the probability of wildfire (DFG, 1988).

Juniper habitats are characterized as woodlands of open to dense aggregations of junipers (western, mountain, California, or Utah) in the form of arborescent shrubs or small trees. Dispersion of junipers ranges from small clumps to widely scattered single plants. Denser stands are commonly associated with a grassy understory; whereas, a shrub understory is found where junipers are more open. Juniper densities have increased in the last century owing to heavy grazing and reduced fire (DFG, 1988).

Pinyon-juniper habitat typically is open woodland of low, round crowned, bushy trees that are needle-leaved, evergreen, and depending on site suitability, range from less than 30 feet to 50 feet in height. Crowns of individual trees rarely touch and canopy cover generally is less than 50 percent. These open groves of overstory trees often have a dense to open layer of shrubs reaching heights of 5 feet. Low herbaceous plants may also be present in this habitat. Stand structure varies depending on site quality and elevation. Pinyon-juniper forms dense cover on favorable sites with little disturbance, whereas on drier sites, spacing between trees increases and tree size decreases. At low elevations, pinyon-juniper stands are rather open, becoming denser at higher elevations. At maximal elevations, this habitat grades rapidly into adjacent habitats. Pinyon-juniper habitat generally occurs at middle elevations adjoining a number of other wildlife habitats. At lower elevations, pinyon-juniper may interface with habitats such as Joshua tree and desert scrub. At higher elevations, habitats such as eastside pine, perennial grass, and Jeffrey pine border on pinyon-juniper. At similar elevations in more southerly latitudes, sagebrush, mixed chaparral, and chemise-redshank chaparral are found adjacent to pinyon-juniper (DFG, 1988).

Mature red fir stands normally are monotypic, with very few other plant species in any layer. Heavy shade and a thick layer of duff, tends to inhibit understory vegetation, especially in dense stands. To the north, in the Klamath Mountains, red fir gives way to noble fir. Stand structure is typified by even-aged (established within 20-year span) groups of trees that cover several to hundreds of acres. The cause of this pattern is probably a history of recurrent lightning fires, wind throws, and insect outbreaks acting to kill groups of trees. In the shrub/sapling stage, large brush fields may develop after hot wildfires and are dominated by Ceanothus or other shrub species for many years (DFG, 1988).

The redwood habitat is a composite name for a variety or mix of conifer species that grow within the coastal influence zone (31 mi) from the coast. In the north coast region of California within 2.5 mi of the coast, the redwood habitat consists of Sitka spruce, grand fir, redwood, red alder, and Douglas-fir. Western red cedar and western hemlock are also associates but seldom comprise the major portion of a stand. Redwood becomes dominant along coastal areas approximately 2 to 10 miles from the ocean where Douglas-fir, red alder, and grand fir are its major associates. Further inland, Douglas-fir becomes dominant with tan oak and madrone as the major associates. The climax stage of the redwood habitat is distinguished by a bilayered canopy, usually with redwood or Douglas-fir as the dominant species. Redwood is a self-perpetuating habitat, with or without fire as a disturbance. Fire and flooding in the redwood ecosystem play a major role in terms of reproduction and plant succession. When fire is introduced, various plant species are affected, ultimately altering the habitat stage (DFG, 1988).

Several species dominate canopies of the subalpine conifer type in different localities, either singly or in mixtures of two or more species. These include Engelmann spruce, subalpine fir, mountain hemlock, western white pine, lodgepole pine, whitebark pine, foxtail pine, bristlecone pine, and limber pine. Although typically of minor importance, a shrub understory may include Parry manzanita, squaw currant, purple mountain heather, oceanspray, and big sagebrush. Willows, western huckleberry, California huckleberry, Sierra bilberry, and alpine laurel occur on moist sites. Western wheatgrass, California brome, several species of lupines, and a variety of flowering annuals are common in the sparse ground cover (DFG, 1988).

The White Fir habitat is characterized by nearly monotypic even aged overstory. Mature white fir stands, normally monotypic, with more than 80 percent occurring as white fir, are found throughout California; from the Klamath Mountains along the north coast to the south coast mountain ranges, and in interior ranges from the Warner Mountains in the Great Basin to the Clark, Kingston, and New York mountain ranges in interior southern California. Fire influences the white fir habitat by causing a mosaic of even-aged stands in different successional stages (DFG, 1988).

Table 4.1-5: Short-needled conifer WHR types in State Responsibility Areas (SRA)

WHR Type	Acres	Anderson Fuel Model	Scott & Burgan Fuel Model	Median FRI (Years)
Closed-Cone Pine-Cypress	88,202	9	TL2	59
Douglas-Fir	1,053,719	8	TL3	12
Juniper	425,940	8	TL4	77
Lodgepole Pine	25,534	8	TL3	36
Pinyon-Juniper	107,031	8	TL4	94
Red Fir	104,270	8	TL3	33
Redwood	796,128	8	TL2	15
Subalpine Conifer	9,457	8	TL1	132
White Fir	173,341	10	TL5	12
Total Acres	**2,783,620**			

4.1.4.2 Life History Features for Shrub-dominated Subtypes

The capacity of species to recover from fire is assumed to be based on two types of regeneration – from buried seeds (the seed bank) and from root sprouting or sprouting from lower stems that have survived the fire (the bud bank). The regeneration capacity from the seed and bud banks is assumed to be relatively short, 1-2 years, during which the potential of stored seed germination and re-sprouting is largely expended. One feature not included in this scheme is the distinction between species that continue to produce new sprouts—though not as vigorously as after fire, but sufficient to rejuvenate their canopies—and species with a much reduced capacity for continual recruitment of new stems from sprouts. This is not a dichotomous condition but a continuum. At one extreme are species of *Cercocarpus* which develop into individuals with a whole range of stem ages and, in old stands, an accumulation of large dead stems. At the other are some obligate seeding *Arctostaphylos* species which rarely produce new sprouts. The WHR vegetation classes compiled for both general and desert shrubland subtypes for

California include bitterbrush, chamise-redshank chaparral, coastal scrub, low sage, mixed chaparral, montane chaparral, sagebrush, alkali desert scrub, desert scrub, desert succulent scrub and Joshua tree.

Bitterbrush stands range from small, widely spaced shrubs to large, closely spaced shrubs with more than 90 percent canopy cover. Stands usually contain 300 to 1200 per acre. Bitterbrush is only occasionally found in pure stands. Antelope bitterbrush often occurs as a codominant with big sagebrush or rubber rabbitbrush. It is also found with gray horsebrush, Douglas rabbitbrush, Mormon tea, curlleaf mountain mahogany, and desert peach. Overstory species found in Bitterbrush habitats are ponderosa or Jeffrey pine, lodgepole pine, or western juniper. Understory herbaceous plants vary greatly in composition and density; examples include Idaho fescue, bottlebrush squirreltail, needlegrass, bluebunch wheatgrass, eriogonum, and phlox. The total understory usually makes up less than 10 percent cover. Desert bitterbrush is found mixed with big sagebrush, fourwing saltbush, creosotebush, rubber rabbitbrush, Mormon tea, spiny hopsage, and, on the north end of its range, antelope bitterbrush. Overstory species commonly found with desert bitterbrush are Utah juniper, singleleaf pinyon, Joshua tree, and, at higher elevations, Jeffrey pine. Some of the common understory species are Thurber needlegrass, eriogonum, common snakeweed, and big galleta. These usually total less than 5 percent ground cover. Bitterbrush reproduces sexually by seeds, vegetatively by stem layering, and by sprouting after fire or mechanical damage. However, some dieback occurred among sprouts from decadent plants and plants that burned very hot. Some stands of desert bitterbrush have been repeatedly renewed by fire, as it sprouts more readily than antelope bitterbrush (DFG, 1988).

Fire occurs regularly in chamise-redshank chaparral and influences habitat structure. Mature chamise-redshank chaparral is single layered, generally lacking well-developed herbaceous ground cover and overstory trees. Chamise-redshank chaparral may consist of nearly pure stands of chamise or redshank, a mixture of both, or with other shrubs. Fire is the primary disturbance initiating secondary succession in chamise-redshank chaparral. Annuals, perennial herbs, and subshrubs are abundant for several years after a fire. Shrubs begin to appear either as seedlings or rootcrown sprouts beginning the first growing season after burning. As the habitat matures, shrub cover and height increase and herbaceous cover declines (DFG, 1988).

Structure of the plant associations that comprise coastal scrub is typified by low to moderate-sized shrubs with mesophytic leaves, flexible branches, semi-woody stems growing from a woody base, and a shallow root system. No single species is typical of all coastal scrub stands. As with structure, composition changes most markedly with progressively more xeric conditions from north to south along the coast. With the change from mesic to xeric sites, dominance appears to shift from evergreen species in the north to drought-deciduous species in the south. Variation in coastal influence at a given latitude produces less pronounced composition changes. Two types of northern coastal scrub are usually recognized. The first type (limited in range) occurs as low-growing patches of bush lupine and many-colored lupine at exposed, oceanside sites. The second and more common type of northern coastal scrub usually occurs at less exposed sites. Here coyotebush dominates the overstory. Other common overstory species are blue blossom ceanothus, coffeeberry, salal, bush monkeyflower, blackberry, poison-oak and wooly sunflower. Bracken fern and swordfern are dominant in the understory; common cowparsnip, Indian paintbrush, yerba buena and California oatgrass are typically present. Around Half Moon Bay, western hazelnut, Pacific bayberry, and sagebrush are also present. Southern sage scrub, occurring intermittently over a larger area than the two northern coastal scrub types, is subdivided into three main types. Differences in composition of these three types correspond mostly to available moisture. A fairly common species in all three types is California sagebrush. The most mesic area, from Mt. Diablo south to Santa Barbara, is dominated by black sage and California buckwheat. In the less mesic region from Santa Barbara south to Orange County, purple sage and California buckwheat join black sage in importance. Golden yarrow, isocoma, rolled leaf monkeyflower, and California encelia are typical. Chaparral yucca is found on the slightly drier sites within the region, especially in Ventura County. The southernmost stands are the most xeric of the form. Composition here is characterized by succulent species and a distinct Baja California influence. In addition to the California sagebrush, California buckwheat, and wooly sunflower typical of the stands farther north, California adolphia, coastal agave, and cunyado are present south of San Diego.

Low sage habitat is typically dominated by either low sagebrush or black sagebrush, often in association with Douglas rabbitbrush, antelope bitterbrush, or big sagebrush; black sagebrush is also commonly associated with winterfat and Mormon-tea. Western juniper may be sparsely scattered in stands dominated by low sagebrush, and Utah juniper and singleleaf pinyon are sometimes scattered in stands dominated by black sagebrush. Common grass species include Sandberg bluegrass, bluebunch wheatgrass, bottlebrush squirreltail, Thurber needlegrass, and Idaho fescue. A rich variety of forbs is usually present. The abundance and distribution of associated plants is highly influenced by soils and precipitation. Wildfire, grazing by large herbivores, and defoliation by larvae of the moth Aroga websterii undoubtedly contributes to stand renewal in the pristine sagebrush steppe of California. However, disturbance of these habitats today apparently results in their replacement by other relatively stable plant communities, completely changing their successional pattern. Indeed, cheatgrass has invaded all potential sagebrush steppe communities of northeastern California, changing succession in an entire vegetation type. Overgrazed stands are reduced to stark shrub communities with much bare ground between the low shrubs. Such stands are readily invaded by medusahead and some cheatgrass, increasing their susceptibility to wildfires. Thus, if the non-sprouting shrubs are destroyed, the site becomes dominated by medusahead (DFG, 1988).

Mixed chaparral is a structurally homogeneous brushland type dominated by shrubs with thick, stiff, heavily cutinized evergreen leaves. Shrub height and crown cover vary considerably with age since last burn, precipitation regime (cismontane vs. transmontane), aspect, and soil type. At maturity, cismontane mixed chaparral typically is a dense, nearly impenetrable thicket with greater than 80 percent absolute shrub cover. Mixed chaparral is a floristically rich type that supports approximately 240 species of woody plants. Composition changes between northern and southern California and with precipitation regime, aspect, and soil type. Dominant species in cismontane mixed chaparral include scrub oak, chaparral oak, and several species of ceanothus and manzanita (DFG, 1988).

Montane chaparral varies markedly throughout California. Species composition changes with elevational and geographical range, soil type, and aspect. One or more of the following species usually characterize montane chaparral communities: whitethorn ceanothus, snowbrush ceanothus, greenleaf manzanita, pinemat manzanita, hoary manzanita, bitter cherry, huckleberry oak, sierra chinquapin, juneberry, fremont silktassel, Greene goldenweed, mountain mahogany, toyon, sumac and California buckthorn. Following fire in the mixed conifer forest habitat type, whitethorn ceanothus-dominated chaparral may persist as a subclimax community for many years. Montane chaparral is characterized by evergreen species; however, deciduous or partially deciduous species may also be present. Understory vegetation in the mature chaparral is largely absent. Conifer and oak trees may occur in sparse stands or as scattered individuals within the chaparral type (DFG, 1988).

Sagebrush stands are typically large, open, discontinuous stands of big sagebrush of fairly uniform height. Often the habitat is composed of pure stands of big sagebrush, but many stands include other species of sagebrush, rabbitbrush, horsebrush, gooseberry, western chokecherry, curlleaf mountain mahogany, and bitterbrush. The most common disturbance factors are wildfire, prescribed burning, seeding to grasses, livestock grazing, and defoliation by larvae of the sagebrush defoliator moth. Stable sagebrush habitats with little herbaceous understory are relatively fire resistant. However, stands subjected to heavy grazing are often invaded by annual grasses and are highly flammable. Stands killed or severely damaged by the larvae of the sagebrush defoliator moth are also subject to wildfire (DFG, 1988).

Table 4.1-6: General Shrubland WHR types in State Responsibility Areas (SRA)

WHR Type	Acres	Anderson Fuel Model	Scott & Burgan Fuel Model	Median FRI (Years)
Bitterbrush	89,041	5	SH2	53
Chamise-Redshank Chaparral	618,039	6	SH6	59
Coastal Scrub	1,185,981	5	SH2	100
Low Sage	92,497	5	SH2	53
Mixed Chaparral	1,930,256	4	SH7	59
Montane Chaparral	309,207	4	SH5	24
Sagebrush	826,432	5	SH7	41
Total Acres	**5,051,453**			

Alkali scrub vegetation generally occurs at lower to middle elevations and interdigitates with a number of other arid and semiarid wildlife habitats. At lower elevations, Alkali scrub may intermingle with barren salt flats and desert scrub; and in the southern part of its range, palm oasis. At lower-middle elevation alkali scrub may interface with Joshua tree; and at upper middle elevations, with juniper, pinyon-juniper, sagebrush, low sagebrush, and bitterbrush. Throughout its range, desert wash and desert riparian may occur within the alkali scrub. In the San Joaquin Valley, alkali scrub borders on annual grassland habitat. In many locations, alkali scrub overlaps with perennial grassland (DFG, 1988).

Desert scrub habitats typically are open, scattered assemblages of broadleaved evergreen or deciduous microphyll shrubs. Creasotebush is often considered a dominant of desert scrub habitats but its dominance is usually owing to its tall stature rather than density. After disturbance, desert scrub habitats proceed slowly through succession. No definitive recovery rates are known (DFG, 1988). Desert scrub habitats occur at relatively low elevations.

Desert succulent shrub habitats typically are low, open shrublands dominated (at least visually) by stem or other succulent plants. When Joshua trees are present in any number the habitat is considered a Joshua tree habitat. Development of desert succulent shrub habitats is relatively slow because many of the more conspicuous plant species are slow growing. The time required to proceed through the successional stages is not fully known; but is probably quite variable depending on climatic and soil factors as well as plant species comprising the habitat (DFG, 1988).

Joshua tree habitats are characterized as open woodlands of widely scattered Joshua trees with a low to more or less dense community of broad-leaved evergreen and deciduous shrubs found in desert scrub habitats. Joshua trees are rarely found as pure stands but generally are associated with other overstory trees and shrubs. Coexisting overstory species include California juniper, Utah juniper, singleleaf pinyon, and Mojave yucca. The time necessary for Joshua tree habitats to progress through successional stages is not known but most likely relates to precipitation, fire, soil characteristics, and livestock use (DFG, 1988).

Table 4.1-7: Desert Shrubland WHR types in State Responsibility Areas (SRA)

WHR Type	Acres	Anderson Fuel Model	Scott & Burgan Fuel Model	Median FRI (Years)
Alkali Desert Scrub	241,110	5	SH2	610
Desert Scrub	384,776	4	SH2	610
Desert Succulent Scrub	15,025	5	SH1	610
Joshua Tree	59,653	5	TU5	610
Total Acres	**700,564**			

4.1.4.3 Life History Features for Grass-dominated Subtypes

The grass-dominated subtypes can be divided into two general categories. Plants that complete their entire life cycle within a single growing season are classified as an annual while perennials may persist for many growing seasons. These subtypes include a diversity of dominant cover types composed of annual and perennial grass and forb species. Grasslands are also commonly associated with oak woodlands. The California grassland is extremely variable both spatially and temporally. Fire spread is governed by the fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured (FRAP, 2003). Fires are predominantly surface fires that move rapidly through the cured grass and associated material. Surface fires, under typical conditions, do not transition into the crowns of associated trees. The WHR vegetation classes compiled for both annual and perennial grassland subtypes for California include annual grassland, blue oak-foothill pine, blue oak woodland, coastal oak woodland, perennial grassland, and valley oak woodland.

Annual Grassland habitats are open grasslands composed primarily of annual plant species. Many of these species also occur as understory plants in Valley Oak Woodland and other habitats. Structure in Annual Grassland depends largely on weather patterns and livestock grazing. Introduced annual grasses are the dominant plant species in this habitat. These include wild oats, soft chess, ripgut brome, red brome, wild barley, and foxtail fescue. Common forbs include broadleaf filaree, redstem filaree, turkey mullein, true clovers, bur clover, popcorn flower, and many others. California poppy, the State flower, is found in this habitat. Perennial grasses, found in moist, lightly grazed, or relic prairie areas, include purple needlegrass and Idaho fescue (DFG, 1988).

Blue-oak foothill pine habitat is typically diverse in structure both vertically and horizontally, with a mix of hardwoods, conifers, and shrubs. The shrub component is typically composed of several species that tend to be clumped, with interspersed patches of Annual Grassland. Woodlands of this type generally have small accumulations of dead and downed woody material and relatively few snags, compared with other tree habitats in California. Blue oak and foothill pine typically comprise the overstory of this habitat, with blue oak usually most abundant. Stands dominated by foothill pine tend to lose their blue oak, which is intolerant of shade. In the foothills of the Sierra Nevada, tree species typically associated with this habitat are interior live oak and California buckeye. In the Coast Range, associated species are the coast live oak, valley oak, and California buckeye. Interior live oak sometimes dominates the overstory, especially in rocky areas and on north-facing slopes at higher elevations (DFG, 1988).

Generally blue-oak woodlands have an overstory of scattered trees, although the canopy can be nearly closed on better quality sites. The density of blue oaks on slopes with shallow soils is directly related to water stress. Blue oak is the dominant species, comprising 85 to 100 percent of the trees present. Common associates in the canopy are coast live oak in the Coast Range, interior live oak in the Sierra Nevada, valley oak where deep soil has formed, and western juniper in the Cascade Range. In the Tehachapi and Paiute Ranges in Kern County, this habitat mixes with species from east of the mountains California juniper and single-leaf pinyon. In interior sections of the southern Coast Range, as in San Luis Obispo County, it mixes with California juniper. Associated shrub species include poison-oak, California coffeeberry, buckbrush, redberry, California buckeye, and various manzanita species (DFG, 1988).

Coastal oak woodlands are extremely variable. The overstory consists of deciduous and evergreen hardwoods 15 to 70 feet tall sometimes mixed with scattered conifers. In mesic sites, the trees are dense and form a closed canopy. In drier sites, the trees are widely spaced, forming an open woodland or savannah. The understory is equally variable. In some instances, it is composed of shrubs from adjacent chaparral or coastal scrub which forms a dense, almost impenetrable understory. More commonly, shrubs are scattered under and between trees. Where trees form a closed canopy, the understory varies from a lush cover of shade-tolerant shrubs, ferns, and herbs to sparse cover with a thick carpet of litter. When trees are scattered and form open woodland, the understory is grassland, sometimes with scattered shrubs. Native American burning in the past was important in maintaining some open stands of coastal oak woodland. Natural and manmade fires may still be important in some areas. Southern oak woodlands have apparently experienced an increase in periodicity of fires in recent years. Studies indicate that Engelmann oak and coast live oak are able to survive most fires. Most coastal oak woodlands are comprised of medium to large trees with few seedlings and saplings, especially in heavily grazed areas. Regeneration of most oaks in the coastal oak woodlands has not been studied thoroughly, but it is generally considered that they do not have the serious regeneration problems found with blue oak and valley oak. However, Engelmann oak is not adequately reproducing itself for reasons similar to those of blue oak.

Perennial Grassland habitats, as defined here, occur in two forms in California: coastal prairie, found in areas of northern California under maritime influence, and relics in habitats now dominated by annual grasses and forbs. The coastal prairie form is described here. Relic perennial grasslands are discussed in the chapter on Annual Grassland habitats. Species of perennial grasses are also common in Wet Meadow and other habitats. Structure in Perennial Grassland habitat is dependent upon the mix of plant species at any particular site. Perennial Grassland habitats are dominated by perennial grass species such as California oatgrass, Pacific hairgrass, and sweet vernal grass. Historically, factors that have affected Perennial Grassland habitats on the north coast include the introduction of non-native annual plant species, increased grazing pressure, elimination of frequent fires, and cultivation (DFG, 1988).

Valley oak woodland habitat varies from savanna-like to forest-like stands with partially closed canopies, comprised mostly of winter-deciduous, broad-leaved species. Denser stands typically grow in valley soils along natural drainages. Tree density decreases with the transition from lowlands to the less fertile soils of drier uplands. Exceptions to this pattern are known, especially in the central coastal counties. Similarly, the shrub layer is best developed along natural drainages, becoming insignificant in the uplands with more open stands of oaks. Valley oak stands with little or no grazing tend to develop a partial shrub layer of bird disseminated species, such as poison-oak, toyon, and coffeeberry. Canopies of these woodlands are dominated almost exclusively by valley oaks. Valley oaks are tolerant of flooding, and young trees will sprout when fire damaged.

Fire transitions easily into and out of grass dominate plant communities (Mutch, 1970). Much of California grassland has been protected from burning by fire suppression policies and heavy grazing. Hence, where remnant perennial grasslands remain, properly timed fire and grazing can improve seedling establishment and survival and can increase the basal area of established native plants. However, the application of prescribed fire and range management in the absence of an established perennial grassland seed source will not result in a greater distribution of perennial establishment (FRAP, 2003).

Table 4.1-8: Annual and Perennial Grassland WHR types in State Responsibility Areas (SRA)

WHR Type	Acres	Anderson Fuel Model	Scott & Burgan Fuel Model	Median FRI (Years)
Annual Grassland	5,845,592	1	GR4	3
Blue Oak-Foothill Pine	792,244	2	GR4	12
Blue Oak Woodland	2,515,538	2	GR4	12
Coastal Oak Woodland	1,031,000	2	GR4	12
Perennial Grassland	145,130	3	GR6	3
Valley Oak Woodland	81,447	2	GR4	12
Total Acres	**10,410,951**			

4.1.5 PROGRAM TREATMENTS

This section expands on the Program Treatments discussion that was presented in Chapter 2, Section 2.2.3.

The VTP consists of three program treatments that are intended to focus on treating fuels that either helps suppression forces more easily contain fire or reduce the area burned by high-intensity fire.

WILDLAND-URBAN INTERFACE (WUI)

The WUI is the geographical overlap of two diverse systems, wildland and structures. At this interface, the buildings and vegetation are sufficiently close that a wildland fire could spread to a structure or a structure fire could ignite wildland vegetation.

ECOLOGICAL RESTORATION

Ecological Restoration is the process of re-establishing the composition, structure, pattern, integrity and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions.

FUEL BREAKS

Fuel breaks are an area in which flammable vegetation has been modified to create a defensible space in an attempt to reduce fire spread to structures and/or natural resources, and to provide a safer location to fight fire. These treatments can be a part of a series of fuel modifications strategically located along a landscape.

4.1.5.1 Wildland-Urban Interface

The Wildland Urban Interface (WUI) is an area where human development is located in close proximity to fire-prone open space, native vegetation, and/or habitat. The WUI creates an environment in which fire can move readily between structural and vegetation fuels. Once homes are built within or adjacent to natural habitat settings, it increases the complexity of fighting wildland fires because the goal of extinguishing the wildland fire is often superseded by protecting human life and private property. Nowhere is this more apparent than in California. Most of the population lives in lower elevations dominated by chaparral shrublands susceptible to frequent high-intensity crown fires. Hence, the WUI's location, extent, and dynamics will continue to be a component in wildland fire management.

4.1.5.1.1 Spatial Modeling

In 2001, CAL FIRE FRAP in conjunction with the California Fire Alliance undertook the task of spatially modeling the Wildland-Urban Interface. The modeling process consisted of three main components: ranking fuel hazard, assessing the probability of wildfire, and defining areas of suitable housing density that lead to Wildland-Urban Interface protection strategy situations (FRAP, 2003). The final geospatial extend of the WUI combines three main factors:

Using these three building blocks, maps were developed that define not only the total footprint of what can be considered "WUI," but also contains specific information within that footprint that supports the development of strategies to prioritize mitigation efforts to achieve efficient results. All three components contribute to a risk assessment of potential loss from wildland fire. In other words, the larger the hazard, the more assets exposed, and the closer these components are to one another, the higher the risk of loss.

WILDLAND FIRE HAZARDS

Wildland fire hazards were derived from a combination of defining the fuel hazard and identifying the probability of burning.

DEFINING THE FUEL HAZARD

CAL FIRE FRAP first began the process of modeling the WUI by defining the fuel hazard. This was achieved by first developing a comprehensive vegetation map consisting of vegetation composition and structure information. The comprehensive vegetation map was then joined to the Fire Behavior Prediction System (FBPS) fuel models, a similar method to the one utilized in the Sierra Nevada Ecosystem Project. Recent large fires were then captured in the data with appropriate burn and growth models applied. This information was then converted to a fire hazard map by calculating the expected fire behavior for unique combination of slope and fuels under average bad fire weather conditions. Each fuel-by-slope-class combination received a surface hazard rank. A final fuel hazard product was created by gridding out the state into approximately 450 acre squares and assigning a hazard rank to each grid cell based on its slope class, fuel model, and the presence of ladder and crown fuels. The assigned values consisted of Very High, High, and Moderate.

PROBABILITY OF BURNING

The probability of fire burning in a given location is based on variety of factors including vegetative fuel condition, weather, ignition sources, fire suppression response, etc. (FRAP, 2003). Through the utilization of 47 years of fire history, fire perimeters, and the comprehensive vegetation map, an annual likelihood that a large damaging fire would occur in a particular vegetation type was developed. This probability matrix is referred to as PFIRE, where:

- Very High is the probability of fire 1% per year or greater,
- High is the probability of fire .33% - 1 % per year,
- Moderate is the probability of fire is less than .33% per year.

These values respectively related to fire frequency equivalents of less than 100 years, 100-300 years, and greater than 300 years.

ASSESING FIRE THREAT

The fire threat is then derived from combining the fuel hazard with the probability of burning. Areas were grouped by Low, Moderate, and High based off the matrix below.

Table 4.1-9: Fire Threat Matrix

PFIRE	Hazard Rank		
	Very High	High	Moderate
Very High	HIGH	HIGH	HIGH
High	HIGH	HIGH	MODERATE
Moderate	HIGH	MODERATE	LOW

The geospatial extent and distribution of the California's fire threat can be viewed in Figure 4.1-2. The creation of the fire threat within the WUI modeling process accounts for the wildland fire hazards component, an important building block when identifying the WUI geospatially.

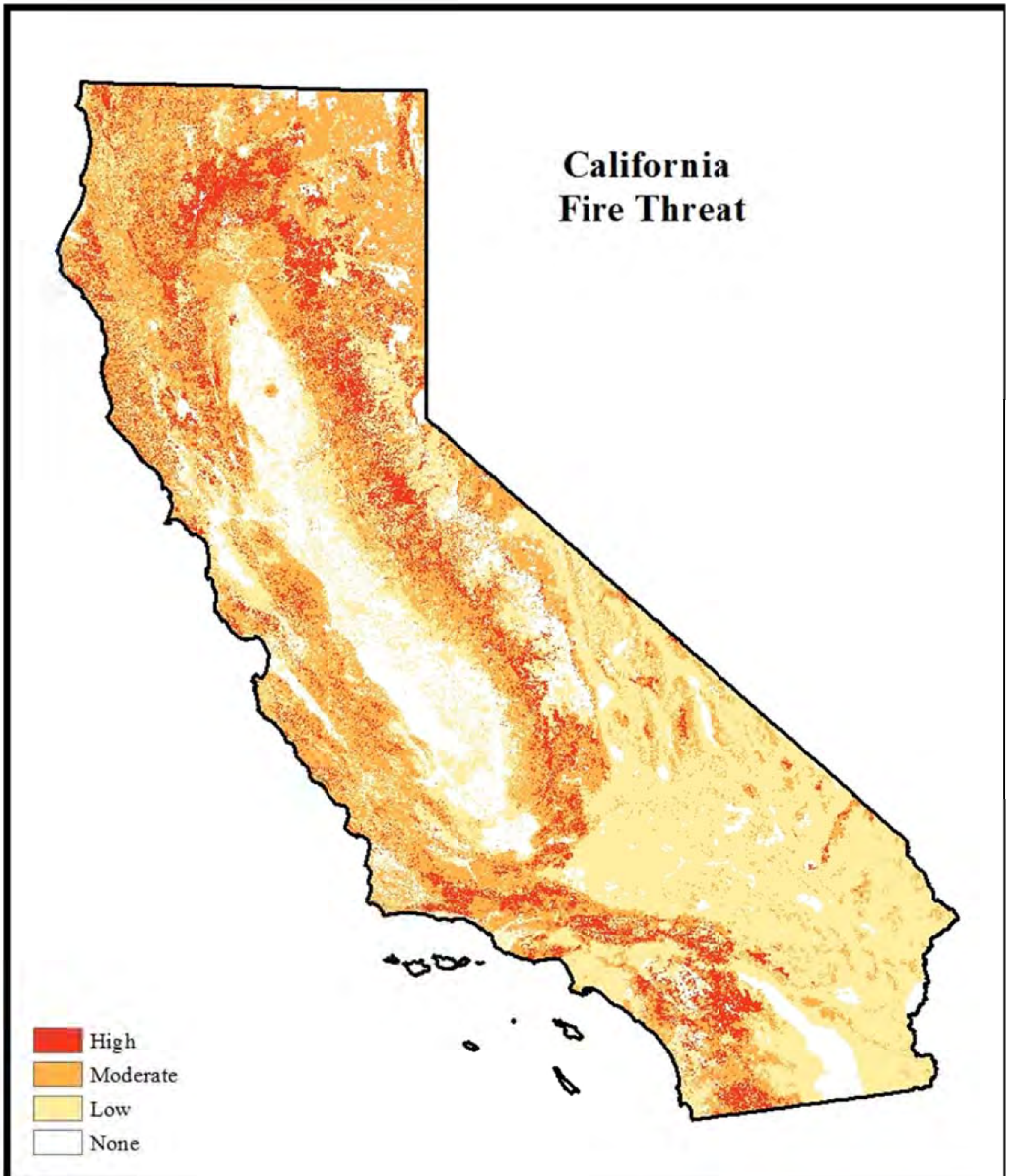


Figure 4.1-2: California Fire Threat

HUMAN ASSET EXPOSURE

Human asset exposure was defined by identifying the Urban-Interface. The conclusion was drawn that the Urban-Interface exists when one house occurred between every 1 to 40 acres. Urban-Interface categories were further developed as follows:

- Urban – 1+ house per ½ acre
- Intermix – 1 house per ½ acre to 1 house per 5 acres
- Rural – 1+ house per 5 acres to 1 house per 40 acres
- Wildland – less than 1 house per 40 acres

To determine the number of structures per acre, census block data was used. Census blocks are typically designed to represent 400 people, leading to wide variation and size. Census blocks do not distinguish undeveloped areas, federal lands, from developed areas or private lands. Therefore to accurately capture housing densities, FRAP migrated the density from restricted development areas to non-restricted development areas. Federal lands are considered restricted development lands for the analysis. Figure 4.1-3 shows the geospatial distribution of the Urban Interface throughout California.

The identification of the Urban-Interface and fire threats to the Urban-Interface within the WUI modeling process accounts for the human asset exposure component, another important building block when identifying the WUI geospatially.

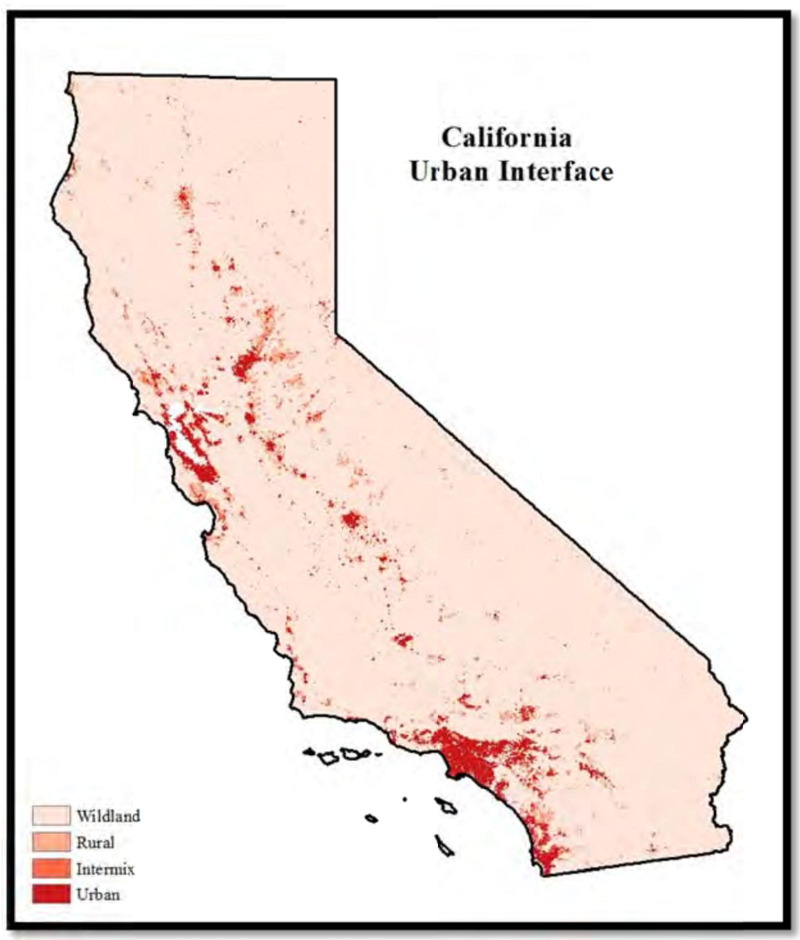


Figure 4.1-3: California's Urban Interface

PROXIMITY

Proximity can be described as areas were Urban-Interface and the vicinity of a fire threat intersects. Vicinity is defined, in accordance with the 2001 California Fire Alliance research, as all areas within 1.5 miles of a fire threat. The 1.5 mile distance is the approximate distance that embers and flaming material (firebrands) can be carried from a wildland fire to the roof or other part of a structure.[1] All Intermix and Rural areas within 1.5 miles of a fire threat were labeled with the highest threat rank, while urban areas (as defined previously under Human Asset Exposure) were labeled with the highest threat rank if they were within ¼ mile of a fire threat. This allowed the capture of urban areas that were in close proximity to wildland areas, while excluding more urbanized areas in the central parts of cities. This approach also reflected that many fires which impact areas of assets come from adjacent wildland areas.

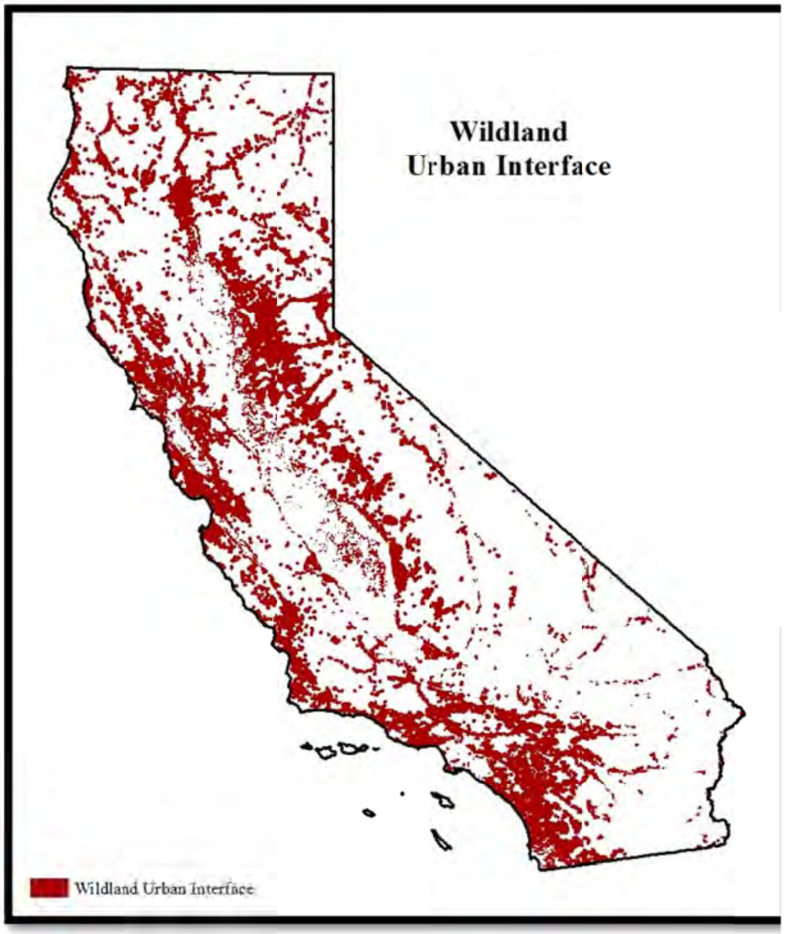


Figure 4.1-4: California's Wildland Urban Interface

[1] While this buffer distance may appear overly large to some, it is important to note that the 1.5 mile buffer is intermediate in value to those discussed historically when characterizing communities at risk. Dave Sapsis (personal communication), FRAP lead analyst of California's Community at Risk mapping effort, recounts that United States Forest Service representatives from the Cleveland National Forest suggested a 6-mile wide WUI buffer based on potential fire growth in a single burning period during initial stages of mapping communities at risk. The 6-mile distance to structures is also significant variable in predicting higher suppression cost (Gude et al., 2013).

4.1.5.1.1.1 Wildland-Urban Interface Zone of Influence

The Wildland-Urban Interface Zone of Influence describes the two zones that emerge within the WUI: the defense zone and the threat zone. The defense zone is the immediate ¼ mile distance from an Urban-Interface area, while the threat zone is the 1 ¼ mile adjacent to the defense zone. These zones of influence are where human assets and wildfire threats intersect. They represent the proximal lands where fuel reduction treatments would likely influence risk to people, property, and other infrastructure. Additional information about the specific process of creating the WUI treatment areas in the VTP is in Appendix A.

4.1.5.1.2 WUI Treatments within the VTP

As illustrated throughout the VTP, fuel treatments are intended to help limit wildland fire size and severity by either directly or indirectly mitigating fire behavior. Activities such as prescribed burning, mechanical thinning, or hand pruning can lower the rate at which fire spreads and decrease fire behavior in order to support fire suppression efforts (Finney, 2001). Figure 4.1-5 provides a WUI treatment example.

Figure 4.1-5: Example of a WUI treatment to protect structures by fuel reduction

In addition to the traditional sense of WUI fuel treatments protecting a community, the relationship can also work in the other direction. Providing fuel treatment along a community can also help protect the vegetation and associated wildlife habitat in the wildland. Figure 4.1-6 helps illustrate this relationship. This association may also be of value in fuel break design along roads and critical infrastructure.

Figure 4.1-6: Benefits of the WUI fuel treatments may work both ways as supporting fire prevention of structure fires and wildland fires.

Within the VTP it is believed that the WUI treatments will account for almost half of all projects. Table 4.1-10 provides a breakdown of acres available for treatment within the modeled WUI treatment areas by Vegetation Formation. Figure 4.1-7 provides a geospatial representation of the modeled WUI treatment areas that fall within the vegetation formations to be treated under the VTP.

Table 4.1-10: Modeled Available WUI Treatment Acres

Bioregion	Tree Dominated	Shrub Dominated	Grass Dominated	Total by Bioregion
Bay Area/Delta	345,235	152,571	794,135	**1,291,941**
Central Coast	53,983	410,122	1,162,785	**1,626,890**
Colorado Desert	357	109,459	3,849	**113,664**
Klamath/North Coast	872,897	226,236	505,615	**1,604,748**
Modoc	377,423	235,956	120,292	**733,671**
Mojave	3,348	185,511	37,398	**226,257**
Sacramento Valley	15,173	3,136	494,494	**512,804**
San Joaquin Valley	4,959	52,595	270,582	**328,136**
Sierra Nevada	1,090,662	323,025	1,470,973	**2,884,660**
South Coast	101,424	958,039	284,868	**1,344,332**
Total by Veg Type	**2,865,462**	**2,656,649**	**5,144,991**	**10,667,101**

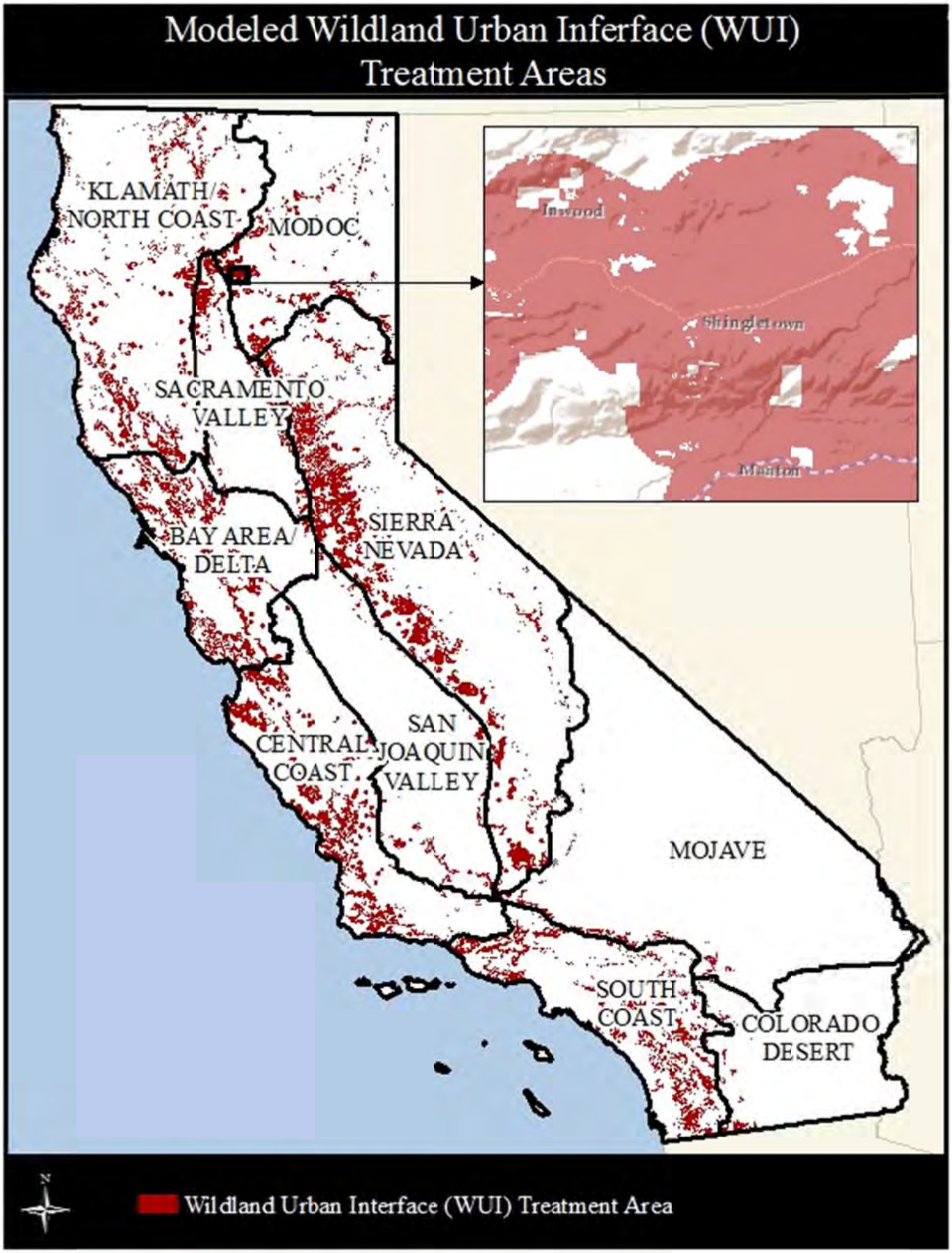


Figure 4.1-7 Modeled Wildland Urban Interface (WUI) Treatment Areas within the VTP.

4.1.5.2 **Ecological Restoration**

Fire is a natural process in many biomes and has played an important role in shaping the ecology and evolution of species (Pyne et al., 1996, Bond and Keeley, 2005). Periodic wildfire helps to maintain ecosystem processes and functions, particularly those in which taxa have developed strategic adaptations to fire (Pyne et al., 1996, Savage et al., 2000, Pausas et al., 2004). Despite the important ecosystem role played by fire, human activities have altered natural fire regimes relative to their historic range of variability (Syphard et al, 2007). In California, the two primary mechanisms altering fire regimes are fire suppression, resulting in fire exclusion, and increased human ignition sources resulting in abnormally high fire frequencies (Keeley and Fotheringham, 2003). Climate change, land use conversions, and other indirect factors may also play a role in altering fire regimes (Lenihan et al., 2003).

While these patterns are widely applicable to many forested landscapes in the western United States, California chaparral shrublands have experienced such substantial human population growth and urban expansion that the increase in ignitions, coupled with the most severe fire weather in the country (Schroeder et al., 1964), have acted to offset the effects of suppression to the point that fire frequency exceeds the historic range of variability (Keeley et al., 1999). Because anthropogenic ignitions tend to be concentrated near human infrastructure, more fires now occur at the urban fringe than in the backcountry (Pyne, 1982; Keeley et al., 2004). Profound impacts on land cover condition and community dynamics are possible if a disturbance regime exceeds its natural range of variability, and altered fire regimes can lead to cascading ecological effects (Landres et al., 1999; Dale et al., 2000).

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning (Agee, 1993; Brown, 1995). Coarse scale definitions for natural (historical) fire regimes have been developed by Hardy et al. (2001) and Schmidt et al. (2002) and interpreted for fire and fuels management by Hann and Bunnell (2001). Following the same concepts as the National Fire Plan, FRAP integrated data specific to California for describing ecosystems and fire-related metrics used in other analyses to specifically define and describe fire-related risks to ecosystems. Fundamental to this idea is that current expected fires are compared to historic fire regimes with respect to fire frequency, size and patchiness, and effects on key ecosystem elements and processes. Thus, an area can be classified based on current vegetation type and structure, an understanding of its pre-settlement fire regime, and current conditions regarding expected fire frequency and potential fire behavior. Figure 4.1-8 demonstrates this concept through a series of pictures in the Yosemite Valley.

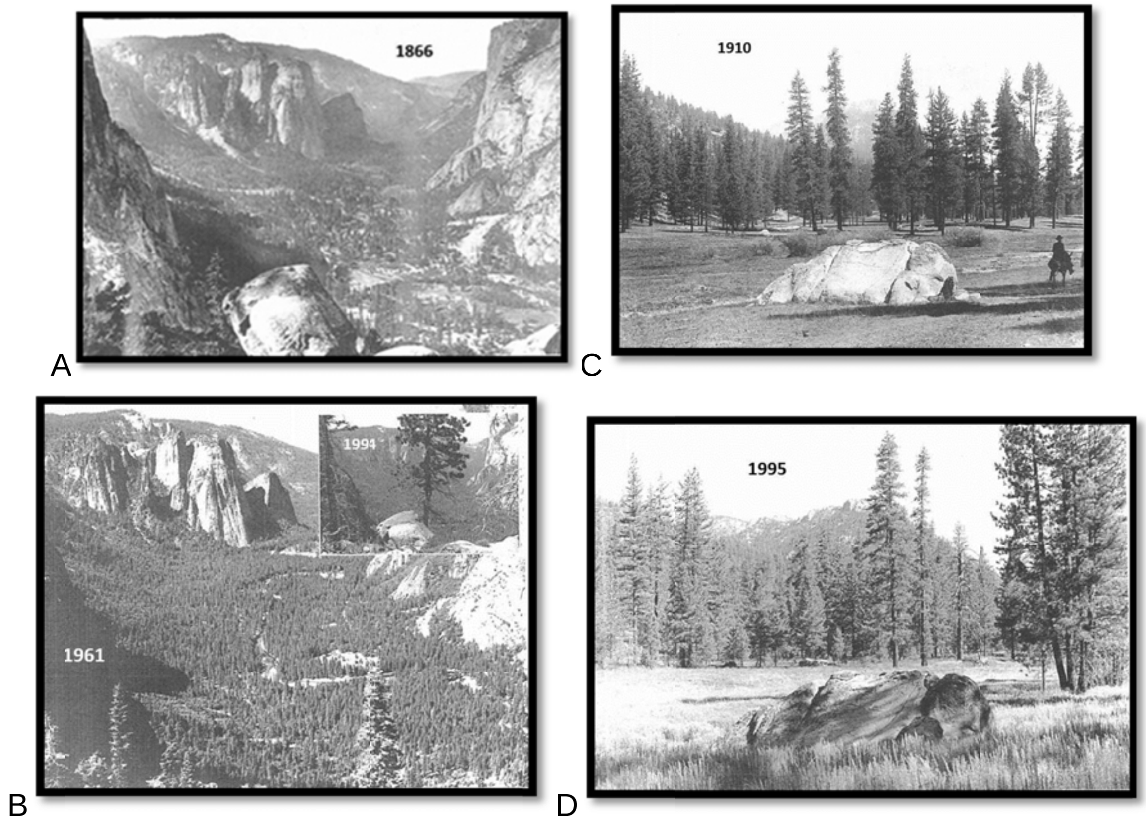


Figure 4.1-8: **Photos demonstrating the concept of ecological change (taken from Gruell, 2001). The historic photos of Yosemite Valley (a) and Trout Meadows/Tulare County (c) indicate a condition analogous to Condition Class I, whereas the modern photos (B and D) reflect Condition Classes 2 or 3. Ecological restoration treatments could be used to restore stand densities, fuel loading, and species composition to a condition that more closely resemble a historic pattern, purpose, or cultural landscape.**

4.1.5.2.1 Spatial Modeling

Spatially, acres eligible for Ecological Restoration under the VTP were identified by excluding all areas identified as WUI then determining where areas of Condition Class 2 or 3 existed in the remaining acres. Condition Class is defined as the, “relative risk of losing key components that define an ecosystem” (Hardy et al 2001). Conditional Classes identified as 2 (Moderate) or 3 (High) are areas where fire behavior is uncharacteristic and vegetation composition is altered due to the loss of the key components of an ecosystem. These areas have vegetation structures and fire frequencies that have deviated from historical levels and pose a moderate or high risk threat to ecosystem health.

4.1.5.2.1.1 Condition Class

In conjunction with the development of the WUI between 2001 and 2003, FRAP also undertook spatial modeling to define and describe the fire-related risks to ecosystems.

Fundamentally this analyzed current expected fires in comparison to historic fire regimes with respect to fire frequency, size and patchiness, and effects on key ecosystem elements and processes (FRAP 2003). Condition Classes were assigned based on current vegetation type and structure, an understanding of pre-settlement fire regime, and current conditions regarding expected fire frequency and potential fire behavior. The conceptual basis is that for fire-adapted ecosystems, much of their ecological structure and processes are driven by fire. Also, disruption of fire regimes leads to changes in plant composition and structure, uncharacteristic fire behavior, opportunities for pests, altered hydrologic processes, and increased smoke production (Table 4.1-11).

Table 4.1-11: Condition Class definitions used in assessment of risks to ecosystem health

Condition Class	Departure from Natural Regimes	Vegetation Composition, Structure, Fuels	Fire Behavior, Severity, Pattern	Disturbance Agents, Native Species, Hydrologic Functions	Increased Smoke Production
Low Cond Class 1	None, Minimal	Similar	Similar	Within Natural Range of Variation	Low
Moderate Cond Class 2	Moderate	Moderately Altered	Uncharacteristic	Outside Historic Range of Variation	Moderate
High Cond Class 3	High	Significantly Different	Highly Uncharacteristic	Substantially Outside Historic Range of Variation	High

Roughly 15.5 million acres within the SRA are ecologically at risk from fire (Moderate and High Condition Classes) with almost 6 million acres at high risk (Table 4.2-17) These areas at risk span diverse ecosystems ranging from pine forests in the Klamath/North Coast to coastal sage scrub communities along the South Coast. Numerous areas in California, including rangelands, are dominated by ecosystems at risk from wildfire. The only area without significant widespread ecosystems at risk is in the Colorado Desert Bioregion, where fire has and continues to largely be a rare phenomenon.

Table 4.1-12: Total Condition Class acreage of lands in SRA and percent of total land the acreage represents

Condition Class	Condition Class in SRA (Acres)	Condition Class Percent of Area
1 - Low	13,014,190	42%
2 - Moderate	9,723,970	31%
3 - High	5,816,383	19%
Non-Forest & Range	2,435,430	8%

A regional assessment of fire risk to ecosystems uses the total amount of area in the Moderate and High Condition Classes compared to the total area available. This regional summary also reveals the diverse types of habitats that fire threatens across California. Several of the forest bioregions have over 50 percent of their land base in Moderate or High Condition Classes. These areas have vegetation structures and fire frequencies that have deviated from historical levels and pose High or Moderate risks to ecosystem health. Table 4.1-13 also shows the High risk typically associated with changed fire regimes of the South Coast and approximately 26 percent of the bioregion is classified as a High Condition Class. The Modoc region, dominated by sagebrush steppe and the pervasive influence of exotic annual grasses, has largely lost its basic ecological integrity and future fires only exacerbate the problem. Similarly, the forested area of the Klamath/North Coast and Sierra Nevada regions are at risk due to unnaturally severe fires, where post-fire succession may result in loss of forested cover for decades without active reforestation efforts. Figure 4.1-9 illustrates the condition classes throughout California.

Table 4.1-13: Condition class acreage estimates in the SRA by bioregion outside of the WUI

Bioregion	Non-Forests & Rangelands	Low	Moderate	High	Total Condition Class Moderate & High
Bay Area/Delta	68,750	1,821,610	1,231,906	1,726,879	**2,958,785**
Central Coast	173,129	293,125	623,384	1,032,370	**1,655,754**
Colorado Desert	65,147	437,047	184,721	205	**184,926**
Klamath/North Coast	225,878	1,221,955	1,122,540	537,878	**1,660,418**
Modoc	40,346	597,765	512,275	64,523	**576,798**
Mojave	57,276	945,972	139,076	5,672	**144,748**
Sacramento Valley	89,887	1,808,735	1,133,497	22,626	**1,156,123**
San Joaquin Valley	25,433	263,375	98,504	29,663	**128,167**
Sierra Nevada	18,889	92,186	145,171	81,256	**226,427**
South Coast	1,695	282,224	73,828	18,273	**92,101**
Total by Treatment	**766,430**	**7,763,994**	**5,264,902**	**3,519,345**	**8,784,247**

Condition class also provides a parameter for prioritizing projects under Ecological Restoration treatments (Figure 2.4-2). All areas identified outside of the WUI that fall in Condition Class 2 or 3 are eligible for Ecological Restoration treatment projects under the VTP. Condition class does not distinguish between a negative and positive deviation from the fire return interval; an evaluation of the existing conditions of the specific project area needs to be conducted to establish the most appropriate action for moving forward on a project level basis. Additional information about the specific process of creating the Ecological Restoration treatment areas within the VTP is found in Appendix A.

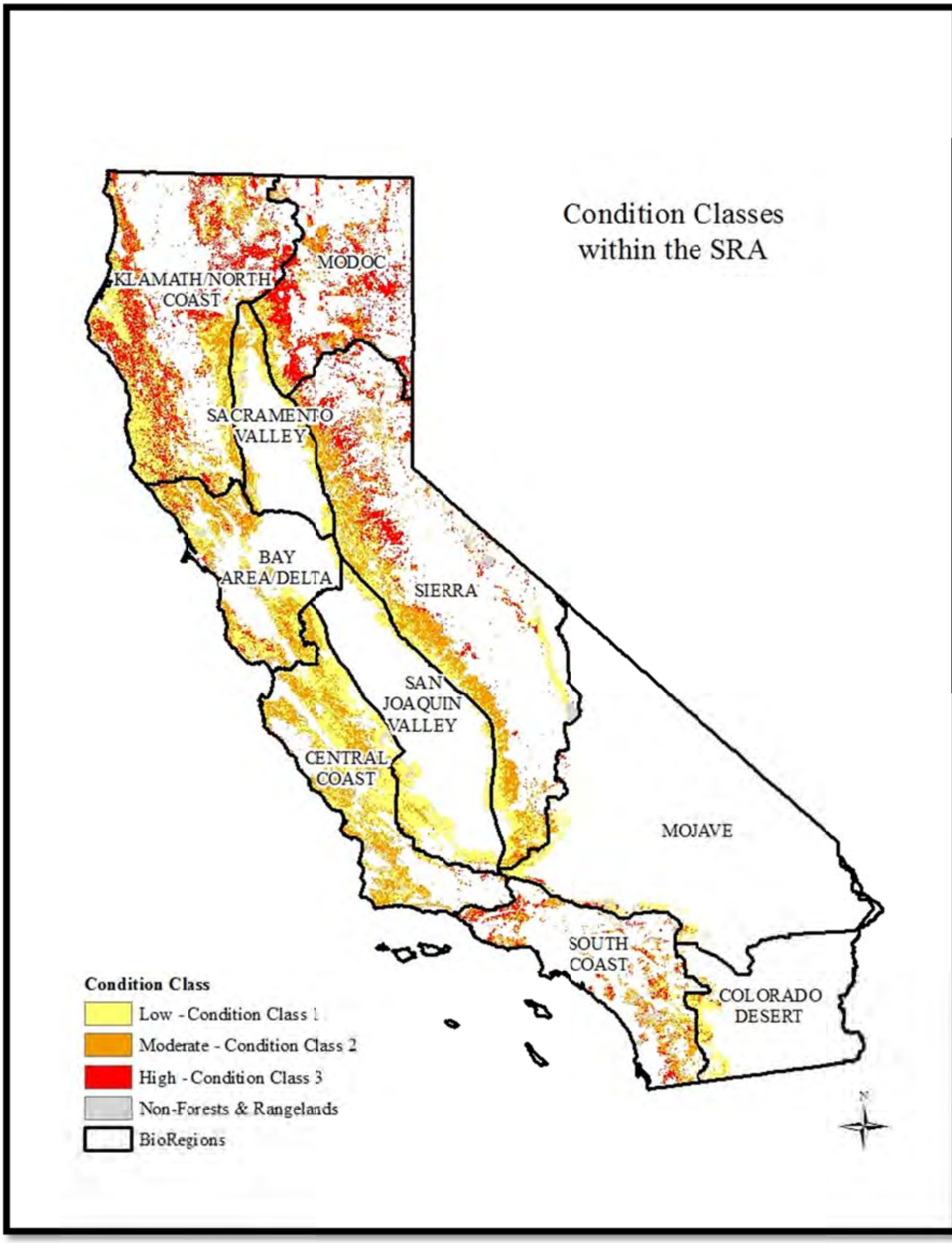


Figure 4.1-9: Fire-related risks to ecosystem health as measured by condition class within the SRA

4.1.5.2.2 Ecological Restoration Treatments within the VTP

Under the Ecological Restoration project type, lands classified as Moderate and High Condition Classes outside of the WUI would be targeted for treatment. Treatments would focus on restoring vegetative communities and fire regimes to at least a moderate condition class to reduce the level of ecological risk.

Ecological Restoration treatments include the removal of invasive or non-native species from a Condition Class 2 or 3 project area in order to promote native fire adapted plant communities. Projects implemented under the Ecological Restoration treatment type would attempt to restore the fire resiliency associated with the specified fire-adapted plant community by renewing degraded, damaged, or destroyed ecosystems and habitats in the environment through active intervention. Ecological restoration could be implemented through grazing, thinning, understory burning, and other methods.

Under the VTP, Ecological Restoration treatments will account for over thirty percent of all treatments. Table 4.1-14 provides a breakdown of acres available for treatment within the modeled Ecological Restoration treatment area by Vegetation Formations. Figure 4.1-10 provides a geospatial representation of the modeled Ecological Restoration treatment areas.

Table 4.1-14: Modeled Available Ecological Treatment Acres

Bioregion	Tree Dominated	Shrub Dominated	Grass Dominated	Total by Bioregion
Bay Area/Delta	191,386	85,988	253,805	**531,178**
Central Coast	41,347	362,589	733,272	**1,137,209**
Colorado Desert	408	45,536	597	**46,541**
Klamath/North Coast	1,443,053	135,324	469,769	**2,048,146**
Modoc	827,087	538,995	124,530	**1,490,612**
Mojave	12,566	40,227	27,062	**79,855**
Sacramento Valley	10,071	6,236	163,818	**180,126**
San Joaquin Valley	1,922	36,231	93,497	**131,651**
Sierra Nevada	722,877	178,085	624,761	**1,525,722**
South Coast	22,850	157,476	35,875	**216,202**
Total by Veg Type	**3,273,567**	**1,586,688**	**2,526,987**	**7,387,242**

Figure 4.1-10 Modeled Ecological Restoration Treatment Areas with the in VTP.

4.1.5.3 **Fuel Break**

Conceptually, fuel breaks are intended to provide strategic locations where fire suppression personnel can attack and contain a fire. Wide fuel breaks covered with low-volume fuels are expected to increase the chances of successfully holding fire lines in conjunction with backfiring operations. Fuel breaks are often located and designed to help protect specific assets at risk. Most commonly these include residential communities, critical infrastructure, and high value natural resources.

Fuel breaks can be used in a variety of different settings. A fuel break along the sides of a fire control road creates more space for vehicle travel during fires and allows the road to serve as a fire control line under certain conditions. Clearing adjacent to highways and public roads provides both safe evacuation routes under hazardous fire conditions and safe access for firefighters. Fuel breaks can also be located along ridge systems to help break up the landscape continuity of natural fuels into smaller blocks. Fuel breaks around or within residential areas, organization camps, groves of trees, or other areas of special value can be incorporated into the landscape-level fuel break system as well as the visual character of the sites they occupy.

Fuel breaks are a fundamental tool in controlling wildfires and continue to be useful in suppressing many fires before they grow beyond initial attack capabilities. More frequently however, the utility of well-placed fuel breaks is realized once the fire becomes large. Fuel breaks have been used many times to stop wildfires under severe fire weather conditions but generally not under the most extreme conditions (Keeley, 2002). During extreme fire weather, fuel breaks have been useful in reducing the lateral spread of fires, occasionally for stopping head fires during periods of reduced wind, and for making possible the protection of isolated communities.

Fuel breaks are not landscape features that will stop a fire by itself. They are dependent on fire suppression activity for successful application. Fuel breaks allow the higher probability of successful fire suppression activity (Agee, et al., 2000). They are intended to be reinforced defensible locations for direct or indirect attacks on wildland fires (Finney, 2001). There is little empirical data on their role in controlling large fires. An article by Syphard et al. (2011) conducted a spatial analysis of the Los Padres National Forest in southern California and concluded that fires stopped at fuel breaks 46 percent of the time. Preexisting fuel breaks allowed fire suppression activity to take advantage of the lighter fuels along the ridge lines to cut control lines. This was useful in both the wilderness areas (utilizing hand line and hose lays) and areas outside the wilderness where heavy equipment could aid in suppression efforts (Syphard et al., 2011).

Colleen Mooney summarizes the advantage of fuel breaks in a 2010 study addressing Canada’s boreal forest:

> *There is consensus in the literature that modification of forest fuels will alter wildland fire behavior (Agee et al. 2000, Alexander and Lanoville 2004, Fites and Henson 2004, Hirsch et al.2001, Martinson and Omi 2003, Martinson and Omi 2006, Omi et al. 2007, Graham et al. 2004 and others). The literature suggests that the primary purpose for fuel breaks is to change fire behavior as it enters the fuel-altered zone (Stratton 2004) resulting in limited, or slowed, fire spread (Davis 1951, Duguy 2007, Dennis 2005, Green and Schimke 1971, van Wagtendonk 1996); reduced flame lengths (van Wagtendonk 1996); and reduced probability of torching and independent crown fire (Agee et al. 2000). A fuel break can provide other numerous advantages as well: it can be used as an anchor point for indirect attack (Salazar and Caban 1987, Murphy et al. 1967); it can facilitate the rapid construction of a fire line/firebreak by suppression forces (Bevers et al. 2004, Murphy et al. 1967); it can provide safe access for ground suppression crews (Salazar and Caban 1987, Murphy et al. 1967); and can allow greater penetration to surface fuels of fire retardants dropped from the air (Agee et al. 2000, Murphy et al. 1967).*

Mooney also acknowledges the fact that fuel breaks need to be tailored to the topography, fuel characteristics, fire regimes and expected weather conditions to improve their effectiveness. A general rule for fuel break width would not be feasible given the diversity of California fuel types, topography and weather conditions. Fuel break widths are variable through their locations across the landscape and through history (Agee, 2000). In addition, the volume of fuels that should be removed is also variable. Depending on the goal and intent of the fuel break, reduction of surface, lateral, and canopy fuels should be considered. Figure 4.1-11 is an illustration of the relationship of fuel reduction and fire behavior. Fuels reduced in the understory of a timber stand may help reduce the climbing effect through ladder fuels that support a crown fire.

During the Zaca Fire in 2007 it was estimated that 33,000 hectares (approximately 81,500 acres) were burned from backfire activity where a significant firefighting effort was focused on fuel breaks along ridgelines (Syphard et al., 2011). The fuel break locations provide an advantageous area to apply backfires. It was also noted that the 1971 Romero Fire near Santa Barbara successfully used fuel breaks to protect a large portion of the Santa Ynez River Watershed (Agee et al., 2000). In general, fuel breaks should be constructed as wide as possible, while considering other values at risk, to increase effectiveness in controlling large wildfires while providing for firefighter safety. It is important to note that fuel treatments outside a fuel break can also help with the success of fuel break design (Van Wagtendonk, 1996).

The focus of fuel breaks, like larger, non-linear treatments, is to redistribute fire risk throughout the landscape by altering fire behavior. Two ways to accomplish this is to alter the rate at which fire spreads or reduce the potential for crowning fires (Cochrane et al., 2012). Effective strategies include reducing surface fuels, increasing the height of the live crown, general reductions to canopy continuity, and reduction of canopy bulk density (Graham et al., 2010). Although the fuel break treatment is linear, it can alter fuel continuity while providing fire suppression resources the opportunity to stop the spread of the fire.

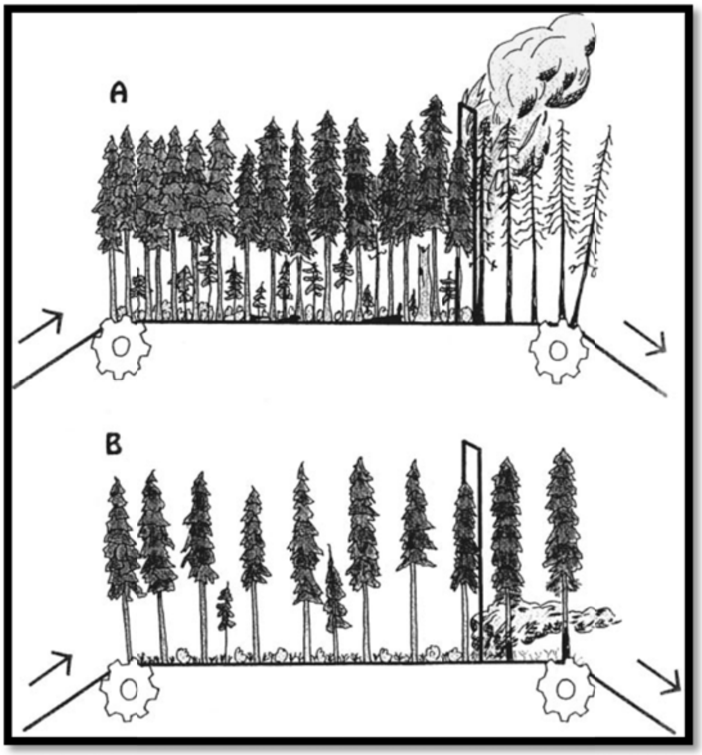


Figure 4.1-11: This figure helps illustrate some of the potential values of understory thinning and crown spacing that can be used within a fuel break strategy. Critical conditions can be visualized by passing a forest along a `conveyor belt' through a stationary flaming front. (A) Under severe fire weather and high rate of spread, higher crown density passes through the flaming front rapidly and exceeds a critical rate, and crown fire occurs. (B) Where crown density is lower under the same rate of spread, critical levels cannot accelerate through the crown and the fire remains a surface fire. (Agee et al. 2000).

Successful Fuel Breaks

1. On September 9, 2015 the Butte Fire broke out on Butte Mountain Road in Amador County. The fire spotted onto the north aspect of the Mokelumne River drainage, into Calaveras County, and headed toward the historic town of Mokelumne Hill (founded in 1848). The Mokelumne Hill fuel break played an integral role in protecting the town from the Butte Fire.

2. The Daughter Hill Wildlife Area Fuel Break is a CDFW project that has existed for nearly 15 years. Each year CAL FIRE assists with maintenance of the fuel break by using a CAL FIRE dozer and operator to cut a 10' wide dozer line, 2 miles long. Each summer this fuel break is tested by roadside fire starts and 2015 was no exception. On 09-18-2015, a vehicle's exhaust sparked a wildland fire in the roadside grass, which quickly moved up the hill. When fire units arrived, the fire was holding at ¼ acre at the fuel break. This fuel break has contributed to keeping wildland fires in this area small on several occasions. (Photographs A & B)

Daughter Hill was contained to a 1/4 acre.

Friday September 18, 2015

Figure 4.1-12 Examples of successful Fuel Breaks

4.1.5.3.1 Spatial Modeling

Identifying the potential treatment areas for Fuel Breaks for analysis purposes within the VTP combined two linear geospatial features: ridgelines and roadways. A 150 foot buffer on each side of the linear feature was then created to model a generic width, although actual fuel break treatment widths will depend on specific fuel types and terrain.

4.1.5.3.1.1 Ridgelines

Within the standard California datasets no generic ridgeline datasets exist at either a regional or statewide level. However, statewide Digital Elevation Models (DEMs) exist at varying resolutions, and by utilizing Map Algebra and a Hydrology Toolset within

ArcMap, major ridgelines could be distinguished. Through that process, a statewide linear ridgeline feature was created utilizing a 30 meter resolution DEM. A 150 foot buffer was then applied to the linear ridgeline features, for a total width of 300 foot.

4.1.5.3.1.2 Roadways

Unlike ridgelines, multiple statewide road datasets exist with varying degrees of accuracy and extensiveness. Within CAL FIRE there is no single statewide road dataset, but instead multiple micro datasets encompassing each CAL FIRE Unit's sphere of influence within their Computer Aided Dispatch (CAD) system, so a generic Environmental Systems Research Institute (ESRI) road dataset was utilized that encompassed all of California. Roads that were not in SRA were excluded from analysis and a 150 foot buffer to each side of the roadway was applied to the remaining roads in the SRA, as was applied to ridgelines. Roadways were further narrowed down to include only those in areas designated as Condition Classes 2 and 3 (See Section 4.1.5.2.1.1 for a detailed discussion about Condition Classes).

4.1.5.3.1.3 Fuel Break Treatment Areas

For analysis, the ridgelines and roadways datasets were combined and any areas of overlap between the two datasets were removed. This combined dataset provided the basis for environmental analysis in this document; however, it is unrealistic to believe that all modeled ridgelines and roadways will be treated during the life of the VTP. Additional information about the process of developing these Fuel Break treatment areas is in found in Appendix A.

4.1.5.3.2 Fuel Break Treatments within the VTP

Under the Fuel Break treatment type, lands classified as Condition Classes 2 and 3 would be prioritized for treatment. Fuel Break treatments would be focused in areas where flammable vegetation can be modified to create a defensible space in an attempt to reduce fire spread to structures and/or natural resources, and to provide a safer location to fight fire.

The Fuel Breaks treatment area overlaps the WUI and the Ecological Restoration treatment areas. In most cases fuel reduction will occur along strategic topographic locations and adjacent to public roads, but it can also occur next to areas naturally low in fuel (rocky outcrops) or high moisture vegetation (wet meadows). These areas are typically referred to as anchor points and help improve the effectiveness of a fuel break. As with all projects implemented under this Program, Fuel Break treatment areas are required to be identified in the Unit Fire Management Plan, which is updated annually.

Depending on the fire return interval, effects on the native plant communities, and condition classes, it may be best to create a fuel break in lieu of performing prescribed fire, mechanical or manual landscape treatments. Burn prescriptions need to balance burning hot enough to stimulate seed germination but not denude the area and risk high erosion (Beyers and Wakeman, 2000). Likewise, activities including mastication, hand cutting or herbicides across a landscape may have a reduced long-term effectiveness due to the presence of seed in the soil (Cochrane et al., 2012). Consequently, protecting an area with fuel breaks for continued ecological values may be an advantage as an alternative treatment (Graham et al, 2010).

Description of Fuel Break treatment terminology:

Figure 4.1-13: Non-shaded fuel break

Non-Shaded Fuel Break - A non-shaded fuel break normally is created along a change in vegetation type, such as from forest or shrubland into grassland. Since a large opening is essentially cleared of woody vegetation to create a non-shaded fuel break, heavy equipment is typically used for construction, except on steep slopes, where manual or prescribed fire treatments are employed (Figure 4.1-13).

Shaded Fuel Break - A shaded fuel break is constructed in a forest setting. Typically, the tree canopy is thinned to reduce the potential for a crown fire to move through the canopy. The woody understory vegetation is likewise thinned out, and in certain situations is eliminated. The shade of the retained canopy helps reduce the potential for rapid re-growth of shrubs and sprouting hardwoods and can reduce rill and gully erosion (Figure 4.1-14).

Figure 4.1-14: Before and after shaded fuel break construction

Both shaded and non-shaded fuel breaks are constructed using a mix of treatments, such as uprooting vegetation using a tractor blade (preferably a comb-like "brush blade") or severing vegetation at the root line manually with a chainsaw. Thinning of the canopy may allow for harvest of merchantable and non-merchantable timber. Mastication (grinding into small pieces using a large grinding head mounted on a piece of heavy equipment) may be used to thin understory vegetation. Slash created by fuel break installation can be treated by removal from the fuel break area, piling and burning, mastication, chipping or lopping and scattering. Fuel breaks can be maintained by a repeat of the treatments that were used for construction or by a different treatment, such as prescribed fire, herbivory, or the use of herbicides.

Under the VTP, Fuel Break treatments will account for just under twenty percent of all treatments. Table 4.1-15 provides a breakdown of acres available for treatment within the model Fuel Break treatment area by Vegetation Formations. Figure 4.1-15 provides a geospatial representation of the modeled Fuel Break treatment areas within the VTP.

Table 4.1-15: Fuel Break acres by bioregions and vegetation type

Bioregion	Tree Dominated	Shrub Dominated	Grass Dominated	Total by Bioregion
Bay Area/Delta	72,525	47,126	203,365	**323,016**
Central Coast	12,248	132,588	354,799	**499,634**
Colorado Desert	1,403	198,732	1,737	**201,872**
Klamath/North Coast	343,006	89,875	184,560	**617,441**
Modoc	199,678	154,778	51,095	**405,551**
Mojave	5,968	591,422	39,460	**636,850**
Sacramento Valley	5,762	2,022	165,764	**173,548**
San Joaquin Valley	1,279	40,560	186,512	**228,350**
Sierra Nevada	154,834	96,448	253,995	**505,276**
South Coast	25,248	252,806	68,969	**347,023**
Total by Veg Type	**821,951**	**1,606,357**	**1,510,255**	**3,938,563**

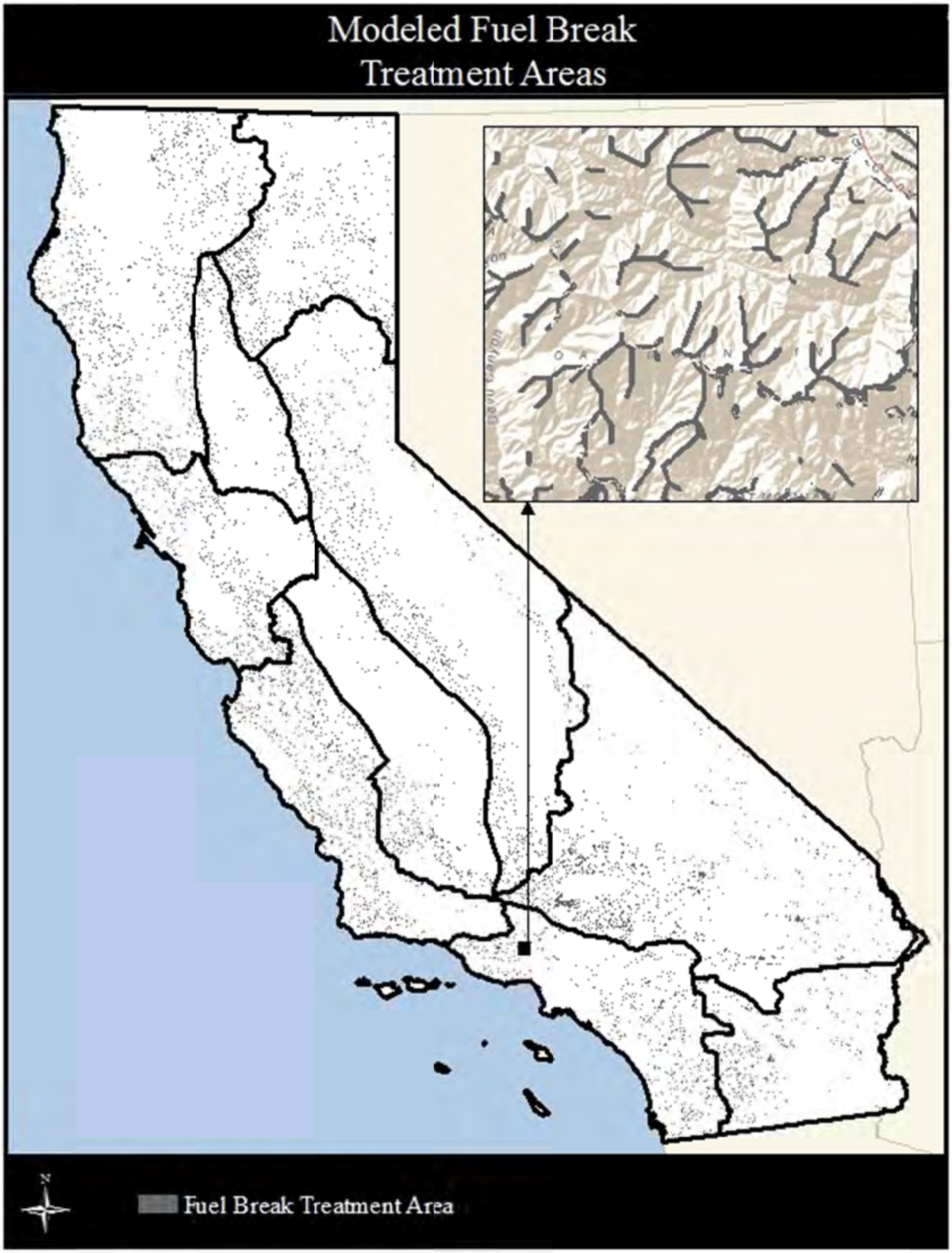


Figure 4.1-15 Modeled Fuel Break Treatment Areas within the VTP.

Fuel Break Example

Interstate 5 Fuel Break

September 2015

The I-5 Fuel Break was tested during a series of fires that erupted on Sunday September 27, 2015.

Without the nine miles of fuel break a wildfire could have spread to the community shown in the top half of the picture. The picture shows how the fuel break assisted in containing the fire.

The nine mile I-5 fuel break was constructed in 2004 within the CAL TRANS I-5 right of way on the west and east sides of the interstate highway between Red Bluff and the Hooker Creek/Auction Yard overpass. The fuel break was constructed using Unit Resources. Since 2013 SRA funds have paid Conservation Camp crews to annually maintain the fuel break. In 2014 the fuel break was expanded north two miles and now provides protection from Red Bluff to the Shasta/Tehama County line. The fuel break aids fire suppression resources responding to roadside fires by slowing the forward motion and intensity to allow sufficient time for resources to respond and provide initial attack. This has proven to prevent wildfires from becoming established in the wildlands adjacent to the highway thus providing protection to the many residential homes along it length. In addition, providing protection to major high voltage transmission lines, a railroad and developed communities. Interstate 5, itself is a critical infrastructure providing a major transportation route between California, Oregon and Washington. Wildland fires adjacent to I-5 can seriously affect traffic flow and interrupt interstate commerce.

The picture below shows where the fuel break ended and depicts how the fire came around the end of the fuel break to burn a structure (yellow arrow).

The nine miles of fuel break kept the series of fires from spreading and threatening the communities west of I-5.

4.1.5.4 Summary of Program Treatments within the VTP

As discussed in previous sections, the VTP is divided into three treatment types: WUI, Ecological Restoration, and Fuel Breaks. Table 4.1-16 comparatively breaks down the treatable acres between each VTP treatment types.

Table 4.1-16 VTP Treatment Acreages Compared

Bioregion	WUI	Fuel Breaks	Ecological Restoration	Total by Bioregion
Bay Area/Delta	1,291,941	323,016	531,178	**2,146,135**
Central Coast	1,626,890	499,634	1,137,209	**3,263,733**
Colorado Desert	113,664	201,872	46,541	**362,077**
Klamath/North Coast	1,604,748	617,441	2,048,146	**4,270,334**
Modoc	733,671	405,551	1,490,612	**2,629,835**
Mojave	226,257	636,850	79,855	**942,962**
Sacramento Valley	512,804	173,548	180,126	**866,478**
San Joaquin Valley	328,136	228,350	131,651	**688,137**
Sierra Nevada	2,884,660	505,276	1,525,722	**4,915,658**
South Coast	1,344,332	347,023	216,202	**1,907,557**
Total by Treatment	**10,667,101**	**3,938,563**	**7,387,242**	**21,992,906**

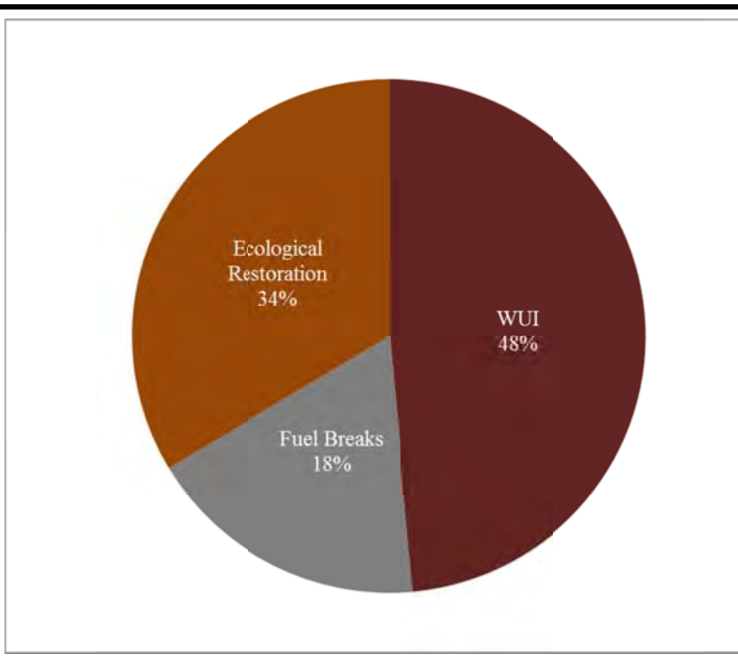


Figure 4.1-16 VTP Modeled Treatment Acres Breakdown

Figure 4.1-16 VTP Modeled Treatment Acres Breakdown shows what percentage each treatment represents with in the entire Vegetation Treatment Program.

Figure 4.1-17, on the following page, shows spatial distribution of the VTP modeled treatment areas.

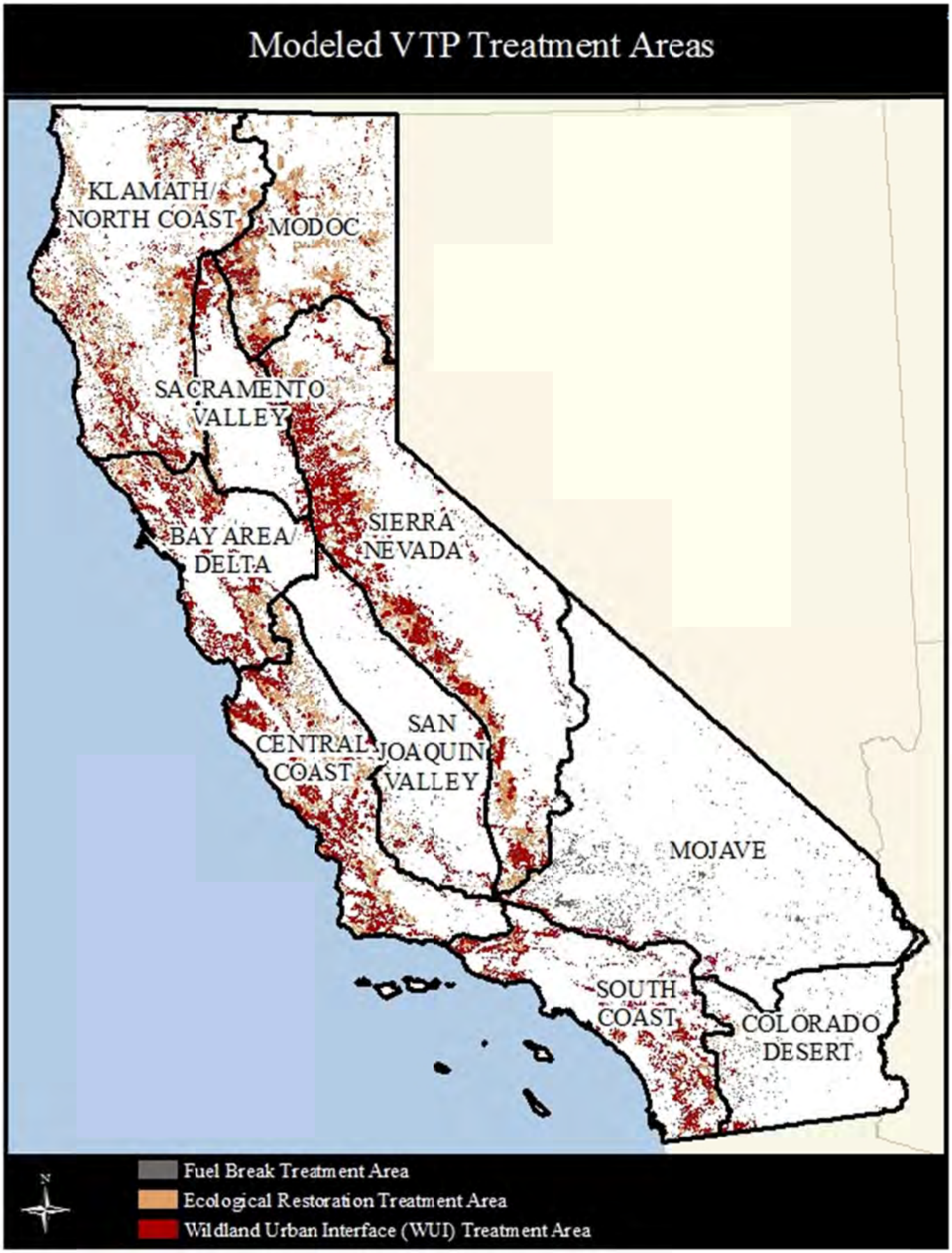


Figure 4.1-17 Modeled Treatment Areas for the VTP

4.1.6 ACTIVITY CONSIDERATION AT THE PROJECT LEVEL

This section continues a more detailed review of the Activities described in Chapter 2.2.3 outlined in Table 2.2-5 Proposed VTP Activities. Activities include prescribed fire, mechanical, manual, herbivory and herbicides.

4.1.6.1 Prescribed Fire Activities

Prescribed fire is the intentional application of fire to fuels under specified conditions of fuels, weather, and other variables. The intent is for the fire to stay within a predetermined area to achieve site-specific resource management objectives. A focus on prescribed low intensity surface fires may be used to control vegetation by enhancing the growth, reproduction, or vigor of certain species, in addition to managing fuel loads and/or maintaining a targeted vegetation community (See additional discussions in section 4.2). In addition, prescribed fires can be used to restore the ecological function in areas that have departed from their natural fire regime (Van Wagtendonk and Lutz, 2007). Burning may be used prior to or after other activities, including herbicide applications, to enhance the effectiveness of those activities.

Factors considered when designing and implementing a prescribed burn include risk to dwellings and property, land use, cultural resources, threatened and endangered species, potential impacts on air and water quality, soil stability, weather conditions, slope and aspect, soil type, vegetation types and density, fuel moisture content, time of year and alternative activity methods.

Prescribed fire may be used in some situations where other activity methods are not feasible due to rocky soils, steep slopes, or irregular terrain; although prescribed fire is limited to situations where sufficient fuel is available and arranged properly to carry the fire. It is also generally less expensive to treat vegetation using fire ($20 to $500 per acre for grasslands, woodlands and shrublands, with higher costs associated with treating forest types). However, project planning and pre-treatment activities often increase costs dramatically.

Pile burning - This tool is used to reduce areas of heavy concentrations of surface fuels. This technique involves gathering concentrations of fuel into a pile, igniting it and limiting the fire to each individual pile at a time. Burning of slash piles created by either tractors or by hand is a common method for treating vegetation where there are constraints that limit other types of burning. CAL FIRE's VTP pile burning activities may also be coupled with other programs (e.g. greenhouse gas reduction funding) where piled materials may be shipped to a biomass/bioenergy facility.

Prescribed fire – A prescribed fire is the application of fire to fuels to accomplish planned resource management objectives under specified conditions of fuels, weather, and other variables.

Prescribed fire can be classified into various types including broadcast burns, underburning, and jackpot burning.

Broadcast burns – The controlled application of fire to wildland fuels in their natural or modified state over a predetermined area; often conducted to reduce wildland fire fuel loads, restore the ecological health of an area, or to clear vegetation. Broadcast burns are usually done on small to moderately large areas to:

- Improve browse or forage for wildlife or domestic stock
- Create fuel breaks
- Control invasive and noxious weeds
- Treat slash in areas cleared of dead and/or live fuels.

Underburn – Defined as a fire that is constrained to surface fuels to leave the canopy intact. Underburns are commonly prescribed for dry forest types such as ponderosa pine or mixed conifer to reduce fuel but leave the overstory intact. Underburns are usually classified as low-severity fires. This is a variation of the broadcast burn and is focused on treating surface or ladder fuels in a shaded fuel break setting to manage understory vegetation for various objectives such as wildlife habitat improvement or for production of cultural plants important to Native Americans.

Jackpot burning – This is tool used to reduce areas of heavy concentrations of surface fuels. This technique involves igniting concentrations or patches of dead and down fuel under specified conditions of fuels moisture, weather, and other variables, sometimes called “spot burning” or “jackpotting.”

Figure 4.1-18 Helicopter application of a prescribed burn in Southern California.

Burning may occur throughout the year, but it is usually conducted during late spring when the ground is still wet or during the fall or winter when precipitation is imminent and after plants have completed their yearly growth cycle and their moisture content has declined. Spring burns are preferred by CAL FIRE staff to ensure a greater measure of public safety. However, there may be other impacts to consider such as interruptions to animal and plant reproduction cycles. Fall burns tend to be more closely aligned with the natural fire cycle found in California. Some broadcast burning in grasslands may be done in May, after the annual grasses have cured and piles of vegetation are available to be burned after the vegetation has dried. Within brush or chaparral communities, fall burning may not be desirable timing due to the possibility of high fire intensities. Due to the complexity of the chaparral community, some species may benefit from spring burns in order to help germinate seed while other species may benefit from fall sprouting (Beyers and Wakeman, 2000). Chaparral communities will have to be evaluated on a case by case basis to determine the best time, if any, for a prescribed burn.

Depending on a specific project's objectives, fuel modeling, and environmental conditions, a broadcast burn can be used to treat various fuel sizes (1 hour, 10 hour, or 100 hour fuels). "Cool" burn prescriptions, using patterned lighting techniques such as backfiring, chevron burning, and flank firing, as well as timing the fires during periods of high humidity and high fuel moisture content, would be expected to result in partial removal of understory or groundcover vegetation. The existing groundcover vegetation would be partially retained in a mosaic pattern in forest and shrub communities. Fire behavior and burn severity would also depend on the properties of various fuel strata and the horizontal and vertical continuity of those strata (Graham, Jain, and Matthews, 2010).

Commonly all prescribed burns will require the construction of control lines using hand or mechanical activities. In some cases, extensive or mature shrubs must be pretreated manually by hand crews or by mechanical equipment to remove the aerial component of the vegetation and reduce the probability of an escaped fire when the vegetation is burned. Sometimes vegetation is pretreated with herbicides to kill the aboveground portions and cause them to dry before burning.

Hand held ignition devices, such as drip torches, propane torches, diesel flame-throwers, and fusees (flares) may be used to start a prescribed fire. Area ignition apparatus include terra-torches and heli-torches (Figure 4.1-18). These apparatus release an ignited gelled fuel mixture onto the area to be treated. Helicopters may also be used to drop hollow polystyrene spheres (similar to Ping-Pong balls) containing potassium permanganate that is injected with ethylene glycol immediately before ignition. The sphere ignition method is best used for spot-firing projects.

Figure Error! No text of specified style in document.**-1 Example of understory prescribed burn to create a fuel break. Wind is blowing in a favorable direction.**

The use of prescribed fire comes with a risk of the fire burning out of control and damaging property and public improvements, endangering human life, and creating hazards from smoke. Timing of prescribed burns is dependent on specific weather condition and fuel conditions that are described in a burn plan prepared for the project and approved by the local air board (Burn plans and air quality standards for prescribed fire are discussed in further detail in Section 4.12). The identified weather condition can often be difficult to meet in unison, because of the inherently inconstant nature of weather and the often short time frames where identified weather exists at the project location area. Thus alternative activities, including mechanical, manual, prescribed herbivory, and herbicide, are often used to control vegetation near communities. In some situations, prescribed fire can encourage the establishment of invasive and noxious plants if the impacted area is not treated with herbicides or re-vegetated with the desired plants immediately following the fire. Although prescribed fire can reduce fine fuels, surface vegetation, and preserve some surface organic layers including course woody debris, it requires a thorough management plan.

Figure 4.1-19 Mastication may be used to reduce the horizontal and vertical continuity of fuels.

Any prescribed burn project under the Vegetation Treatment Program shall require a burn plan that includes a map(s) with the project boundaries, a description of the location and objectives of the project, a prescription describing the required weather conditions, fuel moisture, and soil and duff moisture, desired fire behavior, a public information plan, and a smoke management plan (see Appendix J for an example of a burn plan). The smoke management plan identifies the affected Air Pollution Control District(s) or Air Quality Management District(s), smoke-sensitive areas, wind direction, venting elevation, and visibility factors required to disperse the smoke. The smoke management plan is designed to minimize public exposure to air pollutants generated by prescribed burns. Burning must adhere to local and state regulations and laws. In some cases the local Air Resources Control District may be consulted for special requirements for prescribed fires.

Figure 4.1-20 Mechanical brush removal work completed with a bulldozer. Piles are in the back ground to be treated at an appropriate time for burning.

4.1.6.2 Mechanical Activities

Figure 4.1-21 Ball and chain being towed behind a bulldozer.

Mechanical activities involve the use of motorized equipment (rather than labor intensive hand work), such as wheeled tractors, crawler-type tractors, or specially designed vehicles with attached implements designed to cut, uproot, crush/compact, or chop existing vegetation. The selection of a particular mechanical activity and equipment is based upon a number of factors, such as characteristics of the vegetation, seedbed preparation and re-vegetation needs, topography and terrain, soil characteristics, climatic conditions, and a comparison of the improvement cost to the expected increase in productivity or public and/or private benefit. In some cases, mechanical activities can create a desired stand structure and composition where prescribed fire will not duplicate the intent due to possible risks and uncertainties with its use. Mechanical methods that may be used include tilling, drill seeding, mowing, masticating, grubbing, chaining, feller-bunching, and chippers (Table 4.1-17). In addition, vegetation manipulated using mechanical activities often require secondary activities such as pile burning or chipping. The use of machines can create and maintain a desired forest floor condition in various settings, although if they are used improperly they can displace mineral soil and reduce organic content (Graham, Jain, and Matthews, 2010).

Figure 4.1-22 Feller buncher with a rotary head cutter on an articulated boom. This equipment can be used to help remove un-merchantable material from the understory helping to create a shaded fuel break.

As new technologies and techniques are developed, they may be used if their impacts are similar to or less than those discussed below.

Mechanical activities are effective for removing dense stands of vegetation. Some mechanical equipment can masticate (mulch) or lop and scatter vegetative debris concurrently with vegetation removal (Figure 4.1-19 and Figure 4.1-20). Mechanical methods are appropriate where a high level of control over vegetation removal is needed, such as near home sites, communities, or in sensitive wildlife habitats, and are often used instead of prescribed fire or herbicide activities for vegetation control in the Wildland Urban Interface (WUI). Unless used with follow-up herbicide activities, mechanical activities have limited use for noxious weed control, as the machinery tends to spread seeds and may not kill roots.

Mechanical vegetation management costs from $800 to $1200 per acre for equipment, fuel, and labor. Repeated mechanical activities are often necessary, as residual weed or shrub seed in the soil or re-sprouting of shrubs may re-vegetate treated areas with undesired plants. Mechanical activities tend to cost 3.5 times higher than prescribed burns due to the removal requirements of non-commercial biomass (North, Collins, and Stephens, 2012).

Mechanical activities are generally conducted when soils are not saturated with water to prevent soil compaction, excessive damage to dirt roads, or increased erosion and sedimentation into streams. In general, most mechanical activities occur in late spring, summer, or fall (May 1 to November 15). These treatments are frequently used to install control lines for prescribed burns, to pretreat vegetation for subsequent burning, or as a stand-alone treatment. Disking may be used to uproot herbaceous vegetation and is usually done in late spring or early summer after the grasses and herbaceous vegetation have cured. Bulldozers can crush or uproot shrubs with a straight blade or brushrake. Rotary head cutters on articulated booms are effective at cutting shrubs and trees less than 22 inches in diameter at breast height (4½ feet above the ground). All ground disturbing activities, including land clearing and bull dozer line construction, shall be suspended when a red flag warning is issued by the local National Weather Service office (ADM-5).

It is anticipated that some material generated by the Program might be removed to a biomass plant concurrent with Program operation. Because the cost to remove such fuel is high, it is anticipated that no more than 10% of mechanical activities might generate useable biomass, and only then when the material is chipped on site and only when the projects are near an existing biomass plant.

Removal of forest trees for commercial purposes will require additional CEQA review. These projects would require a Timber Harvesting Plan (THP), Non-industrial Timber Management Plan (NTMP), or some other Program Timber Harvesting Plan (PTHP).

Figure 4.1-23 Another view of a Feller buncher with a masticator head on an articulated boom.

Table 4.1-17 Variations in Mechanical Activity Techniques

Mechanical Activities	Description
Tilling	Involves the use of angled disks (disk tilling) or pointed metal-toothed implements (chisel plowing) to uproot, chop, and mulch vegetation. This technique is best used in situations where complete removal of vegetation or thinning is desired, and in conjunction with seeding operations. Tilling leaves mulched vegetation near the soil surface, which encourages the growth of newly planted seeds. Tilling is usually done with a brushland plow, a single axle with an arrangement of angle disks that covers about 10-foot swaths. Sometimes a crawler-type tractor or a large rubber-tired tractor pulls an offset disk plow, which consists of multiple rows of disks set at different angles to each other. This method is often used for removal of sagebrush and similar shrubs and works best on areas with smooth terrain and deep, rock-free soils. Chisel plowing can be used to break up compacted soils, such as hardpan.
Drill Seeding and Drilling	Is often done in conjunction with tilling. The seed drills, which consist of a series of furrow openers, seed metering devices, seed hoppers, and seed covering devices, are either towed by or mounted on a tractor. The seed drill opens a furrow in the seedbed, deposits a measured amount of seed into the furrow, and closes the furrow to cover the seed. Seed may also be injected into the soil directly through direct “drilling” without creating furrows.
Mowing	Tools, such as rotary mowers on wheeled tractors or other equipment, or straight-edged cutter bar mowers, can be used to cut herbaceous and woody vegetation above the ground. Mowing is often done along highway right-of-ways to reduce fire hazards, improve visibility, prevent snow buildup, or improve the appearance of the area. Mowing is also used in sagebrush habitats to create a mosaic of uneven-aged stands and enhance wildlife habitat. Mowing is most effective on annual and biennial plants. Mowing rarely kills weeds, so an area may have to be mowed repeatedly for the treatment to be effective. However, the use of a “wet blade,” in which an herbicide flows along the mower blade and is applied directly to the cut surface of the treated plant, has greatly improved the control of some species. In addition, chipping equipment can be used to cut and chip vegetation.
Masticating	Equipment installed on small wheeled tractors, wheeled or crawler-type tractors, excavators, or other specialized vehicles, is used to cut shrubs and trees into small pieces that are scattered across the ground, where they act as mulch (Figure 2.4-3). Shrubs and sapling-size trees are typically masticated with small-wheeled tractors and crawler-type tractors, while excavators are often used when larger trees are removed. Small-wheeled tractors generally operate on slopes less than 20% while excavators and tractors can operate on slopes up to 45%.
Grubbing/ Ripping	This is usually done with a crawler-type tractor and a brush or root rake attachment. The rake attachment consists of a standard dozer blade adapted with a row of curved teeth projecting forward at the base of the blade. Shrubs are uprooted and roots are combed from the soil by placing the base of the blade below the soil surface. Grubbing significantly disturbs surface soil horizons and perennial grasses and forbs, so grubbed areas are usually reseeded with desired species to prevent extensive runoff and erosion. Runoff and erosion on steeper slopes and/or more erosive soils can be greatly reduced by pushing shrubs into windrows on contours across the slope. These windrows can be burned, or left in place to become wildlife habitat as they gradually decompose through natural processes. In some cases the grubbing or ripping technique can also pile the vegetation material for pile burning.
Feller bunchers	Are often used within a commercial or pre-commercial thinning or partial cutting for fuel hazard reduction projects such as shaded fuel breaks and wildlife habitat improvement. Feller-bunchers and harvester-forwarder-processors are used primarily east and northeast of the Central Valley, on slopes of less than 35%, and for handling trees that are between 4-22 inches in diameter. Feller-bunchers clamp the trunks of trees, cut them at the base, pick them up, and bundle them into piles or load them onto trucks. Rubber-tired skidders or crawler tractors equipped with grapples skid the piles to landings, where they are processed.
Chipping	Chippers or “tub-grinders” are often used to chip the tops and limbs to generate mulch or biomass, which can be used onsite, sold to homeowners or garden supply stores, or used in power generation facilities.
Chaining	Consists of pulling heavy (40 to 90 pounds per link) chains in a “U” or “J” shaped pattern behind two crawler-type tractors, or by one tractor pulling a chain with a heavy ball attached to the end. Chaining is most effective for crushing brittle shrubs, such as manzanita and chamise, and uprooting woody plants. Chaining can be done on irregular, moderately rocky terrain, with slopes of up to 50%. Although chaining may cause soil disturbance, the resultant plant debris can be left in place to minimize surface erosion, shade the ground surface, maintain soil moisture and provide nutrient recycling. Alternatively, the debris can be burned to facilitate grass seeding, improve aesthetic values, and eliminate potential rodent habitat. Chaining is a cost effective means to incorporate grass seed into soil, especially in burned areas, as it provides a variety of seeding depths and microsites, which can improve ground cover and forage production.

4.1.6.3 **Manual Activities**

Manual activities involve the use of hand tools and hand-operated power tools to cut, clear, or prune herbaceous and woody species. Activities include:

- Thinning trees with chainsaws, loppers, or pruners
- Cutting undesired competing brush species above ground level to favor desirable species and spacing
- Pulling, grubbing, or digging out root systems of undesired plants to prevent sprouting and regrowth
- Placing mulch around desired vegetation to limit competitive growth

Hand tools used in manual activities include the handsaw, axe, shovel, rake, machete, grubbing hoe, mattock (combination of cutting edge and grubbing hoe), pulaski (combination of axe and grubbing hoe), brush hook, hand pruners, and pole pruning saws. Power tools, such as chain saws, power brush saws, and power pruning saws, are also used, particularly for thick-stemmed plants and thick limbs.

Manual activities, such as hand pulling and hoeing, are most effective where vegetation is limited and soil types allow for complete removal of plant material (Figure 4.1-25). Pulling works well for annual and biennial plants, shallow-rooted plant species that do not re-sprout from residual roots, and plants growing in sandy or gravelly soils. Repeated activities are often necessary due to soil disturbance and residual seeds in the soil.

Accumulations of vegetation created by manual activities are typically treated by:

- Lopping to a specified maximum length and scattered within treatment boundary to reduce flame lengths in the event of a fire
- Piling by hand and burning during wet periods of the year
- Piling and leaving piles unburned for wildlife habitat
- Chipping, with the chips blown onto the ground or into piles for later removal
- Cutting tree trunks into lengths for firewood gatherers
- Removing tree trunks by hand for utilization

Figure 4.1-24 Manual construction of a fuel break.

Manual techniques can be used in many areas and usually with minimal environmental impacts. Although they may have limited value for vegetation control over a large area, manual techniques are highly selective. Manual activities are effectively used in sensitive habitats, such as riparian areas and wet areas, areas where burning or herbicide application would not be appropriate, to install control lines for prescribed burns where mechanical equipment cannot be used, around structures, and in areas that are inaccessible to vehicles. In addition, ground disturbance is lower compared to mechanical treatments.

Manual activities are expensive and labor intensive compared to other vegetation management methods, such as prescribed burning and herbicide application. Typical manual vegetation control costs have ranged from $70 to $1200 per acre (Metz, pers. comm., 2006) to upwards of $2,200/acre in the Logtown (El Dorado County) community assistance grant. Manual methods may also be more dangerous for the workers involved in implementation due to the use of various cutting tools, steep terrain, and other adverse conditions. While manual techniques may not be efficient or cost effective over large acreages, they may be useful for targeting specific invasive species, minimizing impacts to desirable species, and for educating public land managers. Manual methods may also be cost effective for small-scale projects where heavy equipment move in/out costs are prohibitive.

CAL FIRE has been utilizing the Conservation Camp Program as a manual labor resource for over 50 years that can be used for multiple purposes including:

- To mitigate wildland fires and other emergencies
- To perform other fire protection and resource management work of the department
- To provide other agencies and approved non-profit organizations with a labor force to perform other public service work projects. (Ref. PRC §4951-4958)

CAL FIRE’s Conservation Camp Program operates in cooperation with the California Department of Corrections and Rehabilitation (CDCR) and the Division of Juvenile Justice (DJJ). CDCR also contracts with Los Angeles County Fire Department as part of this program. Successful operation of this cooperative program provides mutual support to the missions of all of the cooperating agencies. The program supports 47 conservation camps and training centers spread throughout the State. Each camp is organized into four or more inmate crews consisting of at least twelve inmates. These crews can be contracted to help other agencies or approved non-profit organizations for vegetation treatment activities, as well as participate in department fuel reduction projects.

4.1.6.4 **Prescribed Herbivory Activities**

Prescribed herbivory activities involve the intentional use of domestic livestock. Prescribed herbivory activities are used to reduce the targeted plant population to an acceptable level by stressing target plants and reducing competition with the desired plant species.

Domestic livestock, such as cattle, horses, sheep, or goats, control the top-growth of certain non-native invasive and noxious weeds, which can help to weaken the plants and reduce the reproduction potential. The animal benefits by using the weeds as a food source and can, after a brief adjustment period, consume 50 percent or more of their daily diet of the weed, depending on the animal and plant species.

Cattle and horses primarily eat grass, and occasionally cattle also eat some shrubs and forbs. Sheep consume many forbs, as well as grasses and shrubs, but tend not to graze an area uniformly. Goats typically eat large quantities of woody vegetation as well as forbs and tend to eat a greater variety of plants than sheep. Goats and sheep are effective control agents for leafy spurge, Russian knapweed, toadflax, other weed species, and some types of shrubs. In addition, goats tend to be good at controlling young regrowth such as vegetation on cleared fuel breaks but they become increasingly selective as shrubs age. However they do provide a possible alternative to herbicides (Conrad, Roby, and Hunter, 1986).

A successful treatment program can enhance habitat for wildlife. For example, cattle, horses, and sheep feeding in the spring and early summer can thin understory forbs and grasses, reducing competition for light, nutrients, and water for desirable shrub species. The shrub species will then increase their vegetative output for winter browsing by deer and other wildlife.

Figure 4.1-25 Use of goats to reduce competing vegetation.

In order for this activity to be effective, the right combination of animals, stocking rates, timing, and rest must be used. Prescribed herbivory by domestic animals should occur when the target species is (are) palatable and when feeding on the plants can damage them or reduce viable seeds. Additionally, prescribed herbivory should be restricted during critical growth stages of desirable competing species. When desirable species are present, there needs to be adequate rest following the activities to allow the desirable species to recover.

Whenever the use of livestock to control undesirable vegetation is being considered, the needs of the domestic animals as well as the other multiple use objectives for the area must be considered. A herder, fencing, mineral block, and/or a watering site may be required to keep the animals within the desired area. Many weed species are less palatable than desired vegetation, so the animals may overgraze desired vegetation rather than the weeds. Additionally, some weeds may be toxic to certain livestock and not to others, which will influence the management option selected. Proper management of the domestic animals is extremely important if this method of activity is to be successful.

Caution should be used whenever prescribed herbivory or any other vegetation control is prescribed near riparian areas and wet areas, in steep topography, or in areas with highly erodible soils. Weed seeds may still be viable after passing through the digestive tract of animals, so the animals should not be moved to weed-free areas until ample time has passed for all seeds to pass through their systems. Seeds can also travel on the wool or hair of domestic stock. Typical prescribed herbivory costs range from $500 to $1200 per acre.

4.1.6.5 **Herbicide Activities**

Herbicides are chemicals that damage or kill plants. Herbicides can be classified by their mode of action and include growth regulators, amino acid inhibitors, grass meristem destroyers, cell membrane destroyers, root and shoot inhibitors, and amino acid derivatives, all of which interfere with plant metabolism in a variety of ways.

Herbicides can also be categorized as selective or non-selective. Selective herbicides kill only a specific type of plant, such as broad-leaved plants. Some herbicides used for noxious weed control are selective for broad-leaved plants, so that they can be used to control weeds while maintaining grass species. Other herbicides, such as glyphosate (Roundup®) are non-selective, so must be used carefully around non-target plants. Typical herbicides likely to be applied include, but are not limited to:

- Glyphosate (Isopropylamine Salt, Potassium Salt, & Diammonium Salt)
- Hexazinone
- Imazapyr (Isopropylamine Salt)
- Triclopyr (Butoxyethyl Ester & Triethylamine Salt)
- Clopyralid (Monoethanolamine Salt)
- Sulfometuron Methyl

Herbicide activities legally must comply with the U.S. Environmental Protection Agency (EPA) label directions as well as California Environmental Protection Agency and Department of Pesticide Regulation (CDPR) label standards. Several herbicide application methods are available. The application method chosen depends upon an Integrated Pest Management (IPM) analysis, which includes an analysis of the:

1. Activity objective (removal or reduction)
2. Accessibility, topography, and size of the treatment area
3. Characteristics of the target species and the desired vegetation cover
4. Location of sensitive areas and potential environmental impacts in the immediate vicinity
5. Anticipated costs and equipment limitations
6. Meteorological, vegetative, and soil conditions of the treatment area at the time of activity
7. Proximity of human habitation

Herbicide recommendations are developed and updated for each herbicide project, generally by a licensed pest control adviser. The plan includes project specifications, key personnel responsibilities, communication procedures, safety, spill response, and emergency procedures. The plan also specifies minimum buffer widths between activity areas and water bodies when using herbicides not approved for aquatic use.

Herbicides will not be applied within WLPZs or ELZs. All herbicides shall be handled, applied, and disposed of in accordance with the material safety data sheet (MSDS) Fact Sheet and all local, state, and federal laws.

New chemical products and formulations are likely to become available to land managers in the future. Use of one or more of these products may be deemed more desirable for particular vegetation treatment goals than currently available chemicals. New products may be more efficacious at lower application rates or lower active ingredient (a.i.) rates, be less toxic or mobile, have fewer non-target effects, be cheaper, etc. Following is a brief summary of the protocol that will be used to evaluate new products for use:

New chemicals would first have to be registered for the anticipated use under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) by the U.S. EPA. This registration would be backed by toxicological, environmental fate, and ecotoxicity data submitted by the pesticide manufacturer and reviewed by the U.S. EPA. Re-registration by the US EPA of active ingredients and products “that were originally registered before current scientific and regulatory standards were formally established” is also required to evaluate any new information and modify registrations, labels, and tolerances, as necessary (EXTOXNET, 2001). This data is used to assess the potential human health and ecological risks from use of the chemicals.

Before new products are registered for use in California, they would have to be registered by the CDPR, which could add further label restrictions.

The potential use of new herbicides or fungicides in the VTP would require a review to ensure compliance with CEQA. The process would include a review of relevant CEQA (VTP Program EIR and other state agency Program EIRs) and NEPA (USFS, BLM, USFWS and other federal agency Environmental Assessments or Programmatic Environmental Impact Statements) documents, to determine whether any have fully covered the use of the proposed new chemical(s). The review will determine the potential human health and ecological risks of the new chemical's use, by addressing the following criteria:

- Identification of potential use patterns, including target plants, formulation, application methods, locations to be treated, application rate, and anticipated frequency of use.
- Review of chemical hazards relevant to the human health risk assessment, including systemic and reproductive effects, skin and eye irritation, allergic hypersensitivity, carcinogenicity, dermal absorption, eurotoxicity, immunotoxicity, and endocrine disruption.
- Estimation of exposure to workers applying the chemical or reentering a treated area.
- Environmental fate and transport, including drift, leaching to groundwater, and runoff to surface streams and ponds.
- Estimation of exposure to members of the public.
- Review of available ecotoxicity data, including hazards to mammals, birds, reptiles, amphibians, fish, and aquatic invertebrates.
- Estimation of exposure to terrestrial and aquatic wildlife species.
- Characterization of risk to human health and wildlife.

Herbicides will only be applied on the ground from equipment on vehicles (including all-terrain vehicles and tractors) or by manual application devices (Figure 4.1-26). Herbicides may be applied to green leaves with a backpack applicator or spray bottle, wick (wiped on), or wand (sprayed on) or applied as pellets to the ground surface. Herbicides can also be applied to trees around the circumference of the trunk on the intact bark (basal bark), to cuts in the trunk or stem (frill, or "hack and squirt"), to cut stems and stumps (cut stump), or injected into the inner bark.

No aerial applications will be approved or funded under the Proposed Program.

Herbicides can be used selectively to control specific types of vegetation or non-selectively to clear all vegetation on a particular area. Herbicides can be applied over large areas and in remote locations, or applied using spot applications in environmentally sensitive areas. The cost of herbicide application generally ranges from $20 to $250 per acre.

There are several drawbacks and limitations to herbicide use. Herbicides can damage or kill non-target plants. Weeds may develop a resistance to a particular herbicide over time. Herbicides or their adjuvants at sufficient dosages can be toxic or cause health problems in humans, animals, birds, amphibians, reptiles, insects, and fish. Many of these limitations are offset by requirements that apply to application methodology, regulatory requirements (e.g. requirement to have a licensed Pest Control Advisor (PCA) involved in the project, etc.) label restrictions, and project specific guidelines.

Restricted use herbicides must be applied according to written recommendations from a licensed PCA according to the label and by an herbicide applicator certified by CDPR. Permits to apply restricted herbicides are issued by County Agricultural Commissioners (CACs). Since permits are the functional equivalent of CEQA, they must be site and time specific. Site specificity is achieved by a clear description of the site when the permit is issued. Since permits are issued for a 12- or 24-month period, time-specificity is achieved by having the permittee file a “notice of intent” (NOI) to apply the herbicide at least 24 hours before the scheduled application. The notice must describe the site to be treated and the herbicides to be applied. It must also contain information on any changes in the environmental setting (for example, construction of residences or schools or changes in vegetation cover types that may have occurred since the permit was issued). This notice allows the CAC an additional opportunity to review the planned application and apply additional restrictions if needed.

County Agricultural Commissioners may also issue multi-year permits for perennial agricultural plantings (such as fruit trees or grapevines), non-production agricultural sites, and non-agricultural sites. However, the permittee must immediately notify the CAC of any changes in the information on the permit (such as a change in the kind of crops planted, or a newly constructed labor camp or home nearby). County staff review notices of intent and can halt the proposed

Figure 4.1-26 Herbicide application

application if conditions warrant. County staff makes pre-application inspections on at least five percent of the use sites identified by permits or notices of intent. These are primarily spot checks to ensure that information contained on the permit is accurate.

4.1.6.6 **Activity Combinations**

Although the aforementioned activity types are described individually, they are typically implemented in combination. For example, the average prescribed burn of 260 acres requires up to 2.5 miles of fire line, which can result in as many as 11 of the 260 acres being cleared by heavy equipment for use as control lines. Manual activities that do not involve the use of a chipper are often accompanied by slash pile burning the winter after treatment. For analysis purposes, projects that require multiple activities, whether in the same year or in a following year, will have each treatment accounted for separately. Thus, a prescribed fire might require burning 260 acres and conducting 11 acres of mechanical treatment, which for the purpose of analyzing the environmental effects of treatments in this Program EIR is treated as 271 acres, even though the project acreage documented in CAL FIRE accomplishment reports would only be 260 acres. The combined treatments will also have to be described in detail within the project under this Program EIR and addressed through the environmental Project Scale Analysis.

4.1.6.7 **Activity Maintenance**

Most activities require maintenance, usually within three to twenty-five years after the original activity (BLM, 2005). In general, shrub vegetation types would be treated on a 5-10 year rotation, or occasionally on rotations as long as 20 to 25 years, which would allow enough time for dead material to collect in order to sustain a prescribed fire. Activities in conifer vegetation types might initially involve mechanical or hand activity to reduce surface and ladder fuels. Following the initial treatment, prescribed fire could be used at 10 to 15 year intervals to maintain low fuel hazards. Maintenance activity intervals are generally related to the vegetation life form, landscape location (e.g. climate and soil types influence plant regrowth) and to activity type. For analysis purposes, and given no other significant site disturbance such as wildfire, maintenance is assumed to occur at the following time intervals:

- Grasslands – 2-5 years after previous activity
- Shrublands – 5-10 years after previous activity
- Forestlands – 10-15 years after previous activity

Research by Finney indicates that not all acres need to be retreated in order to achieve changes in wildland fire behavior (Finney, 2001; Finney & McHugh, 2005). In addition, because the VTP is based on willing landowner participation, not every acre initially treated will receive a maintenance activity.

Vegetation communities are dynamic and fuel treatments should change over time and space. Often the maintenance treatment is different than the original treatment, such as a prescribed burn followed by herbicide application(s) to control shrub regrowth, or hand activities using chainsaws to create shaded fuel breaks along public roads followed by periodic underburning to keep sprouting and fuel loads low. Maintenance activities can often be conducted with fewer adverse environmental effects than the original activity. Initial activities are not likely to include many herbicide activities, however many of the maintenance activities are expected to utilize herbicides.

A proposed project should identify the time frame to complete the expected project level objectives. Once either the time frame has been met or the contractual agreements in place between CAL FIRE and the project applicant expire, another project may need to be submitted for future maintenance activity. It should be noted that maintenance of a VTP project may not require a new project proposal in the future depending whether or not the impacts of the maintenance activity will be similar to those outlined in this PEIR. It is possible that other CEQA documentation could cover future maintenance activity including, but not limited to, CEQA categorical exemptions.

4.1.7 DISTRIBUTION OF PROJECTS

The distribution of projects in the Proposed Program is described in Chapter 2.3. Table 4.1-18 identifies the possible number of VTP projects by activity type over a ten year period (as described in Chapter 2.3 and 4.1.5) that would occur in each bioregion. It is important to note that these values are projections and are based on the relative application within the bioregions, vegetation types and treatment focus. These values are provided to allow the review and application of this Program’s impacts. They are not considered upper limits of activity but more closely resemble the potential activity within the scope of this Program EIR with optimal funding and staffing needs. As stated in Chapter 2, the application and true acres treated will depend on landowner interest and available funding.

Table 4.1-18 10 year estimate of projects within each Bioregion by activity type

Bioregions	# of Projects per Decade	RX Burn	Mechanical	Manual	Herbicides	Herbivory
Bay Area/Delta	225	113	45	23	23	23
Central Coast	342	171	68	34	34	34
Colorado Desert	38	19	8	4	4	4
Klamath/North Coast	448	224	90	45	45	45
Modoc	276	138	55	28	28	28
Mojave	99	49	20	10	10	10
Sacramento Valley	91	45	18	9	9	9
San Joaquin Valley	72	36	14	7	7	7
Sierra Nevada	516	258	103	52	52	52
South Coast	200	100	40	20	20	20
Totals	**2,308**	**1,154**	**462**	**231**	**231**	**231**

Over a ten year period it is estimated that there will be 2,308 projects implemented. This estimate amounts to approximately 231 projects per year. The lowest volume of projects is expected to be within herbicide application (estimated 21 projects per year) while the highest will potentially be prescribed fire (estimated 122 projects per year). As indicated in Table 4.1-19, the majority of WUI, Fuel Breaks, and Ecological Restoration Treatments project would focus on grass and tree dominated vegetation types.

Table 4.1-19 VTP Project Estimates by Vegetation Formation

Bioregions	Tree	Shrub	Grass	1Y Total	10Y Total
Bay Area/Delta	8	3	11	23	**225**
Central Coast	1	7	27	34	**342**
Colorado Desert	0	3	0	4	**38**
Klamath/North Coast	31	5	10	45	**448**
Modoc	15	9	3	28	**276**
Mojave	2	7	1	10	**99**
Sacramento Valley	0	0	9	9	**91**
San Joaquin Valley	0	0	7	7	**72**
Sierra Nevada	21	6	24	52	**516**
South Coast	2	14	4	20	**200**
Project Totals	**80**	**55**	**96**	**231**	**2,308**
			231		

It is important to note that some bioregions have a proportionately higher number of acres treated annually than other bioregions. Conversely, some bioregions have a very small number of acres treated annually compared to the size of the bioregion (Modoc and Mojave in particular treat as little as 0.13 percent and 0.44 percent of all jurisdiction lands annually). The Sacramento Valley bioregion stands out as an example of a bioregion, which, based on treatment history between 2000 and 2005, annually treats about 2.0 percent of the bioregion jurisdiction lands. Part of the difference between bioregions is the fact that the VTP is based on willing landowners applying to the Program with CAL FIRE and applicants applying in much higher numbers in the Sacramento bioregion than CAL FIRE or applicants in the Modoc or Mojave bioregions. Thus the historical application rate (and the rate projected into the future) is both a matter of how aggressive the VTP coordinator within a specific CAL FIRE Unit is at soliciting landowners as well as how receptive landowners are to engaging with a state agency such as CAL FIRE.

4.1.8 BIOREGION OVERVIEW

For the purpose of this analysis, California was broken down into ten bioregions (See Figure 2.2-1 in Chapter 2). This provided a structure to allow the Program EIR to address the variability with California. The bioregion terminology was originally drafted from those used by the California Biodiversity Council Website in 2010. They are similar to the Baileys Ecoregions concepts. See Appendix A for a more specific Bioregion review.

4.2 BIOLOGICAL RESOURCES

The material presented in 4.2 has been broken into three sections:

- **4.2.1-Affected Environment**
  The Affected Environment section discusses the biological setting in which projects may occur, special concerns present in each bioregion, and the state-wide regulatory framework that limits impacts to biological resources.
- **4.2.2-Effects**
  The Effects section outlines the potential impacts of implementing the proposed project.
- **4.2.3-Mitigations**
  The Mitigation section provides standard mitigations to reduce the likelihood of the proposed project causing adverse impacts to biological resources. The bioregion was determined to be the appropriate scale for this analysis because it is an area that includes a rational ecological community with characteristic physical (climate, geology), biological (vegetation, animal), and environmental conditions.

4.2.1 AFFECTED ENVIRONMENT

The following section contains a summary of the biological resources found in each Bioregion. The description of biological and environmental conditions is excerpted from the California Department of Fish and Wildlife (CDFW) Wildlife Action Plan. See CDFW web site http://www.wildlife.ca.gov to view the full report.

California is a diverse state encompassing numerous climates, topography, vegetative communities, and animal habitats. Bioregions attempt to break the state into areas of common qualities, sensitivities, species and natural processes for purposes of resource management and environmental impact analysis. These similarities allow for a reasonable analysis of the foreseeable cumulative impacts of the proposed project without being neither so large an area as to dilute the impacts, nor too small an area to magnify the impacts. The bioregion was determined to be the appropriate scale to analyze the impacts of the proposed Program. A focused analysis at the scale of the project is required by the Project Scale Analysis (see Appendix J) prior to implementing an individual treatment under the proposed Project. A map of the Bioregions is included as Figure 2.2-1 in Chapter 2.

4.2.1.1 **Regulatory Framework**

State agencies, including CAL FIRE, are directed through a variety of laws and regulations to protect and manage California’s biological resources. These include:

<u>California Laws and Regulations:</u>

- CEQA
- California State Endangered Species Act (CESA)
- Porter-Cologne Water Quality Control Act
- Lake and Streambed Alteration (LSA) Agreement
- Native Plant Protection Act (NPPA)
- California Forest Practice Rules
- California Coastal Act

<u>Federal Laws and Regulations:</u>

- Federal Endangered Species Act (FESA)
- Migratory Bird Treaty Act
- Clean Water Act (CWA)
- Federal Coastal Acts
- Coastal Zone Management Act

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

CEQA provides that public agencies whose activities may affect the environment shall prevent environmental damage (CCR § 15000-15387). Rare threatened, or endangered plant species, subspecies, and varieties are specifically considered in various sections of CEQA (CCR §15380). CEQA Guidelines Section 15380 (b) provides the criteria for Endangered, Rare, and Threatened species. Section 15380 (d) states that species that are not on state and federal lists, but meet the criteria in subsection (b) of Section 15380, “shall nevertheless be considered to be endangered, rare or threatened.” CNPS List 1A, 1B, and 2 plant species will be initially presumed to meet these criteria subject to review and reassessment during scoping. Additionally, under Section 15380 species will be considered Endangered, Rare, or Threatened, if it is listed as such under the California or Federal Endangered Species Act (ESA). Species designated as candidates for listing by the fish and Game Commission under the CESA also are “presumed to be endangered.” The California ESA presumes that candidate species meet the criteria for listing as Endangered, Rare, or Threatened. State certified regulatory programs are subject to provisions in CEQA regarding the avoidance of significant adverse effects on the environment, including native plant communities and rare, threatened, and endangered plants, where feasible (CCR § 15250.) Public Resources Code § 21080.5(d)(2)(a) states that the rules and regulations adopted by the administering agency of a certified regulatory program shall “require that an activity will not be approved or adopted as proposed if there are feasible mitigation measures available which would substantially lessen any significant adverse effect which the activity may have on the environment.” The FPRs are a State Certified Regulatory Program (CCR § 15251 (a)) and are subject to these rules.

CALIFORNIA ENDANGERED SPECIES ACT (CESA)

The California Endangered Species Act (CESA) (Fish and Game Code § 2050-2116) was enacted in 1984 and enhanced protection for endangered, rare, and threatened species. Under CESA, “it is the policy of the state to conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat” (Fish and Game Code § 2052). It is also State policy to disapprove projects that are proposed without feasible mitigation to reduce the impacts below the level of significance and that would jeopardize the continued existence of any endangered or threatened species or result in the adverse modification of habitat essential to the existence of those species (Fish and Game Code § 2053 - 2055). CESA generally parallels the main provisions of the Federal Endangered Species Act and is administered by CDFW. CESA prohibits the "taking" of listed species except as otherwise provided in State law. Unlike its Federal counterpart, CESA applies the take prohibitions to species petitioned for listing (state candidates). Section 86 of the Fish and Game Code defines "take" as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."

State lead agencies are required to consult with CDFW to ensure that any action it undertakes is not likely to jeopardize the continued existence of any endangered or threatened species or result in destruction or adverse modification of essential habitat. A "lead agency" is defined under the California Environmental Quality Act as the public agency which has principal responsibility for carrying out or approving a project that may have a significant effect on the environment. (PRC §21067)

PORTER-COLOGNE WATER QUALITY CONTROL ACT

The Porter-Cologne Water Quality Control Act (Porter-Cologne) gives the State Water Resources Control Board authority over State water rights and water quality policy. Porter-Cologne also establishes nine Regional Water Quality Control Boards to oversee water quality on a day-to-day basis at the local/regional level. The Regional Boards are responsible for preparing and periodically updating the Basin Plan, which identifies the beneficial uses of water, water quality standards, and actions necessary to control these standards. Regional Boards have the authority to regulate all pollutant discharges from both point and non-point sources that may affect any surface or ground water. The State Board and Regional Boards also act on behalf of the U.S. Environmental Protection Agency to implement and enforce the Clean Water Act in California.

LAKE AND STREAMBED ALTERATION (LSA) AGREEMENT

Section 1600, et. seq., of the California Fish and Game Code contains provisions to protect the State’s watercourses from impairment. Among other things, this statute requires notification of the CDFW prior to undertaking any activity that will substantially divert or obstruct the natural flow of, or substantially change or use any material from, the bed, channel, or bank of, any river, stream, or lake. Through this process, CDFW may require mitigation measures or changes to the project design to eliminate or reduce any harmful impacts to fish and wildlife resources.

NATIVE PLANT PROTECTION ACT (NPPA)

The Native Plant Protection Act (Fish and Game Code § 1900-1913) was enacted in 1977. This Act established the criteria for determining if a species, subspecies, or variety of native plant is endangered or rare. It also has been established that state agencies, in consultation with CDFW, shall implement programs for the conservation of endangered or rare native plants (Fish and Game Code §1911). However, THPs submitted in accordance with the Z'berg-Nejedly Forest Practice Act of 1973 are exempt from this type of regulation (Fish and Game Code §1913). Under this Fish and Game Code Section, where CDFW notifies a landowner that a rare or endangered plant is growing on their land, the landowner shall notify the Department at least 10 days in advance of changing the land use to allow the Department to salvage the plant. Submission of a THP is considered notification of CDFW under this section. Other management activities may not be exempted from Fish and Game Code Section 1911 and 1913.

CALIFORNIA FOREST PRACTICE RULES

Forest management activities are subject to the requirements of the Forest Practice Act (FPA) as administered through the Forest Practice Rules (FPR). Registered Professional Foresters (RPFs) follow the provisions of the FPA and FPRs in preparation of timber harvesting plans (THPs). The THP preparation and review process substitutes for the EIR process under CEQA pursuant to PRC section 21080.5. THPs are designed to achieve maximum sustained production of high quality forest products while giving consideration to values relating to recreation, watershed, wildlife, range and forage, fisheries and aesthetic enjoyment as directed by PRC 4651.

The FPRs require timber operations to be designed in a manner that maintains functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed and retains or recruits late and diverse seral stage habitat components for wildlife concentrated in the WLPZs and, as appropriate, to provide for functional connectivity between habitats [14 CCR § 897(b)(1)(B)-(C)]. In addition, the FPRs require RPFs to consider the proposed timber operations in the context of the larger forest and planning watershed in which they are located, so that biological diversity is maintained within larger planning units and adverse cumulative impacts are reduced [14 CCR § 897(b)(2)]. The appendix to Board of Forestry Technical Rule Addendum No. 2 instructs the RPF to consider the factors set forth therein when evaluating cumulative impacts. Factors that the RPF must consider are:

- Any known rare, threatened, or endangered species or sensitive species (as described in the Forest Practice Rules) that may be directly or indirectly affected by project activities
- Any significant known wildlife or fisheries resource concerns within the immediate project area and the biological assessment area
- The aquatic and near-water habitat conditions on the THP and immediately surrounding area (pools and riffles, large woody material in the stream, near-

water vegetation)

- The biological habitat condition of the THP and immediately surrounding area (snags/den trees, hardwood cover, downed, large woody debris, late seral (mature) forest characteristics, multistory canopy, late seral habitat continuity, road density and special habitat elements)

Furthermore, the FPRs require the RPF to specifically address wildlife under Article 9 sections 919 through 919.18. In doing so, the RPF must:

- Retain all snags to provide wildlife habitat, except in certain specific cases (near main ridge tops suitable for fire suppression; near public roads, permanent roads, seasonal roads, landings, and railroads; where safety laws and regulations require snags removal; near structures maintained for human habitation; merchantable snags; and for insect or disease control [14 CCR § 919.1(a)-(e)].
- Provide general protection for sensitive species [per 14 CCR §§ 895.1 and 898.2(d)]. This includes: A mandatory pre-harvest inspection; protection of nest tree(s), designated perch trees(s), screening tree(s), and replacement trees(s) during timber operations; commencement of timber operations as far as possible from occupied nest trees; and protection of the occupied nest tree, screening trees, perch trees, and replacement trees if discovered during timber operations [14 CCR § 919.2(a)-(d)]. Some exceptions to these requirements are allowed.
- Provide specific protection for sensitive species (Bald Eagle, Peregrine Falcon, Golden Eagle, Great Blue Heron, Great Egret, Northern Goshawk, and Osprey). The specific protection measures include buffer zones around all nest trees containing active nests; year-around restrictions within buffer zones; establishment of critical periods for each species with applicable requirements during these critical periods; and limits on helicopter logging during the critical period (14 CCR § 919.4(a)-(e)).
- Incorporate feasible practices to reduce impacts (as described in 14 CCR § 898) where significant adverse impacts to non-listed species are identified (14 CCR § 919.4).
- Ensure that timber operations will not result in “take” of the Northern Spotted Owl and Marbled Murrelet (14 CCR §§ 919, 919.10 and 919.11).
- Provide habitat structure information for late succession forest stands proposed for harvesting where such harvest will significantly reduce the amount and distribution of late succession forest stands or their functional wildlife habitat value so that it constitutes a significant adverse impact on the environment. Also, the RPF must provide a statement of objectives over time for late succession forest stands on the ownership and include a discussion of how the proposed harvesting will affect the existing functional wildlife habitat for species primarily associated with late succession forest stands in the plan or the planning watershed, as appropriate, including impacts on vegetation structure, connectivity, and fragmentation.
- Where timber operations will result in long-term significant adverse effects on fish, wildlife, and listed species known to be primarily associated with late successional forests, feasible mitigation measures to mitigate or avoid such long-

> term significant adverse effects must be described and incorporated. Where long-term significant adverse effects cannot be avoided or mitigated, the RPF must identify the measures that will be taken to reduce those remaining effects and provide reasons for overriding concerns pursuant to 14 CCR § Section 898.1(g), including a discussion of the alternatives and mitigation considered [14 CCR § 919.16(a)-(b)].

The California Forest Practice Rules also provide protections for wetlands in Coastal Zone Special Treatment Areas, and generally for marshes, wet meadows, springs, riparian areas, and other wet areas.

CALIFORNIA COASTAL ACT

Wetlands found in the "coastal zone" are regulated under the California Coastal Act of 1976 (CCA), and are within jurisdiction of the California Coastal Commission. A Coastal Permit is required for activities within the coastal zone that may have an impact on terrestrial or marine habitat, visual resources, landform alterations, or water quality, among other things. Portions of the assessment area for this Program EIR fall within the coastal zone.

FEDERAL ENDANGERED SPECIES ACT (FESA)

The Federal Endangered Species Act (FESA) requires formal or informal consultation with the US Fish and Wildlife Service or NOAA Fisheries where it is likely that the project could affect federally listed threatened or endangered species. The purpose of the ESA is to conserve the ecosystems upon which listed species depend. The laws ultimate goal is to “recover” listed species such that the protections of the Act are no longer needed. The ESA requires that recovery plans be developed that describe the steps necessary to restore the species. Similarly, the ESA provides for the designation of “critical habitat” when prudent and determinable. Critical habitat includes geographic areas where those physical and biological features essential to the conservation of the species are found and which may require special management considerations or protection. Critical habitat designations affect only Federal agency actions or federally funded or permitted activities. The Act also makes it unlawful to kill or injure a listed species, which includes significant habitat modification or degradation where it actually kills or injures listed species by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. The migratory bird species protected by the Act are listed in 50 CFR 10.13.

CLEAN WATER ACT

Pollutants regulated under the CWA include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants, including any pollutant not identified as either conventional or priority. The CWA regulates both direct and indirect discharges.

Federal protection of wetlands is described in Section 401 of the Clean Water Act. This requires that State water quality standards not be violated by the discharge of fill or dredged material into “Waters of the United States.” Section 404 of the Clean Water Act authorizes the US Army Corps of Engineers (ACOE) to issue permits for discharges of dredged or fill material into streams and wetlands.

COASTAL ZONE MANAGEMENT ACT

The Coastal Zone Management Act (CZMA) of 1972 provides for the management of the nation’s coastal resources. The CZMA is administered by NOAA with the goal to preserve, protect, develop, and where possible, to restore or enhance the resources of the nation’s coastal zone. Portions of the assessment area for this Program EIR fall within the coastal zone.

4.2.1.2 **Biological Setting and Concerns by Bioregion**

Ownership patterns, climate, vegetation and wildlife differ across California. The following analysis is conducted at the bioregional scale, which was determined to be the most appropriate framework to scope the impact of the proposed project on biological resources.

KLAMATH/NORTH COAST

Coastal wetland communities, including estuaries, lagoons, marshes, and open-water bays, are important for shorebirds and provide nursery habitats for anadromous, oceanic, and near-shore fish. The coastal wetlands include the estuary at the mouth of the Smith River, Lake Talawa and Lake Earl, Humboldt Bay, the mouth of the Eel River, and Bodega and Tomales bays.

The fish fauna of the Klamath River System (below Copco Lake and Iron Gate reservoir) is dominated by anadromous fish species such as Pacific lamprey, Chinook and coho salmon, and steelhead. Predominately freshwater species are also abundant in the system and include a variety of introduced species and two natives, the speckled dace and Klamath smallscale sucker. Coastal streams, flowing directly to the ocean, support a fish fauna composed predominately of anadromous species including coastal cutthroat Trout and euryhaline freshwater and marine species. The Klamath and Trinity Rivers collectively support the second largest Chinook salmon populations in California. The region is known for these extensive river systems and the anadromous fish populations they support. The majority of California's river segments with state or federal Wild and Scenic river designations occur in the North Coast–Klamath Region, including portions of the Klamath, Trinity, Smith, Scott, Salmon, Van Duzen, and Eel. Anadromous fish species include coho and Chinook salmon, steelhead, coast cutthroat trout, green sturgeon, and Pacific lamprey. The region has seen sharp declines in its fish populations, with an 80 percent decline in salmon and steelhead between the 1950s and 1990s (California State Lands Commission, 1993). Nonetheless, the remaining fish populations still represent the most important anadromous fish runs in the state. The region's rivers support one-third of the state's chinook, most of the state's coho salmon and steelhead, and all of the coast cutthroat trout (California State Lands Commission, 1993).

The region's coastal redwoods are among the largest, tallest, and oldest trees in the world, often exceeding 200 feet in height, 15 feet in diameter, and 2,000 years in age. Redwood groves are patchily distributed across the coastal fog belt that extends up to 40 miles inland and where winter rains and summer fog provide a persistent moist environment. Some inhabitants of coastal redwood forests include Spotted Owl, fisher, Humboldt Marten, black bear, Roosevelt elk, MacGillivray's warbler, olive-sided flycatcher, marbled murrelet, Pacific giant salamander, rough-skinned newt, and the banana slug.

Grasslands, coastal shrub, pine forests, mixed evergreen forests, and redwood forests are typical terrestrial plant communities. Unique, geographically limited habitats include sphagnum bogs and pygmy scrub forests.

The region's inland Klamath-Siskiyou mountain ranges are recognized for their biological diversity and have been designated as an area of global botanical significance by the International Union for Conservation of Nature (IUCN), as one of 200 global conservation priority sites by the World Wildlife Fund, and as a proposed United

Nations' Biosphere reserve (Ricketts et al., 1999). These mountains harbor some of the most floristically diverse temperate coniferous forests in the world, attributable in part to the region's variable climate, geography, and soil types, which create a variety of ecological communities. Unique, localized conditions have given rise to endemic species that have evolved to specialize in these areas, including nearly 100 plant species that are restricted to serpentine soils. Additionally, portions of the region remained un-glaciated during the last ice ages and have served as centers of distribution for numerous species that sought refuge there. Finally, these mountains represent the intersection of coastal ecosystems with the inland Klamath Basin region. As a result, the inland mountains and river systems support a rich flora and fauna that include species from both regions. The Klamath River system, for instance, harbors both coastal fish, like salmonids and Coast Range sculpin, and fish whose ranges extend from the inland Klamath Basin, such as the tui chub.

Ecological communities of the inland mountain ranges include moist inland forests dominated by Douglas fir, ponderosa pine, and sugar pine mixed with a variety of other conifers and hardwoods; drier oak forests and savannas; serpentine soil–associated plant communities and shrublands and high elevation subalpine forests. More than 3,000 plant species are known from these inland mountain ranges, and the area supports some 30 temperate conifer tree species, more than any other ecosystem in the world. Wildlife inhabitants include such sensitive species as the northern spotted owl, northern goshawk, Humboldt marten, and Pacific fisher, as well as common species like mule deer, black bear, and red-tailed hawk.

The upper Klamath River System includes Upper and Lower Klamath Lakes and Tule Lake. The fish fauna is dominated by freshwater species including the Klamath Lake sculpin, shortnose sucker, and the Lost River sucker. Stream and lake dwelling species include the dwarf Pacific lamprey, rainbow trout, Klamath largescale sucker, blue chub, Klamath tui chub, speckled dace, and marbled sculpin. Introduced species numbers appear to be increasing in number in the reservoirs of the river system (Moyle, 1976).

The North Coast and Klamath's wide range of habitats has given rise to remarkable biological diversity. There are 501 vertebrate species that inhabit the area at some point in their life cycle, including 282 birds, 104 mammals, 26 reptiles, 30 amphibians, and 59 fish. Of the total vertebrate species that inhabit this region, 76 bird taxa, 26 mammalian taxa, two reptilian taxa, 13 amphibian taxa, and 42 fish taxa are included on the Special Animal List. Of these, 13 are endemic to the region, and nine other species found here are endemic to California but not restricted to this area.

Table 4.2-1 identifies ownership patterns by habitat type within the Klamath/North Coast Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. Table 4.2-2 identifies the number of acres available for treatment in that bioregion by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that approximately 42 percent of the total landscape within the Klamath/North Coast Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 11,650 acres per year (Table 2.3-1), which represents less than 0.1 percent of the total area of the bioregion.

Table 4.2-1 Habitat Type and Land Ownership Klamath/North Coast Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	151	346	97	7,718	283,556	291,867
Barren/Other	4,917	65,579	472	5,135	45,464	121,566
Conifer	232,822	4,216,190	78,861	241,587	3,150,837	7,920,296
Hardwood	102,099	615,769	26,973	49,368	1,534,917	2,329,125
Herbaceous	72,790	60,927	4,227	22,099	1,520,917	1,680,960
Shrub	226,479	743,299	5,768	32,923	704,052	1,712,521
Urban	373	2,215	185	5,382	115,252	123,407
Water	1,365	59,031	3,712	16,515	74,162	154,785
Wetland	95	5,382	1	9,094	27,647	42,218
By Habitat Type	**641,090**	**5,768,738**	**120,295**	**389,820**	**7,456,804**	**14,376,746**

Table 4.2-2 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Klamath/North Coast Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	872,897	343,006	1,443,053	**2,658,955**
Shrub-Dominated	226,236	89,875	135,324	**451,435**
Grass-Dominated	505,615	184,560	469,769	**1,159,943**
Total by Treatment	**1,604,748**	**617,441**	**2,048,146**	**4,270,334**

CENTRAL COAST

The Central Coast's wide range of habitats has given rise to remarkable biological diversity. There are 482 vertebrate species that inhabit the Central Coast region at some point in their life cycle, including 283 birds, 87 mammals, 42 reptiles, 25 amphibians, and 45 fish. Of the total vertebrate species that inhabit this region, 80 bird taxa, 36 mammalian taxa, 14 reptilian taxa, eight amphibian taxa, and 15 fish taxa are included on the Special Animals List. Of these, 13 are endemic to the Central Coast region, one is endemic to California but restricted to this region, and 24 other species found here are endemic to California but not restricted to this region.

Sand dunes and wetlands occur along the coast. River-mouth estuaries, lagoons, sloughs, tidal mudflats, and marshes make up coastal wetland communities, a unique environment where marine, freshwater, and terrestrial systems meet. Elkhorn Slough and Morro Bay are the region's two largest estuaries, with other significant wetlands found at the Pajaro, Salinas, and Santa Maria river mouths, Devereux Slough, and Goleta Slough (Page and Shuford, 2000).

Other coastal habitats include coastal scrub and maritime chaparral. Coastal scrub and grasslands also extend inland along river valleys, like the lower Salinas Valley, where the moist maritime climate reaches through gaps in the coastal ranges. Maritime chaparral, characterized by manzanita and California lilac species adapted to the foggy coastal climate, once dominated sandy hills along Monterey Bay, Nipomo Mesa, Burton Mesa, and Morro Bay. Maritime chaparral is now one of the region's most threatened community types, with its extent severely reduced by development.

The outer Coast Ranges, including the Santa Cruz and Santa Lucia mountains, run parallel to the coastline. Well-watered by the moist ocean air, these slopes are drained by streams that run all year. The Santa Lucia Mountains provide most of the water supply to the Salinas River. These ranges support mixed coniferous forests and oak woodlands. The dominant coniferous species include ponderosa pine, Douglas fir, red alder, and, in the north, redwoods. The oak woodlands are dominated by coast live oak and valley oak. Rarer, endemic tree species include Monterey pine and Santa Lucia fir.

Moving inland across the Gabilan, Diablo, Temblor, and Sierra Nevada Madre mountain ranges, the climate becomes progressively drier, and the vegetation shifts to oak woodlands, grasslands, interior chaparral, and desert-like interior scrub. Interior streams are mostly intermittent, drying in the summer and fall, except at the higher elevations of the Sierra Nevada Madre ranges, where streams run year round. Biologically diverse oak woodland communities support more than 200 species of plants, 300 vertebrates, and 5,000 invertebrates (Thorne et al, 2002). Large expanses of annual grasslands are dominated by non-native grasses are inhabited by California ground squirrel and black-tailed jackrabbit, along with sensitive species that include the giant kangaroo rat, burrowing owl, San Joaquin kit fox, American badger, and, in the southern portion of the region, reintroduced tule elk and pronghorn. Interior chaparral habitats support drought-resistant woody shrubs, including manzanita, California lilac, and chamise.

The Central Coast's largest drainages include the Salinas, Santa Maria, Pajaro, and Santa Ynez watersheds. Riverine and riparian habitats are important to amphibian and reptile species like the California red-legged frog, foothill yellow-legged frog, and Western pond turtle, and birds like the bank swallow, the Lawrence's goldfinch (on Fish and Game's Special Animals List), and the least Bell's vireo (federally listed as endangered). Steelhead and coho salmon (both federally listed as threatened) are still present, in small numbers, in most of the streams where they historically occurred. Mammals that use riparian habitats include gray fox, striped skunk, mole and shrew species, and ringtail.

Higher-elevation riparian vegetation in moist coastal climates includes willow, alder, bay, maple, Douglas fir, and sometimes redwood, while valley-bottom riparian communities are dominated by sycamore, willow, alder, and cottonwood. Steep coastal streams in the forested Santa Cruz and northern Santa Lucia mountains are some of the region's most intact systems and host relatively healthy anadromous fish populations (CDFW, 1988). In contrast, the majority of the region's large river-valley floodplain and riparian forests have been replaced by agriculture, and lowland fish assemblages have been severely compromised.

Seasonal vernal-pool wetland complexes are found in many parts of the region, including the Salinas River drainage and coastal dune terraces and mesas of Santa Barbara County, and seasonal sag ponds are found along the San Andreas Fault zone, particularly in the eastern portion of San Luis Obispo County.

The San Andreas Fault runs the length of the region and shapes much of the region's geography. Most of the north-south running mountain ranges and valley depressions have been formed as a result of pressure between the two continental plates meeting at this fault zone. Compression, chemical interaction, and surfacing of ancient seabed sediments have produced serpentine soils that are rich in such metals as chromium, nickel, and cobalt, but poor in nutrients. A number of plants have adapted to these harsh, near-toxic conditions, resulting in unique, island-like ecological communities largely restricted to serpentine areas (CBD, 2004; TNC, 1997).

Table 4.2-3 identifies ownership patterns by habitat type within the Central Coast Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. Table 4.2-4 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that approximately 21 percent of the total landscape within the Central Coast Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 8,904 acres per year, which represents less than 0.1 percent of the total area of this bioregion.

Table 4.2-3 Habitat Type and Land Ownership Central Coast Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	329	360	0	4,015	612,723	617,427
Barren/Other	931	17,416	0	6,690	20,248	45,285
Conifer	2,969	290,834	5	12,207	53,899	359,915
Hardwood	762	79,620	52	5,235	68,242	153,911
Herbaceous	341,439	206,150	18,799	274,320	6,007,741	6,848,449
Shrub	84,156	1,124,863	14,195	80,172	982,964	2,286,350
Urban	1,310	588	10	12,681	241,302	255,891
Water	34	413	7	27,982	15,431	43,868
Wetland	0	0	0	2,217	1,456	3,673
By Habitat Type	**431,932**	**1,720,246**	**33,068**	**425,519**	**8,004,005**	**10,614,770**

Table 4.2-4 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Central Coast Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	53,983	12,248	41,347	**107,578**
Shrub-Dominated	410,122	132,588	362,589	**905,299**
Grass-Dominated	794,135	203,365	253,805	**1,251,305**
Total by Treatment	**1,258,240**	**348,201**	**657,741**	**2,264,182**

SOUTH COAST

The region's largest river drainages include the Tijuana, San Diego, San Luis Rey, Santa Margarita, Santa Ana, San Gabriel, Los Angeles, Santa Clara, and Ventura rivers. Pine forests occur along high-elevation stream reaches, and mountain drainages host mountain yellow-legged frog, California red-legged frog, Santa Ana sucker, and Santa Ana speckled dace. Lower-elevation river reaches support riparian vegetation species, including cottonwood, willow, sycamore, and coast live oak, which provide habitat for such riparian bird species as the least Bell's vireo, southwestern willow flycatcher, Swainson's thrush, and yellow warbler, as well as the arroyo toad.

River flow in this bioregion is closely tied to rainfall. In addition, rivers are more intensively channelized and managed by dams than those in other regions of California.

Remnant steelhead runs can be found in the Ventura and Santa Clara Rivers. Other native fish species such as the arroyo chub and Santa Ana sucker have exhibited significant declines in number and available habitat (Trust for Public Lands, 1999).

The region is distinguished by the tremendous population growth and urbanization that have transformed the landscape since the 1940s. This intersection of biological resources and urbanization has made the South Coast the most-threatened biologically diverse area in the continental U.S. (USGS, 2003). More than 150 species of vertebrate animals and 200 species of plants are either listed as protected or considered sensitive by wildlife agencies and conservation groups (Hunter, 1999).

The South Coast's widely variable geography and diverse climate have given rise to remarkable biological diversity. There are 476 vertebrate species that inhabit the South Coast Region at some point in their life cycle, including 287 birds, 87 mammals, 52 reptiles, 16 amphibians, and 34 fish. Of the total vertebrate species that inhabit this region, 82 bird taxa, 40 mammalian taxa, 19 reptilian taxa, eight amphibian taxa, and nine fish taxa are included on the Special Animals List. Of these, 14 are endemic to the South Coast Region, and 14 other species found here are endemic to California but not restricted to this region.

Table 4.2-5 identifies ownership patterns by habitat type within the South Coast Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. Table 4.2-6 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that approximately 27 percent of the total landscape within the South Coast Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 5,204 acres per year, which represents less than 0.07 percent of the total area of this bioregion.

Table 4.2-5 Habitat Type and Land Ownership South Coast Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	536	282	47	25,121	467,881	493,868
Barren/Other	275	10,070	225	5,647	26,812	43,028
Conifer	7,181	372,825	0	30,328	82,303	492,637
Hardwood	596	119,710	505	24,683	66,957	212,452
Herbaceous	3,888	36,597	3,025	113,738	491,698	648,946
Shrub	137,350	1,179,893	19,123	374,206	1,338,593	3,049,166
Urban	406	6,836	560	101,141	1,928,233	2,037,176
Water	131	3,858	11	33,334	22,360	59,694
Wetland	0	211	0	6,384	6,950	13,545
By Habitat Type	**150,364**	**1,730,281**	**23,496**	**714,582**	**4,431,787**	**7,050,511**

Table 4.2-6 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the South Coast Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	101,424	25,248	22,850	**149,523**
Shrub-Dominated	958,039	252,806	157,476	**1,368,321**
Grass-Dominated	284,868	68,969	35,875	**389,712**
Total by Treatment	**1,344,332**	**347,023**	**216,202**	**1,907,557**

SACRAMENTO VALLEY, SAN JOAQUIN VALLEY AND BAY DELTA

The Sacramento Valley, San Joaquin Valley and Bay-Delta Region comprise most of the low-lying lands of Central California. Much of the region is part of a vast hydrological system that drains 40 percent of the state's water. This water, falling as either rain or snow over much of the northern and central parts of the state, drains along the Sacramento and San Joaquin rivers into the Delta. In the Delta, freshwater from these rivers mixes with saltwater from San Francisco Bay, creating a rich and diverse aquatic ecosystem. Encompassing 1,600 square miles of waterways, the San Francisco Bay and Delta together form the West Coast's largest estuary and the second-largest estuary in the nation. The Sacramento Valley, San Joaquin Valley and Bay-Delta Regions also support the colorful waterfowl of the Pacific Flyway that funnel through the area during their annual migrations.

The region has four distinct sub-regions: the San Francisco Bay Area, the Delta, the Sacramento Valley, and the San Joaquin Valley. Each has unique combinations of climate, topography, ecology, and land-use patterns.

The San Francisco Bay Area sub-region, the most densely populated area of the state outside of the Southern California metropolitan region, consists of the low-lying bay lands, aquatic environments, and watersheds that drain into San Francisco Bay. It is bounded on the east by the Delta sub-region, on the north by the North Coast Region, on the south by the Central Coast Region, and on the west by the Pacific Ocean. Low coastal mountains surround San Francisco Bay, with several peaks rising above 3,000 feet. The region receives 90 percent of its surface water from the major Central Valley rivers via the Delta. Other major rivers draining into the Bay include the Napa and Petaluma rivers and Sonoma, Petaluma, and Coyote creeks. The Bay Area has relatively cool, often foggy summers and cool winters, strongly influenced by marine air masses. Rain falls almost exclusively during the winter (October to April) and averages 15–25 inches annually, with occasional snowfall at higher elevations. Rainwater runs off rapidly, and most of the smaller streams are dry by the end of the summer.

The topography allows for a variety of different habitats. The Bay itself has both deep and shallow estuarine (mixed freshwater and saltwater) environments. In addition to estuarine species, the Bay also supports many marine species, including invertebrates, sharks, and even, on occasion, whales. Along the shoreline are coastal salt marsh, coastal scrub, tidal mudflats, and salt ponds. Freshwater creeks and marshes, especially those that still have patches of riparian vegetation, are home to aquatic invertebrates and freshwater fish such as Delta smelt and sturgeon. Upland areas support a mixture of grasslands, chamise chaparral, and live oak and blue oak woodlands. Small stands of redwood, Douglas fir, and tanoak grow in moister areas.

The Great Central Valley of California contains the other three sub-regions: the Sacramento Valley, the San Joaquin Valley, and the Sacramento–San Joaquin Delta. Together, they form a vast, flat valley, approximately 450 miles long and averaging 50 miles wide, with elevations almost entirely below 300 feet. The Sutter Buttes, a circular set of 2,000-foot-high hills which rise from the middle of the valley floor (promoted locally as the “Smallest Mountain Range in the World”), is the only topographic feature that exceeds that height. The Central Valley is surrounded by the Sierra Nevada on the east, the coastal ranges on the west, the Tehachapi Mountains on the south, and the Klamath and Cascade mountains on the north. Less influenced by marine air than San Francisco Bay, the valley’s climate has hot, dry summers and foggy, rainy winters. Annual rainfall averages from 5 inches to 25 inches, with the least rainfall occurring in the southern portions and along the west side (in the rain shadow of the coastal mountains). Agriculture dominates land uses in the Central Valley, with very few remnants of natural land remaining.

The major natural upland habitats are annual grassland, valley oaks on floodplains, and vernal pools on raised terraces. The more arid lands of the southern San Joaquin Valley also contain alkali sink and saltbush shrublands. Slow-moving rivers along the valley floor provide habitat for fish and invertebrates and help maintain adjacent riparian, wetland, and floodplain habitats.

Hydrology is the main difference between the three Central Valley sub-regions. The Delta is a low-lying area that contains the tidally influenced portions of the Sacramento, San Joaquin, Mokelumne, and Consumnes rivers. The Delta was once a huge marsh formed by the confluence of the Sacramento and San Joaquin rivers. Once described as a “terraqueous labyrinth of such intricacy that unskillful navigators have been lost for days in it” (Bryant 1848), it has been extensively drained and diked for flood protection and agriculture. Exposure of the rich, organic soils behind these levees has increased oxidation a rate to such an extent that the land is breaking down and much of the surface has now subsided below sea level. Due to its natural patterns of flooding, the Delta is relatively less populated than the other sub-regions. The second sub-region, the Sacramento Valley, contains the Sacramento River, the largest river in the state. This river historically overflowed into several low-lying areas, particularly in its lower reaches.

The lower 180 miles of the river, below Chico Landing, are now constrained by levees, and excess floodwaters are diverted into large bypasses to reduce risks to people.

The third sub-region of the Central Valley, the San Joaquin Valley, has two distinct, or separate, drainages. In the northern portion, the San Joaquin River flows north toward the Delta. It captures water via several major rivers that drain the central Sierra Nevada. The southern portion of the valley is isolated from the ocean and drains into the closed Tulare Basin, which includes the beds of the former Tulare, Buena Vista, and Kern lakes. These lakes and vast wetlands historically were fed by the rivers that drain the southern Sierra Nevada (the Kings, Kaweah, Tule, and Kern). These lakes are now dry most of the time because water has been diverted to upland agriculture. Runoff during the wettest years will occasionally flood out of river channels and temporarily refill some of these lakebeds. The California Aqueduct extends along the entire western edge of the valley, delivering water from the Delta to farmers in the Tulare basin and over the Tehachapi Mountains to Southern California. The wildlife of this region is beset by a wide variety of stressors, described below. The major problem has been the loss, degradation, and fragmentation of habitats, both terrestrial and aquatic, due to the development of agriculture and urban areas. Many of the streams have been dammed, blocking fish migration, or have been so severely degraded that they are no longer usable by salmon. Flood control structures, such as dikes, levees, and hardened embankments (riprap), have altered floodplain habitats like riparian forests and wetlands throughout the region. Many other species that persist on the remaining habitat fragments are at risk of local or range wide extinction. Ninety-five percent of the historic Central Valley salmon habitat has been lost (DFG, 1993).

This region is primarily in private ownership, and the role of private landowners is very important for conservation. More than 75 percent of the known California locations of 32 animal species of concern occur predominately on private lands. Examples of these species include Swainson’s hawk, burrowing owl, San Pablo vole, and Buena Vista Lake shrew.

Improvement in the status and sustainability of this bioregions’ four runs of Chinook salmon is an important resource management goal. Reservoir dams block access to historically available Chinook salmon and steelhead spawning and rearing habitat. The current extent of spawning habitat available for salmonids (approximately 300 miles) is 5 percent of that available historically (Trust for Public Lands, 2001). Dams have also interrupted the recruitment of coarse sediment and organic material to downstream reaches. Central Valley reservoirs support sport fisheries composed primarily of non-native species or hatchery supplemented fish populations.

There are 490 vertebrate species that inhabit the Central Valley and Bay-Delta Region at some point in their life cycle, including 279 birds, 88 mammals, 40 reptiles, 18 amphibians, and 65 fish. Of the total vertebrate species that inhabit this region, 80 bird taxa, 38 mammalian taxa, 11 reptilian taxa, six amphibian taxa, and 25 fish taxa are included on the California Department of Fish and Game’s Special Animals List. Of these, 20 are endemic to the Central Valley and Bay-Delta Region, and 28 other species found here are endemic to California but not restricted to this region.

Table 4.2-7 identifies ownership patterns by habitat type within the San Joaquin Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. Table 4.2-8 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). These figures were reported earlier in Tables 2.5-1 through 2.5-4. Comparison of the two tables below indicates that approximately 8 percent of the total landscape within the San Joaquin Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 1,877 acres per year, which represents 0.02 percent of the total area of this bioregion.

Table 4.2-7 Habitat Type and Land Ownership San Joaquin Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	6,693	0	0	30,080	4,937,082	4,973,854
Barren/Other	121	526	0	237	2,156	3,040
Conifer	5,986	57,273	0	11,807	10,758	85,825
Hardwood	28	1,863	0	3,741	23,814	29,446
Herbaceous	239,681	3,605	0	234,769	1,862,981	2,341,036
Shrub	67,600	9,269	0	15,948	162,739	255,556
Urban	2,858	119	0	9,241	408,431	420,649
Water	3,547	0	0	11,611	27,006	42,163
Wetland	34	0	0	19,534	53,256	72,824
By Habitat Type	**326,547**	**72,656**	**0**	**336,967**	**7,488,223**	**8,224,394**

Table 4.2-8 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the San Joaquin Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	4,959	1,279	1,922	**8,160**
Shrub-Dominated	52,595	40,560	36,231	**129,386**
Grass-Dominated	270,582	186,512	93,497	**550,591**
Total by Treatment	**328,136**	**228,350**	**131,651**	**688,137**

Table 4.2-9 identifies ownership patterns by habitat type within the Bay Delta Bioregion. Table 4.2-10 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that approximately 35 percent of the total landscape within the Bay Delta Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 5,855 acres per year, which represents 0.1 percent of the total area of this bioregion.

Table 4.2-9 Habitat Type and Land Ownership Bay Delta Valley Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	915	0	4,093	60,145	1,353,552	1,418,706
Barren/Other	62	0	1,238	2,171	7,638	11,108
Conifer	7,429	0	18,815	164,712	316,800	507,757
Hardwood	3,352	0	1,903	76,869	405,137	487,260
Herbaceous	5,217	0	30,731	359,093	1,323,469	1,718,510
Shrub	30,374	0	26,038	186,815	369,847	613,074
Urban	62	0	2,953	89,495	932,228	1,024,737
Water	125	0	946	60,208	36,760	98,038
Wetland	549	0	1,071	31,948	77,203	110,771
By Habitat Type	**48,086**	**0**	**87,788**	**1,031,454**	**4,822,633**	**5,989,962**

Table 4.2-10 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Bay Delta Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	345,235	72,525	191,386	**609,145**
Shrub-Dominated	152,571	47,126	85,988	**285,685**
Grass-Dominated	794,135	203,365	253,805	**1,251,305**
Total by Treatment	**1,291,941**	**323,016**	**531,178**	**2,146,135**

Table 4.2-17 identifies ownership patterns by habitat type within the Sacramento Valley Bioregion. Table 4.2-18 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that approximately 22 percent of the total landscape within the Sacramento Valley Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 2,364 acres per year, which represents 0.06 percent of the total area of this bioregion.

Table 4.2-11 Habitat Type and Land Ownership Sacramento Valley Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	334	12	0	37,042	1,797,895	1,835,283
Barren/Other	289	10	0	1,910	16,337	18,547
Conifer	19	4	0	295	3,370	3,688
Hardwood	854	22	0	14,652	62,155	77,683
Herbaceous	36,716	394	0	184,529	1,310,670	1,532,309
Shrub	6,063	0	0	1,661	24,960	32,684
Urban	209	22	0	14,492	306,373	321,096
Water	549	10	0	19,144	32,968	52,671
Wetland	386	22	0	28,470	49,928	78,807
By Habitat Type	**45,420**	**497**	**0**	**302,197**	**3,604,657**	**3,952,770**

Table 4.2-12 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Sacramento Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	15,173	5,762	10,071	**31,007**
Shrub-Dominated	3,136	2,022	6,236	**11,395**
Grass-Dominated	494,494	165,764	163,818	**824,076**
Total by Treatment	**512,804**	**173,548**	**180,126**	**866,478**

MODOC

The Modoc Plateau Region is located in the northeastern corner of the state, framed by and including the Warner Mountains and Surprise Valley along the Nevada border to the east and extending west to the edge of the southern Cascades Range. The region extends north to the Oregon border and south to include the Skedaddle Mountains and the Honey Lake Basin.

A million years ago, layered lava flows formed the 4,000-5,000 foot elevation Modoc Plateau, separating the watersheds of the region from the Klamath drainage to the northwest. The waters of the western slope of the Warner Mountains and the Modoc Plateau carved a new course, the Pit River, flowing to the southwest through the Cascades and joining the Sacramento River.

Situated on the western edge of the Great Basin, the Modoc Plateau historically has supported high desert plant communities and ecosystems similar to that region-shrub-steppe, perennial grasslands, sagebrush, antelope bitterbrush, mountain mahogany, and juniper woodlands. Sagebrush plant communities are characteristic of the region, providing important habitat for sagebrush-dependent wildlife. Conifer forests dominate the higher elevations of the Warner Mountains and the smaller volcanic mountain ranges and hills that shape the region. Wetland, spring, meadow, vernal pool, riparian, and aspen communities scattered across the rugged and otherwise dry desert landscape support diverse wildlife. The region has varied aquatic habitats, from high mountain streams to the alkaline waters of Goose Lake and Eagle Lake to clear spring waters of Fall River and Ash Creek.

Northeastern California is an outstanding region for wildlife, providing habitat for mountain lion, mule deer, pronghorn, Rocky Mountain elk, greater sage-grouse, and the colorful waterfowl of the Pacific Flyway that funnel through the area during their annual migrations.

Golden eagles, peregrine and prairie falcons, northern goshawks, sandhill cranes, and American white pelicans nest and hunt or forage in the region. The varied aquatic habitats and natural barriers along the Pit River and its tributaries have allowed the evolution of several unique aquatic communities that include endemic fish and invertebrates.

Sixty percent of the region is federally managed; the Forest Service manages 30 percent, BLM manages 26 percent, and the Fish and Wildlife Service and the Department of Defense each manage about 2 percent of the lands. State Fish and Game manages 1 percent of the region as wildlife areas. About 37 percent of the lands are privately owned or belong to municipalities.

Only 9 percent of the forests and rangelands of the Modoc region are designated as reserves, such as wilderness areas, less than is protected in other regions of the state except the Central Valley. The wilderness areas and refuges in the region are grazed by livestock (CAL FIRE, 2003). The combined total of lands managed by State Parks and the National Park Service is about 2,500 acres.

There are 399 vertebrate species that inhabit the Modoc Plateau region at some point in their life cycle, including 235 birds, 97 mammals, 23 reptiles, six amphibians, and 38 fish. Of the total vertebrate species that inhabit this region, 57 bird taxa, 21 mammalian taxa, three reptilian taxa, one amphibian taxon, and 20 fish taxa are included on the Special Animals List. Of these, three are endemic to the Modoc Plateau region, one is endemic to California but introduced to this region, and three species found here are endemic to California but not restricted to this region.

Many of the region's plant communities and ecosystems have been substantially altered or degraded over the last 120 years by a combination of stressors. Despite being in one of the least-developed regions of the state, the sagebrush, perennial bunchgrass, aspen, bitterbrush, and mountain mahogany habitats of the Modoc Plateau are among the most threatened ecosystems of North America (Nature Conservancy, 2001). Aspen stands are in sharp decline (Di Orio et al., 2005). Many of the meadow and riparian areas are overgrazed or are suffering from encroachment by juniper, pine, fir, and invasive plants (Loft et al., 1998; USFS, 2001; 1991b).

Table 4.2-19 identifies ownership patterns by habitat type within the Modoc Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. **Error! Reference source not found.**Table 4.2-14 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that approximately 32 percent of the total landscape within the Modoc Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 7,175 acres per year, which represents approximately 0.09 percent of the total area of this bioregion.

Table 4.2-13 Habitat Type and Land Ownership Modoc Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	3,230	1,592	46	49,876	430,654	485,397
Barren/Other	35,069	37,304	12,100	1,711	37,164	123,348
Conifer	253,546	1,712,588	87,210	21,351	1,382,115	3,456,811
Hardwood	7,356	39,171	456	4,439	66,859	118,281
Herbaceous	14,898	53,948	61	48,606	297,481	414,995
Shrub	1,075,700	965,456	51,198	83,192	1,021,490	3,197,037
Urban	345	166	60	266	22,725	23,562
Water	8,749	39,291	1,960	53,844	258,880	362,723
Wetland	8,189	20,334	709	14,216	94,709	138,156
By Habitat Type	**1,407,082**	**2,869,849**	**153,801**	**277,501**	**3,612,077**	**8,320,310**

Table 4.2-14 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Modoc Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	377,423	199,678	827,087	**1,404,189**
Shrub-Dominated	235,956	154,778	538,995	**929,729**
Grass-Dominated	120,292	51,095	124,530	**295,917**
Total by Treatment	**733,671**	**405,551**	**1,490,612**	**2,629,835**

SIERRA NEVADA

Extending approximately 525 miles from north to south, the Sierra Nevada and Cascade ranges form the spine of the California landscape. The mostly volcanic southern Cascades stretch from north of the Oregon border southeastward, merging just south of Mt. Lassen with the northern reaches of the predominantly granitic Sierra Nevada. To the south, the Sierra Nevada embraces the Mojave Desert to the east and curves south to link with the Tehachapi Mountains. The region includes the oak woodland foothills on the western slopes of the Sierra Nevada and Cascade ranges and, on the east, the Owens Valley and edges of the Great Basin.

On the west side, the slope of the Sierra Nevada and Cascades rises gradually from near sea level at the floor of the Central Valley to ridges ranging from 6,000 feet in the north to 14,000 feet in the south, then dropping off sharply to the east.

Unlike the Sierra Nevada, however, the east side of the Cascades slopes gradually. As the Sierra Nevada elevation increases from west to east, life zones transition from chaparral and oak woodlands to lower-level montane forests of ponderosa and sugar pine to upper montane forests of firs, Jeffrey and lodgepole pine and, above timberline, to alpine plant communities.

Federal agencies manage about 61 percent of the Sierra Nevada and Cascades: 46 percent by the Forest Service, 8 percent by the National Park Service, and 7 percent by the Bureau of Land Management. About 2 million acres are wilderness areas, mostly in the eastern and southern Sierra Nevada, managed by the Forest Service. Lands managed by the National Park Service include Lassen Volcanic, Sequoia, Kings Canyon, and Yosemite national parks and Devils Postpile National Monument. State parks and wildlife areas account for 1 percent of the region, and the remaining, approximately 36 percent of the Sierra Nevada and Cascades, is privately owned. Most of the higher elevations and the eastern Sierra Nevada are public lands, whereas most of the oak woodlands and lower mixed conifer forests and rangelands below 3,000 feet on the western slope are in private ownership. There is a checkerboard ownership pattern of private and public lands in areas of the northern half of the Sierra Nevada that lie near historical railway routes (Bunn et al, 2005).

About 40 percent of the state's surface-water runoff flows to the Central Valley from the Sierra Nevada and Cascades. These flows are critical to meet California's hydropower demands and agricultural and drinking water needs. Much of the water is stored in reservoirs and is conveyed by aqueducts to irrigate agriculture from Redding to Bakersfield and to provide drinking water for most of urbanized California, including the San Francisco Bay Area and Southern California (DWR, 1998).

Streams of the eastern Sierra make up the Lahontan system. Stream habitat structure and condition are similar across the system which has resulted in a relatively low number of native fish species (8). Introduced brook, rainbow, and brown trout have largely replaced native Lahontan and Paiute cutthroat trout. Paiute sculpin, mountain sucker, mountain whitefish, and speckled dace become an increasingly important part of the fish fauna as stream gradients decrease and the frequency of pool habitats increase.

The hundreds of creeks and streams of the western slope of the Sierra Nevada and Cascades drain via a dozen major river basins to merge with the Sacramento River in the north and the San Joaquin River in the south, eventually joining at the San Francisco Bay Delta. The southern forks of the Kings River and streams further south drain into the Tulare basin. The streams east of the Sierra Nevada crest flow into the Great Basin via the Lahontan, Mono, and Owens drainages. Many of the springs and creeks of northeastern California drain via the Pit River, which winds through the Cascades and joins the Sacramento River at Lake Shasta. Maintaining and restoring the ecological health of these watersheds and aquatic systems is important to ensure clean water.

Bold topography, the large elevation gradient, and varied climatic conditions of the Sierra Nevada and Cascades support diverse plant communities. Fifty percent of California's 7,000 vascular plants are found in the region, and more than 400 plant species are endemic (Shevock, 1996). The varied conditions and floristically and structurally diverse plant communities provide a large array of habitats important for maintaining California's wildlife diversity and abundance.

The altered forest ecosystems of the Sierra Nevada and Cascades largely lack the qualities of old-growth forests or late-seral stage forests (forests that are in the later stages of development with large-diameter trees, snags, and logs) that are important for diverse and abundant wildlife (Franklin and Fites-Kaufman, 1996; USFS, 2001).

Species that depend on old-growth or late-seral stage forest habitat, like the Pacific fisher, have been negatively affected. The degradation of mountain meadows and loss of willows and other riparian woody plants have affected the endangered willow flycatcher and other species that have similar habitat requirements.

New conservation challenges and opportunities will affect the Sierra Nevada and Cascade ranges in the next few decades. How new development is managed will determine the extent of wildlife habitat fragmentation. Changing global climate will alter depth and seasonality of snowpack, further modifying river flow regimes and ecosystems. The relicensing of hydropower projects provides an opportunity to change hydropower operations to reduce their effects on fish and wildlife.

Concerned about the decline of old forests and associated wildlife species of the region, Congress funded, in 1993, the Sierra Nevada Ecosystem Project (SNEP), based at U.C. Davis, for the “scientific review of the remaining old growth in the national forests of the Sierra Nevada in California, and for the study of the entire Sierra Nevada ecosystem by an independent panel of scientists, with expertise in diverse areas related to this issue.” The forests of the Sierra Nevada, Cascades, and the Modoc Plateau were evaluated by a multidisciplinary team of scientists from many organizations.

SNEP completed its work and published a three-volume report in 1996. Based on the work of dozens of scientists, the report analyzed the status of conifer forests, rangelands, meadow and riparian plant communities, and aquatic ecosystems, and suggested alternatives to restore ecosystems. SNEP concluded that aquatic and riparian systems are the most altered and impaired habitats of the Sierra Nevada and Cascades. Among other critical findings, SNEP found that key causes of the decline of mammals, birds, and other vertebrates in the Sierra Nevada, Cascades, and Modoc regions include the loss and degradation of riparian areas, foothill woodlands, and diverse old forest habitats (including large trees, snags, fallen logs, and layered vegetative structure).

Meanwhile, a 1992 technical report by the Forest Service’s Pacific Southwest Research Station highlighting at-risk California spotted owl populations triggered challenges and debate. That debate prompted the Forest Service to initiate a multiyear planning process that resulted in the Sierra Nevada Framework for Conservation and Collaboration, which evolved into the Sierra Nevada Forest Plan Amendment Final Environmental Impact Statement (SNFPA) covering the national forests of the Sierra Nevada, Cascades, and Modoc regions. In January 2001, The U.S. Forest Service announced the SNFPA Record of Decision, describing chosen management options. In January 2004, the SNFPA was amended, reducing livestock-grazing and timber-harvest restrictions and giving the Forest Service greater management discretion.

There are 572 vertebrate species that inhabit the Sierra Nevada and Cascades region at some point in their life cycle, including 293 birds, 135 mammals, 46 reptiles, 37 amphibians, and 61 fish. Of the total vertebrate species that inhabit this region, 83 bird taxa, 41 mammalian taxa, 12 reptilian taxa, 23 amphibian taxa, and 31 fish taxa are included on the Special Animals List. Of these, 26 are endemic to the Sierra Nevada and Cascades Region, two are endemic to California but introduced in this region, and 26 other species found here are endemic to California but not restricted to this region.

Table 4.2-15 identifies ownership patterns by habitat type within the Sierra Nevada Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. Table 4.2-16 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration. Comparison of the two tables below indicates that approximately 26 percent of the total landscape within the Sierra Nevada Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 13,411 acres per year, which represents 0.07 percent of the total area of this bioregion.

Table 4.2-15 Habitat Type and Land Ownership Sierra Nevada Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	8,925	1,211	7	6,605	312,117	328,866
Barren/Other	18,846	781,560	441,328	86,261	31,948	1,359,942
Conifer	182,538	5,077,244	942,537	95,082	1,543,788	7,841,189
Hardwood	68,453	446,941	105,980	46,472	758,582	1,426,428
Herbaceous	126,237	210,380	25,569	93,819	2,663,056	3,119,062
Shrub	759,165	1,828,689	63,199	325,995	616,226	3,593,274
Urban	1,129	6,127	578	8,647	160,485	176,967
Water	7,985	76,903	18,572	124,475	132,259	360,195
Wetland	1,398	47,456	19,691	12,576	14,633	95,753
By Habitat Type	**1,174,675**	**8,476,512**	**1,617,460**	**799,933**	**6,233,095**	**18,301,675**

Table 4.2-16 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Sierra Nevada Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	1,090,662	154,834	722,877	**1,968,373**
Shrub-Dominated	323,025	96,448	178,085	**597,557**
Grass-Dominated	1,470,973	253,995	624,761	**2,349,729**
Total by Treatment	**2,884,660**	**505,276**	**1,525,722**	**4,915,658**

MOJAVE

About 80 percent of the Mojave Desert in California is managed by federal agencies. The Bureau of Land Management (BLM), the largest land manager of the region, oversees 8 million acres, or 41 percent, of the federally owned sector. The National Park Service manages the Mojave National Preserve and Death Valley and Joshua Tree national parks, which account for another 26 percent of the region. The Department of Defense manages five military bases that cover about 13 percent of the region. About 30 percent of the region belongs to private landowners or municipalities (CPAD, 2014).

The Amargosa and Mohave Rivers are found in this bioregion and provide habitat for the desert pupfish and other pupfish species.

There are 439 vertebrate species that inhabit the Mojave Desert Region at some point in their life cycle, including 252 birds, 101 mammals, 57 reptiles, 10 amphibians, and 19 fish. Of the total vertebrate species that inhabit this region, 69 bird taxa, 38 mammalian taxa, 15 reptilian taxa, four amphibian taxa, and nine fish taxa are included on the Special Animals List. Of these, 14 are endemic to the Mojave Desert Region, one is endemic to California but restricted to this region, and 15 other species found here are endemic to California but not restricted to this region.

Table 4.2-17 identifies ownership patterns by habitat type within the Mojave Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. Table 4.2-18 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that less than 5 percent of the total landscape within the Mojave Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 2,573 acres per year, which represents 0.01 percent of the total area of this bioregion.

Table 4.2-17 Habitat Type and Land Ownership Mojave Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	1,503	14	0	383	184,099	185,999
Barren/Other	56,623	2,254	234,759	10,592	150,487	454,715
Conifer	188,932	31,991	210,392	20,729	162,938	614,981
Hardwood	760	917	25	632	9,027	11,361
Herbaceous	60,883	4,198	0	6,378	107,240	178,699
Shrub	7,810,179	45,124	4,702,663	405,682	5,148,067	18,111,715
Urban	12,982	78	3,201	1,998	322,414	340,673
Water	2,924	164	2,061	3,359	8,869	17,376
Wetland	6,981	47	741	66	11,052	18,887
By Habitat Type	**8,141,766**	**84,787**	**5,153,842**	**449,819**	**6,104,193**	**19,934,407**

Table 4.2-18 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Mojave Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	3,348	5,968	12,566	**21,882**
Shrub-Dominated	185,511	591,422	40,227	**817,160**
Grass-Dominated	37,398	39,460	27,062	**103,920**
Total by Treatment	**226,257**	**636,850**	**79,855**	**942,962**

COLORADO DESERT

The region’s terrestrial habitats include creosote bush scrub; mixed scrub, including yucca and cholla cactus; desert saltbush; sandy soil grasslands; and desert dunes. Higher elevations are dominated by pinyon pine and California juniper, with areas of manzanita and Coulter pine. In addition to hardy perennials, more than half of the desert’s plant species are herbaceous annuals, and appropriately timed winter rains produce abundant early spring wildflowers. In the southern portion of the region, the additional moisture supplied by summer rainfall fosters the germination of summer annual plants and supports smoketree, ironwood, and palo verde trees.

In the Colorado Desert's arid environment, aquatic and wetland habitats are limited in extent but are critically important to wildlife. Runoff from seasonal rains and groundwater springs forms canyon mouth- associated alluvial fans, desert arroyos, desert fan palm oases, freshwater marshes, brine lakes, desert washes, ephemeral and perennial streams, and riparian vegetation communities dominated by cottonwood, willow, and non-native tamarisk. Two of the region's most significant aquatic systems are the Salton Sea and the Colorado River.

While most desert wildlife depends on aquatic habitats as water sources, a number of species, such as arroyo toad, desert pupfish, Yuma clapper rail, and southwestern willow flycatcher, are restricted to these habitats. In some places, summer rains produce short-lived seasonal pools that host uncommon species like Couch's spadefoot toad.

Desert fan palm oases are rare ecological communities found only in the Colorado Desert here permanent water sources are available. With an overstory of desert fan palm trees, these communities provide unique islands of shade, moisture, and vegetation in an otherwise arid and sparse landscape.

BLM administers about 2.9 million acres, or 43.1 percent of the region. Department of Defense lands account for about 500,000 acres, or 7 percent, of the region and are the bioregions largest land manager. Joshua Tree National Park spans the transition from the Mojave to the Colorado Desert, with slightly less than half the park, about 340,000 acres, in the Colorado Desert. Anza Borrego Desert State Park encompasses over 600,000 acres, or nearly 9 percent, of the region, and the Santa Rosa Wildlife Area, which includes Fish and Wildlife, State Lands Commission, and BLM lands, encompasses about 100,000 acres.

Together, Joshua Tree National Park, Anza Borrego Desert State Park, and the Santa Rosa Wildlife Area, along with other protected lands in the Mojave Desert, are part of the Mojave and Colorado Deserts Biosphere Reserve, designated by the United Nations as an important global site for preservation of the biological and cultural resources of these two desert regions.

The diverse wildlife inhabiting the Colorado Desert includes many species specially adapted to the unique desert habitats. There are 481 vertebrate species that inhabit the region at some point in their life cycle, including 282 birds, 82 mammals, 66 reptiles, 16 amphibians, and 35 fish. Of these vertebrate species, 84 bird taxa, 34 mammalian taxa, 21 reptilian taxa, five amphibian taxa, and four fish taxa are in included on the Special Animals List. Of these, four are endemic to the Colorado Desert region, and four other species found here are endemic to California but not restricted to this region.

Table 4.2-19 identifies ownership patterns by habitat type within the Colorado Desert Bioregion. As discussed in Section 2.5, the scale of the proposed program is limited by several constraints. Table 4.2-20 identifies the number of acres available for treatment by dominant vegetation formation (tree, shrub and grass) and treatment type (wildland urban interface (WUI), fuel break, and ecological restoration). Comparison of the two tables below indicates that approximately less than 1 percent of the total landscape within the Colorado Desert Bioregion is available for treatment. Of those acres available, the proposed project anticipates treating approximately 988 acres per year, which represents less than 0.01 percent of the total area of this bioregion.

Table 4.2-19 Habitat Type and Land Ownership Colorado Desert Bioregion (CPAD, 2014)

Habitat Type	Bureau of Land Management	United States Forest Service	National Park Service	Other Public	Private	Total
Agriculture	16,357	2	0	28,225	775,248	819,833
Barren/Other	90,780	35	165	7,477	1,826	100,284
Conifer	17,501	1,273	1,155	55,811	5,837	81,577
Hardwood	3,594	576	0	1,484	823	6,477
Herbaceous	3,779	20	0	696	59,750	64,245
Shrub	2,767,070	6,972	343,168	777,248	1,355,994	5,250,451
Urban	6,600	36	151	4,428	166,125	177,341
Water	4,594	0	0	203,163	44,032	251,788
Wetland	3	0	0	42	585	630
By Habitat Type	**2,910,277**	**8,914**	**344,640**	**1,078,574**	**2,410,219**	**6,752,625**

Table 4.2-20 Treatable Acres by Dominant Vegetation Type and Treatment Alternative within the Colorado Desert Bioregion

Dominate Vegetation Type	WUI	Fuel Breaks	Ecological Restoration	Total by Dominate Vegetation Type
Tree-Dominated	357	1,403	408	**2,167**
Shrub-Dominated	109,459	198,732	45,536	**353,727**
Grass-Dominated	3,849	1,737	597	**6,183**
Total by Treatment	**113,664**	**201,872**	**46,541**	**362,077**

4.2.1.3 How the Fire Ecology of Southern Shrub Ecosystems Differs from that of Forest in Regards to Fire

Shrublands have varied fire frequencies. Resilience is realized differently among shrub species and can be simplistically divided into vigorous post-fire sprouters, weak post-fire sprouters, obligate seeders, and other. The vigorous sprouting species are of two types, those that also establish seedlings in abundance post fire (e.g., Chamise *Adnenostoma fasciculatum*) and the much more numerous group of species that do not (e.g. Toyon *Heteromeles arbutifolia*). The weak re-sprouters include many coastal sage scrub drought deciduous species such as *Salvia* spp. and California Sagebrush *Artemisia californica*. These species also re-establish by seed and many can recruit new individuals to the canopy in the periods between fire if suitable gaps appear or are present. The 'other' category is included because there are possibilities not covered in the simple scheme as laid out here. Finally, it needs to be emphasized that there is geographic variation in fire response. Some species will sprout readily in some areas and not in others.

Taking all of this together, it can be said that virtually all shrub ecosystems will recover well from wildfire, but the transition of species is not always a certainty. To clarify the management-relevant risks Zedler (1995) proposed the concepts of "senescence risk" and "immaturity risk," defined as follows:

> *Senescence risk* is the risk that species populations may be greatly reduced or goes locally extinct because of death or a loss of vigor of individual plants resulting from extreme age. Stands facing senescence risk will change significantly when burned because of the inability of formerly dominant species to regenerate.
>
> *Immaturity risk* is the risk that species will be burned before they have accumulated enough reserves of seeds or stored energy for re-sprouting at the time of fire. This risk is real, as has been demonstrated not only in California (e.g., Sampson 1944), but also in other Mediterranean climate regions.

In the past, some managers have felt strongly that because of the obvious capacity of some shrub systems to recover from fire, such systems needed frequent fire to remain "healthy." Since this belief aligned with the objective of reducing fuel loads and "flammability," the idea that chaparral needed to have prescribed fire frequently applied was widely accepted. Over time, instances of the loss or significant reduction of species that were victims of immaturity risk began to accumulate. In addition, the study of chaparral ecosystems began to reveal that chaparral, in addition to being resilient to fire at shorter intervals, was also resilient to fire at long intervals (Sampson, 1944; Horton and Kraebel, 1955). Contrary to ideas that chaparral was subject to significant senescence, it was observed that the accumulation of dead and dying plants was part of a normal cycle of post fire stand development. Though in theory it might be possible for chaparral to become "senescent" in the sense defined above, it was evident that this would not occur for many decades and at ages far in excess of those that were the target for fuel reduction strategies.

4.2.1.3.1 Chaparral and Fire

In some forested types, actions that reduce the probability of severe fires can be more or less aligned with the restoration of a more natural fire regime. That is, the asymmetry between human needs and ecological needs can be acceptably small. The desired management regime of the ponderosa pine, Jeffrey pine, and Sierran mixed conifer forest types can fall into this category. There is good reason to believe that past management actions and non-action has resulted in fuel structures that are significantly different from those that existed historically, with the result that fires are larger and especially more severe and damaging to the system than those that occurred historically. This may justify actions to modify fuel structure to permit management burning to be used to simulate the historical pattern.

But this “fuel reduction model,” which aims at the restoration of a more natural fuel structure and a more natural fire regime through fuel manipulations and the imposition of management burns, does not apply to southern chaparral and coastal sage scrub. These are vegetation types that might be characterized as being “obligate crown fire systems.” That is, if they burn, they burn in an intense crown fire that kills most or all of the above-ground plant tissue. Because of this, unmanaged chaparral is seen as a serious hazard to humans and their property. Given past and current urban development policy and the fact that communities are stretching further into the wildlands, chaparral wildfires have resulted in significant damage to property and loss of life. Thus from a strict “human hazard reduction” viewpoint, management to reduce the amount of burnable biomass is said to be justified in many instances, especially within well-developed urban interface areas.

But in chaparral landscapes the discrepancy between what is best for the ecological integrity of the chaparral and what is best to minimize hazards to humans is very large. The best available information strongly suggests that fire return intervals for chaparral are much longer than many have believed. The Van de Water and Safford (2011) review of fire frequency estimates for California vegetation types supports the idea that chaparral is an infrequent fire system. The mean and median fire return intervals for the composite type “chaparral and serotinal conifers” are 55 and 59 years respectively. The mean minimum is 30 years. These numbers are significantly greater than those that have traditionally been cited. A widely held misconception is that the typical fire return interval is between 25-30 years (Dodge, 1970), when in fact that is on the low end of the Van de Water and Safford (2011) estimates. This leads to the conclusion that in its present state, and in consideration of the substantial pressure from human-caused or human-related fire, chaparral does not need more fire, it needs less (Safford and Van de Water, 2014). However, new scientific information could modify that conclusion in the future as it becomes available. For example tree-ring data collected by Lombardo *et al*.

(2009) in bigcone Douglas-fir stands surrounded by chaparral indicate that both extensive and smaller fires were present in historical time.

Summarizing the important features of chaparral with respect to fire:

- Mature chaparral has, in general, a continuous canopy capable of supporting very large, high-intensity fires which are difficult to control. If chaparral has not evolved to burn as research suggests, it appears it does allow for rapid rates of fire spread under certain environmental condition.
- Chaparral rarely experiences surface fire. If fire is burning beneath the shrubs, ignition of the canopy is almost certain to result. Thus there is no possibility of instituting frequent “light” management burns to reduce the fuel in a manner analogous to what is done in certain forest types.
- After fire the fuel loads of chaparral drops precipitously. Thus very young stands (meaning stands in the early stages of recovery after fire) are significantly less likely to propagate fires. But this period of significantly reduced propensity to burn is brief (less than 10 years) relative to the 50 year median time to the next fire.
- If very young stands do burn, the obligate seeding species face significant risk of dramatic population decline because of a lack of seeds.
- Immaturity risk aside, burning chaparral at high frequency opens up stands, and if continued over long periods will degrade chaparral and foster the invasion of undesirable aliens, specifically the annual grasses.
- In some cases the increase in light fuels following fire-induced degradation can result in shorter intervals between fires, furthering the rate of degradation.

Though it may be the case that completely removing fire from the landscape could cause significant and perhaps undesirable shifts in southern chaparral communities (i.e. quantity and distribution), it would likely require a number of decades before the shift became a practical concern. Lightning, human accidents, and arson, combined with drought intervals, all appear to provide numerous opportunities for fire to visit southern California chaparral systems. Burning in southern chaparral systems, to enhance ecological function, at intervals shorter than natural fire return frequencies, may lead to adverse ecological results.

On private range lands there is much less obligation to preserve native systems, and burning at high rates to convert shrubs to systems with a higher proportion of grass can perhaps be economically justified. There are cases where aggressive burning that reduces shrub cover can have adverse ecological consequences. The most likely negative effect will be on steep erodible slopes where shrub removal can destabilize slopes. Another example of fuel reduction in shrubs includes projects that might contribute to a landscape level plan for improving access and control in the event of a wildfire.

4.2.1.3.2 Other Shrub Species and Fire

NORTHERN SHRUBLANDS

The management of shrublands in the northern areas of the state does not necessarily hold the same concerns as those in the southern portion of the state (Modoc Bioregion verses the South Coast bioregion). Vegetation type-conversion here is of far less concern given the observed recovery of these ecosystems post-fire. Northern shrublands also do not necessarily require a reduction in fire on the landscape as the southern ecosystems do (Safford and Van de Water, 2014), and do not have the high number of human-caused fires. For these reasons, an ecological rationale for fuel treatments in shrub dominated and co-dominated ecosystems in northern California can be used.

COASTAL SAGE SCRUB TYPES

Coastal sage scrub (CSS) is a general term to describe shrub vegetation that is generally of lower stature (but with exceptions – such as sumac *Malosma laurina*) and with a much higher occurrence of facultatively drought deciduous species, for example *Salvia* spp., California buckwheat *Eriogonum fasciculatum*, and California sagebrush *Artemisia californica*. Further north, Coyote Brush *Baccharis pilularis* is a common species that fits within CSS in the broad sense. In general, the response of coastal sage scrub is similar to that of other chaparral in that burned CSS will quickly recover after fire undergoing the same kind of so-called “auto successional” process (Hanes, 1971) in which species present before a fire are predominately the species present after the fire. This species composition is because of re-sprouting and germination from a seed bank. Unlike most evergreen chaparral species, however, many of the non-evergreens are capable of expanding and rejuvenating their populations without fire. Seedlings will germinate and, when vegetation openings are present, can survive to maturity. This same ability makes CSS species more invasive than most other chaparral species. This process has blurred the patterns of distribution of CSS from its historical range. For example, disturbed roadsides through chaparral landscapes will often be dominated by, e.g. *Eriogonum fasciculatum* and other opportunistic species.

The prescription and cautions applying to chaparral mostly also apply to CSS. Like chaparral, CSS does not “require” frequent fire to remain “healthy.” In fact, in the Van de Water and Safford (2011) paper CSS is assigned a median fire return of 100 years, about double the fire return interval of chaparral. Thus the cautions about prescribed burning apply equally to CSS.

SAGEBRUSH STEPPE AND RELATED TYPES

Sagebrush dominated vegetation occurs in mountain valleys and in the northeast portion of California within the Great Basin biotic province. Van de Water and Safford

(2011) report median fire return intervals in the 30 and 40 year cycles. Despite the relatively short return intervals, sagebrush vegetation is not as clearly fire adapted as the vigorously sprouting and reseeding chaparral species. Current published literature is not clear if fire used as a management tool actually benefits sagebrush systems. This leads to a general recommendation to avoid imposing burning treatments unless there are compelling reasons. One of these reasons may exist where sagebrush forms an understory in some forest types where low severity fire regimes are known to exist.

4.2.2 EFFECTS

This section analyzes the potential impacts of implementing the proposed project or alternatives to wildlife, aquatic species, and vegetation resources as well as invasive species.

4.2.2.1 Significance and Threshold Criteria

Based on the CEQA Guidelines and mandatory findings of significance and other applicable wildlife protection laws, a project would have a significant impact on wildlife, aquatic species, and vegetation and in relation to invasive species if it would:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by CDFW or USFWS
- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by CDFW or USFWS
- Have a substantial adverse effect on federally protected wetlands, as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool coastal, etc.), through direct removal, filling, hydrological interruption, or other means
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites
- Conflict with any County, City, or local adopted policies, ordinances or General Plan protecting biological resources, such as a tree preservation policy or ordinance
- Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional or state habitat conservation plan

Under the Federal Endangered Species Act, activities may not result in the take, direct or indirect, of a special status species. Direct take involves the killing of a special status plant or animal. Indirect take includes the alteration of habitat, harassment, and any other activity that may contribute to the reduction in numbers of a special status species. Only indirect take, due to alteration of habitat by invasive non-native species, is applicable to activities affecting special status species under the Proposed Program or the Alternatives.

For the purpose of this Program EIR, the following thresholds are used to determine whether there is a significant effect to botanical, wildlife, aquatic and invasive species or resources as a result of implementation of treatments under the Program or any of the Alternatives. A significant effect occurs when there is a:

a) Threat to eliminate a plant community.
b) Violation of any state or federal wildlife protection law.
c) Contribution either directly (through immediate mortality) or indirectly (through reduced productivity, survivorship, genetic diversity, or environmental carrying capacity) to a substantial, long-term reduction in the viability of any native species or subspecies at the state level.
d) Adverse effect, either directly or through habitat modification, on any species identified as a special status species in local or regional plans, policies, or regulations, or by CDFW or USFWS.
e) Net effect in a local project area was a substantial increase in the population of invasive species AND this occurred on over 10 percent of a WHR lifeform in a bioregion.
f) Creation of a public nuisance.

4.2.2.2 **Data, Assumptions, and Approach to Bioregional Analysis**

Implementation of the proposed program may result in impacts to vegetative communities, wildlife habitat, aquatic habitat, and invasive species. CNDDB is a system designed to enable the management, visualization, and analysis of biogeographic data collected by CDFW and its Partner Organizations. In addition, CNDDB facilitates the sharing of those data within the CNDDB community. CNDDB integrates GIS, relational database management, and ESRI's ArcIMS technology to create a statewide, integrated information management tool that can be used on any computer with access to the Internet (https://www.wildlife.ca.gov/).

VEGETATION

Impacts to botanical resources were analyzed by examining special status plants and communities listed in the California Natural Diversity Database (CNDDB) database for each bioregion. SPR BIO-2 requires VTP applicants to use the most appropriate databases for biological information, including but not limited to CNDDB, CWHR or BIOS, to check for occurrences of special status plants in their project area and provide this scoping information to the wildlife agencies.

The Natural Resources Agency and CDFW have developed guidelines for assessing the effects of proposed projects on rare, threatened, or endangered plants and natural communities entitled “Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities” (DFG, 2009). The California Native Plant Society has also developed botanical survey guidelines – “CNPS Botanical Survey Guidelines” (CNPS, 2001).

These measures as explained above are designed to reduce the potential impacts to vegetation to less than significant.

WILDLIFE

Effects of fuel reduction on wildlife depend on the specific ecological requirements of individual species and thus are difficult to generalize, especially in a treatment area as large and complex as that considered here. Furthermore, responses of wildlife to fuel reduction treatments have not been studied extensively and information on many taxonomic groups are lacking. Direct and indirect effects on wildlife are likely to differ. As a rule, negative effects will be greatest on species dependent on the fuels being removed, while positive effects will be greatest on species that have evolved in fire-dependent and other disturbance-prone ecosystems.

Effects of a given treatment will be influenced greatly by characteristics of adjacent parcels. An isolated patch of habitat will take much longer to recover from treatment than one surrounded by similar habitat. Treatments occurring near similar habitat will likely have less impact on wildlife, as the surrounding habitat will provide displaced animals somewhere to flee and facilitate their return to the treated area post-project as conditions become suitable.

To address potential direct and indirect effects of the VTP on wildlife in an ecologically meaningful way, species have been represented by four broad guilds (subterranean (soil invertebrates, burrowing mammals, etc.), ground-dwelling (terrestrial invertebrates, reptiles and amphibians, including partially aquatic forms, and mammals), shrub-dwelling (shrub-nesting birds, etc.), and arboreal (arboreal invertebrates, cavity and tree nesting birds and mammals, etc.) based on how they typically use the vertical environment. Shaffer and Laudenslayer (2006) used similar guilds in addressing effects of fire on animals, but they considered shrub-dwelling species as a subset of arboreal fauna. Since many of the treatments considered here specifically target either scrub habitats or the shrub layer in wooded habitats, we have elevated shrub species to their own guild. We feel such an approach is preferable to addressing broad taxonomic guilds wherein species occupy the full range of available vertical strata because fuel reduction treatments in structurally complex habitats are typically layer-specific. Species are assigned to a single guild based on their primary or most critical (for instance, breeding or over-wintering) use area.

Prescribed fire will be the most common treatment type used to reduce fuels under the Proposed Program and thus, will have the most-wide-ranging effects on wildlife throughout the treatment area. Because nearly all of California's vegetation types are fire-adapted (Sugihara et al., 2006), restoring fire to these communities should be mostly beneficial to wildlife so long as consideration is given to the natural fire regime on the landscape (Huff et al., 2005). Furthermore, prescribed fire treatments are typically low-intensity and patchy, resembling natural fire conditions more than the stand-replacement fires that often occur as a result of fire suppression. However, temporal and spatial effects as well as the short- and long-term effects that fire will have on the animals residing within these landscapes need to be considered (Shaffer and Laudenslayer 2006).

Mechanical treatments typically are applied on a scale smaller than that of prescribed fire treatments, comparable to that of most biological treatments (browsing and grazing), and larger than that of manual treatments.

Although all the acreage available for treatment under the VTP is suitable for manual treatment, it is labor-intensive and time-consuming; thus expensive and therefore expected to be implemented primarily in relatively small areas where other treatments are unfeasible. Given the relatively low impact of this treatment type and limited extent to which it is likely to be implemented, its cumulative impact on wildlife is expected to be extremely low. However, certain mitigation measures are still appropriate to minimize or avoid potential impacts.

Herbivory treatments also could be used in every VTP project. Their negative impact on wildlife is expected to be small, assuming that effects can be contained within intended treatment areas (that is, that livestock are confined and do not spread invasive plants). Managed livestock grazing can increase the productivity of selected species, increase the nutritive quality of the forage, and increase habitat diversity (Vavra 2005).

While each of the various treatment types proposed in this program come with potential negative direct and/or indirect effects on wildlife, one must weigh these effects against the known effects on wildlife from catastrophic high severity wildfire; which in most cases in California is the inevitable eventual consequence of lack of fuel reduction coupled with fire suppression. In general, direct wildlife mortality due to fire is low since most animals are able to escape or take shelter (Lawrence 1966, Smith 2000) however stand-replacement can displace many animals, often over a huge area (greatly exceeding the area proposed for any VTP project), and set habitat succession back. Negative effects on wildlife of any well planned, implemented, and monitored VTP project are likely to be minor in comparison, highlighting the need to perform more managed fuel reduction activities.

Over 600 special status wildlife taxa occur in California, and over 300 occur in habitats likely to be treated under the VTP. In accordance with SPR’s BIO-2, BIO-3, and BIO-4 a CNDDB query will need to be conducted at the project level and potential impacts to special status taxa evaluated during the environmental review and completion of the environmental checklist.

For the purpose of this bioregional analysis, adverse effects were considered to be significant if they would affect taxa that are listed as either threatened or endangered at the federal or state level.

In order to analyze the potential effects of implementing the Program or Alternatives it was necessary to consider the types of treatments proposed, the extent of those treatments and the SPR’s and PSR’s included in the VTP that are designed to mitigate potential impacts to wildlife species (Section 2.6).

Impacts to wildlife species as a result of the proposed project will be mitigated with the implementation of SPR’s and PSR’s. This will reduce the potential impacts to wildlife to less than significant.

AQUATIC

The average annual acreage proposed for treatment within the VTP in the first decade is 60,000 acres (0.2 percent of the total acreage of SRA in California). This means that there will be very few projects spread over many acres, and the probability of numerous projects occurring in a single watershed is very low, even over 10 years. The treatment types, proportions by bioregion and percent of watersheds in varying disturbance classes are listed in Chapter 2 for the Program and Alternatives.

The aquatic species most likely to be affected by VTP projects include 34 species or distinct populations of fish and 12 species or distinct populations of amphibians listed as Endangered or Threatened at the state or federal level (CDFW, 2012). Most species have evolved with disturbances of varying types and magnitudes, including fire, and are able to recover from them (Thode et al., 2006). All of the listed aquatic species are sensitive to changes in water quality in respect to biologic resources, though their individual and population-level resilience differs between species. Temperature, sediment and peak flows are the primary water quality parameters affecting aquatic species that could be altered by VTP treatments. In addition to these changes in water quality characteristics, physical changes to riparian vegetation and in-stream habitat may also affect aquatic communities (Thode et al., 2006). The underlying assumption in the following analysis is that if changes to water quality, riparian habitat and in-stream physical habitat are not significant then adverse impacts to aquatic species are unlikely.

Direct impacts to aquatic species that occur within saline and fresh emergent wetlands, lacustrine, riverine, and estuarine habitat types are unlikely because these habitat types are excluded from treatment. Riparian and upland vegetation types adjacent to these excluded vegetation types may be treated and indirect effects are possible.

In order to analyze the potential effects of implementing the Program or Alternatives it was necessary to consider the types of treatments proposed, the extent of those treatments and Standard Program Requirements (SPR's) BIO-10, BIO-11, BIO-12, HYD-1, HYD-2, HYD-3, HYD-4, HYD-5 HYD-6, HYD-7, HYD-8, HYD-9, HYD-10, HYD-11, HYD-12, HYD-13, HYD-14, HYD-15, HYD-16, & HYD-17 included in the VTP that are designed to moderate potential impacts to water quality.

INVASIVE SPECIES

The impacts from non-native invasive species are analyzed by changes in the structure and composition of these populations in relation to vegetation in the dominant natural plant community types. The effects of VTP projects can be analyzed as long as they are distinguishable from presumed changes in the pre-existing plant community composition without any VTP projects. The additive effects of past actions (such as wildfire suppression, timber harvest, mining, nonnative plant introductions, and ranching) have shaped the present landscape and corresponding populations of special status and invasive species.

For purposes of this analysis, beneficial effects are those where invasive non-native plants are either eradicated or their abundance and diversity are significantly reduced in relationship to native species. A significant beneficial impact would be a major reduction of invasive non-native plant populations sufficient to enable the natural plant community to dominate treated areas within the short-term (2-5 years).

Adverse effects are those where invasive non-native plants are able to either successfully invade or reinvade treatment areas and establish viable populations, either because the treatments prepared hospitable site conditions or left viable populations of invasive non-native plants intact and able to increase in extent. A significant adverse impact would be a major increase in population sufficient to enable invasive non-native plants to dominate the natural plant community within the short-term (2-5 years).

PSR's identified during project development and SPR's BIO-8 & BIO-9 (described at the end of this sub chapter) will reduce the potential impact from invasive species resulting from the implementation of projects to less than significant. These include watercourse buffer zones, protection of special status plants & plant populations through CDFW consultation, utilization of an integrated pest management approach, and utilization of only weed free straw and mulch.

4.2.2.3 Direct Effects Common to all Bioregions from Implementing the Program/Alternatives

Implementation of the proposed program will impact vegetative community's wildlife habitats aquatic habitats and invasive species in similar ways throughout the state. Discussion of those impacts common to all bioregions follows.

VEGETATION

Plant communities to be treated under the VTP have been subject to fire for centuries. It has been the primary disturbance regime in most California ecosystems, and many plant species have evolved in the presence of recurrent fires. As a result, many plant species reproduce most successfully following fire, which makes their continued success and abundance dependent on fire. To the extent that VTP treatments mimic the natural disturbance patterns of the vegetation type to which they are applied, it is reasonable to expect the long-term impacts of treatments to be beneficial. However, at the individual project level, there is always the possibility of harming or damaging individuals of a species during treatment implementation. In many cases, the treatments in non-forested vegetation types will return all or a portion of the treated area to an early successional stage, killing off disturbance intolerant species, and freeing up resources such as light and nutrients for early successional species, such as perennial grasses and forbs (USDI BLM, 2005).

In order to avoid direct take of individual special status plant taxa, SPR's BIO-3 and BIO-4 will apply to each project ensuring that a DFW biologist, USFWS, or a qualified biologist will be required to review and propose measures that will mitigate to a level less than significant and avoid take, and the measures will be incorporated into the project design. At the program scale the question for this EIR is whether or not the habitats of common natural communities and special status plants and communities are negatively impacted over the long-term. This can be determined by first analyzing the direct effects of the treatments from an individual project and then by expanding these effects to the bioregional scale to determine the proportion of the habitat types to be affected per decade. In order for an effect to be considered significant at the bioregional level, the species in question would have to be impacted enough to meet one of Significance Criteria stated above. The amount of habitat that would have to be adversely modified to cause a substantial adverse effect has not been scientifically determined for most species and is likely unknowable until the threshold has been crossed and the species is in jeopardy.

WILDLIFE

Direct effects are those of the treatment procedure itself (i.e., during and shortly after treatment) as opposed to those that are a function of the desired fuel condition. Direct effects to special status wildlife taxa due to fuel reduction treatments are inherently adverse and will not vary much between bioregions. Some potential exists for substantial adverse effects, however implementation of SPR's ADM-1 and ADM-2 which require that prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using SPR's and for all protected resources be flagged, painted or otherwise marked. Additional protection is implement through BIO-1 - BIO-7 which requires that projects shall be designed to avoid significant effects and avoid take of special status species. The project coordinator shall run a nine-quad search or larger search area and write a summary of all special status species identified in the biological scoping. A CAL FIRE Environmental Coordinator will analyze impacts to CNDDB species and submit the summary and preliminary report for consultation. The vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties shall adhere to special requirements. In shrublands containing native oaks, treatments may incorporate retention of older, acorn producing oaks and establish buffers around any special status animal, nest site, den location, or plant within the project area will reduce the potential for impacts to wildlife.

Direct effects are highly dependent on a treatment method and will have the most adverse effect on species with limited mobility and those that are disturbance intolerant. The direct effects discussed should be compared with the direct effects to wildlife that would result from catastrophic wildfire likely to occur in the absence of treatment.

AQUATIC

VTP treatments have the potential to affect aquatic species via impacts to water quality, quantity, and modification of aquatic habitats directly and indirectly. Treatments may have adverse effects on aquatic species, including: riparian function, headwater stream ecosystems, headwater habitat relationships, sources and recruitment methods for large woody debris (LWD), detritus (e.g. leaf litter) production, stream bank stability, sediment control and transport, stream shading, and microclimate at a local level. However direct impacts to aquatic species that occur within saline and fresh emergent wetlands, lacustrine, riverine, and estuarine habitat types by causing elevated stream temperatures, increased sediment loads, fecal coliform contamination, or elevated peak flows are unlikely because these habitat types are excluded from treatment. Riparian and upland vegetation types adjacent to these excluded vegetation types may be treated and indirect effects are possible. However, implementation of PSR's and SPR's would limit the extent of these impacts and would ensure that impacts would remain at the less-than-significant level. Specifically, BIO-10 requires that if water drafting becomes a necessary component of the proposed project, drafting sites shall be planned to avoid adverse effects to special status aquatic species and associated habitat, in-stream flows, and depletion of pool habitat. Screening devices shall be used for water drafting pumps, and pumps with low entry velocity shall be used to minimize removal of aquatic species, including juvenile fish, amphibian egg masses and tadpoles, from aquatic habitats. In addition, BIO-11 requires that aquatic habitats and species shall be protected through the use of watercourse and lake protection zones, as described in California Forest Practice Regulations (14 CCR) (WLPZ's) and other operational restrictions. Please see HYD-3 for these standard protection measures. Finally, BIO-12 requires that if a watercourse crossing is necessary, a CDFW Streambed Alteration Agreement shall be obtained and any BMPs identified in the agreement shall be incorporated into the project. Implementation of the SPRs will reduce the potential for impacts to aquatic species.

INVASIVE SPECIES

Invasive non-native plant species can be threats to natural habitats in California. Many of these species colonize habitats following ground disturbance when seeds are introduced from regions where these species are common, from the disturbance of legacy seeds in the soil, and from adjacent areas where colonization has already occurred. The introduction of invasive non-native species into natural habitats is considered a potentially significant impact.

Most notably, invasions have altered fuels, and therefore fire regimes, in many ecosystems. Grasslands previously characterized by frequent surface fires have been converted to shrublands and woodlands as fire suppression has facilitated establishment of native woody plants. Simultaneous alterations in fuel have decreased fire frequencies in former grasslands, and have contributed to high-intensity crown fires in some woodlands (McPherson, 2002). Fire can also facilitate non-native plant invasion by reducing competition from native species and increasing the availability of soil nutrients.

Invasive plant species occur predominantly in plant communities subject to periodic natural disturbance such as stream channels, in areas adjacent to development (e.g. coastal bluffs, coastal terrace, valley bottoms), and in areas where native species cover and natural regeneration has been displaced, thereby providing an opening for non-native species invasions (USDI National Park Service, 2003). This situation can occur as a result of some VTP projects, particularly prescribed burning and associated fire lines. An unintended consequence of extensive fuel break construction and maintenance may be the establishment of non-native plant species.

Although there is some variability in numbers and types of invasive plants between bioregions, all bioregions contain non-native plants with the potential to act as seed sources for the spread of invasive species.

Disturbance is considered one of the primary factors promoting non-native invasion (Rejmanek, 1989; Hobbs and Huenneke, 1992), and a number of studies have documented an association of non-native plant species with disturbed areas similar to fuel breaks, such as logging sites, roads, trails, and pipeline corridors (D'Antonio et al. 1999).

In many cases, non-native species are well adapted to fire and can invade fire-prone ecosystems, particularly when natural fire regimes have been altered through fire suppression, increased human-caused ignitions, or by feedback effects from changes in plant species composition (D'Antonio and Vitousek, 1992; Brooks et al., 2004). Merriam et al. (2006) conducted a study of plant species composition on fuel breaks in a variety of habitats around California. They found that non-native plants were present in 49 percent of the study plots, but differed significantly between vegetation types. Fuel breaks in coastal scrub habitats had the highest relative non-native cover (68.3% +/- 4.0%), followed by chaparral (39.0% +/- 2.4%), oak woodland (25.0% +/- 2.5), and coniferous forests (4.0% +/- 1.1%) (Merriam et al., 2006).

Other relevant conclusions of their study are that non-natives become increasingly dominant over time and may thrive on fuel breaks because they can more easily tolerate frequent disturbances caused by fuel break maintenance. Fuel breaks may act as points of introduction for non-natives because they receive external inputs of nonnative seeds through vehicles, equipment, or humans traveling on them (Schmidt, 1989; Lonsdale and Lane; 1994). Equipment may disperse the seeds of non-native plants into fuel breaks during construction and maintenance. The establishment of invasive plants within fuel treatments is a serious concern because many treated areas extend into remote, pristine wildland areas. If invasive species can establish a seed source in fuel breaks, adjacent wildland areas might become more susceptible to widespread invasion, particularly following widespread disturbances such as natural or prescribed fires (Merriam et al., 2006).

Implementation of BIO-8 which requires that only certified weed-free straw and mulch be used if needed to prevent the inadvertent introduction of invasive species, and BIO-9 which requires that the project coordinator determine if there is a significant risk of introducing invasive plants and if so develop specific mitigation measures using principles outlined in the document “Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition” or other relevant documents) would result in less-than-significant impacts related to the potential for introduction of invasive plants. Specific examples of these practices include Planning BMPs, Project Materials BMPs, Travel BMPs, as well as Tool, Equipment and Vehicle Cleaning BMPs. Waste Disposal BMPs and Soil Disturbance BMPs.

4.2.2.3.1 Prescribed Fire Activities

VEGETATION

Fire suppression activities can also have a detrimental effect on ecological processes such as soil compaction and erosion, water sedimentation, chemical pollution, biodiversity and the introduction of invasive species (FRAP, 2010). As a result, pre-planning with strategic fuel treatments could reduce the potential detrimental impacts from suppression activities.

All of the common natural communities that might be treated under the proposed VTP have evolved under some degree of natural or human-induced fire. The Proposed Program will reintroduce fire into communities where fire has been excluded through past suppression or control efforts. Generally, prescribed fire is believed to benefit the overall health of fire adapted ecosystems (McKelvey et al. 1996). The reintroduction of a simulated natural fire regime will help maintain structural and species diversity, benefiting the overall habitat value of the community for plants and wildlife. When conducted at the appropriate time, prescribed fire can open up densely vegetated areas, encourage growth of suppressed species, contribute to nutrient cycling, increase species diversity, and increase the diversity of the vegetation’s age structure.

The following list includes some adaptations to fire and examples of native California species that exhibit these adaptations (adapted from Biswell, 1989):

- Thick, platy bark—ponderosa pine
- Corky bark, which is a poor conductor of heat energy—Douglas-fir and white-fir
- Epicormic branching (i.e., trunk and stem sprouts)—coast redwood and many oaks
- Basal sprouting—oaks
- Serotinous cones, which drop seeds only when heated sufficiently—knobcone pine, Monterey pine, and some cypresses
- Stump sprouting after fire—chamise and some manzanitas
- New shoots from underground rhizomes—yerba santa
- Seeds that can remain dormant for many years until heat of fire enables them to germinate—species of manzanita, flannelbush, and ceanothus
- Location of growing points at or below ground level—some perennial grasses
- Sprouting from buried corms or bulbs—some perennial members of the lily and onion families

The responses of plants to fire can be divided into two broad categories – stimulated by fire or not stimulated by fire. "Fire-stimulated plants are further divided into fire-dependent and fire-enhanced categories, while plants not stimulated by fire are either fire-neutral or fire-inhibited. Fire dependent responses occur only with fire, such as seed germination requiring heat, smoke, or chemicals from charcoal. Fire-enhanced responses (e.g. sprouting) are those that are increased by fire but that also occur from other types of damage to the plant (Sugihara et al., 2006).

Prescribed fires can be designed and implemented to leave bare mineral soil that is favorable to seedling establishment of fire-stimulated plants, however they generally do not, especially when they are light underburns or in areas where there is a substantial duff component. Although mortality of some individual plants will occur, most woody plants and species with adaptations to fire will persist through prescribed fire activities that simulate the natural fire regime. The overall vegetative characteristic of the plant community will be maintained.

Prescribed fire activities that do not mimic the natural regime may adversely affect the reproductive capability or viability of a natural community. The response of a plant community to fire is determined by the fire-response categories of its constituent plant species. The season of the burn can affect plants at a sensitive stage of development and may reduce seed production and recruitment that year. For example, each plant species in a community responds differently to the seasonal timing of prescribed burns or wildfires. Chamise (Adenostema fasciculatum) and red shank (Adenostema sparsifolium) are two shrub species commonly found in chaparral communities and they have different patterns of growth, flowering, and fruiting. This leads to early spring fires causing greater mortality in chamise than red shank and a potential shift in the species composition of that community (Sugihara et al., 2006).

The spatial pattern of the burn or other activities also affects the plant population response. Patterns of intensity and severity range from variable and complex to continuous and uniform. “At one extreme, a fire with uniform intensity will have uniform effects, either positive or negative, on the survival, age-class distribution, abundance, and distribution of individuals in a population. At the other extreme, a complex fire, with variable intensity, will have varied effects on a plant population within the area burned. Crown fires tend to be more uniform, whereas surface fires more complex” (Sugihara et al., 2006).

In addition, the existing distribution of individuals of a species – endemic, patchy, or continuous – greatly affects how the plant population responds to an individual fire event. Even fire neutral and fire-inhibited species can fare well if their distribution is continuous. This is particularly true if the spatial pattern of the burn is variable and complex as is more typical in an understory burn than a crown fire (Sugihara et al., 2006).

Burn intensity is also an important factor in how a plant community responds to fire. “High-Intensity fires can often lead to plant communities with lower diversity and increased dominance of a few species” (Sugihara et al., 2006). This occurs by favoring species, which are fire-stimulated in reproduction and establishment, such as chamise. Under the program, these effects would only be expected under prescribed fire in the herbaceous and shrub types where burn intensity is similar to a wildfire.

Large burns have a greater chance of negatively affecting a plant population than small burns due to the potential of large burns to interrupt seed dispersal mechanisms (Sugihara et al., 2006). This fact makes wildfires have potentially much greater impact on plant populations than prescribed burns. Over the past eight years 97.6 percent of the total acreage burned in wildfires was the result of fires greater than 300 acres. On the other hand, the average VTP project size of 260 acres is small in comparison to most wildfires, which often exceed 10,000 acres. Therefore VTP projects are unlikely to eliminate a sub-population, of even a fire-inhibited species, and prevent re-colonization of the area.

A change in the fire frequency in a community through either fire suppression or prescribed burning may change the species composition, spatial structure, nutrient cycling, and canopy structure of the community. For example, fire suppression in the 20th century has affected the ecological processes, spatial patterns, and species composition in some communities (Skinner and Chang, 1996). In some cases, fire-inhibited species such as white fir (Abies concolor) are now dominant trees in forest stands that were historically dominated by fire-tolerant species such as ponderosa pine (Pinus ponderosa). This has significantly altered the spatial structure of these forests from a canopy of large trees with an open understory into dense thickets of young growth occupying the understory.

The changes in vegetative and ground cover from prescribed burning in surface/mixed fire regime habitat types are expected to be less than the impacts in habitats with a crown fire regime. Habitats with more than one canopy layer generally experience less intense fires than chaparral and grassland communities. In general, vegetation types with multiple canopy layers and vertical diversity, such as conifer and hardwood forests, are adapted to a high frequency/low intensity surface/mixed fire regime, and vegetation treatments tend to mimic this effect by focusing on understory treatments. Prescribed burning in the understory is generally low intensity with a patchy distribution making it very unlikely to have a significant long-term impact on even small populations of common plants or special status plants and communities.

On the other hand, grasslands and chaparral are adapted to a low frequency/high intensity crown fire regime. Many chaparral species germinate much better after stimulated by fire such as sugar bush (Rhus ovata), sumac (Malosma laurina), chamise, manzanita (Arctostaphylos spp), yerba santa (Eriodictyon spp.), and ceanothus (Ceanothus spp.) (CAL FIRE, 1981). “In general, there is a high proportion of species with fire-stimulated and fire-dependent germination (e.g., desert ceanothus) and species with strong fire response sprouting (e.g. chamise) in plant communities and bioregions with shrub crown fire regimes, such as chaparral in the Central Coast and South Coast bioregions” (Sugihara et al., 2006). In these types VTP prescribed burning activities have similar intensity and pattern as the natural fire regime, but they may be implemented more frequently than the plant community is naturally adapted to. One of the most significant areas of concern at the state-wide program level is the potential effect of burning too often in the chaparral habitat type. The non-sprouting species may be eliminated from a stand by fires occurring at such short intervals that the seedlings germinating after the first fire do not have time to produce a crop of seed before the next fire (CAL FIRE, 1981).

The conventional wisdom used to be that chaparral types naturally burned every 10-15 years, and under the CMP it has been common to reburn chaparral types to maintain grazing lands at least this frequently. However, research published in the last 10 years indicates that the natural fire return interval in most chaparral types is much longer than previously thought. Historical records suggest a pre-suppression model of burning in chaparral landscapes of many modest-sized summer lightning-ignited fires that burned a relatively small portion of the landscape, punctuated one to two times a century by massive autumn Santa Ana wind-driven fires (Syphard et al, 2006). This is also supported by the historical record of infrequent and large Santa Ana fires as well as the life history characteristics of many dominant woody species in chaparral that are favored by long fire-free intervals and inhibited by fire return intervals of a decade or less (Keeley, 2006).

Wildfires have resulted in vegetation type conversions where aggressive, exotics, and/or non-native invasive species were present prior to the fire and dominated the site after fire. Sagebrush (Artemisia spp.), low sage (Artemisia arbuscula), bitterbrush (Purshia tridentata), juniper (Juniperus spp.), and pinyon-juniper vegetation types are particularly susceptible to type conversion if cheatgrass or medusa-head are well established in them. Type conversion is most likely when a high severity fire completely consumes the existing dominant vegetation (Billings, 1994; Peters and Bunting, 1994; Rasmussen, 1994). The aggressive nature of cheatgrass and medusa-head puts the native shrubs and trees at a competitive disadvantage, preventing them from successfully reestablishing (Billings, 1994; Monsen, 1994). Because of the widespread occurrence of cheatgrass in these community types, the potential exists for accidental type conversion. However, implementation of SPR’s BIO-8 and BIO-9 which requires that only certified weed-free straw and mulch be used, and for the project coordinator to determine whether there is a significant risk of introducing invasive species, and if so develop mitigation measures using principles outlined in the California Invasive Plant Council’s “Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition)” (2012)(see Appendix B), or other relevant documents will reduce the potential for prescribed fire to cause type conversion to less than significant.

In summary, habitat types within the treatment area of the VTP and the plants within them generally are adapted to some pattern of wildfires. The main difference between wildfire and prescribed fire is the ability to control important parameters of the burn including the season, the size, the fire intensity, and the frequency. The potential for substantial adverse effects from prescribed fire are most likely to occur in the conifer woodland, hardwood woodland, herbaceous, and shrub habitat types due to problems with invasive species, impacts to regeneration, burn intensity, canopy removal and burn frequency. PSR’s identified during project development as well as SPR’s BIO-8 & BIO-9, as explained above and listed at the end of this sub-chapter, are designed to reduce the potential impacts to vegetation to less than significant. The small proportion of the plant communities being treated under the VTP makes any long-term effects to the plant communities and special status plant taxa highly unlikely.

OAK WOODLANDS

Plant responses to fire vary greatly and are often determined by a complex interaction among external factors such as temperature, soil moisture, and heat duration, intensity of burn, and season of burn (Chang, 1996). For the first few years after a wildland fire, vegetation is comprised of individuals from the following categories (Ansley et al, 2000):

- Plants that survived the fire with their form intact
- Sprouts or suckers that grew from the base or buried parts of top-killed plants
- Plants that established from seed, which can be further subdivided into:
    - Plants that re-established from seed dispersed from surviving plants (usually trees)
    - Plants that re-established from seed dispersed from off of the burned site
    - Plants that re-established from fire-stimulated seed within the soil seed bank
    - Plants that re-establish from seed that developed on plants that sprouted after the fire.

Oak trees primarily sprout from the base of top killed trees, making them resilient after fires. Most seedlings and many saplings, but very few mature oaks, are top killed by fire. However there is variability among species as described below.

Prescribed fire in oak and hardwood woodlands can result in eventual mortality from fire-induced cavities through which rot can enter that can spread quickly along hardwood stems and lead to breakage (Ansley et al, 2000). Fires are exceptionally damaging to live oak stands, because most species in these stands are susceptible to fire damage. In particular, canyon live oak, interior live oak (Q. wislizenii), sycamore (Platanus spp.), and cottonwood (Populus spp.) have fairly thin bark and are easily top killed by fire (Chang, 1996). However, live oaks are particularly vigorous re-sprouters compared to deciduous oaks, and will likely sprout back from their base even when the entire above ground portion has been killed (McCreary, 2004). In contrast to the live oaks, mature deciduous oaks (black oak, white oak, blue oak, valley oak, etc.) have thick fire resistant bark and are able to withstand low intensity burns (McCreary, 2004), but don’t sprout as vigorously as live oaks when killed.

Small blue oaks (and perhaps other species) are susceptible to top kill during prescribed fire conditions. Bartolome et al. (2002) observed 100 percent top kill of blue oak regeneration that was between 40 and 70 cm tall and less than 10 years old. No stimulatory response of regeneration was observed when comparing burned to unburned sites; that is, sprouts recovering from burning did not grow faster or more vigorously than sprouts that had not been burned as has been hypothesized by some. Bartolome et al. (2002) concluded that at the study site “for successful regeneration into the sapling stage, small plants must be protected from burning and browsing for ten or more years.”

Oak tree size (height and diameter) heavily influences the likelihood of surviving a fire, due to elevation of live foliage and bark thickness. Blue oak trees greater than 8 inches diameter at breast height (dbh) were observed to have 75-100 percent survival after wildfire, while trees 4-8 inches dbh had only 10-90 percent survival (Horney et al., 2002).

It should be noted that effects from wildfire or prescribed fire can create valuable wildlife habitat, such as cavities that can be used for denning and dead branches that provide foraging habitat for woodpeckers, etc. A small to moderate amount of damage to residual overstory trees can serve to increase rather than decrease the biological diversity within many vegetation types.

Prescribed fire in oak woodland rangelands is highly variable due to differences in oak bark thickness, tree structure, and sprouting response. Individual survival is also influenced by understory composition and the degree of fire intensity (Ansley et al, 2000). Blue oak acorn survival and germination can be negatively affected by fire; however, the positive association between blue oak ages and fire dates suggests a temporal concentration of post-fire sprouting. The low rate of recruitment since the 1940s may be partly due to fire suppression and grazing (Ansley et al, 2000).

In Northern Oak woodlands (Holland, 1986) prescribed fire is likely to kill young Douglas-fir regeneration, which retards conversion to mixed evergreen stands and is beneficial to persistence of oak woodland habitats (Barnhart et al., 1996). However, fire in oak woodlands is also likely to top kill most oak seedlings and saplings and retard oak regeneration by ten or more years, which is the time it will take oaks to resprout and grow to their pre-fire heights and diameters (Swiecki and Bernhardt, 2002).

Blue oak (Quercus douglasii), the most abundant hardwood forest type in California, has sapling populations that may be insufficient to maintain current stand densities (Bolsinger, 1988; Muick and Bartolome, 1987; Swiecki and Barnhart, 1999). Although many species of native California oaks are relatively fire resistant, either due to innate low fuel conditions or to vegetative adaptation, fire may not play as much of a role in regeneration as once thought, neither enabling nor preventing regeneration (Bartolome et al, 2002; Lang, 1988). However, frequent fires can compromise re-sprouting from saplings and seedling advance regeneration. According to Swiecki (1999), “A combination of frequent fires and annual livestock grazing would be a prescription for eliminating blue oak regeneration.”

SPR BIO-6 requires applicants to promote species diversity, retain older, acorn producing oaks to create deer forage and to improve wildlife habitat. In shrublands containing native oaks, BIO-8 requires that only certified weed-free straw and mulch shall be used if needed to mitigate project impacts. BIO-9 requires the project coordinator develop mitigation measures using principles outlined in the California Invasive Pest Council's "Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition)" (2012), or other relevant documents, if there is a significant risk of introducing invasive plants. When properly implemented, these SPRs should help reduce the impacts of prescribed fire to these vegetation types.

Prescribed fire in these types usually does not result in more than 20 percent canopy reduction in the overstory, and can often maintain or improve growth of remaining trees by reducing competition from understory trees and shrubs for scarce water resources. PSR's identified during project development as well as Implementation of SPR's BIO-6 which requires that in shrublands containing native oaks, treatments may incorporate retention of older, acorn producing oaks to create deer forage. CAL FIRE or applicants may plant other vegetation to promote species diversity and improve wildlife habitat, when such practices are not in conflict with program goals, BIO-8 which requires that In order to reduce the spread of new invasive plants species, only certified weed-free straw and mulch shall be used. During the planning phase BIO-9 requires that if the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures shall be developed using principles outlined in the document "Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers" (3rd edition or other relevant documents). Coordination of the mitigations will also include consultation with CDFW. This will reduce the impact to Oak Woodlands to less than significant.

WILDLIFE

In general, direct wildlife mortality due to fire is low because most animals are able to escape or take shelter (Lawrence, 1966; Smith, 2000). However, animals with limited mobility such as mollusks, salamanders, and the young of more mobile species may be impacted from fire. Because natural fires in California occur mostly in the late summer and fall, animals have adapted to this seasonal pattern by nesting and rearing their young during the spring and early summer. If seasonal activity patterns of these species are not taken into consideration and burning occurs during the spring or summer while immobile young are present, then wildlife mortality associated with burning may be high. Unfortunately, fires can get out of control during late summer and fall and so it is necessary to weigh the possibility of negative long-term effects to wildlife habitat and destruction of human development against the short-term effects of wildlife mortality.

Direct effects from disturbance may also have deleterious effects on wildlife within and adjacent to burn areas. For instance, wildlife may be disturbed by the presence of a large crew required to be on site during a prescribed burn in order to control it and keep it within the planned boundary. Additionally, noise from helicopters occasionally used to ignite fires or smoke drifting over a nest or den site may cause wildlife to leave the area. Control lines also may need to be established around the perimeter of the fire causing disturbances addressed above in the mechanical and manual activity sections. Of particular concern, though, are the short-term consequences of burning near special status taxa where disturbance may cause reproductive failure. In areas where other types of vegetation activities are successfully implemented,

Implementation of SPR's ADM-1, which requires that prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using standard project requirements (SPR's), ADM-2, which requires that all protected resources be flagged, painted or otherwise marked prior to the start of operations, BIO-1 which requires that projects shall be designed to avoid significant effects and avoid take of special status species, BIO-2 which requires that the project coordinator shall run a nine-quad search or larger search, BIO-3 which requires that the project coordinator shall write a summary of all special status species identified in the biological scoping including the CNDDB search with a preliminary analysis & BIO-4 which requires that the project coordinator shall ensure that a CAL FIRE Environmental Coordinator analyze impacts to CNDDB species and any PSR measures identified during project development will reduce impacts to special status species to less than significant. These requirements also relate to "habitat of significant value" and "environmentally sensitive habitat areas" as per CEQA and California Coastal Act, respectively.

AQUATIC

The use of backing prescribed fire within riparian zones is permitted within the Watercourse and Lake Protection Zone (WLPZ) using SPR HYD-3 which requires a watercourse and lake protection zone to be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current California Forest Practice Rules and fifty foot Equipment Limitation Zones (ELZ) to be established for Class III watercourses as well as HYD-4 which prohibits direct ignition of project activity fuels within the WLPZ or ELZ's. According to Rinne and Jacoby (2005) direct mortality of fish due to burning has only been documented in high severity fires that burned through small streams with high fuel loading. Similarly, Pilliod et al. (2003) noted that direct mortality of amphibians due to natural fire is rare due to timing and/or their ability to exploit refugia from fire. High severity fires resulting in mortality of aquatic species are very unlikely to occur under prescribed burning conditions. In fact, use of prescribed fire or other vegetation treatment techniques is intended to reduce the occurrence of high severity wildfires.

In one of the few studies of prescribed burning in riparian systems in the Western U.S., Beche et al. (2005) found that low to moderate intensity fire ignited in the riparian zone had “minimal effects on a small stream and its riparian zone during the first year post-fire.” Impacts from fire to riparian vegetation, LWD, fine sediment, water chemistry, periphyton and macro-invertebrates were considered. The study was conducted in the Western Sierra Nevada Mountain Range on the Blodgett Forest Research Station. There were no significant changes in in-stream macro-invertebrate communities after the prescribed fire, which is important because macro-invertebrates are often used as an index of biological health for other aquatic species (Beche et al., 2005). In a more recent, but still similar study conducted on the Payette National Forest in Idaho, Arkle and Pilliod (2010) concluded, “Despite steep topography, erosion-prone soils, and sampling directly within the burned area, we found no immediate (1–3 month) or delayed (3 years) effects of the prescribed fire on the biotic and abiotic characteristics of the study stream.”

It appears highly unlikely that prescribed fires used in VTP treatments in riparian areas and wet areas will burn hot enough to directly harm aquatic species that live within the water column. Implementation of PSR’s as well as SPR’s HYD-3 which requires that a WLPZ shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current CA Forest Practice Rules (Table 4.2-21). Fifty foot ELZ’s shall be established for Class III watercourses. Vegetation within the WLPZ or ELZ will not be disturbed by project activities, with the exception of backing prescribed fire. Class IV watercourse protections shall be PSR’s specified in the PSA, and designed in conjunction with any recommendations from RWQCB staff & HYD-4 which requires that no direct ignition shall be allowed within the WLPZ or ELZ’s. However, it is acceptable for a fire to enter or back into a WLPZ’s or ELZ’s will reduce the potential for impacts to aquatic species to less than significant.

INVASIVE SPECIES

Fire can be used to either control invasive species or to restore historical fire regimes. However, the decision to use fire as a management tool must consider the potential interrelationships between fire and invasive species. Historical fire regimes did not occur in the presence of many invasive plants that are currently widespread, and the use of fire may not be a feasible or appropriate management action if fire-tolerant invasive plants are present (Brooks and Pyke, 2001). The use of prescribed burning to reduce non-native plant populations can be complicated by the positive effect of fire on many invasive plants, and the subsequent effects of invasive pants on post-fire establishment by native species. In a series of controlled burns in Sequoia Kings Canyon National Park, Keeley et al. (2003) found that non-native plant species respond positively to fire in conifer forests, and this response is greater under higher intensity fires (D'Antonio et al., 2002). This would mean the effects from a cooler burning prescribed fire would be preferable to the effects from a wildfire of higher intensity.

Invasive alien grasses especially benefit from fire, and promote recurrent fire, in many cases to the point where native species cannot persist and native plant assemblages are converted to alien-invaded annual grasslands (Brooks & Pyke, 2001). The management of fire and invasive plants must be closely integrated for each to be managed effectively.

A recent thorough study of the relationship between fire and invasive species in California is in a chapter from "The Landscape Ecology of Fire" (Keeley et al., 2011). Essentially, it is much more complicated than previously understood. Some of the conclusions are worth including here:

- Fires are natural ecosystem processes on many landscapes. Perturbations to the fire regime, such as increased fire frequency and fire suppression, are the real "disturbances" to these systems and can lead to alien plant invasions.
- In forests, both too little fire and too much fire can enhance invasions. Restoration of historical fire regimes may not be the best way to balance these two risks.
- Repeated fires in shrub lands decrease fuel volumes, decrease fire intensity and increase alien plant invasion. Decreasing fire frequency may be the best means of reducing alien invasions.
- Prescription burning that targets noxious species in grasslands is often not sustainable unless coupled with restoration.

4.2.2.3.2 Manual Activities

VEGETATION

Treatment of common natural communities by hand clearing will directly affect these communities through the removal or disturbance of natural vegetation, resulting in reduced overall cover or greatly reduced understory with no impact to the canopy. Manual techniques can be used in many areas with minimal environmental impacts. Although they have limited value for weed control over a large area, manual techniques can be highly selective. Manual activities can be used in sensitive habitats such as riparian areas, areas where burning or herbicide application would not be appropriate, and areas that are inaccessible to ground vehicles (USDI BLM, 1991). Because of the expense of these activities, hand clearing will be used on a limited basis. Hand treatments in areas with special status plants and communities will be limited to small areas scattered throughout the state.

Because of the lack of heavy equipment and the greater control workers have in implementing hand treatments, there is little chance of adverse effects from these treatments as long as SPR's ADM-1 and ADM-2 are adhered to. ADM-1 requires the project coordinator to meet with the contractor to discuss all resources that must be protected using project specific requirements (PSR's). ADM-2 requires that all protected resources be flagged, painted or otherwise marked prior to the start of operations. PSR measures identified during project development as well as implementation of SPR's BIO-1 which requires that projects shall be designed to avoid significant effects and avoid take of special status species, BIO-2 which requires that the project coordinator shall run a nine-quad search or larger search area, BIO-3 which requires that the project coordinator shall write a summary of all special status species identified in the biological scoping, BIO-4 which requires that the project coordinator, shall ensure that a CAL FIRE Environmental Coordinator analyze impacts to CNDDB species, and shall submit the summary and preliminary analysis to the CDFW, USFWS, and [if applicable] NOAA Fisheries for consultation, would ensure that impacts to special status species would be less than significant. These requirements also relate to "habitat of significant value" and "environmentally sensitive habitat areas" as per CEQA and California Coastal Act, respectively.

OAK WOODLANDS

Impacts of hand treatments on forest and rangeland composition and structure are expected to be minimal, as most treatments are expected to selectively remove only non-oak species of understory shrubs, small trees, etc. As a result, impacts are expected to be positive because a decrease in competition for water and nutrients should improve forest and rangeland productivity. Hand treatments are expected to be especially beneficial to Northern Oak Woodlands by selectively removing Douglas-fir while retaining oak regeneration. PSR's identified during project development as well as Implementation of SPR's BIO-6, BIO-8, & BIO-9 will ensure that impacts to Oak Woodlands would be less than significant. BIO-6 requires that in shrublands containing native oaks, treatments may incorporate retention of older, acorn producing oaks to create deer forage. CAL FIRE or applicants may plant other vegetation to promote species diversity and improve wildlife habitat, when such practices are not in conflict with program goals. BIO-8: requires that in order to reduce the spread of invasive plants, only certified weed-free straw and mulch shall be used if needed to mitigate project impacts. BIO-9: requires that if the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures shall be developed using principles outlined in the document “Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition” or other relevant documents). Examples include Planning BMPs project Materials BMPs, Travel BMPs, Tool, Equipment and Vehicle Cleaning BMPs, Clothing, Boots and Gear Cleaning BMPs, Waste Disposal BMPs and Soil Disturbance BMPs. Coordination of the mitigations will also include consultation with CDFW.

WILDLIFE

Manual activities typically have a gentler immediate impact on the environment than either fire or mechanical treatments. There is very little potential for direct mortality of wildlife from this treatment type. However, there is still considerable potential for disturbance, especially when power tools are used (see Section 4.1.6.3). Workers implementing manual treatments may traverse and disturb sensitive habitats such as talus slopes, rock outcrops, and streambeds that are inaccessible to fire and machinery. However, implementation of SPR’s ADM-1, which requires that prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using standard project requirements (SPR’s) and ADM-2, which requires that all protected resources shall be flagged, painted or otherwise marked prior to the start of operations, as well as BIO-1 which requires that projects shall be designed to avoid significant effects and avoid take of special status species, BIO-2 which requires that the project coordinator shall run a nine-quad search or larger search area, BIO-3 which requires that the project coordinator shall write a summary of all special status species identified in the biological scoping including the CNDDB search with a preliminary analysis, identifying which species would be affected by the proposed project & BIO-4 which requires that the project coordinator, shall ensure that a CAL FIRE Environmental Coordinator analyze impacts to CNDDB species, and shall submit the summary and preliminary analysis to the CDFW, USFWS, and [if applicable] NOAA Fisheries for consultation and any PSR measures identified during project development will reduce impacts to special status species to less than significant. These requirements also relate to “habitat of significant value” and “environmentally sensitive habitat areas” as per CEQA and California Coastal Act, respectively.

AQUATIC

Manual treatments typically have a gentler immediate impact on the environment than either fire or mechanical treatments. There is very little potential for direct mortality of aquatic species from this treatment type. Workers implementing manual treatments may traverse and disturb sensitive habitats such as talus slopes, rock outcrops, and streambeds that are inaccessible to fire and machinery. However, implementation of SPR's ADM-1 which requires the project coordinator to meet with the contractor to discuss all resources that must be protected, ADM-2 which requires that all protected resources be flagged, painted or otherwise marked prior to the start of operations, along with HYD-4 which specifies that no direct ignition of project activity fuels is allowed within the WLPZ or ELZ's and HYD-8 which states that when possible, onsite native vegetative material (e.g. cut material) will be utilized for mulching bare soil, as well as any PSR's identified during project development will reduce impacts to aquatic species to less than significant.

INVASIVE SPECIES

In many cases, non-native species are well adapted to fire and can invade fire-prone ecosystems, particularly when natural fire regimes have been altered through fire suppression, increased human-caused ignitions, or by feedback effects from changes in plant species composition (D'Antonio and Vitousek, 1992; Brooks et al., 2004). Merriam et al. (2006) conducted a study of plant species composition on fuel breaks in a variety of habitats around California. They found that non-native plants were present in 49 percent of the study plots, but differed significantly between vegetation types. Fuel breaks in coastal scrub habitats had the highest relative non-native cover (68.3% +/- 4.0%), followed by chaparral (39.0% +/- 2.4%), oak woodland (25.0% +/- 2.5), and coniferous forests (4.0% +/- 1.1%).

Fuel breaks thinned with rubber-tired logging equipment and chainsaws had significantly lower relative non-native cover than fuel breaks constructed by either bulldozers or hand crews. It is apparent that bulldozers scraping off the duff layer and/or topsoil created conditions favorable to invasive species, but why non-native cover was higher in fuel breaks constructed by hand crews is not so clear. The study found that environmental variables significantly associated with non-native species presence and abundance, including overstory canopy, litter cover, and duff depth, were significantly lower on fuel breaks than in adjacent wildlands. These findings suggest that fuel break construction and maintenance strategies that retain some overstory canopy and ground cover may reduce the establishment and widespread invasion of non-native plants (Merriam et al., 2006). It also suggests that fuel break maintenance projects may need to include noxious weed eradication as an integral component.

Other relevant conclusions of their study are that non-natives become increasingly dominant over time and may thrive on fuel breaks because they can more easily tolerate frequent disturbances caused by fuel break maintenance. Fuel breaks may act as points of introduction for non-natives because they receive external inputs of nonnative seeds through vehicles, equipment, or humans traveling on them (Schmidt, 1989; Lonsdale and Lane, 1994). Equipment may disperse the seeds of non-native plants into fuel breaks during construction and maintenance. The establishment of alien plants within fuel treatments is a serious concern because many treated areas extend into remote, pristine wildland areas. If alien species can establish a seed source in fuel breaks, adjacent wildland areas might become more susceptible to widespread invasion, particularly following widespread disturbances such as natural or prescribed fires (Merriam, Keeley, and Beyers; 2006).

PSR's identified during project development and SPR's BIO-8 & BIO-9 as described at the end of this sub chapter will reduce the potential impact from invasive species resulting from the implementation of projects to less than significant. These include watercourse buffer zones, protection of special status plants & plant populations through CDFW consultation, utilization of an integrated pest management approach, and utilization of only weed free straw and mulch.

4.2.2.3.3 Mechanical Activities

VEGETATION

Mechanical activities involves the use of vehicles such as masticators, wheeled tractors, crawler-type tractors, or specially designed vehicles with attached implements designed to cut, uproot, or chop existing vegetation. The selection of a particular mechanical method is based upon access, equipment's availability, and characteristics of the vegetation, such as seedbed preparation and re-vegetation needs, topography and terrain, soil characteristics, and climatic conditions.

Treatment by mechanical clearing of common natural communities will directly affect these communities through the removal or disturbance of natural vegetation, resulting in reduced cover in some areas.

Mechanical activities will be applied to substantially fewer acres than will prescribed burns. In grasslands and shrub lands, the construction of shaded fuel breaks by disking, mowing, or mastication are examples of mechanical treatments. The majority of all vegetative cover would be removed when mechanically treating herbaceous or shrub habitat types, creating the potential for adverse effects to plant resources. The level of impacts will be proportional to the acres treated.

In areas of forested vegetation, mechanical fuel reduction will focus on removing ladder fuels formed by smaller trees and shrubs while maintaining large overstory trees. The reduction in ground level and mid-canopy vegetation may result in a change in species composition of groundcover where small trees (less than ten inches dbh) and shrubs make a substantial contribution to canopy cover. Treatments that leave substantial amounts of litter and slash on the ground can inhibit establishment and growth of many herbaceous species – especially those that are fire-stimulated but also add to the intensity and severity when wildfire does visit the next time. So the tradeoff is that litter and slash are problematic in fire prone areas.

Mastication treatments in particular sometimes generate heavy loadings of woody fuel on the ground, which may inhibit the germination and establishment of shrubs, but also reduces richness of native understory species. Mastication of surface and ladder fuels results in a short to medium term increase in fire severity potential. In a recent mastication effects study, fuel treatments where the masticated material was partially removed by incorporation into the soil or prescribed burning, resulted in greater understory species establishment, but also resulted in higher abundance of fire-stimulated shrubs (Kane et al., in press). If prescribed fire were planned to follow mastication, then the potential for colonization by exotic species would be high due to the more severe burn that would result (Bradley et al., 2006). Severe burns consume a much greater portion of the native vegetation increasing recovery time and creating opportunity for invasive species if they exist nearby. Research shows that time since fire is the most critical factor in alien invasion and colonization. Apparently, it is the closed canopy of pre-fire shrublands that reduces alien populations and thus limits the alien seed bank present at the time of fire (Bradley et al., 2006).

In summary, mechanical activities have the potential for significant effects in all lifeforms since there is no comparable natural disturbance to which individual plants or communities have adapted over time, and because of the high level of disturbance to canopy cover and the soil layer. Whether these adverse effects are significant at the program level depends on the proportion of a lifeform treated and the geographic distribution of the treatments. These are evaluated in the next section.

OAK WOODLANDS

Mechanical activities include tractor piling slash created from handwork, mowing down understory herbaceous vegetation, and mastication of understory shrubby plants. None of these treatments are likely to have significant impacts on mature, overstory oak trees. All of them are likely to retard oak regeneration by removing aboveground portions of seedlings and saplings. Implementation of SPR's ADM-1 (requiring the project coordinator to meet with the contractor to discuss all resources that must be protected using PSR's and specify the resource protection measures and details of the burn plan in the incident action plan (IAP) and attend the pre-operation briefing to provide further information) and ADM-2 (requiring that all protected resources be flagged, painted or otherwise marked prior to the start of operations) will ensure that equipment operators avoid large saplings and small trees.

Mastication can range from limited impacts where masticators move between trees and large shrubs grinding up vegetation in small openings, to treatments where substantial areas are treated and soil disturbance is relatively high. Impacts from mastication can be highly correlated to the amount of vegetation on-site prior to treatment. SPR BIO-6 is intended to help retain overstory cover of oaks in hardwood rangelands.

Mastication, when combined with prescribed burning or followed closely by wildfire may increase residual overstory mortality compared to leaving understory brush untreated. Bradley et al. (2006) reported that mastication of understory brush did not reduce fuels in the short term (less than two years) but rather rearranged them, resulting in a 200 percent increase in 1-hr and 1000-hr size classes and a 300 percent increase in 10-hr and 100-hr size classes in the fuel bed. The concentration of fuels in the fuel bed and hotter burn resulted in significantly increased overstory mortality of black oak and canyon live oak in the Pole (less than eight inch) and overstory (greater than eight inch) size classes compared to adjacent areas that were not masticated prior to burning. However, where understory brush and small trees form fuel ladders to the overstory, prescribed burning without pre-treating the understory vegetation (reducing its height) can also result in significant damage to overstory trees. If understory fuels are removed or allowed to decompose prior to burning there is not likely to be significant damage to overstory trees.

PSR’s identified during project development as well as Implementation of SPR’s BIO-6, BIO-8, & BIO-9 will reduce the impact to Oak Woodlands less than significant. These include requiring retention of older, acorn producing oaks to create deer forage, requiring that in order to reduce the spread of invasive plants, only certified weed-free straw and mulch shall be used if needed to mitigate project impacts and that if the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures shall be developed using principles outlined in the document “Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition” or other relevant documents). Examples include Planning BMPs project Materials BMPs, Travel BMPs, Tool, Equipment and Vehicle Cleaning BMPs, Clothing, Boots and Gear Cleaning BMPs, Waste Disposal BMPs and Soil Disturbance BMPs.

WILDLIFE

Unlike prescribed fire activities, mechanical activities typically leave, and in many cases create, considerable amounts of litter and debris, which then are often piled and/or burned. In fact, mechanical activities are often used as a precursor to prescribed fire activities by making fuel more manageable and creating control lines. Machines typically are noisier, and move more slowly than, prescribed fire, alerting animals to the danger and allowing them time to escape; however, the noise itself may create a disturbance to sensitive wildlife not produced by other treatment types. Such disturbance may result in increased risk of predation or nest failure or disruption of essential behaviors. When mechanical activities are applied when soils are relatively dry their potential for direct effects is relatively low for amphibians but relatively high for most other upland wildlife. Due to the varying climates throughout the state, mechanical activities can be applied any time of the year with the exception of Red Flag Warnings and the presence of excessive soil moisture on the project site. In areas where other types of vegetation treatments are successfully implemented, following any PSR measures identified during project development as well as implementation of SPR's ADM-1, ADM-2, and BIO-1 through BIO-4, will reduce impacts to special status species to less-than-significant. These requirements also relate to "habitat of significant value" and "environmentally sensitive habitat areas" as per CEQA and California Coastal Act, respectively.

INVASIVE SPECIES

Mastication treatments can also create a risk of invasive species colonization and spread. Mastication of surface and ladder fuels results in a short to medium term increase in fire severity potential. If prescribed fire were planned to follow mastication, then the potential for colonization by exotic species would be high due to the more severe burn that would result (Bradley et al., 2006). Severe burns consume a much greater portion of the native vegetation, increase recovery time for native species, and create opportunity for non-natives to invade if they exist nearby. Research shows that time since fire is the most critical factor in alien invasion and colonization. Apparently, it is the closed canopy of pre-fire shrublands that reduces alien populations and thus limits the alien seed bank present at the time of fire (Bradley et al., 2006).

PSR's identified during project development and SPR's BIO-8 & BIO-9 as described at the end of this sub chapter will reduce the potential impact from invasive species resulting from the implementation of projects to less than significant. These include watercourse buffer zones, protection of special status plants & plant populations through CDFW consultation, utilization of an integrated pest management approach, and utilization of only weed free straw and mulch.

4.2.2.3.4 Herbivory Activities

VEGETATION

Herbivory is a natural process that has influenced the evolution of plants for millennia. Along with fire, it was the first vegetation management tool ever applied by humans. Herbivory, or grazing, is a constant influence on all natural plant communities. Every plant species varies in its ability to survive and prosper in a grazed ecosystem. Most established plants are not killed with a single grazing event that removes its foliage, flowers, and stems. Rather, plants have evolved mechanisms that reduce their likelihood of being grazed or promote their regrowth after grazing (Hendrickson and Olsen, 2006).

The effects of grazing on individual plants can be difficult to predict because plants grow in complex ecosystems that are subject to seasonal and yearly fluctuations in weather and natural disturbances. Plants differ in their ability to tolerate or compensate for grazing. The ability of a plant to regrow after grazing depends on its age and physiological condition, stage of development, and carbohydrate allocation patterns. In addition, competition with other plants for space, soil nutrients, and water can influence how a plant responds to grazing (Hendrickson and Olsen, 2006).

A plant’s ability to recover after grazing depends largely on its ability to reestablish leaves and renew photosynthesis. Plants tolerant of grazing generally have an abundant supply of viable meristems or buds that can be quickly activated to initiate regrowth if water and nutrients are available (Hendrickson and Olsen, 2006).

Grasses are different from forbs and shrubs in how they respond to grazing because of where their growing points or meristems are located. Grasses maintain apical and axillary buds near the base of the plant until flowering is initiated.

On the other hand, forbs and shrubs have axillary buds all along the stem and apical buds at the tips of branches. These meristems are readily available to herbivores and can be removed throughout the plant’s life. Some forbs and shrubs have numerous growing points in the root crown at the base of the plant that can produce new shoots or underground runners called rhizomes. Shrubs and rhizomatous herbs would not be affected by short-term grazing since the plants would only be knocked back rather than killed.

Plant phenology, or how plants grow through the season, should be considered when using grazing to manage vegetation. A plant’s growth stage will determine how it responds to grazing. For example, most grasses and forbs tolerate early-season grazing, a time when soil moisture and nutrients needed for regrowth are abundant (Hendrickson and Olsen, 2006).

There is ample research to indicate that grazing is actually beneficial to many native herbaceous species – including those linked with special habitats such as vernal pools (Hayes and Holl, 2006; Marty, 2005). Vernal pools are poorly drained depressional features that occur throughout California in grassland areas underlain by a hardpan or clay pan layer that restricts percolation of water through the soil. They are significant for special status plants and communities because they contain a very high degree of diversity with more than 100 species of endemic plants (Marty, 2005).

Research conducted on the effects to vernal pool habitat on the 12,362-acre Howard Ranch property in eastern Sacramento County demonstrated that the relative cover of native plant species remained highest in continuously grazed plots, while declining in those where grazing was removed (Marty, 2005). Grazing removal did not affect the cover of native vegetation in the pools themselves but did negatively impact native cover in both the edge and upland zones.

It was also found that the change in native richness per quadrat over the first three years of the study was positive in grazed pools and negative in un-grazed pools. There was a decline in diversity with the removal of grazing after only three years, and this effect was most significant on the edge (Marty, 2005).

Another important habitat for native plants is the coastal prairie ecosystem. Over the last twenty to thirty years one quarter of the California coastline has been set aside in conservation status leading to the removal and cessation of livestock grazing. Now annual wildflowers, many of which are rare and endangered, are found more commonly on private lands adjoining conservation lands (Hayes and Holl, 2006).

Hayes and Holl found that annual forb species richness and cover increased significantly with grazing on the California coastal prairie sites analyzed. This may be due to decreased vegetation height and litter depth. Grasses show mixed responses to grazing, and exotic forb abundance increases with grazing (Hayes and Holl, 2006).

Overall, prescribed herbivory is not likely to have an adverse effect in any of the habitat types in the VTP, and in many cases will be beneficial to plant communities. PSR's identified during project development as well as SPR's BIO-8 & BIO-9, as listed and explained at the end of this sub-chapter, are designed to reduce the potential impacts to vegetation to less than significant.

OAK WOODLANDS

In contrast to forested settings where goats are more likely to be used, cattle are more likely to be used in oak woodlands. The stock type, intensity, duration and season of use will vary in response to site conditions and project objectives.

Prescribed herbivory in oak woodlands can result in localized reduction in advance regeneration of oaks, but is not likely to result in impacts to overstory trees. In one study the authors concluded that, “in rangeland seasonally stocked with moderate cattle densities, planting sites must be protected from cattle browsing and trampling in order to successfully restock valley oak” (Bernhardt and Swiecki, 1997). In the same study though, the authors noted that cattle grazing on Harding grass, which competes for water and nutrients with oak seedlings, resulted in increased growth rates for oak seedlings that had been caged to protect them from cattle.

Timing of herbivory affects potential damage to oak seedlings and saplings. Generally late spring and summer grazing are most damaging to oak regeneration due to cattle preference for green living oak leaves rather than the dry forage that is available this time of year. In one study, early spring grazing (March) resulted in minimal grazing of oak regeneration compared to grazing later in the season (May, June, July) (Jansen et al., 1997).

PSR’s identified during project development as well as Implementation of SPR’s BIO-6, BIO-8, & BIO-9 will reduce the impact to Oak Woodlands less than significant.

WILDLIFE

The level and nature of potential direct effects on native wildlife of fuel treatments using livestock are similar to those of manual treatments, though perhaps more concentrated and intense. There is some potential for disturbance but little for mortality beyond that already present from native ungulates.

Following any PSR measures identified during project development as well as implementation of SPR’s ADM-1, ADM-2, and BIO-1 through BIO-4, will reduce impacts to special status species to less-than-significant. These requirements also relate to “habitat of significant value” and “environmentally sensitive habitat areas” as per CEQA and California Coastal Act, respectively.

AQUATIC

Effects of manual activities or prescribed herbivory activities to aquatic organisms are reduced to a less-than-significant impact through the utilization of mitigations such as

SPR's ADM-1, ADM-2, and BIO-11 and any PSR's. Direct contamination of the water column due to fecal runoff from prescribed herbivory treatments is unlikely to occur due to the requirement that program participants follow SPR ADM-1 requiring the project coordinator to meet with the contractor to discuss all resources that must be protected using project specific requirements (PSR's) and specify the resource protection measures and details of the burn plan, in the incident action plan (IAP) and attend the pre-operation briefing to provide further information. ADM-2 requires that all protected resources be flagged, painted or otherwise marked prior to the start of operations, and BIO-11 mandates that aquatic habitats and species shall be protected through the use of watercourse and lake protection zones, as described in California Forest Practice Regulations (14 CCR) (WLPZ's) and other operational restrictions.

INVASIVE SPECIES

The prescribed grazing or herbivory will have a range of vegetation treatment goals, with the reduction of invasive plants being an important one. The challenges of controlling invasive plants on rangelands include vast road less areas that limit access for weed control. These challenges limit the feasibility of chemical and mechanical treatments and favor use of biological control (Launchbaugh, 2006). An unknown proportion of herbivory treatments will target the spread of non-native species, and this proportion will vary between alternatives. Overall, prescribed herbivory treatments are expected to have a net beneficial effect on the status of non-native plant populations since livestock will often be used to reduce the spread of non-native seeds in livestock, from the movement of animals during implementation of projects. Prescribed grazing is an effective technique, rivaling traditional chemical and mechanical control methods, for the management of deleterious invasive plants including leafy spurge, spotted knapweed, yellow star thistle, cheat grass, salt cedar, and kudzu (Pittroff, 2006). Prescribed grazing is viewed as an "environmentally friendly" alternative to traditional methods because it leaves no chemical residue, does not utilize potentially toxic substances, and can mimic natural disturbance processes.

Current research is beginning to lay the foundation for herbivory management strategies capable of being (a) selective against undesired species, and (b) selective in favor of desired species. Thus, understanding prescribed herbivory (and prescribed fire, for that matter) as planned disturbances and studying their effects on plant communities has the potential to significantly contribute to better understanding of ecosystem level processes underpinning weed invasion (Pittroff, 2006).

There is variation in growth curves and life cycles amongst plants in all plant communities. The timing and intensity of herbivory can be used to fine-tune and steer grazing selectivity. In particular, goats are extremely selective and thus ideally positioned to become rather highly specific bio-control agents (Pittroff, 2006).

Implementation of BIO-8 which requires that only certified weed-free straw and mulch be used if needed to prevent the inadvertent introduction of invasive species, and BIO-9 which requires that the project coordinator determine if there is a significant risk of introducing invasive plants and if so develop specific mitigation measures using principles outlined in the document “Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition” or other relevant documents) would result in **less-than-significant impacts** related to the potential for introduction of invasive plants. Specific examples of these practices include Planning BMPs, Project Materials BMPs, Travel BMPs, as well as Tool, Equipment and Vehicle Cleaning BMPs. Waste Disposal BMPs and Soil Disturbance BMPs.

4.2.2.3.5 No Treatment

VEGETATION

Stand-replacing wildfire is likely to occur eventually in most California ecosystems in the absence of fuel reduction. Direct effects of catastrophic wildfire on plant communities are overwhelmingly negative.

WILDLIFE

Stand-replacing wildfire is likely to occur eventually in most California ecosystems in the absence of fuel reduction. Such wildfires kill or displace most of the animals present and destroy their nests and often their shelters. A few predatory animals may benefit in the short term from the prey exposed, injured, or killed by these fires, but direct effects of catastrophic wildfire on animals are overwhelmingly negative.

AQUATIC

Research indicates that high intensity wildfire has the potential to indirectly harm aquatic life through impacts to water quality; peak flows and stream channel morphology. The Proposed Program would help to reduce the detrimental environmental effects of wildfire to watersheds and thus to aquatic lifeforms by helping reduce fire severity across the landscape.

The potential direct adverse impacts to aquatic resources are not likely to vary by bioregion for the same reasons as described above for the entire state, i.e. PSR's, SPR's, and low intensity of prescribed burns.

Most VTP activities are essentially less intense versions of wildfire and timber harvest, and the potential types of indirect impacts are considered to be similar. However, due to lack of monitoring of fuel management treatments and little focus by researchers on this topic, the indirect impacts of these treatments on aquatic ecosystems is largely unknown (Thode et al., 2006). Thus, much of the analysis in this chapter is via inference from effects of wildfire or timber harvest in comparable environmental settings.

In reference to wildfire Rinne and Jacoby (2005) listed the primary indirect impacts to fish (including listed salmonids) in watercourses as: changes in stream temperature due to understory and overstory plant removal, ash-laden slurry flows, increases in flood peak flows, and sedimentation due to increased landscape erosion. Shaffer and Laudenslayer (2006) noted that significant impacts to salmonids after fires are "generally linked to changes in watershed hydrology after a large proportion of drainage is burned and little vegetation or woody debris remains on the landscape." There has been less research regarding effects from fire on lakes or small ponds, but the available information indicates minimal impacts to fish or amphibians following wildfire (Shaffer and Laudenslayer, 2006). Murphy (1995) listed the following indirect mechanisms by which timber harvest has impacted anadromous salmonids: decreased shade, decreased supply of LWD, addition of slash to streams, stream bank erosion, altered stream flow, increased erosion, increased nutrients, barriers to migration, and inputs of fine organic and inorganic sediment. BLM (2005) described potential impacts to fish from fire as the short-term effects of fire on fish populations are a function of both the degree and duration of fire-caused changes in water quality and quantity, and the proportion of each inhabited stream network affected by burning. An isolated or fragmented fish population would recover far more slowly from any adverse effects of burning than would a population inhabiting a widespread and well-connected stream system.

The water quality and quantity impacts described above for wildfires and timber harvest may occur sporadically at the local level due to VTP activities. In most cases, VTP activities are relatively small in area (average treatment size of 260 acres) and do not affect a large proportion of any stream network - unlike some wildfires or extensive timber harvest. The relative isolation of specific populations of fish or other aquatic species would have to be considered at the site-specific level, and specific protection measures devised, if significant impacts to water quality or habitat were expected.

The non-water quality and quantity related impacts potentially caused by timber harvest and wildfire described above include input of slash to streams, decreased supply of

LWD, and creation of migration barriers. Because of the stream protection PSR's and SPR's included in the VTP, there should be no input of slash into streams from activities. Slash created during VTP activities is typically left in place, chipped, or piled and burned, not placed in streams. Road building and construction/reconstruction of stream crossings are not funded activities within the VTP, so crossings will not be impacted positively or negatively, and unplanned installation of fish migration barriers in stream channels (e.g. from poorly installed culverts) should not occur under the Program or Alternatives.

Supplies of LWD from streamside recruitment zones will not be significantly impacted by VTP activities because overstory trees are neither subject to removal nor to high mortality rates from prescribed fire. LWD within stream channels will not be burned up during prescribed fires or removed during mechanical activities. Beche et al. (2005) noted that only 4.4 percent of trees ranging in size from 11.7 to 40.4 cm dbh were killed due to prescribed burning in riparian forests and the prescribed burn did not change the amount or movement of LWD in the channel. Minor amounts of overstory tree mortality due to prescribed burning could be viewed as a benefit to aquatic species, because it provides a moderately accelerated recruitment mechanism for LWD.

Beche et al. (2005) observed that percent bare ground increased from 3.5% (+/- 8.2%) pre-fire to 34.2% (+/- 21.8%) post-fire due to a prescribed fire in a riparian zone. However, fine sediment in pools adjacent to the burned riparian areas and wet areas as measured by V* (the average residual pool volume of fine sediment), did not significantly change post-fire. The author also measured sediment composition (percent finer than 11.3 mm) as well as longitudinal and cross section surveys of channel morphology. None of the sediment or channel morphology metrics indicated a change due to the prescribed fire in the riparian zone. The author attributed this to the fact that the fire only removed surface vegetation from 70 percent of the total area burned, which was only 14 percent (18 hectare) of the total watershed area (129 hectare). The prescribed burn retained a considerable amount of litter and surface vegetation on site, which would reduce surface erosion. A wildfire would likely affect a larger percentage of a given watershed, and leave relatively less litter and surface vegetation in place.

Mechanical and prescribed fire activities in crown fire regime vegetation types tend to result in low vegetative cover and high extent of bare ground after treatment, both of which can lead to increased sediment delivery rates and higher peak flows. Also, the lack of an overstory tree canopy in the riparian zone in crown fire regime vegetation types means that reductions in riparian vegetation density due to treatment have a higher likelihood of altering the riparian microclimate, i.e. decreased humidity and increased air temperatures. However, changes in riparian microclimate conditions are not likely to change water column temperatures because the overwhelming determinant of water temperature is direct solar exposure, not ambient air temperature (Beschta et al., 1987).

INVASIVE SPECIES

The impacts from non-native invasive species are analyzed by changes in the structure and composition of these populations in relation to vegetation in the dominant natural plant community types. The effects of VTP projects can be analyzed as long as they are distinguishable from presumed changes in the pre-existing plant community composition without any VTP projects. The additive effects of past actions (such as wildfire suppression, timber harvest, mining, nonnative plant introductions, and ranching) have shaped the present landscape and corresponding populations of special status and invasive species. One of the most extensive influences invasive plants can have on an ecosystem is to alter their fire regimes. As invasive species move into ecosystems, their intrinsic fuel properties, which involve the plant's flammability and ignition potential, and extrinsic fuel properties, which relates to how the plants are arranged on the landscape, both can directly influence fuel loads, fire frequency, intensity and seasonality, and burn continuity. These changes in fire regimes can alter a plant community and even transform entire ecosystems, allowing the invasive species to take over the entire community and also lead to new opportunities for more invasive species to colonize or expand their habitat (Brooks et al., 2004). Annual nonnative Eurasian grasses now dominate 98 percent of California grasslands (Barbour et al., 2007). Nonnative Bromus spp., like cheat grass, rip gut, and red brome frequently convert native coastal and desert shrubland communities into annual grasslands (Brooks et al., 2004). The finely textured grasses produce fuels that dry quickly under low soil and low atmospheric humidity conditions and increase the horizontal fuel continuity and fuel bed bulk density which promotes ignitions and fires earlier in the spring and later in the fall than normal fire regimes, often increasing the fire season and changing the ecosystem's historical infrequent fire interval of 60 to 100 years to a rapid 3 to 5 year interval (Barbour et al., 2007). The invasive grasses are able to exploit these changes in the fire regime by more quickly establishing than the native species in the post fire disturbed areas, and eventually the original components of the plant community have been changed, and in turn alters the entire ecosystem. Once the fire frequency of native shrub landscapes has gone through these type conversion transformations, they may never recover because of changed factors such as soil nutrients and high densities of the invaders' seed banks (Brooks et al., 2004). These new communities burn more rapidly and frequently, which affects animals that are dependent on this landscape for forage and cover, such as the sage grouse, black-tailed jack rabbit, and Paiute ground squirrel, which in turn affects predators that depend on these species for food, such as golden eagles and prairie falcons. Fast moving fires are lethal to native reptiles such as snakes and desert tortoises, which are killed in these circumstances (Brooks et al., 2004).

There are fewer invasive species found in California's montane conifer forests than shrub and grasslands, however these ecosystems are also experiencing negative changes from invasive plants, largely due to unintended side effects from past and current management practices. Practices such as logging, livestock grazing, and fire suppression have allowed for unusually high woody fuel accumulation and has changed forest systems from surface fire to more intensive crown fires, altering forest fire regimes. If a forest in these altered conditions experiences a wildfire, large crown gaps are created and adult trees and cones are diminished or destroyed, so new tree generation can be slow because normal seed dispersal mechanisms are not functioning. This allows for invasive species to establish. Post fire management can also promote invasive species in conifer forests. The common practice of using herbicides to suppress shrubs in order to reduce competition with new seedlings actually interferes with the natural seral stages of nitrogen fixing shrub establishment, which normally prepares the soil for seedling growth. With the absence of shrubs, invasive annual grasses have a better chance of establishing, which diminishes habitat and food sources for small mammals and eventually alters the fuel structure, fire frequency, and thus entire fire regime (Keeley et al., 2011).

4.2.2.4 **Effects and Goals of the Proposed Program and Alternatives**

Because the scale of Alternatives A, B, C, and D would be the same as the Proposed VTP at 60,000 treated acres for ten years, with the same vegetation treatment activities by vegetation type expected to occur, Alternatives A, B and C would have similar impacts to biological resources as the proposed VTP. The No Project Alternative and Alternative D would each treat approximately half the acres as the Proposed VTP, and Alternative D would use substantially less prescribed fire as the other Alternatives. A brief discussion of each relative to biological resources is found at the end of this section.

VEGETATION

All of the common natural communities that might be treated under the proposed VTP have evolved under some degree of natural or human-induced fire. The Proposed Program will reintroduce fire into communities where fire has been excluded through past suppression or control efforts. Plants stimulated by fire are fire-dependent and fire-enhanced categories, while plants not stimulated by fire are either fire-neutral or fire-inhibited (Sugihara et al., 2006). The existing distribution of individuals of a species –

endemic, patchy, or continuous – greatly affects how the plant population responds to an individual fire event (McKelvey et al., 1996). Factors such as burn intensity and the spatial pattern of the burn or other activities affect the plant population response (Sugihara et al., 2006). Generally, prescribed fire is believed to benefit the overall health of fire adapted ecosystems (McKelvey et al., 1996). Prescribed fires generally leave exposed bare mineral soil that is favorable to seedling establishment of fire-stimulated plants. Prescribed fire treatments that do not mimic the natural regime may adversely affect the reproductive capability or viability of a natural community (Sugihara et al., 2006).

However, implementation of prescribed burn activities could result in an alteration of the natural fire regime. Changes in burning patterns which affect the timing, intensity, frequency, or size of fires on the landscape could potentially have significant adverse effects to plants. Large burns have a greater chance of negatively affecting a plant population than small burns due to the potential of large burns to interrupt seed dispersal mechanisms (Sugihara et al., 2006).

PSR's identified during project development as well as SPR's BIO-8 & BIO-9, as listed and explained at the end of this sub-chapter, are designed to reduce the potential impacts to vegetation to less than significant.

OAK WOODLANDS

Oak woodlands cover approximately 10 million acres in California. About half of this acreage occurs in the foothills of the Sierra Nevada and North Coast/Klamath bioregions. Oak woodlands in California have evolved in a Mediterranean climate where the dry summer seasons create typical fire return intervals of 30-50 years (McCreary, 2004). However, as with other vegetation types in the state, fire suppression activities have interrupted this cycle for most of the 20th century. Prior to fire suppression, frequent low-intensity fires initiated by American Indians or lightning burned through woodlands, killing understory brush and small trees and favoring retention of large diameter overstory trees (McCreary, 2004). Oak woodlands are the most biologically diverse habitat type in California, home to over 300 vertebrate wildlife species (Merenlander and Crawford, 1998).

Blue oak (Quercus douglasii) is California's dominant oak species, representing more than one third of the state's oak woodlands. Live oaks (Q. chrysolepsis, Q. wislizenii, Q. agrifola) comprise another third of California's oak woodlands. However, on California's oak forestlands (as opposed to woodlands and not analyzed in this section) tanoak (Lithocarpus densiflorus), black oak (Q. kelloggii) and canyon live oak (Q. chrysolepsis) account for 80 percent of the hardwoods (Gaman and Firman, 2006).

The most immediate and direct threat to oak woodlands is conversion to other uses. Since 1945 the extent of oak woodlands has decreased by 1.2 million acres (Bolsinger, 1988). Between 1945 and the early 1970's the primary reason for loss of woodlands was conversion to rangelands, but since then commercial and residential development has become the primary source of conversion (Bolsinger, 1988; Spero, 2002). More recently, conversion of oak woodlands to vineyards has also become a major impact (Merenlander and Crawford, 1998). An additional 750,000 acres of oak woodlands are at risk of conversion before 2040 (Gaman and Firman, 2006).

A less immediate, but more widespread threat to the majority of oak woodlands, is lack of adequate oak regeneration. Regeneration of coast live oak and blue oak is sparse and nearly non-existent for valley oak (Q. lobata). However, seedlings and saplings are abundant in canyon live oak stands and moderately abundant in interior live oak, black oak and white oak stands (Bolsinger, 1988). Altered fire regimes, grazing pressure from livestock, suppression by woody plants and invasion of European weedy annual grasses are considered to be likely culprits for poor regeneration (Swiecki et al., 1997).

In the North Coast range of California (Sonoma, Mendocino, Humboldt and Del Norte Counties) invasion of Douglas-fir (Pseudotsuga menziesii) into Northern Oak woodlands presents a threat to the continued dominance of Quercus species in these stands (Barnhart et al., 1996). Encroachment of Douglas-fir into these relatively mesic (wet) oak woodlands is the result of fire suppression since the early 1900's (Barnhart et al., 1996). Prior to fire suppression, frequent low intensity fires killed most Douglas-fir regeneration before it grew large enough to become fire resistant. In the absence of fire or other controls on Douglas-fir regeneration in Northern Oak woodlands it is likely that many of these stands will eventually convert to mixed evergreen forest, rather than oak dominated woodlands.

PSR's identified during project development as well as Implementation of SPR's BIO-6, BIO-8, & BIO-9 as listed and explained at the end of this sub-chapter, are designed to reduce the potential impacts to Oak Woodlands to less than significant.

WILDLIFE

To address potential direct and indirect effects of the VTP on wildlife in an ecologically meaningful way, species have been assigned to four broad guilds (subterranean (soil invertebrates, burrowing mammals, etc.), ground-dwelling (terrestrial invertebrates, reptiles and amphibians, including partially aquatic forms, and mammals), shrub-dwelling (shrub-nesting birds, etc.), and arboreal (arboreal invertebrates, cavity and tree nesting birds and mammals, etc.) based on how they typically use the vertical environment (See Appendix D). Shaffer and Laudenslayer (2006) used similar guilds in addressing effects of fire on animals, but they considered shrub-dwelling species as a subset of arboreal fauna. Since many of the activities considered here specifically target either scrub habitats or the shrub layer in wooded habitats, we have elevated shrub species to their own guild. We feel such an approach is preferable to addressing broad taxonomic guilds wherein species occupy the full range of available vertical strata because fuel reduction activities in structurally complex habitats are typically layer-specific. Species are assigned to a single guild based on their primary or most critical (for instance, breeding or over-wintering) use area.

Following PSR's that are identified during project development as well as implementation of SPR's ADM-1, ADM-2, and BIO-1 through BIO-4, as listed and explained at the end of this sub-chapter, are designed to reduce the potential impacts to wildlife to less than significant. These requirements also relate to "habitat of significant value" and "environmentally sensitive habitat areas" as per CEQA and California Coastal Act, respectively.

AQUATIC

Direct impacts to aquatic species that occur within saline and fresh emergent wetlands, lacustrine, riverine, and estuarine habitat types are unlikely because these habitat types are excluded from treatment. Riparian and upland vegetation types adjacent to these excluded vegetation types may be treated and indirect adverse effects to aquatic resources are possible, particularly where multiple VTP projects occur in a single watershed. However, with the implementation SPR's HYD-1 through HYD-14 and HYD-16, as listed and explained at the end of this sub-chapter, as well as PSR's identified during project development, the proposed program is not likely to cross the following thresholds of significance:

- violate any state or federal wildlife protection law regarding aquatic species
- contribute directly (through immediate mortality) or indirectly (through reduced productivity, survivorship, genetic diversity, or environmental carrying capacity) to a substantial, long-term reduction in the viability of any native aquatic species or subspecies at the state level.

Therefore, after mitigations, any significant impacts from implementing the Program or Alternatives are reduced to less-than-significant.

INVASIVE SPECIES

The impacts from non-native invasive species are analyzed by changes in the structure and composition of these populations in relation to vegetation in the dominant natural plant community types. The effects of VTP projects can be analyzed as long as they are distinguishable from presumed changes in the pre-existing plant community composition without any VTP projects. The additive effects of past actions (such as wildfire suppression, timber harvest, mining, nonnative plant introductions, and ranching) have shaped the present landscape and corresponding populations of special status and invasive species.

If the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures will be developed using principles outlined in the California Invasive Plant Council's "Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition)" (2012), or other relevant documents. Implementation of SPR's BIO-8 & BIO-9 as described at the end of this sub chapter as well as PSR's identified during project development and implementation will reduce the potential impact from invasive species resulting from the implementation of projects to less than significant. These include watercourse buffer zones, protection of special status plants & plant populations through CDFW consultation, utilization of an integrated pest management approach, and utilization of only weed free straw and mulch.

DISCUSSION OF ALTERNATIVES

The No Project and Alternatives A-D are considered under this analysis. No Project: Existing Programs Business as Usual, Alternative A: WUI Only, Alternative B: WUI and Fuel Breaks, Alternative C: Projects Limited to Very High Fire Hazard Severity Zones, and Alternative D: Treatments that Minimize Potential Impacts to Air Quality. The No Project alternative would continue to treat approximately 30,000 acres annually, mostly with prescribed fire and without assurances that SPR's identified in the proposed VTP and alternatives would be implemented. Alternative A proposes to limit fuel reduction projects to WUI areas only, while Alternative B would combine Alternative A with the option to create fuel breaks outside of the WUI. Under Alternative C, vegetation treatment activities would be focused in areas with the highest hazard classification of very high fire hazard severity zones (VHFHSZ). Alternative D would reduce the number of acres treated by prescribed fire and also reduce the average number of acres treated annually to 36,000.

For Alternatives A, B, and C, the scale of the project remains the same as the proposed VTP at 60,000 treated acres per year for ten years, with the same vegetation treatment activities by vegetation type expected to occur. That is, the same amount of acreage would be treated with manual, mechanical, prescribed fire, and herbicide treatments. Geographically, the areas available to be treated by Alternatives A, B, and C are reduced compared to the proposed VTP: Alternatives A and C would have approximately 11.5 million acres available for treatment, while Alternative B would have approximately 16 million acres available for treatment (see Table 3.8-1). Concentrating treatments in a smaller geographic area may increase the impacts to sensitive species and their habitats that exist within the area available for treatment under Alternatives A, B and C. However, with the implementation of HYD-16 projects are not anticipated to be heavily concentrated at the planning watershed level under any of these alternatives. Because the nature of treatment activities are expected to be the same and the scale of the program is similar to that of the VTP, it is expected the overall impacts would be similar to the Proposed VTP for Alternatives A, B, and C.

The No Project Alternative and Alternative D propose to treat fewer acres (27,000 and 36,000 respectively) annually than the proposed VTP. The No Project Alternative would continue the programs CAL FIRE already has in place to treat wildland fuels anywhere in the SRA and establishes the baseline for with the Proposed VTP and all alternatives are measured against. Alternative D proposes to use less prescribed fire (approximately 6,000 acres annually) on an annual basis than the other alternatives. Geographically, the area available for treatment would be the same as the proposed VTP as the treatments would be distributed across the landscape under the same constraints. Projects under Alternative D would be required to implement the same SPR’s and mitigation measures as the proposed VTP. Due to the reduction in the number of acres treated with prescribed fire, Alternative D would not be expected to yield the same level of benefit to fire adapted ecosystems that have degraded due to fire exclusion as the other alternatives. All other impacts are expected to be similar in nature to those from the proposed VTP, but should be reduced in scale due to the reduction in the total number of acres treated annually. Because fewer acres are treated under the No Project Alternative and Alternative D, it is expected that the overall impacts to biological resources would be less than the Proposed VTP.

4.2.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

The results from the bioregional analysis of potential impacts to water quality from VTP projects indicates little overlap with bioregions designated by the State as the “high priority landscape ” for water quality (FRAP, 2010). The high priority landscape includes the North Coast/Klamath bioregion, and selected watersheds in the Sierra and South Coast bioregions (FRAP, 2010). Thus, the additional potential risk attributable to VTP projects will not occur in watersheds already deemed by the state to be high quality and at elevated risk of impairment to water quality. Similarly, the FRAP Assessment (2010) identified high and medium priority landscapes for wildlife habitat (including aquatic species) at risk of damage from wildfire; most high and medium priority landscapes occur in the North Coast/Klamath, Sierra, and Modoc bioregions. Again, the bioregions at elevated risk of water quality impairment due to VTP projects do not occur within the high and medium priority landscapes for wildlife (FRAP, 2010). Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design.

4.2.3.1 **Standard Project Requirements**

Standard project requirements (SPRs) are minimum standards set by the program for individual projects. SPRs apply to all projects governed by the VTP. SPRs are a collection of standard operating procedures, Best Management Practices, and known regulatory requirements related to project impact assessment, implementation, and oversight.

ADM-1: Prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using standard project requirements (SPRs). If burning operations are done with CAL FIRE personnel, the Battalion Chief and/or their Company Officer designee shall meet with the project coordinator onsite prior to operations to discuss resource protection measures. Additionally, the project coordinator shall specify the resource protection measures and details of the burn plan in the incident action plan (IAP) and shall attend the pre-operation briefing to provide further information.

ADM-2: All protected resources shall be flagged, painted or otherwise marked prior to the start of operations by someone knowledgeable of the resources at risk, their location, and the applicable protection measures to be applied. This work shall be performed by a Registered Professional Forester (RPF), or his/her supervised designee, for any project in a forested landscape as defined in PRC § 754.

BIO-1: Projects shall be designed to avoid significant effects and avoid take of special status species as defined in the glossary as a plant or animal species that is listed as rare, threatened, or endangered under Federal law; or rare, threatened, endangered, candidate, or fully protected under State law; or as a sensitive species by the California Board of Forestry and Fire Protection.

BIO-2: The project coordinator shall run a nine-quad search or larger search area (may be required if a project is on the boundary of two USGS quad maps) of the area surrounding the proposed project for special status species, using at a minimum, the California Natural Diversity Database (CNDDB) or its successor (e.g., DFW's Vegetation Classification and Mapping Program, VegCAMP).

BIO-3: The project coordinator shall write a summary of all special status species identified in the biological scoping including the CNDDB search with a preliminary analysis, identifying which species would be affected by the proposed project. A field review will then be conducted by the project coordinator to identify the presence or absence of any special status species, or appropriate habitat for special status species, within the project area.

BIO-4: The project coordinator shall ensure that a CAL FIRE Environmental Coordinator analyze impacts to any species identified in a CNDDB or BIOS search and shall submit the summary and preliminary analysis to the CDFW, USFWS, and [if applicable] NOAA Fisheries for consultation. The preliminary analysis shall be accompanied with a standard letter containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning; mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- The output from the CNDDB run, including a map of any special status species located during the field review, and the SPRs that will be implemented to minimize impacts on the identified special status species.
- A request for information regarding the presence and absence of special status species, including any applicable HCPs, in the project vicinity, and potential take avoidance measures to be implemented as PSRs.
- An offer to schedule a day to visit the project area with the project coordinator.

BIO-5: Vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties shall:

- Be designed to prevent vegetation type conversion.
- Not take place in vegetation that has not reached the age of median fire return intervals.
- Not re-enter treatment areas for maintenance in an interval shorter than the median fire return interval outside of the wildland urban interface and excluding fuel break maintenance.
- Not take place in old-growth chaparral without consultation regarding the potential for significant impacts with the CDFW and the CNPS.
- Take into account the local aesthetics, wildlife, and recreation of the shrub-dominated subtype during the planning and implementation of the project.

- During the project planning phase provide a public workshop or public notice in a newspaper that is circulated locally describing the proposed project during the project planning phase for projects outside of the WUI. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

BIO-6: In shrublands containing native oaks, treatments may incorporate retention of older, acorn producing oaks to create deer forage. CAL FIRE or applicants may plant other vegetation to promote species diversity and improve wildlife habitat when such practices are not in conflict with program goals.

BIO-7: Unless otherwise directed by CDFW, a minimum 50 foot avoidance buffer shall be established around any special status animal, nest site, or den location and a minimum 15 foot avoidance buffer shall be established around any special status plant within the project area. Additional buffer distances may be required through consultation with the appropriate State or Federal agencies, or a qualified biologist to avoid significant effects to special status species (see BIO-4).

BIO-8: In order to reduce the spread of new invasive plants, only certified weed-free straw and mulch shall be used.

BIO-9: During the planning phase, if the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures shall be developed using principles outlined in the document “Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition)” or other relevant documents. Coordination of mitigation measures will also include consultation with CDFW.

BIO-10: If water drafting becomes a necessary component of the proposed project, drafting sites shall be planned to avoid adverse effects to special status aquatic species and associated habitat, in-stream flows, and depletion of pool habitat. Screening devices shall be used for water drafting pumps, and pumps with low entry velocity shall be used to minimize removal of aquatic species, including juvenile fish, amphibian egg masses, and tadpoles, from aquatic habitats.

BIO-11: Aquatic habitats and species shall be protected through the use of watercourse and lake protection zones (WLPZ), as described in California Forest Practice Rules (14 CCR Chapters 4, 4.5, and 10). Other operational restrictions may be identified through consultation with CDFW and RWQCB (see BIO-4). See HYD-3 for these standard protection measures.

BIO-12: For projects that require a non-construction-related CDFW Streambed Alteration Agreement, any BMPs identified in the agreement shall be developed and implemented.

BIO-13: If any special status species are identified within the project area, an onsite meeting shall occur between the project coordinator and operating contractor. At this meeting the project manager shall conduct a brief review of life history, field identification, and habitat requirements for each special status species, their known or probable locations in the vicinity of the treatment site, project specific requirements or avoidance measures, and necessary actions if special status species or sensitive natural communities are encountered.

HYD-1: The project shall comply with all applicable water quality requirements adopted by the appropriate Regional Water Quality Control Board and approved by the State Water Board (i.e., Basin Plan).

HYD-2: During the planning phase the project coordinator shall submit a standard letter to the appropriate RWQCB containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- Notification of whether the project drains directly into an impaired water body, and the type of water quality constituent(s) that is impairing the water body.
- A request for information and recommendations regarding the potential for significant water quality impacts from the proposed project and an offer to schedule a day to visit the project area with the project coordinator. The project shall incorporate the recommendations that prevent significant impacts to water quality as PSRs.

HYD-3: A WLPZ shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current California Forest Practice Rules (**Error! Reference source not found.**). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation within the WLPZ or ELZ will not be disturbed by project activities, with the exception of backing prescribed fire. Class IV watercourse protections shall be PSRs specified in the PSA, and designed in conjunction with any recommendations from RWQCB staff.

Table 4.2-21 Watercourse and lake protection zone buffer widths by watercourse classification and hill slope gradient (See HYD -3)

Note: ELZ-Equipment Limitation Zone, PSR-Project Specific Requirement

Water Class Characteristics or Key Indicator / Beneficial Use	1)Domestic supplies, including springs, on site and/or within 100 feet downstream of the project area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning	1) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for non-fish aquatic species. 3) Excludes Class III water that are tributary to Class I waters	No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II water under normal high water flow conditions of timber operations	Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use
Water Class	Class I	Class II	Class III	Class IV
Slope Class (%)	Width (ft.)	Width (ft.)	Width (ft.)	Width
<30	75	50	50 (ELZ)	PSR
30-50	100	75	50 (ELZ)	PSR
>50	150	100	50 (ELZ)	PSR

HYD-4: No direct ignition shall be allowed within the WLPZ or ELZs. However, it is acceptable for a fire to enter or back into a WLPZ's or ELZ's.

HYD-5: Compacted and/or bare linear treatment areas (e.g., fire breaks, roads, or trails) capable of generating storm runoff shall be drained via water breaks using the spacing guidelines contained in Sections 914.6, 934.6, and 954.6(c) of the California Forest Practice Rules.

HYD-6: Compacted and/or bare treatment areas shall be drained such that they are hydrologically disconnected from watercourses or lakes. Measures to hydrologically disconnect these areas shall be guided by consulting with Technical Rule Addendum #5 of the California Forest Practice Rules – Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings

HYD-7: No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or damage to soil structure. Saturated soil means that soil and/or surface material pore spaces are filled with water to such an extent that runoff is likely to occur. Indicators of saturated soil conditions may include, but are not limited to: (1) areas of ponded water, (2) pumping of fines from the soil or road surfacing material during timber operations, (3) loss of bearing strength resulting in the deflection of soil or road surfaces under a load, such as the creation of wheel ruts, (4) spinning or churning of wheels or tracks that produces a wet slurry, or (5) inadequate traction without blading wet soil or surfacing materials.

HYD-8: For remaining hydrologically connected areas of compacted or bare linear treatment areas, disturbed areas will be mulched with onsite native vegetative material (e.g., cut material).

HYD-9: During dry, dusty conditions, unpaved roads shall be wetted using water trucks or treated with a non-toxic chemical dust suppressant (e.g., emulsion polymers, organic material). Any dust suppressant product used shall be environmentally benign (i.e., non-toxic to plants and shall not negatively impact water quality) and its use shall not be prohibited by the ARB, U.S. Environmental Protection Agency (EPA), or the State Water Resources Control Board. Exposed areas shall not be over-watered such that water results in runoff. The type of dust suppression method shall be selected by the contractor based on soil, traffic, site-specific conditions, and local air quality regulations.

HYD-10: Prior to the start of onsite activities, all equipment will be inspected for leaks and regularly inspected thereafter until equipment is removed from the project area. All contaminated water, sludge, spill residue, or other hazardous compounds will be contained and disposed of outside the boundaries of the site, at a lawfully permitted or authorized destination.

HYD-11: Staging areas shall be designated and located to prevent leakage of oil, hydraulic fluids, or other chemicals into watercourses or lakes.

HYD-12: All heavy equipment parking, refueling, and service shall be conducted within designated areas outside of the WLPZ or ELZ.

HYD-13: No new roads (including temporary roads) shall be constructed or reconstructed (reconstruction is defined as cutting or filling involving less than 50 cubic yards/0.25 linear road miles). Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice Rules.

HYD-14: Heavy equipment is prohibited on slopes exceeding 65 percent or on slopes greater than 50 percent where the erosion hazard rating is high or extreme. Heavy equipment is prohibited on slopes greater than 50 percent that lead without flattening to watercourses.

HYD-15: Burn piles shall not exceed 20 feet in length, width, or diameter, except when on landings, road surfaces, or on contour.

HYD-16: At the CalWater Planning Watershed scale, if the combined, appropriately-weighted acreage subjected to fuels treatments and logging exceed 20% of the watershed area within a 10-year timespan (see Appendix K for calculation procedures); an analysis will be performed to determine the potential for hydrologically-induced significant impacts of the proposed activity.

HYD-17: If herbivory is proposed to treat vegetation in a project area containing watercourses, then the following items must be addressed as PSRs:

- The project will require water on site in the form of an on-site stock pond outside the WLPZ or ELZ, or a portable water source located outside the WLPZ or ELZ.
- The project will specify animal containment measures in the PSA to prevent animals from entering the WLPZ and/or ELZs. These might include the use of fencing (i.e., fixed or portable), the use of guard or herd dogs, or the use of an on-site herder.

4.3 GEOLOGY, HYDROLOGY AND SOILS

Physical processes do not act independently within a watershed. In recognition of this, we use a hydrogeomorphic framework for describing the baseline conditions of the affected area and for assessing the impacts of the Program and the alternatives. Hydrogeomorphology is the “the interaction and linkage of hydrologic processes with landforms or earth materials and the interaction of geomorphic processes with surface and subsurface water in temporal and spatial dimensions” (Sidle and Onda, 2004). Given this definition, a hydrogeomorphic framework is appropriate for analyzing impacts to geologic, hydrologic, and soil resources.

Examples of linked hydrogeomorphic processes include changes in the magnitude and frequency of stream discharge which can drive changes in sediment transport, or increased pore water pressures which can decrease the forces that resist landsliding. Project-induced hydrogeomorphic process alterations have the potential to significantly impact the beneficial uses of water and/or other resources of concern (Figure 4.3-1). Acknowledging the linkages between physical processes and the resource(s) of concern provides a more effective approach for impact assessment than compared to dealing with each impact in isolation. In turn, this analysis provides a basis for the aquatics and water quality impacts analysis in Sections 4.2 and 4.5, respectively.

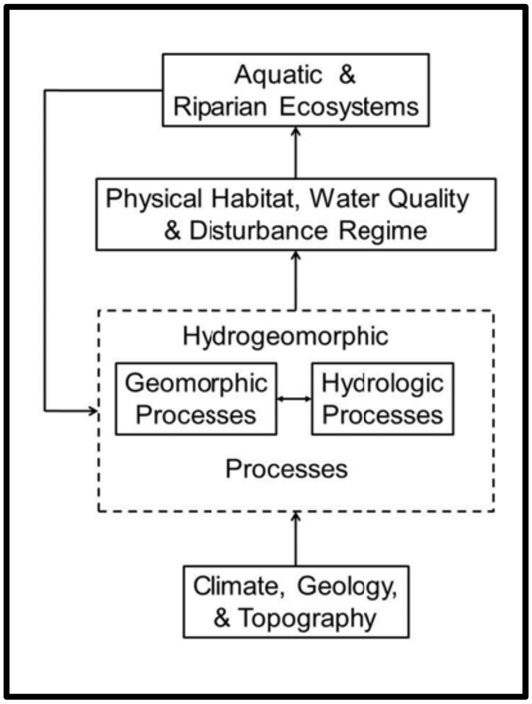


Figure 4.3-1 A schematic illustration of the linkages between hydrogeomorphic processes and aquatic/riparian ecosystem response. At regional scales, these process and functional linkages are controlled by climate, geology, and topography (adapted from Montgomery, 1999).

The material presented in Section 4.3 has been broken into three components:

- **4.3.1 Affected Environment**
  - The Affected Environment section discusses the regulatory framework that limits impacts to geologic, hydrologic and soil resources, as well as the baseline hydrogeomorphic setting in which the Program occurs, and special concerns present in each geomorphic province.
- **4.3.2 Effects**
  - The Effect section outlines the potential impacts of implementing the proposed Program and the alternatives.
- **4.3.3 Mitigations**
  - The Mitigation section provide the standard program requirements to reduce the likelihood of the proposed Program in causing adverse impacts to geologic, hydrologic, and soil resources.

4.3.1 AFFECTED ENVIRONMENT

The following section summarizes the baseline regulatory setting and environmental conditions for geology, hydrology, and soils for the areas potentially affected by the Program.

4.3.1.1 **Regulatory Setting**

The proposed Program is subject to a number of geologic, hydrologic, and soil-related requirements associated with federal and state regulations.

CLEAN WATER ACT (33 U.S.C. SECTION 1251 ET SEQ.)

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972. The CWA provides standard regulations for the discharge of pollutants to the waters of the United States (U.S.) in order to maintain their chemical, physical, and biological integrity and protect their beneficial uses. In addition, the CWA provides the statutory basis for the National Pollutant Discharge Elimination System (NPDES). Waters of the U.S. are defined as coastal waters, territorial seas, bays, rivers, streams, lakes, ponds, and wetlands (Code of Federal Regulations 40 CFR 122.2).

The CWA requires states to adopt water quality standards that must be approved by the U.S. Environmental Protection Agency (EPA) and requires NPDES permits for the discharge of pollutants in U.S. waters. In addition, the CWA gives authority to the EPA to (1) implement pollution control programs, including setting waste water standards and effluent limits on an industry-wide basis; and (2) authorize the NPDES Permit Program permitting, administration, and enforcement to state governments with oversight by the EPA.

Under Section 303(d) of the CWA, states (states, territories, and tribes) are required to develop lists of impaired and threatened waters. Impaired waters (e.g., rivers, streams, and lakes) are defined as those that do not meet water quality objectives because required pollution control mitigations are not sufficient to attain or maintain these standards. A 303(d) listing acts a “trigger” for states to monitor these water-bodies and develop Total Maximum Daily Loads (TMDL) for each pollutant. The TMDL is a calculation of the maximum allowable amount of a pollutant impaired waters can receive without significant negative environmental effects, violation of water quality standards, and/or harm to beneficial uses. The TMDL process also provides an analysis of the linkages between pollutant reductions and the attainment of water quality objectives. The TMDL may also function as an action plan that provides management priorities and mitigation strategies for addressing water quality impairments. The EPA must approve a state’s TMDL or, if denied, the EPA will prepare and implement its own.

Sections under “Title IV-Permits and Licenses” of the Clean Water Act regulate the permits and licenses required for any activity that could impair surface waters.

- Section 401, enforced by the SWRCB and RWQCBs, require the discharger to obtain certification from the state that potential discharges will comply with approved effluent limits and water quality standards.
- Section 402 regulates the point- and non-point source discharges to surface waters through the NPDES permit program. The NPDES permit program is overseen by the SWRCB and administered by each RWQCB. A general (covers multiple facilities within a specific category) or individual NPDES permit is required for any municipal or industrial point-source discharge and nonpoint-source storm water discharge. NPDES permits set limits on allowable pollutant emissions or effluent discharges, prohibit the discharges not specifically allowed by the NPDES permit and provide the discharger with required mitigations to monitor and reduce potential point- and nonpoint-source pollutant discharges. NPDES permits issued for listed pollutants must be consistent with TMDL load allocations.
- Section 404, regulated by the U.S. Army Corps of Engineers (USACE), requires a permit prior to any activity that involves the discharge of dredged or fill material into waters of the U.S. at designated approved locations. Projects with impacts less than or equal to 0.5 acres may be approved through the Nationwide Permit Program (NWP).

Phase I and Phase II of the EPA storm water program were promulgated under the CWA in order to further protect water quality, aquatic habitat, and beneficial uses from storm water runoff. The EPA storm water program requires that projects involving more than one acre of ground disturbance develop and obtain approval of a Storm Water Pollution Prevention Plan (SWPPP) prior to construction activities, and the implementation of best management practices (BMPs) to control runoff from construction sites during and after construction operations. A Notice of Intent (NOI) must be submitted to the SWRCB when a project is subject to a NPDES permit. Construction projects involving less than one acre of ground disturbance are exempt from these regulations.

SECTIONS 9 AND 10 OF THE RIVERS AND HARBORS ACT (33 U.S.C. 401 ET SEQ.)

Sections 9 and 10 of the Rivers and Harbors Act (33 U.S.C. 301 et seq.) are regulated by the USACE and require a permit for the construction of any structure within or over “navigable water”: excavation, dredging, or deposition of material in or any obstruction or alteration of “navigable waters.” Navigable waters include coastal and inland waters, lakes, rivers, and streams that are wide and deep enough to provide passage; territorial seas; and wetlands adjacent to aforementioned navigable waters. A Section 10 Permit is also required in un-navigable waters, if the activity will have an influence on the course, location, condition, or capacity of the navigable water body.

FEDERAL ANTIDEGRADATION POLICY (CODE OF FEDERAL REGULATIONS - TITLE 40: PROTECTION OF ENVIRONMENT 40CFR 131.12)

The Federal Antidegradation Policy was issued in 1968 by the U.S. Department of the Interior to (1) ensure that activities will not lower the water quality of existing use, and (2) restore and maintain “high quality water.” The federal policy maintains that states shall adopt a statewide antidegradation policy that includes the following conditions:

- Existing instream water uses and a level of water quality necessary to maintain those uses shall be maintained and protected.
- Water quality will be maintained and protected in waters that exceed water quality levels necessary for supporting fish, wildlife, and recreational activities, and water quality, unless the State deems that water quality levels can be lowered to accommodate important economic or social development. In these cases, water quality levels can only be lowered to levels that support all existing uses.
- Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

PORTER-COLOGNE WATER QUALITY ACT (CAL. WATER CODE DIV. 7)

The Porter-Cologne Water Quality Act is a key element of California water quality control legislation. Under the act, the SWRCB is given authority over state water rights and water quality policy and it established the State’s nine RWQCBs to regulate and oversee regional and local water quality issues. The RWQCB is also responsible for developing and updating Basin Plans targeted toward (1) protecting waters designated with beneficial uses, (2) establishing water quality objectives for surface water and groundwater, and (3) determining actions necessary to maintain water quality standards and control point- and nonpoint-sources of pollution into the State’s waters. Under the Act, proposed waste dischargers are required to file Reports of Waste Discharge (RWDs) to the RWQCB and the SWRCB and RWQCB are granted jurisdiction over the issuance and enforcement of Waste Discharge Requirements (WDRs), NPDES permits, and Section 401 water quality certifications.

CALIFORNIA STATE ANTIDEGRADATION POLICY (SWRCB RESOLUTION NO. 68-16, "POLICY WITH RESPECT TO MAINTAINING HIGHER QUALITY WATERS IN CALIFORNIA")

In 1968, the State of California adopted an antidegradation policy in response to directives under the Federal Antidegradation Policy. The antidegradation policy applies to high quality waters of the State, including surface waters and groundwater, and all existing and potential uses. The policy requires that high quality waters be maintained to the maximum extent possible and any proposed activities that can adversely affect high quality surface water and groundwater must (1) be consistent with the maximum benefit to the people of the State, (2) not unreasonably affect present and anticipated beneficial use of the water, and (3) not result in water quality less than that prescribed in water quality plans and policies.

CALIFORNIA DEPARTMENT OF FISH AND GAME CODE SECTIONS 1600–1603 (STREAMBED ALTERATION)

The California Department of Fish and Wildlife (CDFW) is responsible for conserving, protecting, and managing California's fish, wildlife, and native plant resources. The CDFW Lake and Streambed Alteration Program (Fish and Games Codes 1600-1603) states that it is unlawful to substantially divert or obstruct the natural flow of any river, stream or lake, or substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it could pass into any river, stream, or lake as designated by CDFW. Any proposed activity that violates the aforementioned rule must obtain a Lake or Streambed Alteration Agreement. The Lake or Streambed Alteration Agreement notifies CDFW of the proposed activity and provides proof that the activity will not substantially adversely affect existing fisheries and wildlife, and mitigation measures or BMPs will be employed to protect fish and wildlife resources. The Lake or Streambed Alteration Agreement is required for any work conducted within the 100-year floodplain of a stream or river and adjacent riparian areas.

OTHER FEDERAL AND STATE REGULATIONS

Other federal and state regulations pertaining to geologic, hydrologic, and/or soil resources, but not affected by the Program include:

- National Earthquake Hazards Reduction Act (U.S. Code Title 42 Section 7704)
- Alquist Priolo Earthquake Fault Zoning Act (Public Resources Code Section 2621-2630)
- Seismic Hazards Mapping Act (Public Resources Code, Chapter 7.8, Section 2690-2699.6)
- Surface Mining and Reclamation Act of 1975 (Public Resources Code Section 2710)

4.3.1.2 Environmental Setting

The following subsections use geomorphic provinces as stratification for characterizing baseline geologic, hydrologic, and soils conditions (i.e., hydrogeomorphic conditions) at the state-wide scale.

4.3.1.2.1 Geomorphic Provinces

At very broad scales, climate, geology, and topography determine overall runoff characteristics, earth material properties, and slope (Montgomery, 1999). Climate drives temperature and precipitation, which can influence geologic weathering and the type, timing, and magnitude of hillslope and fluvial runoff. Geology controls material strength and lithology (rock type), which directly affects the hydrologic properties (i.e., infiltration capacity, hydraulic conductivity) of soils due to the parent material's differing proportion of sand, silt, and clay (Montgomery and Bolton, 2003). Topography has an important influence on hydrogeomorphic processes due to its effect on slope, which controls the hydraulic gradient of water flow, as well as the driving forces for landsliding (Montgomery, 1999).

Geomorphic provinces are spatial units that distinguish between variations in tectonic setting, topography, rock type, geological structure, climate, and climate history (Montgomery, 1999). This hierarchical perspective helps to focus broad scale impact assessment of proposed projects on hydrogeomorphic processes and the resources of concern that are influenced by these processes (Frissell et al., 1986). This assessment utilizes the geomorphic province as the principle stratification when assessing impacts to geomorphic and hydrologic processes.

Figure 4.3-2 shows the recognized geomorphic provinces for California and Table 4.3-1 provides a general description for each province. Table 4.3-1 also provides a relative characterization for province scale tectonic setting, rock/soil strength, topographic relief, and precipitation. These variables will be described in more detail further in this subsection.

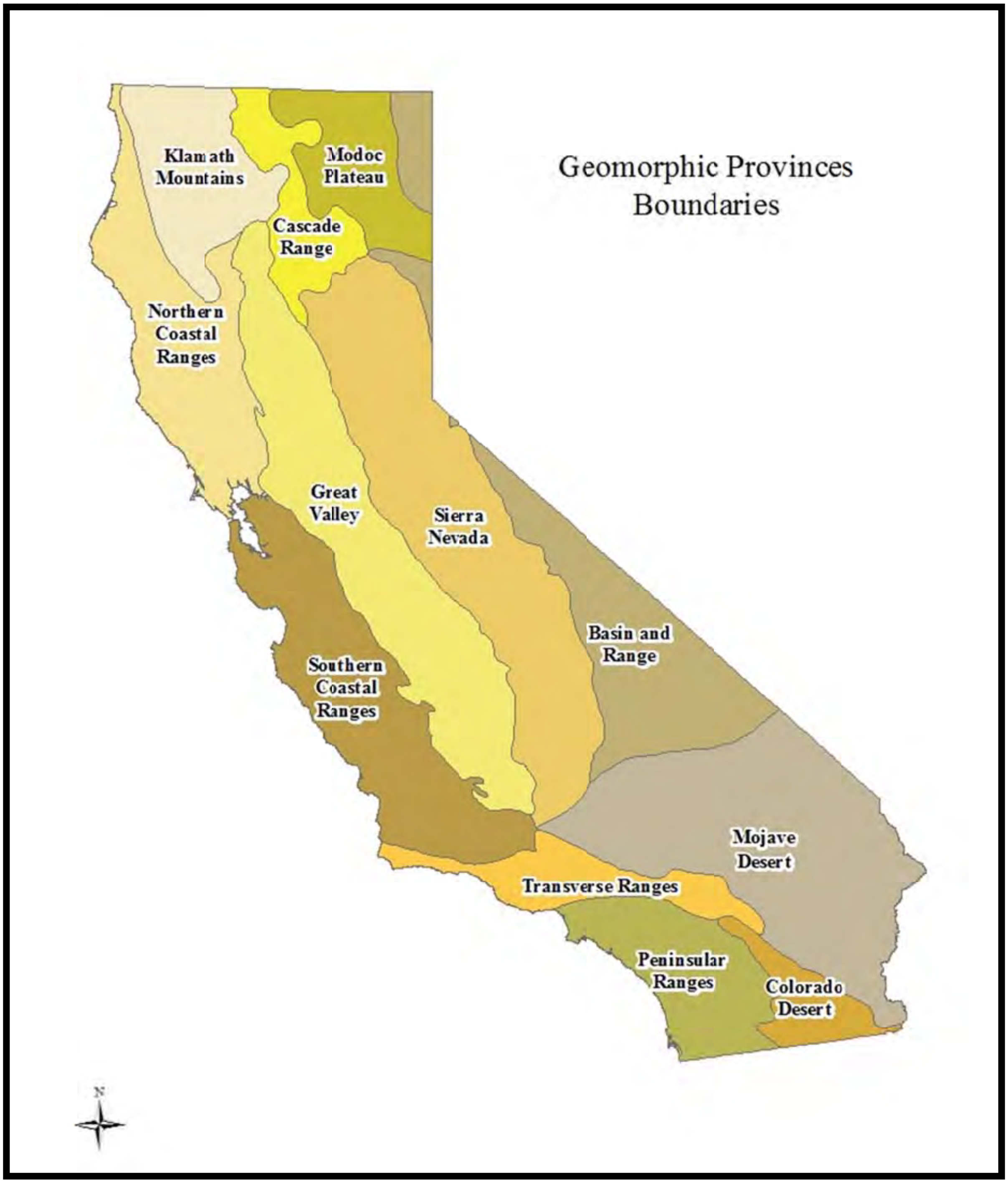


Figure 4.3-2 Geomorphic provinces of California (CGS, 2002)

BASIN AND RANGE

The Basin and Range province is a large region of alternating north-south trending faulted mountains and valley floors that encompasses the majority of the western U.S, including portions of southern Oregon, eastern California, southern portions of Arizona and New Mexico, western Texas, and the majority of Nevada. The province is characterized by rugged desert country with high topographic relief. Within California, the lowest point is 282 feet below sea level in Death Valley and the highest elevation is 14,242 feet above sea level at White Mountain Peak (Sharp, 1994). California's portion of the Basin and Range province includes three separate physiographic areas. The northernmost portion of the province is bounded by the Modoc Plateau province and the Nevada border. The middle portion of the province is bounded to the north by the Modoc Plateau province and to the south by the Sierra Nevada province. The largest and southernmost portion of the province is bounded on the west by the Sierra Nevada province, to the south by the Mojave Desert province, and to the east by the Nevada border. The Basin and Range province is cut off abruptly by the Garlock fault to the south. The mountain ranges and intervening valleys are 50 to 100 miles long and 15 to 20 miles wide (Sharp, 1994).

CASCADE RANGE

The Cascade Range is a mountainous region stretching from British Columbia, Canada, down to northern California. The Cascade Range is part of the Pacific Ring of Fire, a nearly continuous arc of intense seismicity and volcanoes around the Pacific Ocean. All of the known historic eruptions in the contiguous United States have originated from Cascade Range volcanoes (Sutch and Dirth, 2003). The last Cascade Range volcano to erupt in California was Lassen Peak, which erupted from 1914 to 1921. Lassen Peak is the most southerly active volcano in the Cascade Range volcanic chain.

The California portion of the Cascade Range province is located between the Klamath Mountains province to the west and the Modoc Plateau province to the east, and extends south from the Oregon border to the Great Valley and Sierra Nevada provinces (Sutch and Dirth, 2003). The northern part of the Cascade Range in California is divided into the Western Cascade Range and the High Cascade Range. The Western Cascades are composed of eroded Oligocene to Pliocene volcanic and volcaniclastic rocks overlying older Upper Cretaceous and Eocene sedimentary rocks. Volcanic rocks of the Western Cascade series were faulted and tilted eastward and northeastward in the Late Miocene (MacDonald, 1966).

Erosion destroyed the steep volcanic landforms of the Western Cascade Range and reduced the region to gentle rolling hills before renewed volcanism built the High Cascade Range. Southward the volcanic rocks of the Western Cascade Range are overlapped by those of the High Cascade Range. The High Cascade Range within California consists largely of pyroxene andesite and is characterized by a long ridge of eroded topography with few, if any, large volcanic cones (MacDonald, 1966).

COAST RANGES

The Coast Ranges province extends 400 miles along the Pacific Coast from the Oregon Border south to the Santa Ynez Mountains at the Transverse Ranges boundary. The evolution of the Coast Ranges is a result of typical tectonic, sedimentary, and igneous processes of the circum-Pacific orogenic belt (Page, 1966). The province can be further divided into northern and southern ranges separated by the San Francisco Bay. The San Francisco Bay is located in a structural depression created by the east-west expansion of the San Andreas and Hayward fault systems.

The California Coast Ranges are primarily composed of Jurassic- to Cretaceous-age (about 65-150 million years old) marine sedimentary and volcanic rocks of the Franciscan assemblage. The Franciscan assemblage consists of partially metamorphosed greenstone, basalt, chert, and graywacke that originated as sea floor sediments. The coastline along this province is uplifted, wave-cut, and terraced. The eastern border of the Coast Ranges province is characterized by strike-ridges and valleys in Mesozoic strata (CGS, 2002).

COLORADO DESERT

The Colorado Desert province is located to the east of the Peninsular Ranges province and west of the Mojave Desert province. Part of the boundary on the north is formed by the eastern Transverse Ranges. The eastern boundary runs along the Little San Bernardino, Orocopia, and Chocolate Mountains. The Colorado River runs through the extreme southeast corner of the province. Elevations throughout the province are low and extend below sea level in the valley bottoms. The Salton Trough, a northwest trending basin located completely within the province, is the largest area below sea level in the Western Hemisphere. The trough is a pull-apart structure where crustal spreading is taking place. The Salton Sea, the largest lake in California, is located within the Salton trough and receives drainage from the Coachella Valley to the north and the Imperial Valley to the south. The crust beneath the Salton Sea is 12 to 15 miles thick, about six miles thinner than continental crust in other areas, and is seismically active

(Sutch and Dirth, 2003). The Salton Trough was filled intermittently with the large ancient Cahuilla Lake during the Pleistocene. Fossil shorelines are well defined at the base of the Santa Rosa Mountains.

GREAT VALLEY

The Great Valley of California, also called the Central Valley of California or the San Joaquin-Sacramento Valley, is a nearly flat alluvial plain extending from the Tehachapi Mountains on the south to the Klamath Mountains to the north, and from the Sierra Nevada to the east to the Coast Ranges to the west. Elevations of the alluvial plain are nearly 300 feet above sea level, with extremes ranging from a few feet below sea level to about 1,000 feet above sea level. The only prominent topographic feature within the central part of the valley is the Marysville (Sutter) buttes, a Pliocene volcanic plug that abruptly rises 2,000 feet above the surrounding valley floor.

Geologically, the Great Valley is a large elongate northwest-trending asymmetric structural trough that has been filled with tremendously thick sequences of sediments ranging in age from Jurassic to Recent and has a long stable eastern shelf supported by the subsurface continuation of the granitic Sierran slope and the short western flank expressed by the upturned edges of the basin sediments. The basin has a regional southward tilt and is cut by two significant cross-valley faults. The northernmost fault, the Stockton fault, is the boundary used by most geologists to separate the Great Valley Basin into the Sacramento and San Joaquin River basins. The other great cross-fault lies near the southern end of the basin and is named the White Wolf fault.

KLAMATH MOUNTAINS

The Klamath Mountains cover an elongated north-trending area within northern California and southern Oregon. In California, it includes many different mountain ranges including the South Fork, Salmon, Scott, Scott Bar, and Marble Mountains, the Trinity Alps, and the southern portion of the Siskiyou Mountains (Irwin, 1966). Accordant summit levels, highly dissected old land surfaces, and high elevation glacial topography are striking features of many of the ranges within the Klamath Mountains province. The slopes of most of the ranges are heavily forested with fir and pine, particularly in the western portion of the province. The thick forest cover is largely due to heavy rainfall during the winter months (Irwin 1966). Most of the rainfall drains westerly through deeply incised canyons of the Klamath and Trinity Rivers. The easternmost areas of the province drain towards the east and then south to the Sacramento River (Irwin 1966).

The principle rocks of the Klamath Mountains were deposited and concreted during the Nevadan Orogeny (Late Jurassic). The rocks range from Ordovician to Late Jurassic in age and consist largely of greywacke sandstones, mudstones, greenstones, radiolarian cherts, limestone, and igneous intrusive rocks (Irwin, 1966). Their pattern of distribution is one of concentric arcuate belts that from east to west are referred to as the Eastern Klamath, Central Metamorphic, and Western Paleozoic and Triassic, and Western Jurassic belts.

MODOC PLATEAU

The Modoc Plateau consists of a series of northwest to north-trending block-faulted ranges, with intervening basins filled with broad-spreading “plateau” basalt flows, or with small shield volcanoes, steeper sided lava or composite cones, cinder cones, and lake deposits resulting from disruption of the drainage by faulting or volcanism (MacDonald, 1966). The Modoc Plateau contains an expanse of lava flows at an altitude of 4,000 to 6,000 feet and is considered a part of the western extent of the Great Basin that was flooded by volcanics related to the Cascade Range volcanics (MacDonald, 1966). The province is bounded on the west by the Cascade Ranges province, to the east and south by the Basin and Range province, and to the north by the Oregon border.

MOJAVE DESERT

The Mojave Desert Province is a broad interior region isolated by mountain ranges separated by expanses of desert plain (CGS, 2002). Valley bottoms range in elevation from 2,000-4,000 above sea level and mountains range between 3,500 and 5,000 feet. The highest elevation in the province is 7,929 feet at Clark Mountain (Sutch and Dirth, 2003). The province is situated in the southeastern corner of California and bordered by the Basin and Range province and the Sierra Nevada province to the north, and the Transverse Ranges province and the Colorado Desert provinces to the southwest (Sutch and Dirth 2003). In relation to tectonics, the Mojave Desert is bordered by the Garlock fault to the north, the San Andreas Fault to the southwest, and the southern extension of the Death Valley fault zone to the east (Walker et al. 2002). Rocks of Precambrian to late Cenozoic age are exposed across the greater Mojave Desert Province region. The area forms the southeastern extent of the Precambrian continental North America (Martin and Walker, 1992).

PENINSULAR RANGES

The Peninsular Ranges province consists of southeast-northwest trending ranges separated by long valleys that run sub-parallel to faults branching from the San Andreas Fault. The Peninsular Ranges merge northward into the Los Angeles Basin, where their northwest trend eventually terminates against the east-west trending Transverse Ranges Province. The Peninsular Ranges province is bounded by the Transverse Ranges province to the north, the Colorado Desert province to the east, and the Mexico border to the south. Westward, the province does not end at the Pacific shore, but continues far out under the ocean as a broad submerged continental borderland.

SIERRA NEVADA

The Sierra Nevada is a strongly asymmetric mountain range with a long gentle western slope, and a high and steep eastern escarpment. It is 50 to 80 miles wide and runs northward through eastern California for more than 400 miles, from the Mojave Desert in the south to the Cascade Range in the north. The topography of the Sierra Nevada is shaped by uplift and glacial action. The Sierra Nevada is a huge block of the earth's crust that has broken free on the east along the Sierra Nevada fault system and been tilted westward. It is overlapped on the west by sedimentary rocks of the Great Valley and on the north by volcanic sheets extending south from the Cascade Range. A blanket of volcanic material caps large areas in the northern part of the range.

Most of the south half of the Sierra Nevada and the eastern part of the northern half are composed of plutonic (chiefly granitic) rocks of the Mesozoic age. These rocks compose the Sierra Nevada batholith, a part of an early continuous belt of plutonic rocks that extend from Baja California northward through the Peninsular Ranges and the Mojave Desert. It extends east through the Sierra Nevada at an arcuate angle to the long axis of the range and to the west into Nevada.

TRANSVERSE RANGES

The Transverse Ranges province averages 30 miles long and is nearly 300 miles wide, extending from Point Arguello eastward to the Eagle Mountains in the Colorado Desert (Sharp, 1994). Mountains in the Transverse Ranges province are composed of progressively older rocks from the west to the east (Sutch and Dirth, 2003). The east-west trending landscape defines the Transverse Ranges province, so named because structurally, the geologic features of this province are crosswise to the usual north-westerly trend of California topography. This characteristic is established by faults and folds that control the trend and shape of the mountains, valleys and coastline. Sedimentary rocks predominate in the west and older igneous and metamorphic rocks predominate in the east (Sharp, 1994). One of the largest pre-historic landslides in the nation, the Blackhawk landslide, is found within this province. This landslide is located on the north side of the San Bernardino Mountains and is five miles long and two miles wide and up to 100 feet thick. The volume of the landslide is estimated to be 370 million cubic yards in size (Sutch and Dirth, 2003).

TECTONIC SETTING

Tectonics refers to the large scale processes that move and deform the earth's crust. Tectonics is most relevant to hydrogeomorphic processes through the mechanisms of relief production and the weakening of earth materials through fracturing (Molnar et al., 2007). Relief production increases the potential energy of erosive agents, whereas rock fracturing decreases the size of earth material thereby making it more susceptible to transport. Table 4.3-1 characterizes the tectonic setting for the various geomorphic provinces. A designation of "low" indicates that tectonic activity is relatively quiescent, whereas "high" indicates that tectonic activity has resulted in seismic activity, relatively high relief, and/or large scale weakening of earth materials.

The lowest tectonic activity is associated with the Great Valley and Modoc Plateau geomorphic provinces. The tectonic setting of the Great Valley is one of a forearc basin situated between the Sierran arc and the Mesozoic subduction zone, whereas the Modoc Plateau has been subject to crustal extension (Harden, 2004). The Sierra Nevada and Klamath Mountains display moderate tectonic activity. The Sierra Nevada is the recently uplifted remains of an ancient volcanic arc formed by Mesozoic subduction and accretion. The Klamath Mountains province is a result of Mesozoic subduction, accretion, and intrusion of granitic plutons (Harden, 2004).

Moderate to high levels of tectonic activity are present in the Transverse Ranges, Basin and Range, Peninsular Ranges, and Coast Ranges. The Transverse Ranges are presently subjected to transform plate motion and strike-slip shearing. The left-stepping bend in the San Andreas Fault has resulted in compressional forces causing some of the highest rates of uplift in the world (Harden, 2004). The Basin and Range province has been subjected to crustal extension for the past 22 million years (Harden, 2004) and has been subject to strong earthquakes. The Peninsular Ranges are currently subject to transform faulting and are also subject to uplift (Harden, 2004). The Coast Ranges have a complex tectonic history of Mesozoic subduction and accretion, as well as Cenozoic transform plate motion associated with the San Andreas Fault.

Some of highest levels of tectonic activity are associated with crustal extension in the Colorado Desert geomorphic province. This tectonic activity has resulted in features such as the Salton Trough, a pull-apart sedimentary basin that has also experienced relatively recent volcanism. The Mojave Desert province is bounded on the west by the San Andreas Fault and the north by the Garlock Fault, and has also been subjected to crustal extension and recent volcanism. The Cascade Range province is associated with active subduction along the Cascadia subduction zone. Active subduction has resulted in volcanic cone formation, with the elevation of Mount Shasta exceeding 14,000 feet. High levels of tectonic activity are also associated with portions of the Coast Ranges proximal to the Mendocino Triple Junction. This portion of the Coast Ranges has been subjected to extensive deformation, crustal thickening, and relief production (Furlong and Govers, 1999).

ROCK/SOIL STRENGTH

Rock and soil strength refers to the ability of the earth material to resist deformation by compressive, tensile, or shear stresses, the ability of the material to resist abrasion, or the resistance of the material to be transported in a fluid (Selby, 1982). Weaker materials will generally be more susceptible to significant impacts (i.e., erosion, mass wasting, etc.) from land use activities than stronger materials. In Table 4.3-1, a designation of “low” means that the rock/soil material has relatively high erodibility, whereas a designation of “high” indicates that the earth material has a high resistance to erosion processes.

The weakest materials are shale, claystone, pre-existing landslides, and unconsolidated sedimentary units. Intermediate rock strength values are assigned to materials such as weakly cemented sandstones. The highest material strength is assigned to crystalline rock (e.g., granitic rocks) and strongly cemented sandstones. Figure 4.3-3 shows that the largest areas of weak earth materials are in the sedimentary basins of the Great Valley, Mojave Desert, and Colorado Desert geomorphic provinces. However, slopes in these areas are generally gentle or flat. Areas of low rock strength are also common in the Transverse Ranges and Coast Ranges geomorphic provinces. Intermediate rock/soil strength is common in the Cascade Range, Modoc Plateau, and Northern Coastal Ranges geomorphic provinces. The highest strength values for earth materials are in the Klamath Mountains and Sierra Nevada geomorphic provinces, although some high strength rock units are also found in the Transverse Ranges, Peninsular Ranges, and in portions of the Coast Ranges geomorphic provinces.

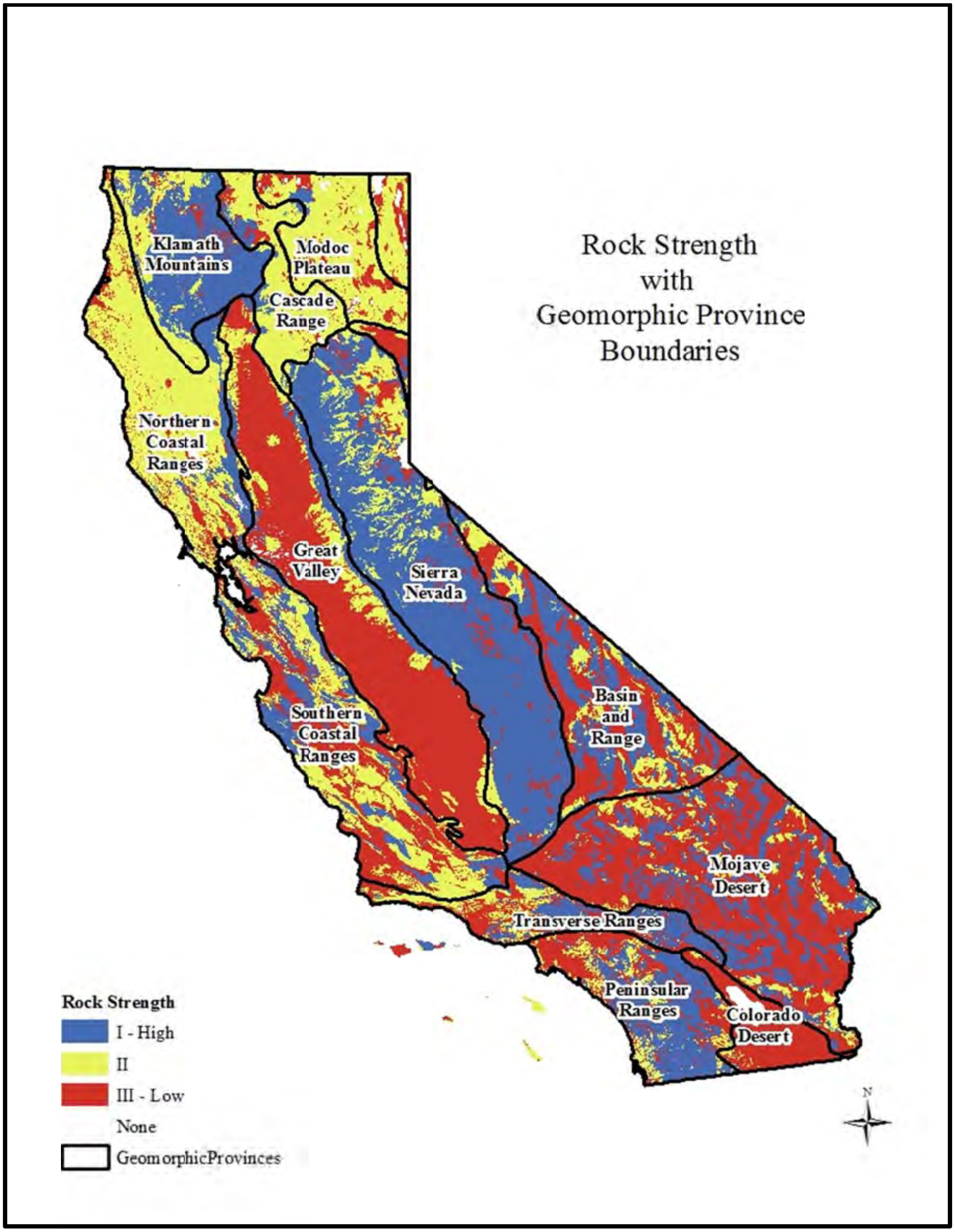


Figure 4.3-3 Relative rock strength by geomorphic province. Category I (blue) represents the highest rock strength, Category II (yellow) represents moderate rock strength, and Category III represents low rock strength (CGS, 2011). Lower rock strengths typically represent less resistance to erosion processes.

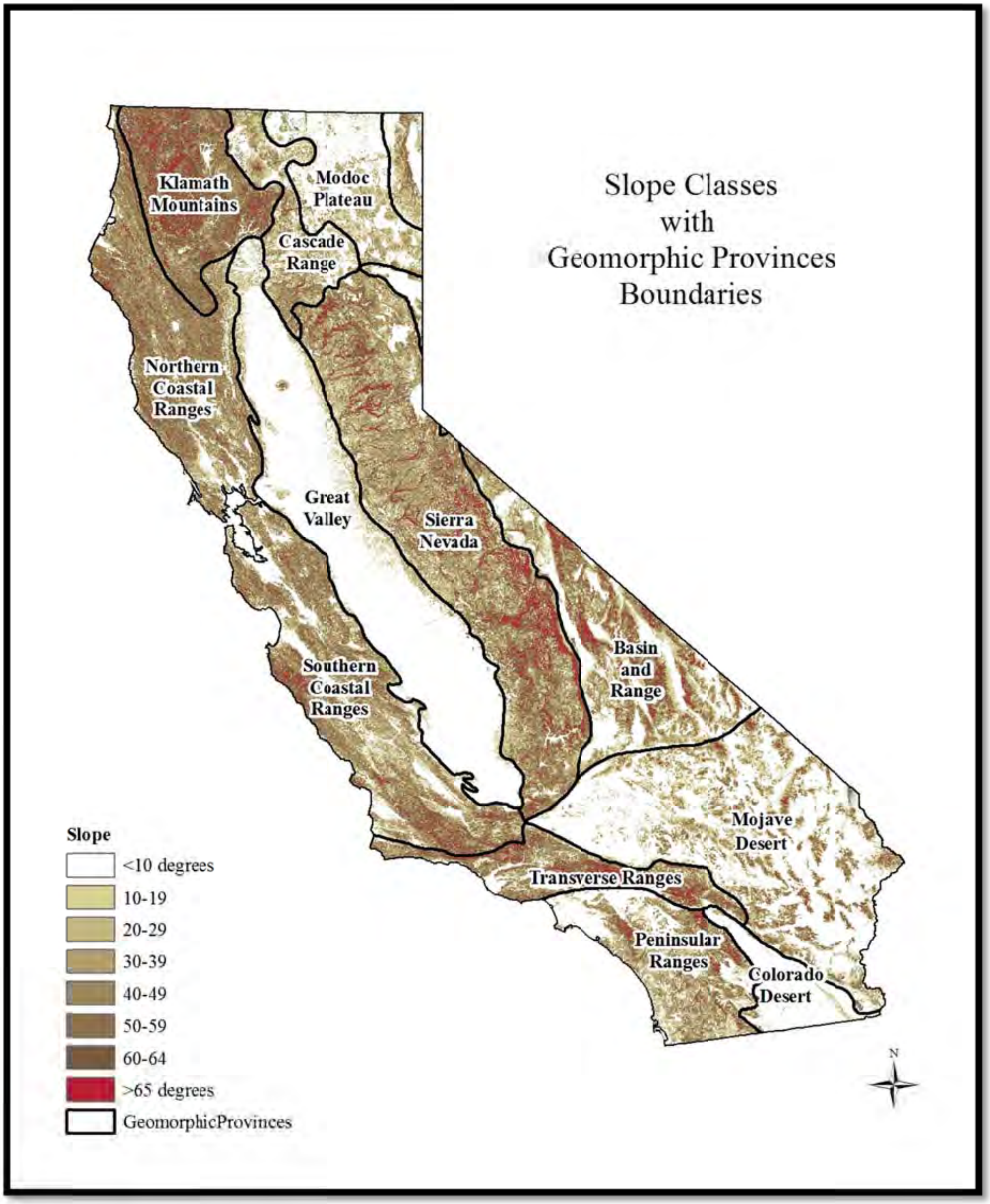


Figure 4.3-4 Slope percentage class by geomorphic province. The steepest slopes are in the Klamath Mountains, Coast Ranges, Sierra Nevada, and Transverse Ranges. Slopes over 65% are more susceptible to shallow landsliding (CGS, 2013).

TOPOGRAPHIC RELIEF

Topography has an important influence on hydrogeomorphic processes due to its effect on slope, which controls the hydraulic gradient of water flow, the energy of erosive runoff, as well as the driving forces for landsliding (Montgomery, 1999). Topography is strongly controlled by an area's tectonic setting (Wobus et al., 2006). In Table 4.3-1, a designation of "low" means that the geomorphic province has relatively gentle slopes and a province with a characterization of "high" has relatively steep slopes.

Geomorphic provinces with low topographic relief include the Colorado Desert and the Great Valley provinces. Low to moderate topographic relief exists for the Modoc Plateau and the Mojave Desert geomorphic provinces. Low to high relief is a characteristic of the Basin and Range province, whereas the Coast Ranges province displays moderate to high topographic relief. The highest topographic relief occurs in the Klamath Mountains, Sierra Nevada, and Cascade Ranges geomorphic provinces, where maximum elevations exceed 9,000 to 14,000 feet.

PRECIPITATION

Precipitation is a driving input that influences weathering, soil moisture, hillslope runoff, and hydrology. In general, areas with higher magnitudes of precipitation will have a higher susceptibility to impacts from land use activities. Precipitation can have a paradoxical effect on erosion due to its influence on vegetative cover. Areas with higher precipitation can have lower erosion rates due to the shielding cover of vegetation. However, in the absence of vegetative cover, higher precipitation magnitudes generally will result in higher erosion rates. As such, geomorphic provinces designated as "high" (Table 4.3-1) will have the highest precipitation magnitudes, and potentially the most significant erosion processes.

The lowest annual precipitation occurs in the Mojave Desert, Colorado Desert Basin and Range, and Great Valley geomorphic provinces. Both the Basin and Range and Great Valley provinces show a progressive increase in precipitation magnitude in a northward direction. The Modoc Plateau and Peninsular Ranges shows a low to moderate annual precipitation magnitude, whereas the Transverse Ranges and southern portion of the Coast Ranges show a moderate amount of annual precipitation. The highest amount of precipitation is associated with the crests of the Northern Coast Ranges, Cascade Ranges, Klamath Mountains, and Sierra Nevada geomorphic provinces.

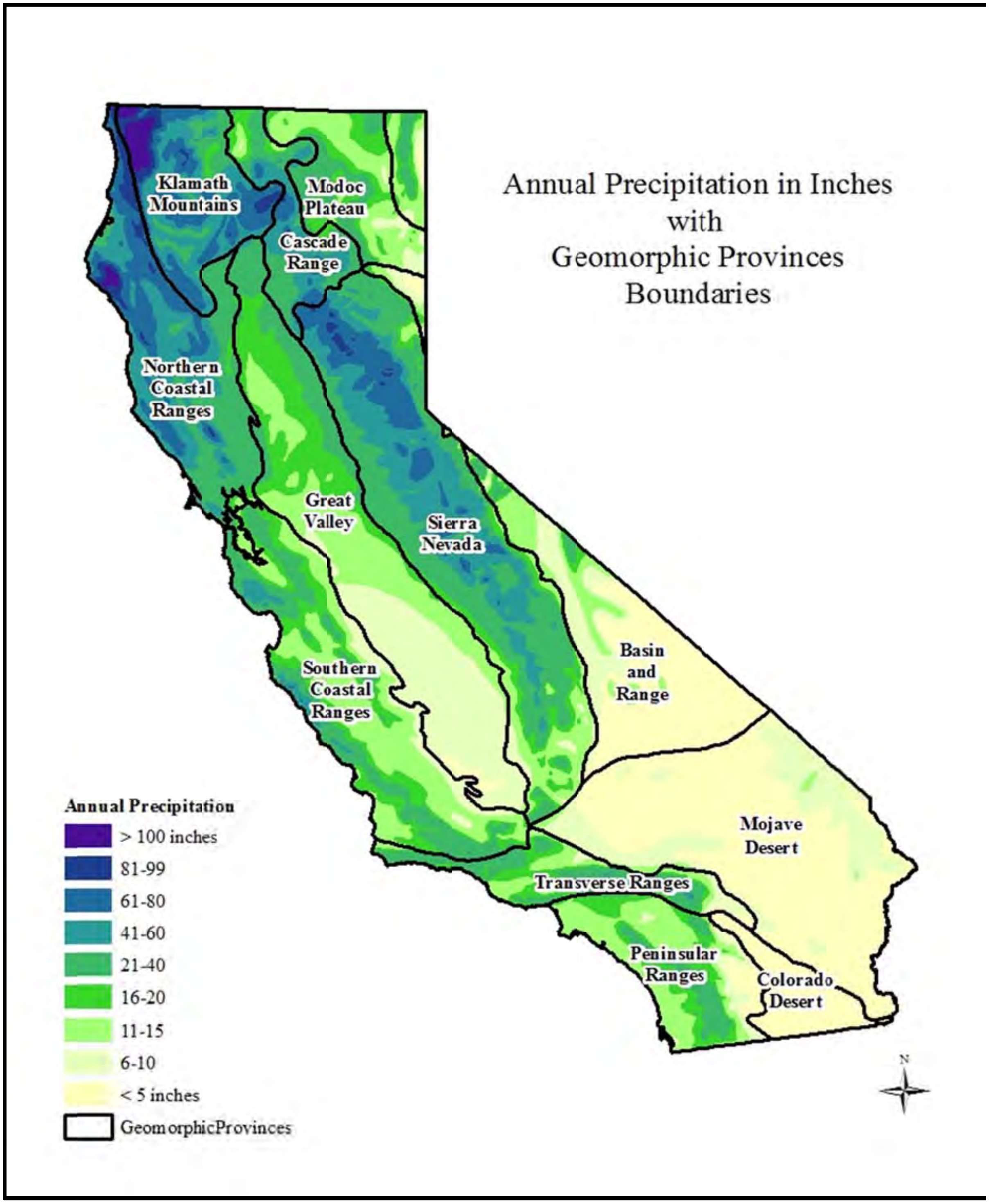


Figure 4.3-5 Annual precipitation by geomorphic province. The Northern Coast Ranges, Klamath Mountains, Cascade Range, and Sierra Nevada have the highest precipitation rates.

Table 4.3-1 Summary of the factors driving hydrogeomorphic processes for each geomorphic province. Relative rankings of the three variables provided by California Geological Survey Engineering Geologist Chris Gryszan, P.G. and Senior engineering Geologist Donald Lindsay, P.G., C.E.G., P.E..

Geomorphic Provinces	Description of Geomorphic Provinces	Tectonic Setting	Rock/Soil Strength	Topographic Relief	PPT
Colorado Desert	A low-lying barren desert basin, about 245 feet below sea level in part, is dominated by the Salton Sea. The province is a depressed block between active branches of alluvium-covered San Andreas Fault with the southern extension of the Mojave Desert on the east.	High	Low	Low	Low
Cascade Range	The Cascade Range, a chain of volcanic cones, extends through Washington and Oregon into California. It is dominated by Mount Shasta, a glacier-mantled volcanic cone, rising 14,162 feet above sea level. The southern termination is Lassen Peak, which last erupted in the early 1900s. The Cascade Range is transected by deep canyons of the Pit River. The river flows through the range between these two major volcanic cones, after winding across interior Modoc Plateau on its way to the Sacramento River	High	Moderate to High	High	High
Modoc Plateau	A volcanic table land (elevation 4,000-6,000 feet above sea level) consisting of a thick accumulation of lava flows and tuff beds along with many small volcanic cones. Occasional lakes, marshes, and sluggishly flowing streams meander across the plateau. The plateau is cut by many north-south faults. The province is bound indefinitely by the Cascade Range on the West and the Basin and Range on the east and south.	Low	Moderate	Low to Moderate	Low to Moderate
Sierra Nevada	A tilted fault block nearly 400 miles long. Its east face is a high, rugged multiple scarp, contrasting with the gentle western slope (about 2°) that disappears under sediments of the Great Valley. Deep river canyons are cut into the western slope. Their upper courses, especially in massive granites of the higher Sierra, are modified by glacial sculpturing. The northern Sierra boundary is marked where bedrock disappears under the Cenozoic volcanic cover of the Cascade Range.	Moderate	High	High	High
Great Valley	An alluvial plain about 50 miles wide and 400 miles long in the central part of California. Its northern part is the Sacramento Valley, drained by the Sacramento River and its southern part is the San Joaquin Valley drained by the San Joaquin River. The Great Valley is a trough in which sediments have been deposited almost continuously since the Jurassic.	Low	Low	Low	Low
Klamath Mountains	Rugged topography with prominent peaks and ridges reaching 6,000-8,000 feet above sea level In the western Klamath, an irregular drainage is incised into an uplifted plateau called the Klamath peneplain. The Klamath River follows a circuitous course from the Cascade Range through the Klamath Mountains. The province is considered to be a northern extension of the Sierra Nevada.	Moderate	Moderate to High	High	High

Geomorphic Provinces	Description of Geomorphic Provinces	Tectonic Setting	Rock/Soil Strength	Topographic Relief	PPT
Transverse Ranges	An east-west trending series of steep mountain ranges and valleys. The east-west structure of the Transverse Ranges is oblique to the normal northwest trend of coastal California, hence the name "Transverse." The province extends offshore to include San Miguel, Santa Rosa, and Santa Cruz islands. Its eastern extension, the San Bernardino Mountains, has been displaced to the south along the San Andreas Fault. Intense north-south compression is squeezing the Transverse Ranges. As a result, this is one of the most rapidly rising regions on earth.	Moderate to High	Low to High	High	Moderate
Basin and Range	The westernmost part of the Great Basin. The province is characterized by interior drainage with lakes and playas, and the typical horst and graben structure (subparallel, fault-bounded ranges separated by down dropped basins). Death Valley, the lowest area in the United States, is one of these grabens. Another graben, Owens Valley, lies between the bold eastern fault scarp of the Sierra Nevada and Inyo Mountains. The northern Basin and Range Province includes the Honey Lake Basin.	Moderate to High	Low to High	Low to High	Low
Peninsular Ranges	A series of ranges separated by northwest trending valleys, subparallel to faults branching from the San Andreas Fault. The trend of topography is similar to the Coast Ranges, but the geology is more like the Sierra Nevada, with granitic rock intruding the older metamorphic rocks. The Peninsular Ranges extend into lower California and are bound on the east by the Colorado Desert. The Los Angeles Basin and the island group (Santa Catalina, Santa Barbara, and the distinctly terraced San Clemente and San Nicolas islands), together with the surrounding continental shelf (cut by deep submarine fault troughs), are included in this province.	Moderate to High	High	High	Low to Moderate
Coast Ranges	Northwest-trending mountain ranges (2000 to 6000 feet a.s.l.) and valleys. The ranges and valleys trend northwest, subparallel to the San Andreas Fault. Strata dip beneath alluvium of the Great Valley. To the west is the Pacific Ocean. The coastline is uplifted, terrace and wave-cut. The Coast Ranges are composed of thick Mesozoic and Cenozoic sedimentary strata. The northern and southern ranges are separated by a depression containing the San Francisco Bay. The northern Coast Ranges are dominated by irregular, knobby, landslide-topography of the Franciscan Complex. The eastern border is characterized by strike-ridges and valley in Upper Mesozoic strata. In several areas, Franciscan rocks are overlain by volcanic cones and flows of the Quien Sabe, Sonoma, and Clear Lake volcanic fields. The Coast Ranges are subparallel to the active San Andreas Fault. West of the San Andreas is the Salinian Block, a granitic core extending from the southern extremity of the Coast Ranges to the north of the Farallon Islands.	Moderate to High	Low to Moderate	Moderate to High	Moderate to High
Mojave Desert	A broad interior region of isolated mountain ranges separated by expanses of desert plains. It has an interior enclosed drainage and many playas. There are two important fault trends that control topography: a prominent NW-SE trend and a secondary east-west trend (apparent alignment with the Transverse Ranges is significant). The Mojave province is wedged in a sharp angle between the Garlock Fault (southern bounded Sierra Nevada) and the San Andreas Fault, where it bends east from its northwest trend. The northern boundary of the Mojave is separated from the prominent Basin and Range by the eastern extension of the Garlock Fault.	High	Low to Moderate	Low to Moderate	Low

4.3.1.2.2 Hydrology

Climate influences streamflow through the interactions between temperature and the type, amount, and timing (i.e., season) of precipitation (Montgomery and Bolton, 2003). Historically, precipitation is typically dominated by snow for elevations above 4,500-6,000 feet, with the snowline typically decreasing in elevation with increasing latitude (Krutz, 1972). Rock type is an important determinant of runoff characteristics due to its effect on permeability. Some permeable rock types (e.g., young basalts) show a paucity of surface runoff and the predominance of spring-fed rather than storm dominated runoff. Runoff processes are highly nonlinear and spatially and temporally variable, partially due to topographic variability in soil moisture, slope, and vegetation (Montgomery and Bolton, 2003).

SURFACE WATERS

For the purposes of the Program EIR, surface waters occur as streams, lakes, ponds, coastal waters, lagoons, and estuaries, or found in floodplains, dry lakes, desert washes, wetlands and other collection sites. Waterbodies modified or developed by man, including reservoirs and aqueducts, are also considered surface waters. Surface water resources are very diverse due to the high variance in tectonics, topography, geology/soils, climate, precipitation, and hydrologic conditions. Overall, California has the most diverse range of watershed conditions in the U.S., with varied climatic regimes ranging from Mediterranean climates with temperate rainforests in the north coast region to desert climates containing dry desert washes and dry lakes in the southern central region.

The average annual runoff for the State is 71 million acre-feet (DWR, 1998). The state has more than sixty major stream drainages and more than 1,000 smaller, but significant basins that drain coastal mountains and inland mountainous areas. High snowpack levels (during years with normal or above normal precipitation) and resultant spring snowmelt yield high surface runoff and peak discharge in the Sierra Nevada and Cascade Mountains that feed surface flows, fill reservoirs and recharge groundwater. Federal, state and local engineered water projects, aqueducts, canals, and reservoirs serve as the primary conduits of surface water sources to areas that have limited surface water resources. Most of the surface water storage is transported for agricultural, urban, and rural residential needs to the San Francisco Bay Area and to cities and areas extending to southern coastal California. Surface water is also transported to southern inland areas, including Owens Valley, Imperial Valley, and Central Valley areas.

GROUNDWATER

The majority of runoff from snowmelt and rainfall flows down mountain streams into low gradient valleys and either percolates into the ground or is discharged to the sea. This percolating flow is stored in alluvial groundwater basins that cover approximately 40 percent of the geographic extent of the state (DWR, 2003). Groundwater recharge occurs more readily in areas underlain by coarse sediments, primarily in mountain base alluvial fan settings. As a result, the majority of California's groundwater basins are located in broad alluvial valleys flanking mountain ranges, such as the Cascade Range, Coast Ranges, Transverse Ranges, and the Sierra Nevada.

There are 250 major groundwater basins that serve approximately 30 percent of California's urban, agricultural and industrial water needs, especially in the southern portion of San Francisco Bay, the Central Valley, greater Los Angeles area, and inland desert areas where surface water is limited. On average, more than 15 million acre-feet of groundwater are extracted each year in the state, of which more than 50 percent is extracted from 36 groundwater basins in the Central Valley. Over-pumping has become a major concern in the last two decades.

4.3.1.2.3 Hydrology by Geomorphic Province

This section provides a narrative description of hydrology by geomorphic province based on Rantz (1972). Terminology discussed in the narrative follows that outlined by Rantz (1972) in Table 4.3-2.

Table 4.3-2 Runoff classification by precipitation zones (Rantz, 1972). This terminology is used in the narrative descriptions of hydrology by geomorphic province below.

Precipitation zone	Mean annual precipitation (in)	Mean annual runoff (in)	Duration of flow in an average year
Arid	Less than 10	Less than 0.5	A few days to a few weeks
Semiarid	10-20	0.3-5.0	A few days to 275 days
Sub-humid	20-40	3-20	90-365 days
Humid	More than 40	More than 10	335-365 days

COLORADO DESERT AND MOJAVE DESERT

The Colorado Desert and Mojave Desert geomorphic provinces display very similar runoff characteristics (Rantz, 1972). Both provinces are arid, with most of the precipitation occurring during winter storms or during convective storms during the summer. Rainfall intensity is generally higher during the summer, but these types of storms will only generally produce runoff for a few days. In some cases, many years may elapse between runoff generating events. Perennial springs exist in both provinces, but are generally discontinuous as surface flow is rapidly infiltrated into the ground as it progresses from the spring source.

CASCADE RANGES AND MODOC PLATEAU

Similar rock types in the Cascade Range and Modoc Plateau geomorphic provinces (i.e., young volcanic rocks) means that the runoff characteristics of watercourses are similar. The precipitation in these provinces range from humid on the westward side of the Cascade Ranges to semiarid in eastern portions of the Modoc Plateau. In general, precipitation increases in with elevation and decreases in an eastward direction. Snowmelt is an important runoff mechanism in much of the area due to the relatively high elevations associated with the two provinces. Due to the permeability of the young volcanic rocks, water is rapidly infiltrated and typically emerges as base flow. As a result, watercourses are not as responsive to precipitation inputs as in areas with less permeable rock types. The density of watercourses in an area is typically lower due to the high permeability of the surface rock and the general lack of erosive surface flows on young volcanic rock types (Jefferson et al., 2010).

SIERRA NEVADA

Mean annual precipitation for the Sierra Nevada increases with increasing altitude and with increasing latitude. In general, westward slopes receive more precipitation than leeward slopes. Mean annual precipitation fluctuates from 10 inches in the southeast portion of the province to 90 inches in the Feather River basin. As a result, mean annual runoff varies considerably across the province. Snowmelt runoff is the dominant runoff mechanism for most of the large hydrologic basins. Rainfall-related storm runoff is more important for low altitude basins (e.g., Fresno, Calaveras, and Bear River watersheds) and for foothill tributary streams. Base flow is more dominant on eastside streams due to the highly fractured nature of the underlying bedrock, whereas the west side streams have a more variable base flow depending upon the permeability of the underlying bedrock.

GREAT VALLEY

The Great Valley is a low altitude province with annual precipitation ranging from arid in the south to humid in the north. Latitude is the primary determinant of precipitation magnitude. As a result, runoff is typically greatest in the north and lowest in the south. Due to the overall low elevation of the province, snowmelt is not a factor in the hydrology of the province. Streams that originate entirely within the Great Valley province are typically intermittent or ephemeral due to the high permeability of valley alluvium and to the long dry season. Streams originating in the humid mountains around the Valley are typically perennial in nature, but may still lose runoff through seepage to the valley alluvium. Streams originating in the southern portions of the Coast Ranges that drain to the Great Valley are generally ephemeral or intermittent due to seepage losses.

KLAMATH MOUNTAINS

The Klamath Mountain province ranges from humid in the west to semiarid in the east. Precipitation generally decreases from west to east, and increases with elevation. In general, precipitation decreases with distance from the ocean, and increases with elevation. The Klamath Mountains are characterized by highly variable precipitation, with the higher altitudes in the coastal Smith River basin having mean annual precipitation of 120 inches, whereas the Shasta River valley in the east only has an annual precipitation magnitude of 10 inches. Snowmelt is the dominant runoff mechanism for watersheds with much of their elevation over 4,500 feet, whereas storm flow is the more common runoff mechanism when the majority of the watershed is below 4,500 feet. Base flow is well sustained with the exception of small, low altitude watersheds where streams can run dry during summer or early fall.

COAST RANGES

Mean annual precipitation for the Coast Ranges geomorphic province ranges from humid in the north to arid in the southeast. Annual precipitation generally increases with altitude, and when a slope is west-facing or windward. As a result, annual runoff is highest in the northern part of the province and on westward facing slopes. Runoff is generally perennial in the north, but intermittent or ephemeral in the southern portions of the Coast Ranges. Storm runoff is generally the dominant runoff mechanism in the province, but the Yolla Bolly Mountains in the northern portion of the province have an important snowmelt component. There is a substantial difference in runoff regimes between the northern and southern portions of the Coast Ranges, due to the fact that the southern portion of the Coast Ranges doesn't receive storm runoff until later in the winter season.

TRANSVERSE RANGES

The mean annual precipitation of the Transverse Ranges geomorphic province varies from sub-humid to semiarid. Mean annual precipitation increases with altitude and reaches a maximum of 40 inches in some areas. Precipitation is usually higher on south facing slopes than on north slopes. Runoff magnitude follows that of precipitation magnitude. Snowmelt can be a dominant runoff mechanism in watersheds above 6,000 feet. Streams draining alluvial basins only flow during intense storms and most of the runoff can occur in a few days per year. Areas with low rock permeability exhibit flashy runoff response, and 50 percent of the annual runoff may occur in less than 60 days of the year. More permeable lithologies or higher elevation watersheds may have a higher duration of flow throughout the year, with base flow being sustained throughout the summer (e.g. East Fork of the San Gabriel River).

PENINSULAR RANGES

The mean annual precipitation for the Peninsular Ranges geomorphic province varies from sub-humid to arid. Higher elevations receive more precipitation with a maximum magnitude of approximately 40 inches per year. Precipitation is generally higher on the western side of the ranges than on the eastern side. The eastern sides may only receive approximately three inches per year. The spatial pattern of annual runoff mirrors annual precipitation. Snowmelt can be an important runoff process in the higher altitudes, particularly in the northeast portion of the province (i.e. Mount San Jacinto). Streams in the alluvial basins react similarly to those in the Transverse Ranges.

BASIN AND RANGE

The Basin and Range province ranges from arid to semi-arid; with a small area in the north that exhibits a sub-humid environment. Mean annual precipitation and runoff increases with altitude and from south to north. The northern portions of the Basin and Range receive precipitation from winter frontal storms and summer convective storms, and these areas have significant snowmelt runoff. The portion of the province near Goose Lake is underlain by volcanic rocks and has well sustained base flow. The portion of the province draining to Honey Lake is underlain by sedimentary rock has less persistent base flow than the far northern portion. The southern portion of the Basin and Range province on the lee side of the Sierra Nevada receives most of its precipitation during winter frontal storms. Snowmelt is a significant runoff source and base flow can be fairly well sustained. The southernmost arid portion of the Basin and Range is subject to convective summer storms and runoff typically occurs during very short duration runoff events.

4.3.1.2.4 Soils

Soil conditions in California are extremely variable and reflect a diversity of geologic, topographic, climatic, temporal, and vegetative conditions that influence soil formation and composition (Jenny, 1994). Soils are not unique to specific regions or have specific characteristics or properties that distinguish them from other soils. Instead of specific properties that define a regional soil, there is a general gradational transition between the properties of one soil compared to another. As a result, a regional evaluation of soils beyond inventory data is not informative or useful in the context of the VTP PEIR. Rather, general discussions of soil properties are provided.

Soils can be classified using a variety of methods depending on the application of the information. Engineers use classification methods that evaluate the engineering properties of a soil (e.g., Unified Soil Classification System). Soil scientists typically use classification methods that group soils by their intrinsic properties, geologic origin, and soil behavior in different conditions. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) utilizes the USDA soil taxonomy system for the classification of soils. This classification is based on chemical, biological, and physical characteristics of soils, including soil color, texture, structure, mineralogy, salt content, and depth. These characteristics are defined in Chapters 2 and 3 of the 1993 USDA Soil Survey Manual and Soils and Geomorphology authored by Peter Birkeland (1984).

The NRCS has completed comprehensive soil surveys through the NRCS National Cooperative Soil Survey, a nationwide partnership of federal, state, and local agencies that among other things, investigate, classify, interpret, disseminate, and maintain information about soils in the U.S. Soil surveys have been conducted throughout California by the NRCS and information is provided in the U.S. General Soil Map (STATSGO2) and the Soil Survey Geographic (SSURGO2) digital databases. STATSGO2 provides state general soils maps based on generalized soil survey data and is designed as a tool for county, state, regional, and national resource planning and management. SSURGO2 provides detailed soil maps based on field and air photo surveys conducted by the NRCS at scales of 1:15,840 to 1:31,680. These databases not only provide spatial data, but also provide specific soil property data and analyses of potential soil hazards (e.g., soil erodibility). This information should be used when evaluating soils affected by change-in-use projects pursuant to the proposed Program.

SOIL ORDER

Soil Order represents the broadest category of soils using the USDA "Soil Taxonomy." Soil Taxonomy is a basic system of soil classification. There are 12 soil orders, differentiated by the presence or absence of diagnostic horizons: Alfisols, Andisols, Aridisols, Entisols, Gelisols, Histosols, Inceptisols, Mollisols, Oxisols, Spodosols, Ultisols, and Vertisols. Orders are divided into Suborders and the Suborders are farther divided into Great Groups. Ten of the twelve soil orders can be found in California. The following descriptions come from the USDA NRCS web site: soils.usda.gov.

Alfisols: Alfisols are found in semi-arid to moist areas. These soils result from weathering processes that leach clay minerals and other constituents out of the surface layer and to the subsoil, where they can hold and supply moisture and nutrients to plants. They are formed primarily under forest or mixed vegetative cover and are productive for most crops. Alfisols are considered a more productive order of soils.

Andisols: The central concept of Andisols is that of soils dominated by short-range-order minerals. They include weakly weathered soils with much volcanic glass as well as more strongly weathered soils. Hence the content of volcanic glass is one of the characteristics used in defining andic soil properties. Materials with andic soil properties comprise 60 percent or more of the thickness between the mineral soil surface or the top of an organic layer with andic soil properties and a depth of 60 cm or a root limiting layer if shallower. Andisols are considered a more productive order of soils.

Aridisols: The central concept of Aridisols is that of soils that are too dry for mesophytic plants to grow. They have either (1) an aridic moisture regime and an ochric or anthropic epipedon and one or more of the following with an upper boundary within 100 cm of the soil surface: a calcic, cambic, gypsic, natric, petrocalcic, petrogypsic, or a salic horizon or a duripan or an argillic horizon, or (2) a salic horizon and saturation with water within 100 cm of the soil surface for one month or more in normal years. An aridic moisture regime is one that in normal years has no water available for plants for more than half the cumulative time that the soil temperature at 50 cm below the surface is greater than 5° C. and has no period as long as 90 consecutive days when there is water available for plants while the soil temperature at 50 cm is continuously greater than 8° C.

Entisols: The central concept of Entisols is that of soils that have little or no evidence of development of pedogenic horizons. Many Entisols have an ochric epipedon and a few have an anthropic epipedon. Many are sandy or very shallow.

Histosols: The central concept of Histosols is that of soils that are dominantly organic. They are mostly soils that are commonly called bogs, moors, or peats and mucks. A soil is classified as a Histosol if it does not have permafrost and is dominated by organic soil materials.

Inceptisols: The central concept of Inceptisols is that of soils of humid and subhumid regions that have altered horizons that have lost bases or iron and aluminum but retain some weatherable minerals. They do not have an illuvial horizon enriched with either silicate clay or with an amorphous mixture of aluminum and organic carbon. Inceptisols may have many kinds of diagnostic horizons, but argillic, natric kandic, spodic and oxic horizons are excluded.

Mollisols: The central concept of Mollisols is that of soils that have a dark colored surface horizon and are base rich. Nearly all have a mollic epipedon. Many also have an argillic or natric horizon or a calcic horizon. A few have an albic horizon. Some also have a duripan or a petrocalic horizon. Mollisols are considered a more productive order of soils.

Spodosols: The central concept of Spodosols is that of soils in which amorphous mixtures of organic matter and aluminum, with or without iron, have accumulated. In undisturbed soils there is normally an overlying eluvial horizon, generally gray to light gray in color that has the color of more or less uncoated quartz. Most Spodosols have little silicate clay. The particle-size class is mostly sandy, sandy-skeletal, coarse-loamy, loamy, loamy- skeletal, or coarse-silty.

Ultisols: The central concept of Ultisols is that of soils that have a horizon that contains an appreciable amount of translocated silicate clay (an argillic or kandic horizon) and few bases (base saturation less than 35 percent). Base saturation in most Ultisols decreases with depth.

Vertisols: The central concept of Vertisols is that of soils that have a high content of expanding clay and that have at some time of the year deep wide cracks. They shrink when drying and swell when they become wetter. Vertisols are considered a more productive order of soils.

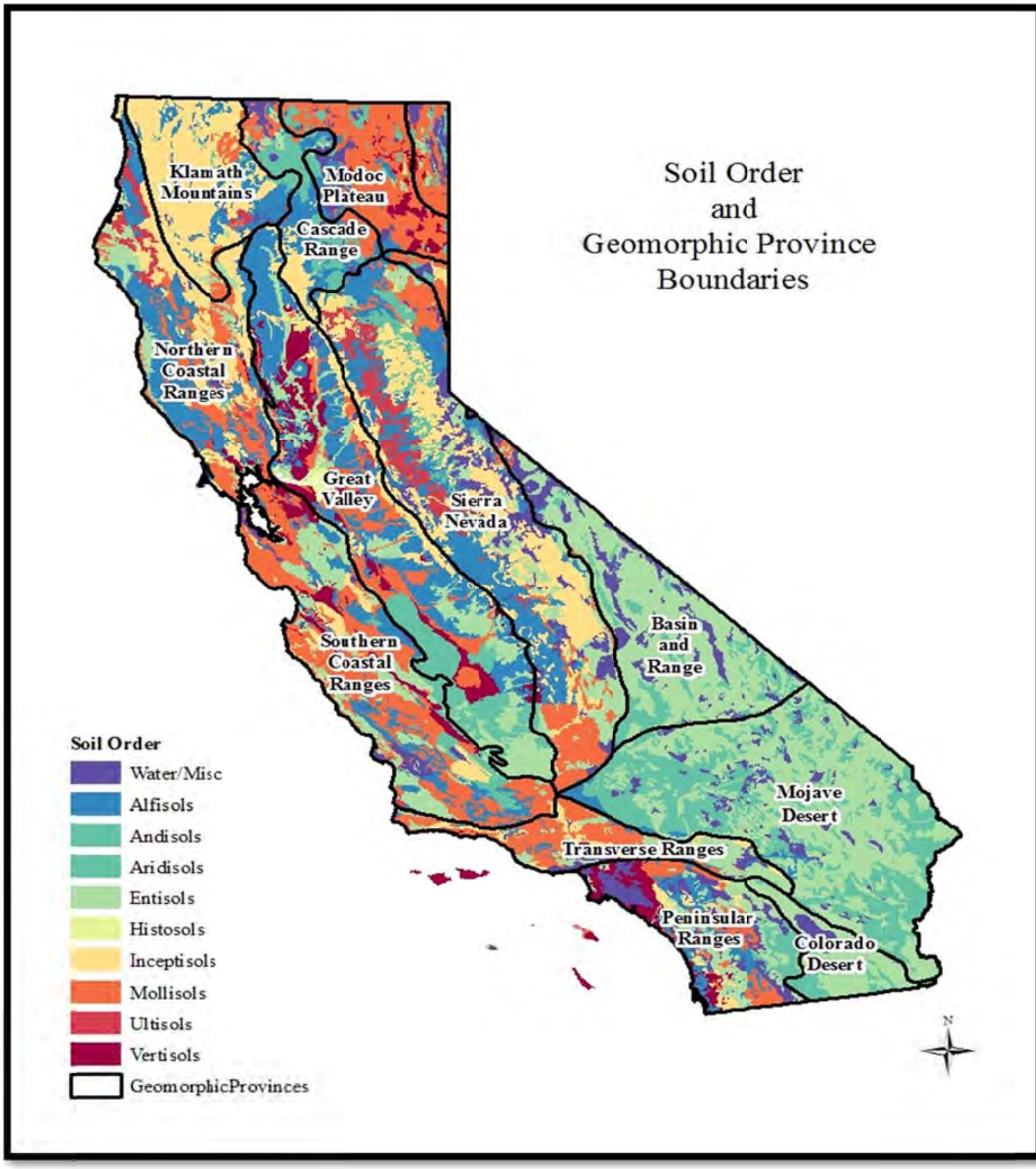


Figure 4.3-6 Soil order by geomorphic province

SOIL ORDERS BY GEOMORPHIC PROVINCE

Table 4.3-3 Soil order acreage by geomorphic province

Geomorphic Provinces	Water/Misc	Alfisols	Andisols	Aridisols	Entisols	Histosols	Inceptisols	Mollisols	Ultisols	Vertisols	Total by Bioregion
Basin and Range	1,853,263	50,380	60,228	1,369,269	5,779,892		60,479	1,007,947		53,202	10,234,661
Cascade Range	284,592	917,058	1,094,468	56,428	122,783		498,894	562,108	17,026		3,553,357
Colorado Desert	222,093			533,528	1,508,223				39,399		2,303,244
Great Valley	81,462	4,202,823		1,808,932	2,719,748	208,121	1,054,494	1,903,976	60,881	1,656,260	13,696,697
Klamath Mountains	75,595	1,078,560	165,963		123,590		3,990,214	342,022	520,113		6,296,057
Modoc Plateau	430,465	317,434	177,827	306,962	30,234		14,419	2,811,174		358,048	4,446,562
Mojave Desert	874,872	305,371		6,119,805	8,428,591		16,547	11,077			15,756,263
Northern Coastal Ranges	136,981	2,882,494	23,175		962,023		2,178,749	1,827,452		118,025	8,128,900
Peninsular Ranges	1,089,628	819,379		454,385	1,371,378		355,959	865,601		720,169	5,676,498
Sierra Nevada	1,674,526	3,713,580	910,433	80,440	1,854,985		4,781,607	1,895,850	1,252,368	64,610	16,228,399
Southern Coastal Ranges	391,776	1,532,601		691,406	2,208,959	3,076	689,035	4,560,026	26,216	687,906	10,791,002
Transverse Ranges	321,226	231,824		30,699	1,130,694		536,263	1,429,071	2,583	59,420	3,741,779
Total by Soil Order	**7,436,480**	**16,051,503**	**2,432,093**	**11,451,855**	**26,241,099**	**211,197**	**14,176,662**	**17,216,304**	**1,918,586**	**3,717,640**	**100,853,419**

Table 4.3-3 shows soil orders by geomorphic province. The Cascade Range, Great Valley, Coast Ranges, and Modoc Plateau all have greater than 50 percent of their area in more productive soil orders (i.e., Alfisols, Andisols, Mollisols, and Vertisols). The arid Colorado Desert, Mojave, and Basin and Range Provinces have 0, 2, and 11 percent of the land in more productive soil orders, respectively.

4.3.1.2.5 Process Domains

The hydrogeomorphic processes operating across the landscape are not uniform in time and space. Rather, the landscape should be viewed as a mosaic of process domains – areas where distinct and systematic sets of hydrogeomorphic processes that govern the response of water quality, physical habitat, and biotic response to natural and anthropogenic disturbance (Montgomery, 1999). In terms of hierarchy, process domains are typically nested within areas with similar lithology and/or topography (Montgomery, 1999). Figure 4.3-7 demonstrates the concept of process domains at the watershed scale. Generalized and specific process domains within the scope of the affected area are summarized in Table 4.3-4.

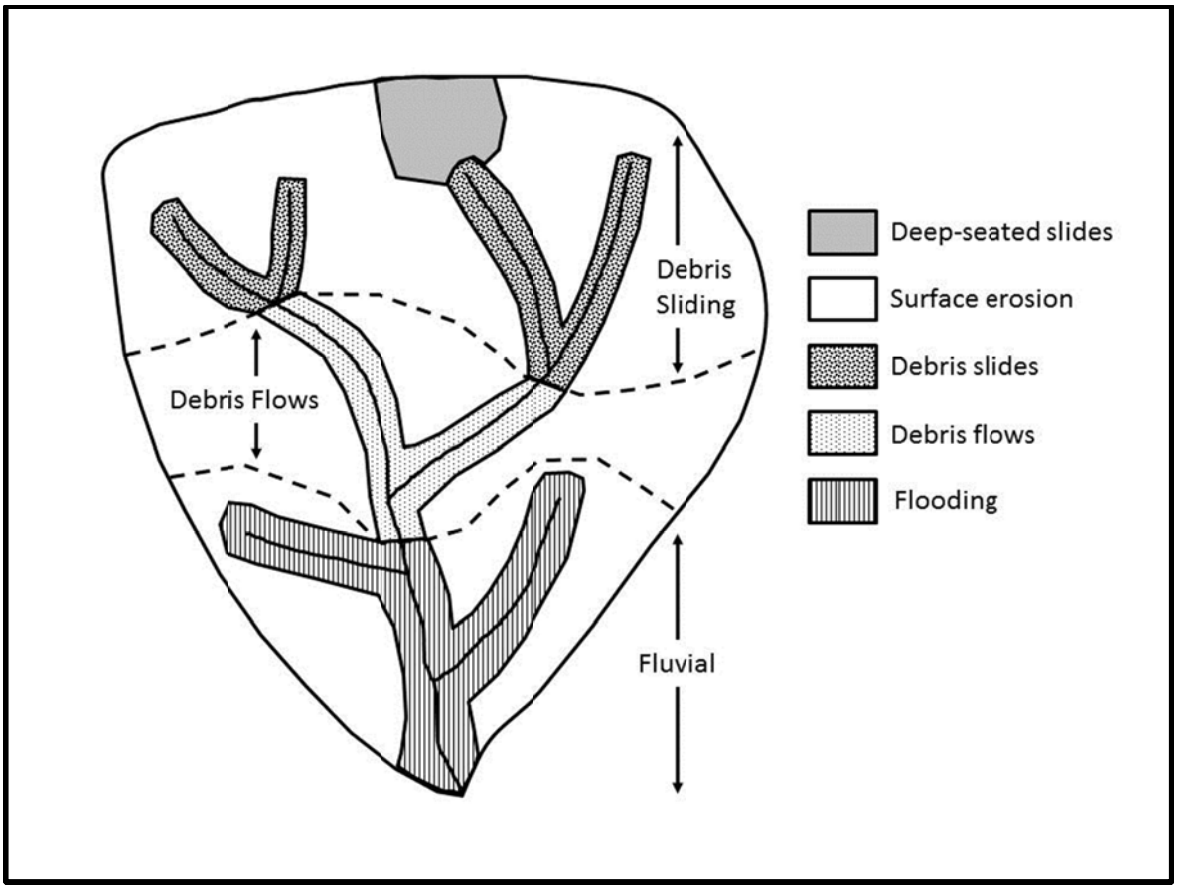


Figure 4.3-7 An example of linked process domains in a hypothetical watershed (adapted from Montgomery, 1999)

Table 4.3-4 Characteristics of erosion processes within the affected area (adapted from Reid 2010)

Erosion Process	Grain Size	Sediment Input Timing	Location	Potential Influences
Rainsplash	Fine	During intense or high magnitude precipitation events	Hillslopes with low ground cover	Disaggregating soil particles, Accelerated runoff through soil sealing
Sheetwash and rilling	Fine	During intense or high magnitude precipitation events where runoff concentrates and flows at erosive velocities	Hillslopes with low ground cover, Compacted hillslopes, Convergent slopes	Accelerated runoff, Increased hillslope sediment delivery, Alered soil productivity
Gully erosion	Fine to medium	Periods of runoff, Early season flows	Hillslopes with low cover, Compacted hillslopes, Small to medium watercourses	Accelerated runoff, Increased sediment hillslope delivery, Lowered water table, Altered soil productivity, Increased bank erosion, Altered watercourse form, Reduced floodplain connectivity
Bank erosion	Fine to medium	High flows, After high flows	Moderate to large watercourses	Altered woody debris, riparian vegetation, and watercourse form
Soil creep	Fine to medium	Chronic	Pervasive	Increased bank erosion
Debris slides	Fine to course	High-intensity rain onto wet ground	Inner gorges, Convergent slopes/hollows, Undercut banks, Certain lithologies, Toes of deep-seated slides	Flow deflection, Altered soil productivity
Deep-seated slides	Fine to very course	Very wet seasons	Certain lithologies or geologic structures	Flow deflection, Altered soil productivity
Earthflows	Fine to very Course	Very wet seasons	Certain lithologies or geolofic structures	Flow deflection, Altered soil productivity
Debris flows	Fine to course	High-intensity rain onto wet ground	Convergent slopes, Certain lithologies	Altered watercourse roughness, Flow deflection, Altered woody debris, Watercourse blockage

4.3.1.2.5.1 Unstable Hillslopes

Unstable hillslopes, also known as unstable areas, refer to areas susceptible to landsliding. Landslides consist of the downslope movement of soil and rock under the influence of gravity. The geologic and topographic features of the landscape are the primary determinants of the shear strength of the hillslope materials (i.e., resistance to landslides) and hillslope shear stress (i.e., propensity for landsliding). Landslides occur when the shear stress exceeds the shear strength of the materials forming the slope (Selby, 1982). Climate and vegetative cover also affect landslide hazard because of their influence on soil root support and moisture.

Factors contributing to high shear stress on hillslopes include:

- steep slopes
- high mass loading (e.g., through high soil moisture levels or placement of fill material)
- slope undercutting (e.g., through erosion or excavation)
- soils that vary in volume (shrink and swell) in relation to moisture content

Factors contributing to low shear strength of hillslope materials include:

- bedding planes that dip in the same direction as the slope at the same or a lesser degree of steepness
- high water pressure in soil pores (e.g., saturated soil underlain by a restrictive layer)
- presence of faults or joints
- weak materials (e.g., soft soils or rock, unconsolidated materials, fine grain size) (Selby, 1982)

The best indicator of high landslide potential is evidence of previous landsliding (Gray and Leiser, 1982).

Landslides can be classified as active or dormant, based on how recently they have moved. Active landslides typically display cracks or sharp, bare scarps. Vegetation is usually more sparse on active landslides than on adjacent stable ground; if trees are present, they are usually “jackstrawed” (i.e., leaning), indicating that ground movement has occurred since they became established. Dormant landslide features have typically been modified by weathering, erosion, and vegetative growth and succession.

Active landslides are generally more unstable than dormant landslides and may require mitigation measures to avoid mobilization. Excavation, the use of heavy equipment, soil saturation, or the removal of root support can mobilize active landslides. Although dormant landslides are less likely to be mobilized by human activities, portions of dormant landslides (e.g., their steep headwalls and margins) are often unstable.

Several types of landslides and associated landforms can be associated with vegetation management in California and are described below. These landforms have distinct hazard indicators and require special management practices to reduce the hazard.

TRANSLATIONAL AND ROTATIONAL DEEP-SEATED LANDSLIDES

Translational and rotational landslides are moderate or slow, relatively deep-seated movements of typically cohesive rock masses. These movements commonly occur along bedrock bedding planes that dip parallel to the surface, as may be observed at rock outcroppings. Translational slides consist of downward displacements of material parallel to the ground surface; they commonly occur along bedding planes, faults, and contacts between bedrock and overlying deposits. Rotational slides (or “slumps”) occur along a well-defined curved surface and are likely to occur in incompetent, clayey bedrock material under saturated soil conditions. Most translational and rotational slides feature a nearly vertical scarp near their head or sides. Slide deposits are typically hummocky. The presence of sag ponds or wet-site vegetation may indicate the impaired drainage that is characteristic of slide deposits.

EARTH FLOWS

Earth flows consist of the slow movement of saturated soil and debris, often following a slump. They are composed of clay-rich materials that swell when wet, thus reducing intergranular friction and shear strength. They usually occur in areas where low soil permeability restricts groundwater movement. They often feature hummocky, highly erodible surfaces.

DEBRIS SLIDES

Debris slides refer to the movement of unconsolidated material along a shallow, flat failure plane. They usually occur on slopes exceeding 65 percent where shallow bedrock forms an impervious layer that concentrates water near the surface. Debris slides often occur during intense storms in response to excessive pore water pressure within the saturated surface layer. As with other landslides, the presence of bedding planes aligned parallel to the slope is an indicator of high debris slide hazard.

Debris slide amphitheaters and slopes are characterized by steep slopes that have been sculpted by many debris slides. Although areas within these landforms are typically well-vegetated, they usually also feature debris slide scars, incised depressions, areas of active debris sliding, and exposed bedrock.

DEBRIS FLOWS

Debris flows are often initiated by the discharge of material into a stream channel from debris slides on adjacent hillslopes or by failure of fill materials at stream crossings caused by high flows. Debris flows are common when debris slide source areas are connected to steeper watercourse channels (Benda et al. 2005). Post-fire debris flows are well noted in the Transverse and Peninsular Ranges provinces (Wells, 1987), but will also happen in other areas where hillslopes are sufficiently steep to initiate debris sliding (Benda et al., 2005).

INNER GORGES

Inner gorges are over steepened stream banks extending from the stream channel to the first break in the slope above the channel. The slope generally exceeds 65% and is formed by debris sliding and erosion caused primarily by the down cutting of the stream channel and undercutting of landslide toes by stream erosion (CGS, 2013).

LANDSLIDE SUSCEPTIBILITY

Landslide susceptibility is the relative likelihood that landsliding will occur. For the purposes of demonstrating landslide susceptibility for the affected area, landsliding can be broken into two categories; shallow-seated and deep-seated landsliding. Shallow-seated landsliding occurs in the regolith – the unconsolidated earth material and soil overlying bedrock. Deep-seated landsliding occurs below the regolith and includes failure into bedrock. Shallow landsliding typically occurs on slopes greater than 65 percent (CGS, 2013), and in steep, convergent areas. Deep-seated landsliding is primarily a function of rock strength and slope, but it is also affected by precipitation and earthquake potential (CGS, 2011). Shallow-landsliding occurrence is most likely to occur in the mountainous portions of the Coast Ranges, Klamath Mountains, Transverse Ranges, and the Sierra Nevada (Table 4.3-4). Figure 4.3-9 shows the modeled susceptibility for deep-seated landsliding performed by the California Geological Survey (2011). Figure 4.3-9**Error! Reference source not found.** indicates that the highest susceptibility for deep-seated landsliding is in the Coast Ranges, Klamath Mountains, and Transverse Ranges provinces.

4.3.1.2.5.2 Stable Hillslopes

Stable hillslopes are ones that are not susceptible to landsliding, but may be subjected to surface erosion processes. Surface erosion caused by water, the most important agent of erosion from a vegetation management perspective, occurs when the shear stress of water flowing over a slope exceeds the shear resistance of soil particles. The susceptibility of a soil to detachment (i.e., shear resistance) and transport by flowing water varies widely among soils with differing textures; a silt loam soil, for example, may be more than 30 times more erodible than a gravelly clay loam (USDA, 1993).

Surface erosion is classified into four general types: rain splash, sheet, rill, and gully erosion (Figure 4.3-8). Sheet erosion is the removal of soil of a generally uniform depth across a slope and is caused by non-concentrated runoff. Rill erosion refers to the removal of soil in shallow (i.e., less than approximately 6 inches deep), usually parallel, channels from a slope and is caused by concentrated runoff. Gully erosion consists of removal of soil from deeper channels and is also caused by concentrated runoff. Although usually less conspicuous than rill and gully erosion, sheet erosion tends to result in greater soil loss over a wide area.

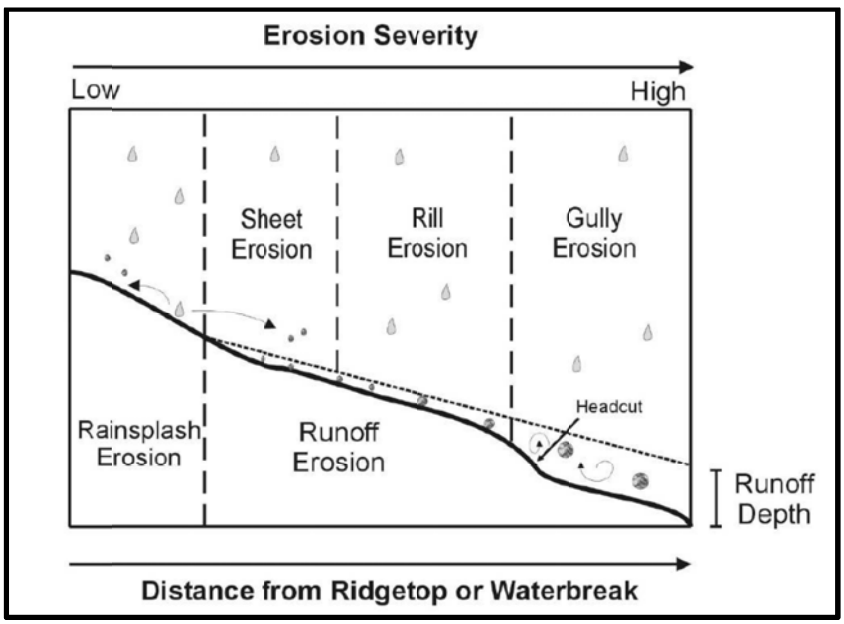


Figure 4.3-8 Erosion process and erosion severity as a function of distance from ridgetop or distance downslope of water break. Erosion severity increases as more runoff accumulates in the downslope direction (Central Valley Regional Water Quality Control Board, 2010).

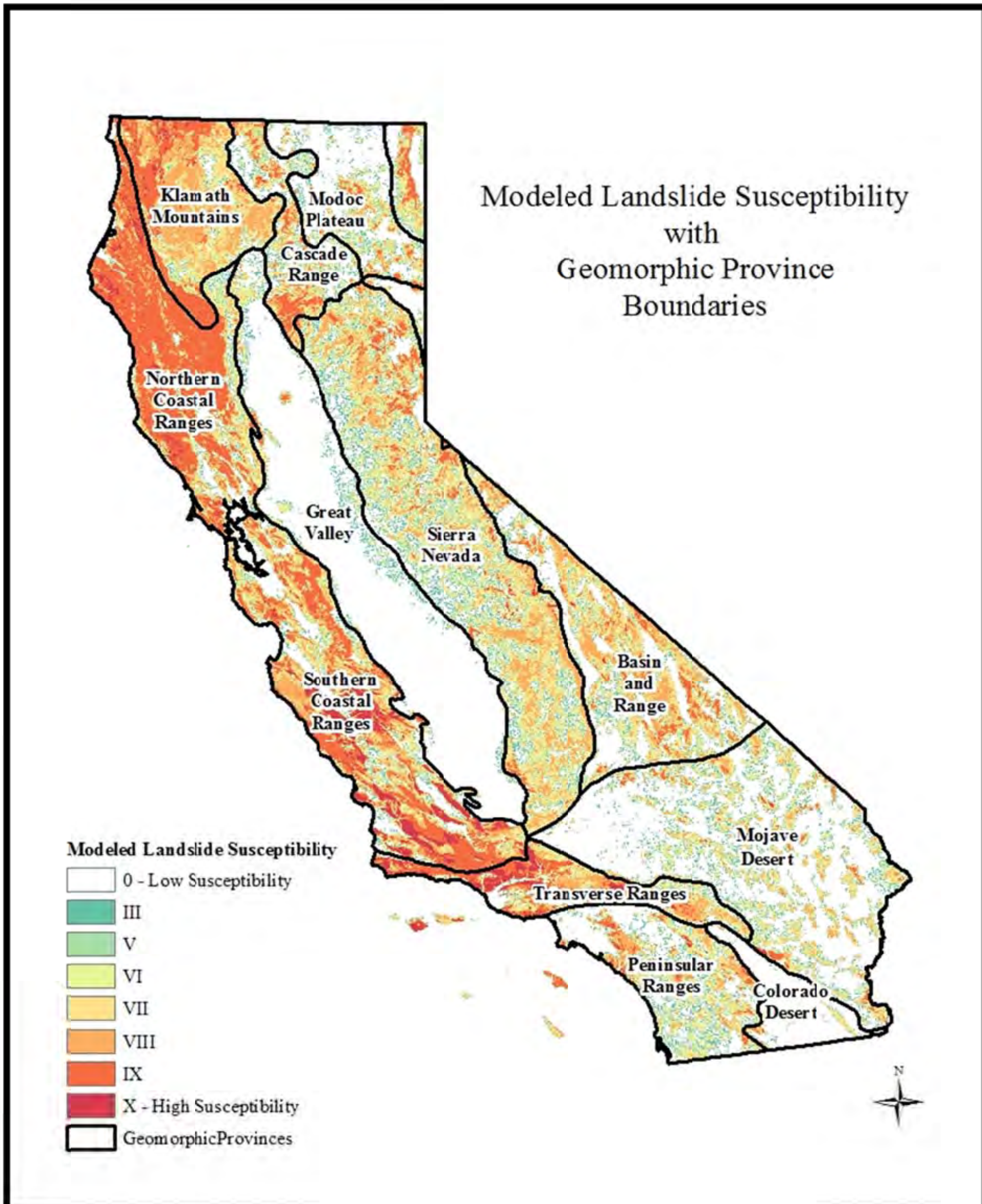


Figure 4.3-9 Deep-seated landsliding susceptibility based on rock strength and slope. The Coast Ranges, Klamath Province, and Transverse Ranges have the highest likelihood for deep-seated landsliding. Data taken from CGS (2011).

The force of raindrops falling contributes to water erosion. The raindrops dislodge and mobilize soil particles, causing a net downslope soil movement. Raindrops falling on bare soil also cause fine soil particles to plug soil pores, resulting in a crust on the soil surface that may increase runoff rates.

The factors that most influence the inherent wind erodibility of a soil are soil texture, organic matter content, calcium carbonate content, cohesion and gravel content (USDA, 1993). Wind erosion hazard is greatest where such soils occur and high winds are common, vegetation cover has been removed, and the soil has been disturbed.

EROSION HAZARD RATING

Each soil survey map unit is rated for water erosion hazard. The erosion hazard rating is qualitative; a typical range is slight/low to severe/extreme. The erosion hazard rating indicates the tendency of erosion to occur when the soil is barren of vegetation or when the soil is disturbed. The primary factors that control water erosion hazard are slope gradient, soil texture, and vegetative cover. Other factors include length of slope, organic matter content, structure (i.e., aggregation characteristics), permeability, and gravel content. Erosion hazard ratings using the Revised Universal Soil Loss Equation (RUSLE) are shown for California in Figure 4.3-10.

4.3.1.2.5.3 Channels and Floodplains

HEADWATER CHANNELS

Headwater channels are process domains where fluvial processes are dominant or partially dominant, and are associated with erosional portions of the landscape (Schumm, 1977). Channels (i.e., watercourses) begin where surface runoff is concentrated enough to cause scour and distinct banks, and typically originate in strongly convergent areas (MacDonald and Coe, 2007). Headwater channels are closely linked to sediment sources on hillslopes (MacDonald and Coe, 2007). The uppermost portions of the headwater channel network typically start out flowing over a colluvial valley fill and exhibit weak or transient fluvial transport (Montgomery and Buffington, 1997). Headwater channels are can be subject to debris flows and hyperconcentrated (i.e., sediment laden) floods (Benda et al., 2005). In the downstream direction, channel slopes typically decrease, channel bed forms become more organized and regular, and fluvial processes become more dominant (Montgomery and Buffington, 1997). Channels that are steeper than two percent slope or are confined (i.e., narrow valley walls) are considered transport channels, and efficiently deliver sediment and water to downstream reaches. Unconfined channels that are less than two percent slope are typically are typically "response" channels, where depositional processes start to become dominant (Montgomery and Buffington, 1998). Relatively steep and confined headwater channels that transition quickly to more gentle slopes and less confined valleys can induce alluvial fans – a cone-shaped landform composed of coarse-grained poorly sorted sediment (Blair and McPherson,1994). Alluvial fans are subject to flooding and/or shifting/migrating channels (Slingerland and Smith, 2004).

FLOODPLAIN CHANNELS

Floodplain channels are process domains where fluvial processes are dominant, and are characterized by low channel slopes and wide valleys. These channels generally occupy depositional portions of the landscape (Schumm 1977), and are generally disconnected from hillslope sediment sources (Montgomery and Bolton, 2003). (Montgomery and Bolton, 2003). As opposed to headwater channels and valleys, floodplain channel and valleys are primarily a sediment accumulating system rather than a sediment-evacuating system (Church, 2002). Floodplain channels are often subject to meandering, channel-shifting (i.e., avulsion), and flooding (Montgomery, 1999).

4.3.1.2.5.4 Wildfire and Process Domains

Wildfires affect the described process domains in a variety of ways. Moderate to high severity wildfire can greatly increase the likelihood of debris sliding, debris flows, and hyperconcentrated flows (Benda et al., 2005). Surface erosion from high severity wildfire can increase runoff and erosion rates by two or more orders of magnitude relative to unburned conditions (Robichaud et al., 2009). Excess sediment and runoff from wildfire can induce flooding and morphologic change in headwater and floodplain channel systems (Benda et al., 2004; Benda et al., 2005).

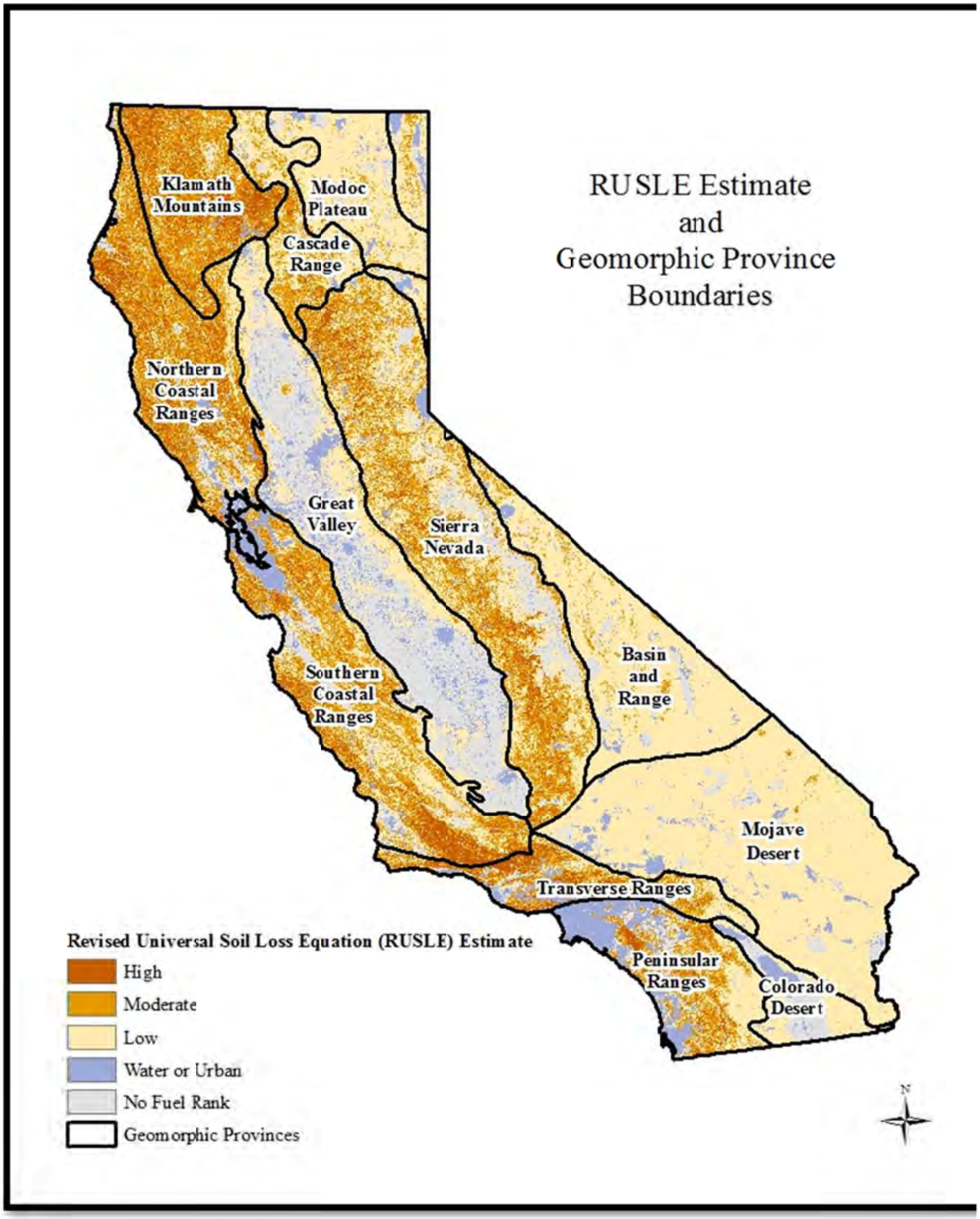


Figure 4.3-10 Erosion hazard classes determined through the use of the Revised Universal Soil Loss Equation (RUSLE).

4.3.2 EFFECTS

4.3.2.1 Significance and Threshold Criteria

The following significance criteria have been developed based on the “Geology and Soils” and “Hydrology and Water Quality” sections of CEQA Appendix G: Environmental Checklist Form of the State CEQA Guidelines. The impact of the Program on geology, hydrology, and soils would be considered significant if projects that qualify for implementation under the proposed Program would:

- Be located on unstable geologic units or soils, including expansive soils, or located on geologic units or soils that could become unstable as a result of the project, resulting in ground failures.
- Exposure of people or structures to the risk of loss, injury, or death involving landslides.
- Result in substantial soil erosion or loss of topsoil.
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge, such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.
- Substantially alter the existing drainage pattern of the site or area, including through alteration of the course of a stream or river, in a manner that would result in substantial erosion or sedimentation on- or off-site.
- Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.
- Place housing within a 100-year flood hazard area, as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map, or other flood hazard delineation map.
- Place structures within a 100-year flood hazard area that would impede or redirect flood flows.
- Expose people or structures to a significant risk of loss, injury, or death from flooding, including flooding resulting from the failure of a levee or dam.
- Inundation by seiche, tsunami, or mudflow.

Numerical modeling to determine threshold exceedance of these listed criteria is too difficult to perform given the potential scale of the Program, the high spatial and temporal variability in hydrogeomorphic processes (MacDonald and Coe, 2007), and the lack of most numerical models to adequately model these physical processes at scales relevant for this Program EIR (Murray, 2003). Criteria A, B, and J will be evaluated on whether Program activities will trigger landsliding or will increase the probability that landslides are initiated.

4.3.2.2 **Analysis Assumptions**

This analysis will consider the characteristic impact of the various fuels reduction activities (e.g., mechanical, fire) on geologic, hydrologic, and soil resources within the context of the Program and associated alternatives. Since roads are used to access the project areas, and roads are well-noted sources of runoff and sediment (Luce and Wemple, 2001), roads are also considered in this analysis.

GENERALIZED HYDROGEOMORPHIC IMPACTS OF FUELS REDUCTION ACTIVITIES

Table 4.3-5, Table 4.3-6, and Table 4.3-7 summarizes the hydrogeomorphic impacts of the various fuels reduction activities. For the likelihood of impacts are highest for areas with a higher soil burn severity and for treatments that cause more compaction and/or bare soils (Robichaud et al., 2010). As a result, it is assumed that the highest likelihood of impacts will occur for prescribed fire and mechanical treatments, particularly in shrub dominated vegetation types, as these activities will result in almost the full removal of vegetation and the post-treatment recovery time is likely highest for chaparral. Road use during project operations may also result in impacts. Detailed summaries of generalized hydrogeomorphic impacts from fuel reduction activities in the western United State are covered in Elliot et al. (2010)

Table 4.3-5 Impacts to geologic, hydrologic, and soils resources from prescribed fire activities.

Prescribed Fire		
Activity	Impact Type	POTENTIAL IMPACTS TO GEOLOGIC, HYDROLOGIC, AND SOIL RESOURCES
Pile Burn	Soil disturbance	Pile burning can completely consume the duff and organic layer under high soil burn severity (Reid, 2010). Removing the organic layer can expose mineral soil to rain splash and overland flow. Combustion of organic matter within the mineral soil can cause soil disaggregation, further increasing soil erodibility (DeBano et al., 1998). Heating from the burn pile may create a water repellent layer in the soil.
	Increased runoff	Water repellency and the increased likelihood of soil sealing can lead to overland flow generation. (Larsen et al., 2009; Robichaud et al., 2010).
	Increased fluvial erosion	Increased overland flow and exposure of mineral soil can lead to rain splash, sheetwash, and rill erosion within the footprint of the burn pile (Reid 2010; Robichaud et al., 2010).
Broadcast Burn	Soil disturbance	Broadcast burning can remove litter and surface fuels under low soil burn severity, or can completely consume the duff and organic layer under high burn severity. Removing the organic layer can expose mineral soil to rain splash and overland flow. Combustion of organic matter within the mineral soil can cause soil disaggregation, further increasing soil erodibility. Increased water repellency and the breakdown of soil structure will reduce the infiltration rate, and thereby increase erosion potential (Robichaud et al., 2010).
	Increased runoff	If soil burn severity is high, post-fire reduction of infiltration capacity and the increased likelihood of soil sealing will lead to overland flow generation. Burning large areas can result in the excess surface flow being routed to convergent areas and low order streams (Robichaud et al., 2010).
	Increased fluvial erosion	If burn severity is high, increased overland flow and exposure of mineral soil can lead to rain splash, sheetwash, and rill erosion (Robichaud et al., 2010). Runoff concentration in convergent areas may lead to gully erosion, and excess runoff routed into low order streams may potentially lead to bank erosion (Reid, 2010). Fire may burn large woody debris in channel, resulting in the release of stored sediment (Reid, 2010).
	Increased mass wasting	Decreased evapotranspiration will increase soil moisture, potentially increase pore pressure, thereby reducing the resistance to landsliding. Increased surface runoff may initiate debris flows in steep convergent areas. Stream adjacent hillslopes may be undercut by increased flow, thereby triggering shallow debris slides (Reid, 2010).

Table 4.3-6 Impacts to geologic, hydrologic, and soils resources from fuel reduction activities.

Mechanical, Manual, Prescribed herbivory, and Herbicides		
Activity	Impact Type	POTENTIAL IMPACTS TO GEOLOGIC, HYDROLOGIC, AND SOIL RESOURCES
Mechanical	Soil disturbance	Use of mechanical equipment can compact soils or cause rutting (Page-Roese et al., 2010), especially during saturated soil conditions. Mechanical equipment can decrease soil cover and the churning forces of tread or tire traffic can break down soil structure and increase the erodibility of the soil. Heavy equipment on steep slopes can cause extensive soil disturbance. Potential impacts will be greatest in shrub and grass-dominated areas due to complete removal of the fuels/soil cover.
	Increased runoff	Compacted soil will reduce infiltration capacity and generate overland flow (Robichaud et al., 2010). Bare soils are prone to producing overland flow through soil sealing. Equipment tracks can concentrate runoff.
	Increased fluvial erosion	Increased surface runoff and the availability of easily transportable soil increases the likelihood of rain splash, sheetwash, rill, and gully erosion (Reid, 2010; Robichaud et al., 2010).
	Increased mass wasting	Compaction from trails and soil disturbance may generate overland flow that is routed to an unstable area. Removal of vegetation may result in increased soil moisture which can reduce the resisting forces to landsliding (Reid, 2010).
Manual/ Hand	Soil Disturbance	Soil disturbance from hand treatments is considered negligible (Robichaud et al., 2010; McClurkin et al., 1987)
Prescribed herbivory	Soil disturbance	Mechanical force from the animal's hoof can compact soil on gentler slopes, and shear and move soil in the downslope direction. When soils have high moisture content, hoof deformation can be even deeper. Animals can form trails or paths through repeated trampling. Combination of grazing and trampling can reduce soil cover (Trimble and Mendel, 1995).
	Increased runoff	Compaction through trampling lowers the infiltration rate and increases the likelihood of overland flow. Trails and/or paths created by the animals can concentrate runoff and alter drainage patterns (Trimble and Mendel, 1995).
	Increased fluvial erosion	Increased runoff and bare erodible soil increase the likelihood of rain splash, sheetwash, and rill erosion. Animal trails/paths can concentrate runoff and initiate gullying (Trimble and Mendel, 1995; Stednick, 2010).
Herbicides	See water quality section	See hazardous materials and water quality section

Table 4.3-7 Impacts to geologic, hydrologic, and soils resources from road activities

Roads		
Activity	Impact Type	POTENTIAL IMPACTS TO GEOLOGIC, HYDROLOGIC, AND SOIL RESOURCES
Roads	Soil disturbance	Roads require the movement of large volumes of soil and earthen material, and the road prism fundamentally alters hillslope morphology. Road surfaces are generally bare of soil cover, and road cut slopes and fillslopes are generally bare initially following road construction. Traffic can generate loose material on the road surface (dust), or traffic on wet roads can create rutting (Robichaud et al., 2010).
	Increased runoff	Road surfaces have very low infiltration rates and produce overland flow in response to low intensity rainfall events. Road cut slopes can intercept hillslope runoff pathways during larger storm events. Lack of road drainage can cause erosive runoff to accumulate. Traffic during wet conditions can create rutting on the road surface which can further concentrate runoff (Robichaud, et al., 2010).
	Increased fluvial erosion	Road surfaces, cut slopes, and fillslopes are subject to rain splash, sheetwash, rill, and gully erosion. Surface erosion increases during rainy conditions and with increased traffic. Gullies and rills can initiate below drainage structures. Streams can be diverted at road-stream crossings, and can cause extensive gullying when routed to unarmored hillslopes (Reid, 2010; Robichaud et al., 2010).
	Increased mass wasting	Oversteepened fill placement can increase the risk of landsliding. Cut slopes can remove the support for upslope areas. Road drainage and diverted streams can initiate landslides below the road (Reid, 2010).

GENERALIZED HYDROGEOMORPHIC IMPACTS BY GEOMORPHIC PROVINCE

This analysis uses the geomorphic province as a hierarchical unit for analyzing impacts from the Program and the alternatives. Table 4.3-1 summarized each geomorphic province with regard to tectonic setting, rock/soil strength, topographic relief, and precipitation. The relative impact of the Program and Alternatives on geologic, hydrologic, and soil resources is illustrated in Figure 4.3-11. This figure assumes that the highest impacts will be in geomorphic provinces where the tectonic setting is characterized as high, the rock/soil strength is characterized as low, the topographic relief is characterized as high, and the precipitation is characterized as high.

Table 4.3-5, Table 4.3-6, and Table 4.3-7 provide a relative likelihood of impact from fuels reduction activities by geomorphic province. Impacts are likely highest for the steep humid to sub-humid portions of the Coast Ranges, Klamath Mountains, Transverse Ranges, Sierra Nevada, and Cascade Range. Highest susceptibility to impacts in these provinces will be in areas with weaker geologic material (Figure 4.3-3). Examples of these types of geologic settings include:

- Young, relatively unconsolidated rocks
    - o Colluvium – especially in convergent topography (i.e., hollows)
    - o Young sedimentary rock on steep slopes
- Poorly consolidated, sheared, and or clay rich metamorphic rocks (e.g., Franciscan Formation)

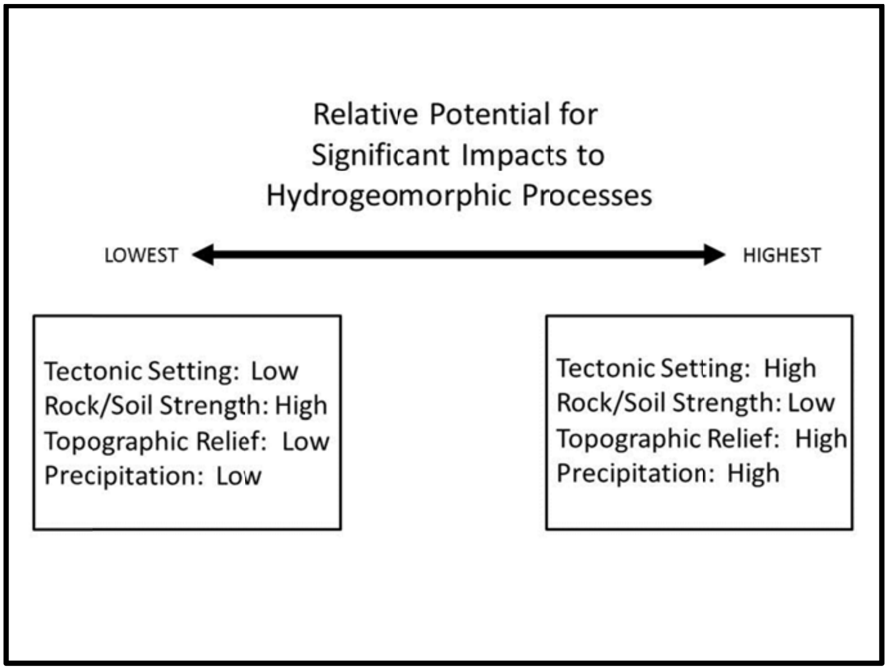
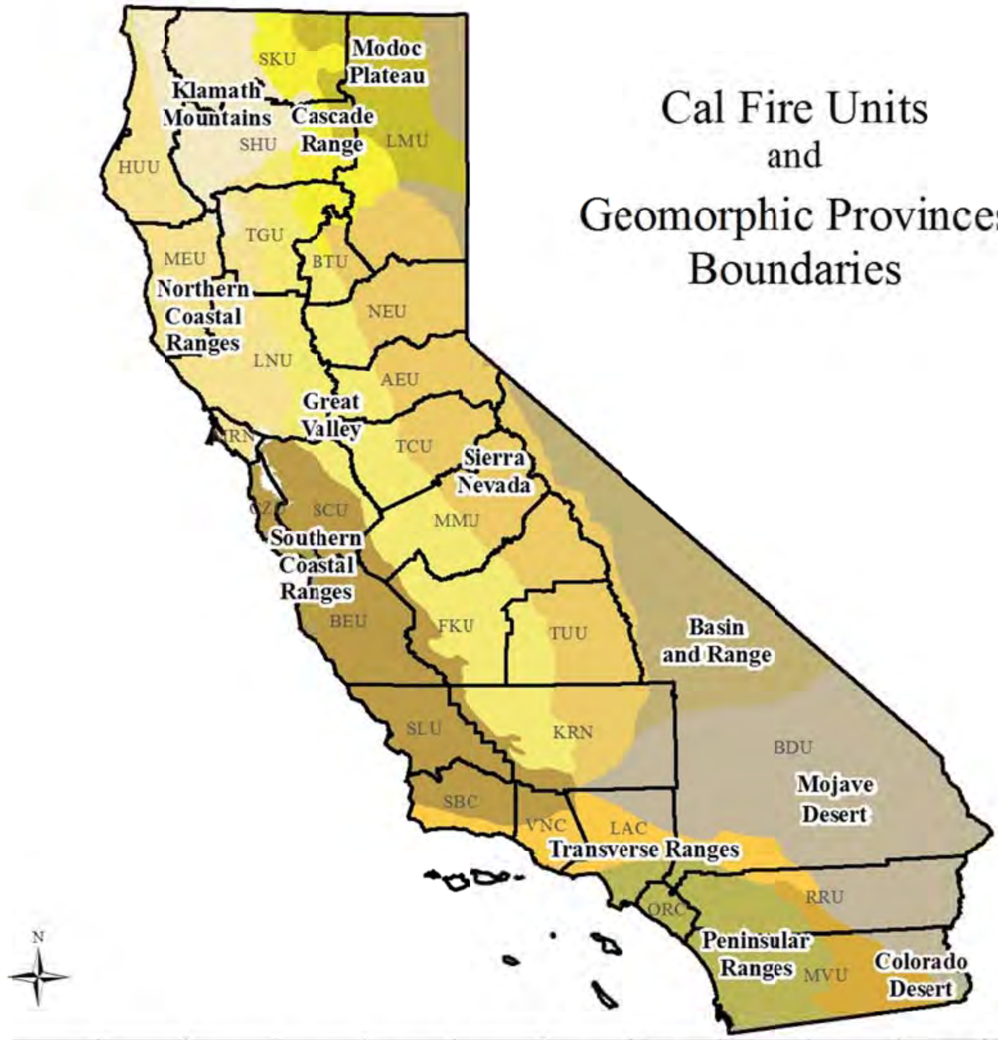


Figure 4.3-11 The conceptual model detailing the relative risk of significant fuel reduction activities based on a geomorphic province's generalized tectonic setting, rock/soil strength, topographic relief, and precipitation magnitude. (Conceptual model approved by California Geological Survey's Engineering Geologist Chris Gryszan (P.G., C.E.G.) and Senior Engineering Geologist Donald Lindsay (P.G., C.E.G., P.E.)

A moderate relative likelihood of impacts is expected for the Peninsular Ranges, Basin and Range, and Colorado Desert geomorphic provinces. The lowest likelihood of impacts is in the Mojave Desert, Modoc Plateau, and Great Valley geomorphic provinces. This is generally due to lower topographic relief, tectonic quiescence, or low precipitation magnitude. Figure 4.3-12 shows where CAL FIRE Units and Contract Counties are located in relation to the geomorphic provinces.



Basin and Range	Cascade Range	Colorado Desert	Great Valley	Klamath Mountains	Modoc Plateau	Mojave Desert	Northern Coastal Ranges	Peninsular Ranges	Sierra Nevada	Southern Coastal Ranges	Transverse Ranges
AEU	SKU	RRU	SHU	HUU	SKU	BDU	HUU	BDU	LMU	FKU	BDU
LMU	LMU	MVU	TGU	SKU	LMU	RRU	SHU	RRU	TGU	MMU	RRU
LMU	SHU		NEU	SHU	SHU	LAC	TGU	ORC	NEU	BEU	SBC
NEU	TGU		LNU	TGU		MVU	MEU	LAC	BDU	SLU	VNC
BDU	BTU		FKU	MEU		KRN	LNU	MVU	FKU	SBC	LAC
KRN			MMU				MRN		MMU	VNC	KRN
			TUU				CZU		TUU	LAC	
			AEU						AEU	CZU	
			TCU						TCU	SCU	
			SCU						KRN	KRN	
			KRN						BTU	SCU	
			BTU								
			SCU								

Figure 4.3-12 CAL FIRE Units and Contract Counties by Geomorphic Province

Table 4.3-8 Relative risk of impacts from fuels reduction activities.

Geomorphic Province	Relative Risk of Impacts
Coast Ranges	High
Klamath Mountains	High
Transverse Ranges	High
Sierra Nevada	High
Cascade Range	High/Moderate
Peninsular Ranges	Moderate
Basin and Range	Moderate
Colorado Desert	Moderate
Mojave Desert	Low
Modoc Plateau	Low
Great Valley	Low

HYDROGEOMORPHIC IMPACTS FROM THE PROGRAM AND ALTERNATIVES

Table 4.3-5, Table 4.3-6, and Table 4.3-7 summarize cause-and-effect relationships between likely Program/Alternatives activities and hydrogeomorphic process response. Process-based knowledge of these relationships allow for the crafting of appropriate program and project requirements that prevent significant impacts to geologic, hydrologic, and soil resources. To this end, Table 4.3-9, Table 4.3-10, and Table 4.3-11 summarize mitigations for each type of hydrogeomorphic process alteration (i.e., impact type) expected under the Program and Alternatives. These required program elements are assumed to be properly implemented to maximize effectiveness, and the significance of the Program and Alternatives are evaluated in the context of properly implemented SPRs and PSRs.

Table 4.3-9 Examples of SPRs and PSRs for Prescribed Fire and Impact Type. The significance criteria related to each SPR/PSR is indicated in bold.

Prescribed Fire		
Activity	**Impact Type**	**SPRs and PSRs to Minimize/Avoid Impacts**
Pile Burn	Soil disturbance	Limit pile size to less than or equal to 20 feet long and 20 feet wide, or 20 feet in diameter. Limiting pile size will reduce the disturbance footprint of each burn pile.
	Increased runoff	Limit pile size to less than or equal to 20 feet long and 20 feet wide, or 20 feet in diameter. Smaller areas of disturbed soil will produce less runoff at the site scale (i.e., Luce and Black, 1999).
	Increased fluvial erosion	Limit pile size to less than or equal to 20 feet long and 20 feet wide, or 20 feet in diameter. Lower site scale runoff rates will result in less sediment transport capacity for runoff (i.e., Luce and Black, 1999).
Broadcast Burn	Soil disturbance	Burning under an appropriate prescription to initiate a low intensity ground fire that results in low soil burn severity (Robichaud et al., 2010)
	Increased runoff	Burning under an appropriate prescription to initiate a low intensity ground fire that results in low soil burn severity (Robichaud et al., 2010.)
	Increased fluvial erosion	Burning under an appropriate prescription to initiate a low intensity ground fire that results in low soil burn severity (Robichaud et al., 2010).
		Prescription fire will not be ignited in WLPZs; Back firing only. Backing fire has lower flame lengths and will generally result in lower fire severity (Ryan and Noste, 1985)
	Increased mass wasting	Avoid treating unstable areas or areas that can affect unstable areas (CGS, 2013).
		Consult with professional geologist on PSRs that will mitigate against significant project-induced impacts related to unstable areas (CGS, 2013).
		Burning under an appropriate prescription to initiate a low intensity ground fire that results in low soil burn severity. This will minimize runoff production (Troendle et al., 2010) that can trigger landsliding (Neary et al., 1999).

Table 4.3-10 Examples of SPRs and PSRs for Mechanical and Impact Type

Mechanical, Manual, and Prescribed herbivory		
Activity	**Impact Type**	**SPRs and PSRs to Minimize/Avoid Impacts**
Mechanical	Soil disturbance	No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or soil damage (Troendle et al., 2010).
		When possible, onsite native vegetative material (e.g. cut material) will be utilized for mulching bare/compacted soil (Stednick, 2010) on hydrologically connected areas.
		Heavy equipment is prohibited on slopes exceeding 65 percent or on slopes greater than 50 percent where the erosion hazard rating is high or extreme. Equipment limitations used in the California Forest Practice Rules.
	Increased runoff	Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (MacDonald and Coe, 2008).
		When possible, onsite native vegetative material (e.g. cut material) will be utilized for mulching bare/compacted soil on hydrologically connected areas. Runoff potential decreases with increased soil cover (Troendle et al., 2010)
	Increased fluvial erosion	No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or soil damage (Moehring and Rawls, 1970; Page-Dumroese et al., 2010).
		When possible, onsite native vegetative material (e.g. cut material) will be utilized for mulching bare/compacted soil on hydrologically connected areas (Troendle et al., 2010).
		Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (MacDonald and Coe, 2008).
		Heavy equipment is prohibited on slopes exceeding 65 percent or on slopes greater than 50 percent where the erosion hazard rating is high or extreme. Equipment limitations used in the California Forest Practice Rules.
	Increased mass wasting	Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (Montgomery, 1994).
		No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or soil damage. Preventing excess runoff will minimize landslide initiation (Reid, 2010).
		Consult with professional geologist on PSRs that will mitigate against significant project-induced impacts related to unstable areas (CGS, 2013).
Manual Hand Treatments	Increased runoff	Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (Luce and Black, 1999)
Prescribed herbivory	Soil disturbance	Use fencing, herding, and on-site water will minimize impacts (Trimble and Mendel, 1995; Hubbard et al., 2004).
	Increased runoff	Use fencing, herding, and on-site water will minimize impacts.
	Increased fluvial	Use fencing, herding, and on-site water will minimize impacts.

Table 4.3-11 Examples of SPRs and PSRs for Herbicides and Road activities and impact type

Herbicides and Roads		
Activity	**Impact Type**	**Example SPRs and PSRs**
Herbicides	See water quality section	See water quality section
Roads	Soil disturbance	No new roads (including temporary roads) may be constructed or reconstructed Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice rules.
		During dry, dusty conditions, unpaved roads shall be wetted using water trucks or treated with a non-toxic chemical dust suppressant (Ziegler et al., 2000).
		Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (MacDonald and Coe, 2008).
	Increased runoff	Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (MacDonald and Coe, 2008.
	Increased fluvial erosion	No new roads (including temporary roads) may be constructed or reconstructed Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice rules.
	Increased fluvial erosion Increased mass wasting	During dry, dusty conditions, unpaved roads shall be wetted using water trucks or treated with a non-toxic chemical dust suppressant (Ziegler et al., 2000).
		Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (MacDonald and Coe, 2008).
	Increased mass wasting	Consult with professional geologist on PSRs that will mitigate against significant project-induced impacts related to unstable areas (CGS, 2013).
		Compacted and/or bare linear treatment areas capable of generating storm runoff will be drained using water breaks (Montgomery, 1994).
		No new roads (including temporary roads) may be constructed or reconstructed Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice rules.

Given the discussion above, we know that the highest likelihood for significant adverse hydrogeomorphic impacts will occur with prescribed fire and mechanical treatments in portions of the Coast Ranges, Klamath Mountains, Transverse Ranges, Sierra Nevada, and Cascades dominated by shrub vegetation types. In general, prescribed fire and mechanical treatments will have a higher likelihood for hydrogeomorphic impacts than other fuel reduction activities.

In order to evaluate the potential for significant adverse impacts due to the Program and associated alternatives, it is necessary to determine which fuel reduction activity is most likely given the treatment type (i.e., WUI, fuel breaks, and ecological restoration) and vegetation type. To determine this, we surveyed CAL FIRE Registered Professional Foresters to determine which type of activity was most likely given a specific treatment and vegetation type.

Results from the survey are shown in Table 4.3-12. In general, it shows that relatively more impactful prescribed burning will most likely be highly utilized for ecological restoration treatments in grass vegetation types, will be moderately utilized for fuel break and ecological restoration in forest vegetation, and moderately utilized for fuel break treatments in shrub vegetation. Mechanical treatments will be highly utilized for all treatment types in forest vegetation, and in WUI treatments in shrub vegetation types. Mechanical treatments will be moderately utilized for ecological restoration treatments in shrub vegetation types, and for WUI and fuel break treatments in grass vegetation types.

Table 4.3-12 The relative likelihood of using a fuel reduction activity type based on the desired treatment and dominant vegetation type. Likelihood determined through the averaging of surveyed CAL FIRE Registered Professional Foresters. L=Low likelihood; M=Moderate likelihood; H=High likelihood

Activity	Forest			Shrub			Grass		
Type	WUI	Fuel breaks	Eco	WUI	Fuel breaks	Eco	WUI	Fuel breaks	Eco
Burning	L	M	M	L	M	L	M	M	H
Hand Treatments	H	M	M	M	M	M	L	L	L
Mechanical	H	H	H	H	L	M	M	M	L
Herbicide	M	M	L	L	M	L	L	L	L
Herbivory	L	L	L	L	M	L	L	M	M

The next step in evaluating the potential hydrogeomorphic impacts of the proposed Program and associated alternatives requires knowing which geomorphic provinces the projects will be located under each scenario. Knowing the treatable acreage under each treatment can also help to focus the impact assessment, as the Alternatives are generally comprised of different combinations of the three treatment types. Table 4.3-10 shows the treatable acreage by geomorphic province and treatment type. Table 4.3-11, Table 4.3-12, and Table 4.3-13 show the same for tree, shrub, and grass-dominated vegetation types, respectively.

Table 4.3-13 Treatable acreage under the proposed Program by treatment type.

Geomorphic Provinces	WUI	FUEL BREAK	ECO	Total By Geomorphic
Basin and Range	209,623	155,560	188,940	554,123
Cascade Range	552,463	251,546	789,246	1,593,255
Colorado Desert	1,735	54,896	2,347	58,978
Great Valley	1,139,001	329,766	269,782	1,738,548
Klamath Mountains	333,063	138,048	522,834	993,945
Modoc Plateau	185,457	148,617	759,206	1,093,281
Mojave Desert	110,280	503,728	12,521	626,529
Northern Coastal Ranges	1,587,841	496,035	1,488,237	3,572,113
Peninsular Ranges	969,653	305,147	191,812	1,466,612
Sierra Nevada	2,653,444	320,286	1,571,587	4,545,318
Southern Coastal Ranges	2,209,980	863,180	1,461,217	4,534,376
Transverse Ranges	714,030	190,430	129,277	1,033,738
Total by Treatment	**10,666,570**	**3,757,239**	**7,387,006**	**21,810,815**

Table 4.3-14 Treatable tree-dominated acres under the proposed Program

Geomorphic Provinces	WUI	FUEL BREAK	ECO	Total By Geomorphic
Basin and Range	27,239	7,595	22,907	57,741
Cascade Range	324,989	158,118	590,675	1,073,782
Colorado Desert	0	3,567	0	3,567
Great Valley	30,479	37,043	8,592	76,114
Klamath Mountains	239,480	103,438	456,346	799,264
Modoc Plateau	67,020	60,356	340,726	468,103
Mojave Desert	71	11	31	113
Northern Coastal Ranges	770,849	232,020	917,359	1,920,228
Peninsular Ranges	57,303	13,055	19,566	89,924
Sierra Nevada	1,142,114	30,183	831,047	2,003,344
Southern Coastal Ranges	155,876	162,064	79,944	397,885
Transverse Ranges	49,982	10,684	6,343	67,008
Total by Treatment	**2,865,402**	**818,134**	**3,273,537**	**6,957,073**

Table 4.3-15 Treatable shrub-dominated acres under the proposed Program

Geomorphic Provinces	WUI	FUEL BREAK	ECO	Total By Geomorphic
Basin and Range	169,249	144,650	158,518	472,417
Cascade Range	87,668	36,613	66,049	190,330
Colorado Desert	1,652	51,323	2,347	55,321
Great Valley	36,729	21,842	4,876	63,447
Klamath Mountains	45,704	22,026	37,821	105,551
Modoc Plateau	101,417	82,290	381,561	565,268
Mojave Desert	102,829	499,026	6,774	608,629
Northern Coastal Ranges	184,755	77,690	122,636	385,081
Peninsular Ranges	714,257	258,692	149,904	1,122,853
Sierra Nevada	253,494	69,329	168,201	491,025
Southern Coastal Ranges	476,340	199,418	404,100	1,079,858
Transverse Ranges	482,332	143,457	83,712	709,501
Total by Veg Type	**2,656,426**	**1,606,356**	**1,586,498**	**5,849,280**

Table 4.3-16 Treatable grass-dominated acres under the proposed Program

Geomorphic Provinces	WUI	FUEL BREAK	ECO	Total By Geomorphic
Basin and Range	13,134	3,315	7,515	23,964
Cascade Range	139,806	56,815	132,522	329,143
Colorado Desert	83	6	0	90
Great Valley	1,071,792	270,880	256,315	1,598,987
Klamath Mountains	47,879	12,584	28,667	89,130
Modoc Plateau	17,020	5,971	36,919	59,910
Mojave Desert	7,381	4,690	5,716	17,787
Northern Coastal Ranges	632,236	186,324	448,243	1,266,804
Peninsular Ranges	198,093	33,400	22,342	253,836
Sierra Nevada	1,257,836	220,774	572,339	2,050,949
Southern Coastal Ranges	1,577,764	501,697	977,172	3,056,634
Transverse Ranges	181,717	36,289	39,222	257,228
Total by Veg Type	**5,144,742**	**1,332,748**	**2,526,972**	**9,004,462**

PROPOSED PROGRAM

Significant effects have a higher likelihood of occurring in geomorphic provinces dominated by shrub vegetation types (i.e., Southern Coast Range, Transverse Ranges, and Peninsular Ranges), since prescribed burning can result in higher burn severity in shrub-dominated vegetation. Moderate to high soil burn severity can increase runoff and erosion rates relative to unburned conditions. Also, mechanical treatments in shrub-dominated vegetation generally have to remove the majority of the vegetation to be effective in fuels reduction. The large number of mechanical treatments in the forested areas of the Coast Ranges, Sierra Nevada, Klamath Mountains and Cascade Range provinces also have a higher potential for significant impacts. This has the potential to decrease soil cover, which is an important control on erosion. The effects analysis requires a Project Scale Analysis, which will identify any locally-detected impacts that may not be detected at the bioregion or province scale.

The Proposed Program proposes to treat 60,000 acres per year in a combination of WUI, Fuel breaks, and Ecological Restoration treatments. By using Table 4.3-13 through Table 4.3-16, and assuming that projects will occur in proportion to the area in a given geomorphic province, vegetation formation, and treatment type, it is possible to determine how many projects are likely to occur in scenarios with a higher likelihood for impacts. See Table 4.3-18 below.

Table 4.3-17 Estimated project types by geomorphic provinces

Bioregions	# of Projects per Decade	RX Burn	Mechanical	Manual	Herbicides	Herbivory
Basin and Range	6	3	1	1	1	1
Cascade Range	17	8	3	2	2	2
Colorado Desert	1	0	0	0	0	0
Great Valley	18	9	4	2	2	2
Klamath Mountains	10	5	2	1	1	1
Modoc Plateau	12	6	2	1	1	1
Mojave Desert	7	3	1	1	1	1
Northern Coastal Ranges	38	19	8	4	4	4
Peninsular Ranges	15	8	3	2	2	2
Sierra Nevada	48	24	10	5	5	5
Southern Coastal Ranges	48	24	10	5	5	5
Transverse Ranges	11	5	2	1	1	1
Totals	**171**	**86**	**34**	**17**	**17**	**17**

Several standard project requirements (SPRs) and project specific requirements (PSRs) will reduce impacts to geologic, hydrologic, and soil resources when the Proposed Program is implemented. These SPRs and PSRs are related to individual impact types in Table 4.3-9, Table 4.3-10, and Table 4.3-11 summarized in section 4.3.3. The individual impact types relate back to the significance criteria in Section 4.3.2.1 as following:

- Practices that minimize or avoid soil disturbance relate to Significance Criteria C, E, F, and I.

- Practices that minimize or avoid runoff increases relate to Significance Criteria C, E, F, I, and J.
- Practices that minimize or avoid fluvial erosion relate to Significance Criteria C, E, F, and J.
- Practices that minimize or avoid mass wasting relate to Significance Criteria A, B, I, and J.

Geologic impacts can be minimized to less than significant levels by avoiding unstable areas, or by developing PSRs in consultation with a Professional Geologist/Certified Engineering Geologist (GEO-1). The most important requirement for minimizing effects due to prescribed fire is to utilize prescribed fire under the appropriate prescription to minimize soil burn severity and associated hydrogeomorphic impacts associated with moderate to high soil burn severity (GEO-2, FBE-1 through FBE-3, and HYD-4). For mechanical treatments, erosion control requirements will be utilized to prevent runoff concentration (HYD-5 through HYD-9, HYD-13 through HYD-16). Although addressed in more detail Section 4.5 (Water Quality), watercourse and lake protection zones (WLPZs) will be required to buffer against project-induced increases in runoff and/or erosion. Fuel reduction activities will result in **less than significant impacts** once SPRs and PSRs are implemented.

ALTERNATIVES

The “No Project” alternative is expected to have fewer impacts than the Proposed Program. This is primarily because the project acreage under this alternative is less than half of that under the proposed program (i.e., 27,000 acres per year; 104 projects per year). On a unit acre basis, the “No Project” alternative might be more impactful due to the fact that there are fewer best management practices than those offered by the Proposed Program. Historically, the VMP relied on burning for 50 percent of its treatments, and burning is generally more impactful than most other forms of fuel reduction activities. However, fewer treated acres will generally result in fewer potential impacts. **The No Project alternative would result in no significant impacts to geologic, hydrologic, or soil resources.**

Alternative A treats 60,000 acres per year solely in the WUI treatment type. This alternative will more than double the number of projects in the WUI from 108 projects per year, to 231 projects per year. The same SPRs and PSRs will be utilized as in the Proposed Program. In general, WUI treatments will seldom utilize prescribed burning in shrub and forest dominated vegetation and will place an increased emphasis on mechanical and hand treatments in these areas. As such, fewer impacts from prescribed fire will occur using this alternative, but impacts from mechanical activities will increase. It is expected that impacts from Alternative A will be slightly less than those in the Proposed Program, despite the same amount of area being treated.

Alternative A would result in no significant impacts to geologic, hydrologic, or soil resources.

Alternative B treats 60,000 acres per year between the WUI and fuel breaks treatment type. Projects in the WUI are projected to be 36 percent higher than the Proposed Program (n=147), and projects utilizing fuel breaks treatments are expected to increase by 80 percent relative to the Proposed Program. Burning for fuel breaks treatments in shrub dominated areas is expected to rise by 50 percent, and in general the use of mechanized fuel reduction activities will increase due to the increased focus on WUI and fuel breaks. It is expected that impacts from Alternative B will be comparable to those projected from the Proposed Program, with a slight increase in impacts to shrub dominated areas subjected to fuel breaks treatments. **Alternative B would result in no significant impacts to geologic, hydrologic, or soil resources.**

Alternative C treats 60,000 acres per year in Very High Fire Hazard Severity Zones (VHFHSZ) only. This alternative utilizes all fuel reduction activities to achieve fuel hazard reduction. While this alternative treats the same acreage annually as the Proposed Program, Alternative A, and Alternative B, the distribution of VHFHSZ is more dispersed in nature. Dispersing activities will theoretically lessen impacts to geologic, hydrologic, and soil resources. As such, this alternative will have slightly less impact than the Proposed Program. **Alternative C would result in no significant impacts to geologic, hydrologic, or soil resources.**

Alternative D treats 36,000 acres per year but limits prescribed fire to only 6,000 acres annually. As such, this alternative would rely on mechanical, herbicide, hand treatment, and herbivory activities to implement WUI, fuel break, and ecological restoration treatments. The scale of this alternative is smaller than Alternatives A, B, or C, and therefore the potential for significant impacts is the lowest of any alternative other than the “no project” alternative. **Alternative D would result in no significant impacts to geologic, hydrologic, or soil resources.**

4.3.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design. Tables 4.3-9 thru 4.3-11 shows example SPRs and PSRs related to each type of geologic, hydrologic, or soil-related impact previously discussed in Table 4.3-5.

4.3.3.1 Administrative Standard Project Requirements

ADM-6: The project coordinator or designee shall consult with the USFS, CAL FIRE, or other public agencies as appropriate to develop a list of past, current, and reasonably foreseeable probable future projects within the planning watershed of the proposed project. If the total combined acreage disturbed in the planning watershed exceeds 20% in a 10-year period, compliance with HYD-16 must be met prior to any ground disturbing operations. Projects that may combine with VTP projects to create the potential for significant effects include, but are not limited to, controlled burning, fuel reduction, and commercial timber harvesting.

4.3.3.2 Fire Behavior-Related Standard Project Requirements:

FBE-1: The prescribed fire burn prescription shall be designed to initiate a surface fire of sufficient intensity that will only consume surface and ladder fuels. The prescribed fire burn prescription shall be designed and implemented to protect soil resources from direct soil heating impacts. Soil damage will not occur as a result of this project.

FBE-2: A burn plan shall be created using the burn plan template. The burn plan shall include a fire behavior model output of BEHAVE or other fire behavior modeling simulation and performed by a fire behavior technical specialist (S-490 qualified). The burn plan shall be created with input from the vegetation project's Battalion Chief and a fire behavior technical specialist (S-490 qualified).

FBE-3: The project coordinator shall run a First Order Fire Effects Model (FOFEM) to analyze fire effects. The results of the analysis shall be included with the Burn Plan. FOFEM calculates consumption of fuels, tree mortality, predicted emissions, GHG emissions, and soil heating.

4.3.3.3 Geologic Standard Project Requirements:

GEO-1: An RPF or licensed geologist shall assess the project area for unstable areas and unstable soils as per 14 CCR 895.1 of the California Forest Practice Rules. Guidance on identifying unstable areas is contained in the California Licensed Foresters Association *Guide to Determining the Need for Input From a Licensed Geologist During THP Preparation* and California Geological Survey (CGS) Note 50 (see Appendix C). Priority will be placed on assessing watercourse-adjacent slopes greater than 50%. If unstable areas or soils are identified within the project area, are unavoidable, and are potentially directly or indirectly affected by the project operations, a licensed geologist (P.G. or C.E.G.) shall conduct a geologic assessment to determine the potential for project-induced impacts and mitigation strategies. Project shall incorporate all of the recommended mitigations. Geologic reports should cover the topics outlined in CGS Note 45 (see Appendix C).

GEO-2: The potential impacts of prescribed fire on geologic processes shall be reduced by following the Fire Behavior-related SPRs FBE-1, FBE-2, and FBE-3.

4.3.3.4 Hydrologic and Water Quality-Related Standard Project Requirements

HYD-1: The project shall comply with all applicable water quality requirements adopted by the appropriate Regional Water Quality Control Board and approved by the State Water Board (i.e., Basin Plan).

HYD-2: During the planning phase the project coordinator shall submit a standard letter to the appropriate RWQCB containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- Notification of whether the project drains directly into an impaired water body, and the type of water quality constituent(s) that is impairing the water body.
- A request for information and recommendations regarding the potential for significant water quality impacts from the proposed project and an offer to schedule a day to visit the project area with the project coordinator. The project shall incorporate the recommendations that prevent significant impacts to water quality as PSRs.

HYD-3: A WLPZ shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current California Forest Practice Rules (**Error! Reference source not found.**). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation within the WLPZ or ELZ will not be disturbed by project activities, with the exception of backing prescribed fire. Class IV watercourse protections shall be PSRs specified in the PSA, and designed in conjunction with any recommendations from RWQCB staff.

Table 4.3-18 Watercourse and lake protection zone buffer widths by watercourse classification and hill slope gradient (See HYD -3)

Note: ELZ-Equipment Limitation Zone, PSR-Project Specific Requirement

Water Class Characteristics or Key Indicator / Beneficial Use	1)Domestic supplies, including springs, on site and/or within 100 feet downstream of the project area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning	1) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for non-fish aquatic species. 3) Excludes Class III water that are tributary to Class I waters	No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II water under normal high water flow conditions of timber operations	Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use
Water Class	Class I	Class II	Class III	Class IV
Slope Class (%)	Width (ft.)	Width (ft.)	Width (ft.)	Width
<30	75	50	50 (ELZ)	PSR
30-50	100	75	50 (ELZ)	PSR
>50	150	100	50 (ELZ)	PSR

HYD-4: No direct ignition shall be allowed within the WLPZ or ELZs. However, it is acceptable for a fire to enter or back into a WLPZ's or ELZ's.

HYD-5: Compacted and/or bare linear treatment areas (e.g., fire breaks, roads, or trails) capable of generating storm runoff shall be drained via water breaks using the spacing guidelines contained in Sections 914.6, 934.6, and 954.6(c) of the California Forest Practice Rules.

HYD-6: Compacted and/or bare treatment areas shall be drained such that they are hydrologically disconnected from watercourses or lakes. Measures to hydrologically disconnect these areas shall be guided by consulting with Technical Rule Addendum #5 of the California Forest Practice Rules – Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings.

HYD-7: No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or damage to soil structure.

Saturated soil means that soil and/or surface material pore spaces are filled with water to such an extent that runoff is likely to occur. Indicators of saturated soil conditions may include, but are not limited to: (1) areas of ponded water, (2) pumping of fines from the soil or road surfacing material during timber operations, (3) loss of bearing strength resulting in the deflection of soil or road surfaces under a load, such as the creation of wheel ruts, (4) spinning or churning of wheels or tracks that produces a wet slurry, or (5) inadequate traction without blading wet soil or surfacing materials.

HYD-8: For remaining hydrologically connected areas of compacted or bare linear treatment areas, disturbed areas will be mulched with onsite native vegetative material (e.g., cut material).

HYD-9: During dry, dusty conditions, unpaved roads shall be wetted using water trucks or treated with a non-toxic chemical dust suppressant (e.g., emulsion polymers, organic material). Any dust suppressant product used shall be environmentally benign (i.e., non-toxic to plants and shall not negatively impact water quality) and its use shall not be prohibited by the ARB, U.S. Environmental Protection Agency (EPA), or the State Water Resources Control Board. Exposed areas shall not be over-watered such that water results in runoff. The type of dust suppression method shall be selected by the contractor based on soil, traffic, site-specific conditions, and local air quality regulations.

HYD-10: Prior to the start of onsite activities, all equipment will be inspected for leaks and regularly inspected thereafter until equipment is removed from the project area. All contaminated water, sludge, spill residue, or other hazardous compounds will be contained and disposed of outside the boundaries of the site, at a lawfully permitted or authorized destination.

HYD-11: Staging areas shall be designated and located to prevent leakage of oil, hydraulic fluids, or other chemicals into watercourses or lakes.

HYD-12: All heavy equipment parking, refueling, and service shall be conducted within designated areas outside of the WLPZ or ELZ.

HYD-13: No new roads (including temporary roads) shall be constructed or reconstructed (reconstruction is defined as cutting or filling involving less than 50 cubic yards/0.25 linear road miles). Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice Rules.

HYD-14: Heavy equipment is prohibited on slopes exceeding 65 percent or on slopes greater than 50 percent where the erosion hazard rating is high or extreme. Heavy equipment is prohibited on slopes greater than 50 percent that lead without flattening to watercourses.

HYD-15: Burn piles shall not exceed 20 feet in length, width, or diameter, except when on landings, road surfaces, or on contour.

HYD-16: At the CalWater Planning Watershed scale, if the combined, appropriately-weighted acreage subjected to fuels treatments and logging exceed 20% of the watershed area within a 10-year timespan (see Appendix K for calculation procedures); an analysis will be performed to determine the potential for hydrologically-induced significant impacts of the proposed activity.

HYD-17: If herbivory is proposed to treat vegetation in a project area containing watercourses, then the following items must be addressed as PSRs:

- The project will require water on site in the form of an on-site stock pond outside the WLPZ or ELZ, or a portable water source located outside the WLPZ or ELZ.
- The project will specify animal containment measures in the PSA to prevent animals from entering the WLPZ and/or ELZs. These might include the use of fencing (i.e., fixed or portable), the use of guard or herd dogs, or the use of an on-site herder.

4.4 HAZARDOUS MATERIALS, PUBLIC HEALTH AND SAFETY

This section evaluates the potential environmental impacts related to hazardous materials, public health, and safety, which could result as a consequence of implementation of the VTP. This section presents the environmental setting and potential impacts of the vegetation treatment activities related to hazards and hazardous materials. This section incorporates the pesticide background Information gathered for this program (Appendix D).

4.4.1 AFFECTED ENVIRONMENT

4.4.1.1 Regulatory Framework

4.4.1.1.1 Federal

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDES ACT

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provides the basis for regulation, sale, distribution, and use of pesticides in the United States. The FIFRA authorizes the U.S. Environmental Protection Agency (EPA) to review and register pesticides for specified uses. EPA also has the authority to suspend or cancel the registration of a pesticide if subsequent information shows that continued use would pose unreasonable risks. Some key elements of FIFRA include:

- is a product licensing statute; pesticide products must obtain an EPA registration before manufacture, transport, and sale
- registration based on a risk/benefit standard
- strong authority to require data--authority to issue Data Call-ins
- ability to regulate pesticide use through labeling, packaging, composition, and disposal
- emergency exemption authority--permits approval of unregistered uses of registered products on a time limited basis
- Ability to suspend or cancel a product's registration: appeals process, adjudicatory functions, etc.

FIFRA has been amended by the Pesticide Registration Improvement Act of 2003, which provides for the enhanced review of covered pesticide products, to authorize fees for certain pesticide products, and to extend and improve the collection of maintenance fees.

SAFE DRINKING WATER ACT OF 1974

Under the Safe Drinking Water Act of 1974, the EPA establishes maximum contaminant levels (MCLs), which are specific concentrations that cannot be exceeded for a given contaminant in surface water or groundwater. EPA has the ability to enforce these nationwide standards or delegate administration and enforcement duties to state agencies. The California Department of Public Health (CDPH) administers the federal Safe Drinking Water Act in California.

OCCUPATIONAL HEALTH AND SAFETY ADMINISTRATION

Enacted in 1970, the Occupational Safety and Health Act established this administration to ensure healthy working conditions in the United States. There are approximately 2,100 Occupational Health and Safety Administration (OSHA) inspectors, who along with other experts and support staff, establish and enforce protective standards in the workplace. California, under an agreement with OSHA, operates an occupational safety and health program in accordance with Section 18 of the Occupational Safety and Health Act of 1970. The program applies to all public and private sector places of employment in the State, with the exception of federal employees, the U.S. Postal Service, private sector employers on Native American lands, maritime activities on the navigable waterways of the United States, private contractors working on land designated as exclusive Federal jurisdiction, and employers that require Federal security clearances.

U.S. EPA

EPA oversees pesticide use through the Worker Protection Standard (WPS). The WPS is a regulation for agricultural pesticides which is aimed at reducing the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers. The WPS protects employees on farms, forests, nurseries, and greenhouses from occupational exposure to agricultural pesticides. The regulation covers two types of workers:

- Pesticide handlers -- those who mix, load, or apply agricultural pesticides; clean or repair pesticide application equipment; or assist with the application of pesticides in any way.
- Agricultural workers -- those who perform tasks related to the cultivation and harvesting of plants on farms or in greenhouses, nurseries, or forests. Workers include anyone employed for any type of compensation (including self-employed) doing tasks -- such as carrying nursery stock, repotting plants, or watering -- related to the production of agricultural plants on an agricultural establishment. Workers do not include office employees, truck drivers, mechanics, and any others not engaged in handling, cultivation, or harvesting activities.

The WPS contains requirements for pesticide safety training, notification of pesticide applications, use of personal protective equipment, restricted-entry intervals after pesticide application, decontamination supplies, and emergency medical assistance.

U.S. DEPARTMENT OF TRANSPORTATION

The U.S. Department of Transportation, in conjunction with EPA, is responsible for enforcement and implementation of federal laws and regulations pertaining to transportation of hazardous materials. The Hazardous Materials Transportation Act of 1974 (49 U.S. Code 5101 et seq.) directs the U.S. Department of Transportation to establish criteria and regulations regarding safe storage and transportation of hazardous materials. Hazardous materials regulations are contained in 49 Code of

Federal Regulations (CFR) 171–180, and address transportation of hazardous materials, types of materials defined as hazardous, and the marking of vehicles transporting hazardous materials. In particular, 49 CFR 173, titled "Shippers' General Requirements for Shipments and Packaging," defines hazardous materials for transportation purposes; within this portion of the code, 49 CFR 173.3 provides specific packaging requirements for shipment of hazardous materials, and 49 CFR 173.21 lists categories of materials and packages that are forbidden for shipping. 49 CFR 177, titled "Carriage by Public Highway," defines unacceptable hazardous materials shipments.

4.4.1.1.2 State

California's programs for the registration of pesticides and commercial chemicals parallel federal programs, but many of California's requirements are stricter than federal requirements. The California Environmental Protection Agency (Cal/EPA) regulates registration of pesticides and commercial chemicals in California. Within Cal/EPA, the California Department of Pesticide Regulations (CDPR) oversees pesticide evaluation and registration through use enforcement, environmental monitoring, residue testing, and reevaluation. The CDPR works with County Agricultural Commissioners, who evaluate, develop conditions of use, approve, or deny permits for restricted-use pesticides; certify private applicators; conduct compliance inspections; and take formal compliance or enforcement actions.

California also requires commercial growers and pesticide applicators to report commercial pesticide applications to local county agricultural commissioners. The CDPR compiles this information in annual pesticide use reports. CDPR's Environmental Hazards Assessment Program collects and analyzes environmental pesticide residues, characterizes drift and other off-site pesticide movement, and evaluates the effect of application methods on movement of pesticides in air. If a pesticide is determined to be a toxic air contaminant, appropriate control measures are developed with the California Air Resources Board to reduce emissions to levels that adequately protect public health. Control measures may include product label amendments, applicator training, restrictions on use patterns or locations, and product cancellations.

SAFE DRINKING WATER ACT 1976

CDPH administers the federal Safe Drinking Water Act in California. In addition to enforcing the primary MCLs, CDPH uses as guidelines Secondary MCLs that regulate constituents that affect water quality aesthetics (such as taste, odor, or color). Additionally, under the California Safe Drinking Water Act, Cal/EPA's Office of Environmental Health Hazard Assessment develops Public Health Goals (PHGs) for contaminants in California's publicly supplied drinking water. PHGs are concentrations of drinking water contaminants that pose no significant health risk if consumed for a lifetime, based on current risk assessment principles, practices, and methods. Public water systems use PHGs to provide information about drinking water contaminants in their annual Consumer Confidence Reports.

THE SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT

This Safe Drinking Water and Toxic Enforcement Act (Proposition 65), passed as a ballot initiative in 1986, requires the state to annually publish a list of chemicals known to the state to cause cancer or reproductive toxicity so that the public and workers are informed about exposures to potentially harmful compounds. Cal/EPA's Office of Environmental Health Hazard Assessment administers the act and evaluates additions of new substances to the list. Proposition 65 requires companies to notify the public about chemicals in the products they sell or release into the environment, such as through warning labels on products or signs in affected areas, and prohibits them from knowingly releasing significant amounts of listed chemicals into drinking water sources.

CALIFORNIA PESTICIDE REGULATORY PROGRAM

CDPR regulates the sale and use of pesticides in California. CDPR is responsible for reviewing the toxic effects of pesticide formulations and determining whether a pesticide is suitable for use in California through a registration process. Although CDPR cannot require manufacturers to make changes in labels, it can refuse to register products in California unless manufacturers address unmitigated hazards by amending the pesticide label. Consequently, many pesticide labels that are already approved by the EPA also contain California-specific requirements. Pesticide labels defining the registered applications and uses of a chemical are mandated by EPA as a condition of registration. The label includes instructions telling users how to make sure the product is applied only to intended target pests, and includes precautions the applicator should take to protect human health and the environment. For example, product labels may contain such measures as restrictions in certain land uses and weather (i.e., wind speed) parameters.

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

Public Resources Code 4201-4204 directs California Department of Forestry and Fire Protection (CAL FIRE) to map fire hazards within State Responsibility Areas based on relevant factors such as fuels, terrain, and weather. These statutes were passed after significant WUI fires occurred; consequently, these hazards are described according to their potential for causing ignitions to buildings. These zones, referred to as Fire Hazard Severity Zones, provide the basis for application of various mitigation strategies to reduce risks to buildings associated with wildland fires (CAL FIRE 2007). Additionally, the Public Resources Code, beginning with Section 4427, includes fire safety regulations that restrict the use of equipment that may produce a spark, flame, or fire; require the use of spark arrestors on construction equipment with internal combustion engines; specify requirements for the safe use of gasoline-powered tools in fire hazard areas; and specify fire suppression equipment that must be provided on site for various types of work in fire-prone areas. These requirements would apply to VTP activities within a “Very High Fire Hazard Severity Zone.”

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

The California Department of Toxic Substances Control (DTSC), a division of Cal/EPA, has primary regulatory responsibility over hazardous materials in California, working in conjunction with the federal EPA to enforce and implement hazardous materials laws and regulations. DTSC can delegate enforcement responsibilities to local jurisdictions.

The hazardous waste management program enforced by DTSC was created by the Hazardous Waste Control Act (California Health and Safety Code Section 25100 et seq.), which is implemented by regulations described in CCR Title 26. The State program thus created is similar to, but more stringent than, the federal program under RCRA. The regulations list materials that may be hazardous and establish criteria for their identification, packaging, and disposal.

Environmental health standards for management of hazardous waste are contained in CCR Title 22, Division 4.5. In addition, as required by California Government Code Section 65962.5, DTSC maintains a Hazardous Waste and Substances Site List for the state, commonly called the Cortese List. Lands within the project area are included on this list (DTSC 2015).

California’s Secretary for Environmental Protection has established a unified hazardous waste and hazardous materials management regulatory program (Unified Program) as required by Senate Bill 1082 (1993). The Unified Program consolidates, coordinates, and makes consistent the administrative requirements, permits, inspections, and enforcement activities for the following environmental programs:

- Hazardous waste generator and hazardous waste onsite treatment programs
- Underground Storage Tank program

- Hazardous materials release response plans and inventories
- California Accidental Release Prevention Program
- Aboveground Petroleum Storage Act requirements for spill prevention, control, and countermeasure plans
- California Uniform Fire Code hazardous material management plans and inventories

The six environmental programs within the Unified Program are implemented at the local level by local agencies—Certified Unified Program Agencies (CUPAs). CUPAs carry out the responsibilities previously handled by approximately 1,300 State and local agencies, providing a central permitting and regulatory agency for permits, reporting, and compliance enforcement.

CALIFORNIA DEPARTMENT OF INDUSTRIAL RELATIONS, DIVISION OF OCCUPATIONAL HEALTH AND SAFETY ADMINISTRATION

The California Department of Industrial Relations, Division of Occupational Safety and Health Administration (Cal/OSHA), assumes primary responsibility for developing and enforcing workplace safety regulations within the state. Cal/OSHA standards are more stringent than federal OSHA regulations, and are presented in CCR Title 8. Standards for workers dealing with hazardous materials include practices for all industries (General Industry Safety Orders); specific practices are described for construction, and hazardous waste operations and emergency response. Cal/OSHA conducts on-site evaluations and issues notices of violation to enforce necessary improvements to health and safety practices.

CALIFORNIA OFFICE OF EMERGENCY SERVICES

The California Office of Emergency Services (OES) issued the State of California Multi-Hazard Mitigation Plan (Multi-Hazard Mitigation Plan) (California OES 2013) in 2013. The federal Disaster Mitigation Act required all state emergency services agencies to issue such plans, for the states to receive federal grant funds for disaster assistance and mitigation under the Stafford Act (44 CFR 201.4). The overall intent of the Multi-Hazard Mitigation Plan is to reduce or prevent injury and damage from natural hazards in California, such as earthquakes, wildfires, and flooding. The plan identifies past and present hazard mitigation activities, current policies and programs, and mitigation goals, objectives, and strategies for the future.

CALIFORNIA AIR RESOURCES BOARD

California Air Resources Board (ARB) oversees California's Smoke Management Program, which addresses potentially harmful smoke impacts from agricultural, forest, and range land management burning operations. The legal basis of the program is found in the *Title 17 Smoke Management Guidelines for Agricultural and Prescribed Burning,* adopted by ARB on March 23, 2000 (ARB 2011). The Guidelines state that each air district or region shall adopt, implement, and enforce a smoke management program, in coordination with ARB and other appropriate stakeholders. ARB has authority to approve these smoke management programs. Elements of the program include permitting requirements for agricultural and prescribed burns, meteorological and smoke management forecasting, and a daily burn authorization system (ARB 2000). The *California Wildfire Smoke Response Coordination*, prepared under the auspices of ARB's California Air Response Planning Agency (CARPA) and the California Interagency and Smoke Council, provides useful information and resources seeking assistance in protecting the public's health from the impacts of smoke during catastrophic fires (CARPA 2015). This program is discussed in more detail in Section 4.12, Air Quality, of this document.

4.4.1.2 **Environmental Setting**

CAL FIRE is dedicated to the fire protection and stewardship of over 31 million acres of California's privately-owned wildlands that make up a variety of habitats rich in both numbers and variety of plants and animals. In addition, the Department provides varied emergency services in 36 of the State's 58 counties via contracts with local governments. The Department's firefighters, fire engines, and aircraft respond to an average of more than 5,600 wildland fires each year. Those fires burn more than 172,000 acres annually. CAL FIRE's mission emphasizes the management and protection of California's natural resources; a goal that is accomplished through ongoing assessment and study of the State's natural resources and an extensive CAL FIRE Resource Management Program (CAL FIRE 2012a).

CAL FIRE works to protect a variety of habitats rich in both numbers and variety of plants and animals. The SRA includes 12 bioregions and a number of vegetation subtypes (i.e., grassland, desert brush land, general brush land, hardwood, and long and –short needled conifer). Common visitors of SRA land include nearby residents and recreational users. Many SRAs are immediately adjacent to public use, residential, and active agricultural areas (see Figure 4.1-2, Figure 4.1-3, and Figure 4.1-4 in Section 4.1 of this document).

The proposed VTP could be implemented within 24 million acres or 78 percent of SRA land in California (see Section 2.5, Table 2.5.1, of this document). Approximately 50 percent of this acreage is within the proposed WUI treatment type, with the majority of the WUI acreage occurring in the Sierra Nevada and Klamath/North Coast bioregions, respectively. Ecological restoration accounts for approximately 36 percent of the available acreage; with most of the acreage occurring in the Klamath/North Coast, Modoc, and Sierra Nevada bioregions, respectively. Fuel breaks make up the smallest proportion of the treatments, accounting for only 14 percent of the area available for treatment.

4.4.1.3 Hazardous Materials

California Health and Safety Code (Section 25501) defines "hazardous materials" as any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. "Hazardous materials" include, but are not limited to, hazardous substances, hazardous waste, and any material that a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.

Soil contamination generally occurs in areas that are or have been previously developed, especially with industrial-type uses. Soil contamination can also occur in areas where pesticides have been historically applied, as well as in areas that have historically been mined. Contamination is also sometimes associated with leaking utilities (i.e., leaking petroleum or gas pipelines, or leaking transformers on utility poles), or accidental spills. For the most part, treatment sites within the SRA are not located on previously developed land, but would primarily be located in grasslands, wildlands, and undeveloped areas near urban developed areas (i.e., WUI areas). Although limited, some treatment areas may contain remnant contamination from previous agricultural uses, may have been affected by contamination from nearby urban areas, or may have been exposed to leaks from pipelines and/or transformers and utility poles.

4.4.1.3.1 Wildland Fire Hazards

Wildland fires are seasonally common in certain forests, woodlands, grasslands, chaparral, and other high-fuel areas. SRA lands are located in many areas considered to have high wildland fire risk. CAL FIRE designates SRA land into moderate, high, and very high fire hazard severity zones. These zones are based on local vegetation type (fuel loading), slope, and weather. Fires are an integral part of the natural world, but historic human alteration of natural fire cycles has allowed unnatural plant succession and fire fuel build-up. CAL FIRE currently employs fire fuel management practices in the SRA, where wildfire hazards are present, to minimize and manage the potential risk. CAL FIRE also has the primary responsibility for wildland fire response in many State Park units. In areas closer to communities, mutual aid agreements also exist with local fire protection agencies. Fire hazard severity zones are depicted in Figure 4.1-2 of this document.

4.4.1.3.2 User Groups and Sensitive Receptors

User groups and sensitive receptors near and within SRA lands include: recreational users, residents, private landowners, and schools. Generally, visitors to SRA lands use the land for recreational activities (i.e., hiking, biking, off-road motor vehicles, horseback riding, etc.). CAL FIRE manages eight Demonstration State Forests covering over 71,000 acres. CAL FIRE does not have jurisdiction over campgrounds in California, however, camping is allowed on some of the CAL FIRE Demonstration State Forests sites (CAL FIRE 2012b).

4.4.2 EFFECTS

4.4.2.1 Significance and Threshold Criteria

Based on Appendix G of the State CEQA Guidelines, a hazards and hazardous material impact is considered significant if implementation of the project would do any of the following:

- Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials
- Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment
- Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school
- Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, create a significant hazard to the public or the environment
- Result in a safety hazard associated with private airstrips or airports
- Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan
- Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or

where residences are intermixed with wildlands, or otherwise increase the risks of fire damage to these areas

Thresholds

The thresholds used in this analysis are based on the CEQA significance criteria identified above. Thus for this analysis, implementation of the vegetation treatment activities under the VTP would result in significant hazards and hazardous materials related impacts if projects were to:

1. Expose the public or the environment to hazardous materials; or
2. Expose people to existing hazardous material or soil contamination; or
3. Create public hazards related to smoke from prescribed burns; or
4. Increase the risk of wildland fire hazards.

4.4.2.2 **Impact Analysis Methods**

Analysis of impacts related to hazards and hazardous materials involves describing existing conditions and current practices related to vegetation treatment activities for handling, storage, and disposal of hazardous materials, and, considering any impact reductions from implementation of applicable Standard Project Requirements (SPRs), evaluating any changes in those practices. Federal, state, and local agencies would be expected to continue to enforce applicable requirements to the extent that they do so now. In determining the level of significance of potential impacts, the analysis assumes that implementation of the VTP would comply with relevant federal, state, and local ordinances and regulations. As described in Chapter 2, Program Description, SPRs have been developed to implement the VTP. Applicable SPRs are incorporated into the impact statements below, and considered for determination of significance conclusions of environmental impacts.

4.4.2.3 **Impact Analysis**

ISSUES OR POTENTIAL IMPACTS NOT DISCUSSED FURTHER

Implementation of the VTP would not alter roadways or other potential emergency evacuation routes and plans as no permanent alterations to the land would occur. Rather, the project would implement measures to maintain the integrity and accessibility of fire access roads and other access points. While there may be temporary disruptions to some access points when vegetation treatment activities are being implemented, these disruptions would be implemented for the protection of the public during treatment (e.g., prescribed fire burns) and the access would be reinstated once the project is complete. Thus, the VTP would not have any substantial and adverse impacts on adopted emergency response or emergency evacuation plans. This issue is not discussed further in this EIR.

While it is likely that some VTP activities may occur within two miles of an airport, activities proposed under the VTP do not include development of structures or facilities. Therefore, the project would not result in the construction of facilities that would interfere with aircraft flight patterns or air traffic control communications, and not pose a safety hazard for people residing or working within the area. Activities associated with the manual, mechanical, and chemical treatments would not be performed within airport lands, and would not violate structural height standards associated with airport land use requirements. This issue is not discussed further in this EIR. With regards to smoke emissions from prescribed fires and the potential to create safety hazards associated with lower visibility, this issue is discussed further below in Impact 3. Potential respiratory effects of smoke resulting from prescribed burns are analyzed in Section 4.12, Air Quality, of this document.

Schools may be located in close proximity to SRA lands suitable for VTP activities. While children are considered to be of greater sensitivity to hazards and hazardous materials than adults, the relative effects of implementing treatments under the VTP are considered inclusive in the impact analysis below. No substantial differences between the effects on schools compared to the general public are anticipated. Thus, impacts associated with schools are not discussed further in this EIR.

IMPACT 1: EXPOSE THE PUBLIC OR ENVIRONMENT TO HAZARDOUS MATERIALS.

Use of Hazardous Materials

Prescribed fire, hand treatments, mechanical treatments, prescribed herbivory, and chemical treatments associated with the VTP would result in activities that could require the transportation, use, and storage of various pesticides (see Table 4.4-1) and other hazardous materials (e.g., common household hazardous materials such as fuels, oils, lubricants, solvents, and detergents; retardants, foams, and water enhancers to control an escaped prescribed fire). Treatment activities under the VTP would primarily utilize mechanical equipment, which typically does not include routine use of hazardous materials with the exception of small quantities of common household hazardous materials such as fuels, oils, lubricants, solvents, and detergents. CAL FIRE staff would continue to use, transport, store, and dispose of any hazardous materials consistent with OSHA and EPA regulations. As required under state and federal law, plans for notification and evacuation of site workers and local residents in the event of a hazardous materials release would be in place throughout implementation of VTP activities.

Targeted application of herbicides would make up 10 percent of activities under the VTP. Implementation of SPRs HAZ-2 through HAZ-13 would require proper application of herbicides and would minimize the potential for unwanted adverse impacts to non-target species (i.e., aquatic habitat and habitat for listed species). Treatment activities associated with the VTP would result in activities that could require the transportation, use, and storage of various pesticides and other hazardous materials. Existing measures and regulatory requirements currently in place to address spills and accidents would be sufficient for the VTP such that the project would not result in adverse exposure conditions to hazardous materials. CAL FIRE complies with all relevant regulatory requirements pertaining to the handling of hazardous materials including pesticides. Further, SPRs HAZ-2, HAZ-3, HAZ-4, HAZ-5, HAZ-7 through HAZ-13 require several measures to prevent accidental leaks, spills, or other emissions of hazardous materials into the environment including, a Spill Prevention Plan, and a Materials Management Plan, proper handling of herbicides and other chemicals, and minimizing the potential for unwanted adverse impacts to non-target species (i.e., humans, animals, and special status species) Thus, VTP treatments that would require the transportation, use, and storage of hazardous materials associated with the VTP would not result in the exposure of the public or environment to adverse conditions associated with the use of these materials. Further, CAL FIRE would implement SPRs for each treatment activity applying herbicides that would ensure the proper use and application of these chemicals. No increased risk of accidental upset or emission of hazardous materials would occur. The impact is **less than significant**.

<u>Herbicides</u>

The toxicity of a pesticide (i.e., herbicides and fungicides) is determined by the documented adverse laboratory and field effects to target and non-target organisms that occur after an exposure to that compound. The key to potential adverse (toxic) effects is the nature of the exposure to the compound, which is based on the specific amount of the compound that reaches an organism’s tissues (i.e., the dose). Several other factors are involved in an exposure, such as the duration of time over which the dose is received, the target tissue or physiological function affected, and the sensitivity of the organism of interest to the compound.

The toxicity of pesticides are generally measured in controlled laboratory or field studies in which the test organisms are provided only contaminated food (or oral doses of a test substance) at several concentrations for certain times from which a series of toxicity estimates are developed. Most studies are designed to evaluate toxic responses based on tiered increases of dose and to determine at what dose the onset of an adverse physiological or behavioral effect occurs. Toxicity studies commonly evaluate the lethal dose (LD) or the lethal concentration for half of a population (LC50), the highest dose that results in no toxicity to the test organisms (the NOAEL: no observed adverse effect level); or the lowest concentration that causes a measured adverse effect, such as mortality or altered reproduction, in the test organisms (the lowest observed adverse effect level [LOAEL]). In many acute (48 to 96 hours post-exposure) oral toxicity tests, laboratory organisms are not provided alternative food sources, and as a result, these laboratory tests are not particularly representative of realistic exposures in the environment. Furthermore, effects in laboratory species may not adequately represent effects in environmentally relevant species due to genetic, physiological, and behavioral differences. For many pesticides, the suite of tests required for approval of a compound includes other types of exposure, such as dermal, inhalation, and dietary. All of these laboratory data are combined to develop the pesticide product label recommendations and restrictions, incorporating several “safety” factors to provide acceptable use of each product. As a result of the extensive use of safety factors, surrogate test species, and unrealistic exposures to the laboratory animals, the pesticide data available for evaluation of potential adverse impacts for these compounds are subject to uncertainty and conservatism in actual potential effects as described in the Pesticide Technical Background Report (refer to Appendix D of this EIR).

Table 4.4-1 Chemicals Proposed for Use Under the VTP

Active Ingredients	CDPR Codes	Products Actively Registered in California [1]	
		Forestry	Rangeland
Borax, sodium tetraborate decahydrate	79	1	0
Clopyralid, monoethanolamine salt	5050	2	4
Glyphosate, diammonium salt [2]	5810	1	2
Glyphosate, dimethylamine salt	5972	1	1
Glyphosate, isopropylamine salt	1855	56	81
Glyphosate, potassium salt	5820	2	5
Hexazinone	1871	5	3
Imazapyr, isopropylamine salt	2257	7	1
Sulfometuron methyl	2149	3	1
Triclopyr, butoxyethyl ester (BEE)	2170	9	11
Triclopyr, triethylamine salt (TEA)	2131	10	5
Nonylphenol 9 Ethoxylates (NP9E)	1748	NA	NA

[1] The products listed are actively registered in California and include active ingredients proposed for use under the Program and Alternatives, as well as some products that contain additional active ingredients. CDPR = California Department of Pesticide Regulation.
[2] According to CDPR Pesticide Use Reports from 2000 to 2009, this chemical was not used in forestry (CDPR N.D.a). It was only used in rangeland in 2002 and 2010, on 2,800 acres and 5.5 acres respectively.

Table 4.4-1 provides a list of chemicals proposed for use under the VTP. Refer to Appendix D for a detailed description of these chemicals, including their mode of action, purpose under the VTP, and associated toxicity. The appendix was prepared by CAL FIRE in 2010. Because substantial time has elapsed since the preparation of the appendix, CAL FIRE contracted with Bill Williams, Ph.D., of Infinity Solutions Group (ISG) to prepare a technical peer-review of the information contained in the appendix and to update any outdated information or identify where new information has become available. As a result of that peer review process, it was determined that the information and analysis contained within the appendix was generally accurate. However, some new information and studies have become available since the time it was prepared. This new information is presented in the peer-review memo attached to and included in Appendix D. Nonetheless, the conclusions of the appendix were determined to be accurate for purposes of evaluating toxicity and ecological risk in this Program EIR (ISG 2015).

Chemicals proposed for use under the VTP are categorized by the most recent EPA risk assessments as having a ‘low’ or ‘very low’ chronic toxicity to non-target species. Further, none of the chemicals proposed to be used are listed on the California U.S.

EPA's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) as chemicals known to cause reproductive toxicity or cancer (Appendix D).

Ecological Effects of Herbicide Use

Chemical applications would occur in a variety of habitats and settings throughout the State. The herbicides selected for the VTP have been screened for minimal ecological toxicity and environmental fate, minimal transport, and proven efficacy against targeted species (Appendix D). As described in SPR HAZ-3, CAL FIRE when proposing or reviewing proposed VTP projects would first evaluate if there are other viable non-herbicide treatment options to address vegetation treatment. Only if it is determined that other treatment options are not available or feasible at a particular site, would CAL FIRE proceed with herbicide treatments.

While vegetation treatment activities may be located near sensitive habitats occupied by special status species, VTP projects would be subject to the requirements of SPRs HAZ-4, HAZ-5, HAZ-7 through HAZ-13, which would require the proper handling and application of herbicides in accordance with label recommendations. SPR BIO-13 requires that contractors be provided training in the identification and avoidance of sensitive species and their habitats. Further, SPR BIO-3 requires that a survey of the project area be conducted to determine the presence of any sensitive habitats or species or special status plant species. If aquatic habitats, sensitive habitats, or sensitive species are identified, these areas shall be marked and no application of herbicides shall occur within 50 feet of these areas (BIO-7). If it is determined that areas where aquatic habitat, sensitive habitats, or sensitive species cannot be avoided, the proposed VTP project would not qualify for implementation under the VTP Program EIR and CAL FIRE would need to proceed with separate environmental review for that project. Finally, no herbicides would be applied within 15-feet of any identified special status plant species (BIO-7). Herbicide application, when conducted consistent with the VTP and the required SPRs would not affect special status species, aquatic habitats, or sensitive habitats and natural communities and this would be a **less-than-significant** impact.

Herbicide treatment could coat the food sources of special status mammals, resulting in indirect herbicide ingestion. However, impacts to these species resulting from food source exposure would be less than significant because of the limited potential for exposure and low toxicity to small mammals of the dilute herbicides used for this project. As outlined in Appendix D of this document, all proposed herbicides and adjuvants/surfactants have a low toxicity or are practically non-toxic to humans. While special status mammals were not specifically addressed in toxicity studies, testing for human toxicity was primarily conducted on rabbits and rats, and it can be expected that effects on special status mammals is similar to those found in humans. Herbicide treatment represents a small percentage (approximately 10 percent of VTP activities annually) of vegetation treatment activities covered under the VTP and would only be selected if other non-herbicide treatment activities are not feasible (SPR HAZ-3). Further, treatments would likely occur at most once per year for a particular site at doses that that are low to non-toxic to humans and are not anticipated to affect special status mammals. Given the limited nature of the treatment application, it is unlikely that prey insects would be exposed to herbicide spray, and less likely that special status species would consume such insects as they would represent only a tiny portion of the overall food supply. Overall, this would be a **less-than-significant** impact.

IMPACT 2: EXPOSURE OF PEOPLE TO EXISTING HAZARDOUS MATERIALS OR SOIL CONTAMINATION

Treatment activities under the VTP may occur on properties where hazardous materials have been previously used, stored, or released, including former agricultural areas or areas near contaminated urban areas. SPR HAZ-1 requires the project coordinator to conduct an Envirofacts web search to identify any known contamination sites within the project area prior to implementation of vegetation treatment projects. If a proposed vegetation treatment project would occur in an area 1) located on the DTSC Cortese List; 2) previously used for industrial/manufacturing purposes, or 3) that involved the use, handling, transport, or storage of hazardous materials, no treatment activities would occur within 100 feet of the site boundaries (HAZ-1). With identification and avoidance of contaminated sites during vegetation treatment activities, impacts related to human exposure to hazardous materials in soils would be **less than significant**.

IMPACT 3: HAZARDS RELATED TO SMOKE FROM PRESCRIBED BURNS

Prescribed burning is the intentional use of fire to reduce wildfire hazards, clear downed trees, control plant diseases, improve rangeland and wildlife habitats, and restore natural ecosystems. Prescribed burning produces smoke, which may create hazards for people in the project area if not carefully managed.

California's smoke management program is an integrated State and local effort. The State Smoke Management Guidelines, adopted by the California Air Resources Board (ARB), establish the fundamental framework for the program. Additionally, individual local air districts implement and enforce local rules and regulations. CAL FIRE is required to prepare a smoke management plan before obtaining ARB permission to burn (SPR AIR-12). As with all burners, CAL FIRE is required to complete the following planning steps: 1) register their burn with the air district; 2) obtain an air district and/or fire agency burn permit; 3) submit a smoke management plan (SMP) to the air district; and 4) obtain air district approval of the SMP. The SMP specifies the "smoke prescription," which is a set of air quality, meteorological, and fuel conditions needed before burn ignition may be allowed.

In addition to required compliance with State Smoke Management Guidelines, CAL FIRE would also implement SPRs AIR-9, FBE-1 and FBE-4 to further reduce the potential for exposure of people to hazards from smoke as a result of prescribed burns under the VTP. This would be a **less-than-significant** impact.

IMPACT 4: WILDLAND FIRE HAZARDS.

As described above, under Section 4.4.1.3.1, Wildland Fire Hazards, CAL FIRE designates SRA lands as zones of moderate, high, and very high fire hazard severity, based on local vegetation types, slope, and weather. Locations associated with fire hazard severity zones are shown in Figure 4.1-2 of this Program EIR.

Manual and mechanical VTP activities would include creation of defensible space and fuel breaks through the use of mechanical gas-powered equipment (e.g., chainsaws, chippers, Jawz, mowers, etc.). While use of mechanical equipment could ignite dry vegetation and cause fire, CAL FIRE staff is trained in fire suppression techniques and would provide appropriate fire suppression equipment (e.g., extinguishers, water trucks, fire trucks) onsite in the event of an inadvertent ignition. Implementation of HAZ-14 requires all heavy equipment to include spark arrestors or turbo chargers with fire extinguishers onsite and FBE-1 requires prescribed burns to take place when burn intensities are low to moderate, such as during the spring season when the ground is wet or the fall season when plant moisture content is higher. Further, implementation of the VTP would result in the reduction of fuel loads on SRA lands, thereby, reducing overall fire ignition risk compared to existing conditions. This is an objective of the project and benefit of the program.

Chemical treatment options associated with VTP activities would result in transportation, use, and storage of pesticides. Although pesticides may pose some risk of increased fire because of their flammable properties, CAL FIRE would implement SPRs HAZ-4, HAZ-5, and HAZ-7 through HAZ-13, to reduce hazards associated with handling of flammable materials, and overall fuel loads on proposed treatment areas would be reduced.

With regards to the effects of climate change on California's fuel mix, please refer to Section 4.14 of this EIR for a detailed discussion.

The proposed VTP is designed to reduce fire risk within proposed WUI treatment areas, ecological restoration treatment areas, and strategic fuel break treatment areas throughout California (see Figures 2.3-2 through 2.3-4 for an illustration of proposed treatment areas by bioregion). VTP activities would reduce the risk of loss, injury, or death associated with a wildland fire through actions promoting prevention and effective response as well as implementation of SPRs described above. Overall, the VTP would have **no adverse impacts** to the environment related to wildland fire hazards.

4.4.2.4 Hazardous Materials Impact Analysis for Alternatives Considered

Four alternatives are considered under this analysis: Alternative A: WUI Only, Alternative B: WUI and Fuel Breaks, Alternative C: Projects Limited to Very High Fire Hazard Severity Zones, and Alternative D: Treatments that Minimize Potential Impacts to Air Quality. Alternative A proposes to limit fuel reduction projects to WUI areas only, while Alternative B would combine Alternative A with the option to create fuel breaks outside of the WUI. Under Alternative C, vegetation treatment activities would be focused in areas with the highest hazard classification of very high fire hazard severity zones (VHFHSZ). Alternative D would reduce the number of acres treated by prescribed fire and also reduce the average number of acres treated annually to 36,000.

For Alternatives A, B, and C, the scale of the project remains the same as the proposed VTP at 60,000 treated acres per year for ten years, with the same vegetation treatment activities by vegetation type expected to occur. That is, the same amount of acreage would be treated with manual, mechanical, prescribed fire, and herbicide treatments. Geographically, the areas available to be treated by Alternatives A, B, and C are reduced compared to the proposed VTP: Alternatives A and C would have approximately 11.5 million acres available for treatment, while Alternative B would have approximately 16 million acres available for treatment (see Table 3.8-1). The reduced acres available for treatment may increase the likelihood of treatments concentrating in a localized area, but the likelihood is minimal as less than 0.5% of the area available to be treated will be treated in any given year, and only a fraction of those will involve the use of herbicides or other hazardous materials. Implementation of SPR HYD-16 would further reduce the likelihood of treatments concentrating at the planning watershed level. Because the nature of treatment activities are expected to be the same and the scale of the program is similar to that of the VTP, it is reasonable to assume that hazardous materials impacts associated with the VTP would be similar under each of these alternatives. As a result, impacts from exposure, handling, and transport of hazardous materials, smoke-related hazards, and ecological toxicity hazards expected from Alternatives A, B and C would have a similar impact to the project and would be required to implement the same SPR’s and mitigation measures. Overall, impacts would be similar to the project for Alternatives A, B, and C.

Alternative D proposes to treat fewer acres (36,000 annually) than the proposed VTP, and use less prescribed fire (approximately 6,000 acres annually) on an annual basis. Geographically, the area available for treatment would be the same as the proposed VTP as the treatments would be distributed across the landscape under the same constraints. Projects under alternative D would be required to implement the same SPR's and mitigation measures as the proposed VTP. It is reasonable to assume that a reduction of 80 percent, or 24,000 acres, under this Alternative would further reduce hazards related to smoke from prescribed fires. As a result, overall impacts related to smoke hazards would be expected to be reduced. However, this impact was determined to be less than significant with implementation of SPRs. Hazardous impacts associated with the VTP from other treatment activities would be expected to be the same as the proposed VTP because the same number of acres are expected to be treated using mechanical, manual, prescribed herbivory, and herbicides treatment activities. Furthermore, because the same type of treatment activities are expected to occur in the same areas, impacts from exposure, handling, transport of hazardous materials, and ecological toxicity hazards would have similar impacts as the proposed VTP project and would be required to implement the same SPR's. Overall, Alternative D would result in slightly less hazardous impacts compared to the Proposed Program because of the reduced smoke hazards that would occur throughout the State.

4.4.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design.

FBE-4: Approximately two weeks prior to commencement of prescribed burning operations the project coordinator shall 1) post signs along the closest major road way to the project area describing the project, timing, and requesting for smoke sensitive persons in the area to contact the project coordinator; 2) publish a public interest notification in a local newspapers describing the project, timing, and requesting for smoke sensitive persons in the area to contact the CAL FIRE project coordinator; 3) send the local county supervisor a notification letter describing the project, its necessity, timing, and summarize the measures being taken to protect the environment and prevent escape; and 4) develop a list of smoke sensitive persons in the area and contact them prior to burning.

HAZ-1: Prior to the start of vegetation treatment activities, the project coordinator shall conduct an Envirofacts web search to identify any known contamination sites within the project area. If a proposed vegetation treatment project occurs in areas located on the DTSC Cortese List, no activities shall occur within 100 feet of the site boundaries.

HAZ-2: Prior to the start of vegetation treatment activities, the project coordinator or contractor shall inspect all equipment for leaks and regularly inspect thereafter until equipment is removed from the site.

HAZ-3: Prior to the selection of treatment activities, CAL FIRE shall determine if there are viable, cost-effective, non-herbicide treatment activities that could be implemented prior to the selection of herbicide treatments.

HAZ-4: Prior to the start of herbicide treatment activities, the project coordinator shall prepare a Spill Prevention and Response Plan (SPRP) to provide protection to onsite workers, the public, and the environment from accidental leaks or spills of herbicides, adjuvants, or other potential contaminants. This plan shall include (but not be limited to):

- A map that delineates VTP staging areas, where storage, loading, and mixing of herbicides will occur
- A list of items required in a spill kit onsite that will be maintained throughout the life of the project
- Procedures for the proper storage, use, and disposal of any herbicides, adjuvants, or other chemicals used in vegetation treatment

HAZ-5: If remediation of hazardous contamination is needed, the project coordinator shall hire a licensed contractor with expertise in performing such work. The contractor shall comply with all laws and regulations governing worker safety and the removal and disposal of any contaminated material.

HAZ-6: All pesticide use shall be implemented consistent with Pest Control recommendations prepared annually by a licensed Pest Control Advisor.

HAZ-7: All appropriate laws and regulations pertaining to the use of pesticides and safety standards for employees and the public, as governed by the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, and local jurisdictions shall be followed. All applications shall adhere to label directions for application rates and methods, storage, transportation, mixing, and container disposal. All contracted applicators shall be appropriately licensed by the state. The project coordinator shall coordinate with the County Agricultural Commissioners, and all required licenses and permits shall be obtained prior to pesticide application.

HAZ-8: Projects shall avoid herbicide treatment in areas adjacent to water bodies and riparian areas. Application of herbicides shall be outside the WLPZ and ELZ as specified in HYD-3, or at the distances set forth in the herbicide label requirements, whichever is greater. No aerial spraying of herbicides shall occur under this Program EIR.

HAZ-9: The following general application parameters shall be employed during herbicide application:

- Application shall cease when weather parameters exceed label specifications, when sustained winds at the site of application exceeds seven miles per hour (MPH), or when precipitation (rain) occurs or is forecasted with greater than a 40 percent probability in the next 24-hour period to prevent sediment and herbicides from entering the water via surface runoff
- Spray nozzles shall be configured to produce a relatively large droplet size
- Low nozzle pressures (30-70 pounds per square inch [PSI]) shall be observed
- Spray nozzles shall be kept within 24 inches of vegetation during spraying

Drift avoidance measures shall be used to prevent drift in locations where target weeds and pests are in proximity to special status species or their habitat. Such measures can consist of, but would not be limited to, the use of plastic shields around target weeds and pests and adjusting the spray nozzles of application equipment to limit the spray area.

HAZ-10: All herbicide and adjuvant containers shall be triple rinsed with clean water at an approved site, and the rinsate shall be disposed of by placing it in the batch tank for application per 3 CCR § 6684. Used containers shall be punctured on the top and bottom to render them unusable, unless said containers are part of a manufacturer's container recycling program, in which case the manufacturer's instructions shall be followed. Disposal of non-recyclable containers will be at legal dumpsites. Equipment would not be cleaned and personnel would not bathe in a manner that allows contaminated water to directly enter any body of water within the treatment areas or adjacent watersheds. Disposal of all pesticides shall follow label requirements and local waste disposal regulations.

HAZ-11: Storage, loading and mixing of herbicides shall be set back at least 150 feet from any aquatic feature or special status species or their habitat or sensitive natural communities.

HAZ-12: Appropriate non-toxic colorants or dyes shall be added to the herbicide mixture where needed to determine treated areas and prevent over-spraying.

HAZ-13: For treatment activities located within or adjacent to public recreation areas, signs shall be posted at each end of herbicide treatment areas and any intersecting trails notifying the public of the use of herbicides. The signs shall consist of the following information: signal word, product name, and manufacturer; active ingredient; EPA registration number; target pest; treatment location; date and time of application; date which notification sign may be removed; and contact person with telephone number.

Signs shall be posted at the start of treatment and notification will remain in place for 72 hours after treatment ceases.

HAZ-14: All heavy equipment shall be required to include spark arrestors or turbo chargers that eliminate sparks in exhaust, and have fire extinguishers onsite.

4.5 WATER QUALITY

Vegetation treatment activities proposed by this Program have the potential to generate water quality impacts. The material presented in 4.5 has been broken into three sections:

- **4.5.1 – Affected Environment**
  - The Affected Environment section discusses the regulatory framework that limits impacts to water quality as well as the baseline water quality conditions in each Water Quality Region.
- **4.5.2 – Effects**
  - The Effect section outlines the potential impacts of implementing the proposed Program and the alternatives.
- **4.5.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that prevent the proposed Program from causing significant adverse impacts to water quality.

4.5.1 AFFECTED ENVIRONMENT

4.5.1.1 Regulatory Setting

The areas affected by the Program are subject to the following water quality-related requirements associated with federal and state regulations.

CLEAN WATER ACT (33 U.S.C. SECTION 1251 ET SEQ.)

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972. The CWA provides standard regulations for the discharge of pollutants to the waters of the United States (U.S.) in order to maintain their chemical, physical, and biological integrity and protect their beneficial uses. In addition, the CWA provides the statutory basis for the National Pollutant Discharge Elimination System (NPDES). Waters of the U.S. are defined as coastal waters, territorial seas, bays, rivers, streams, lakes, ponds, and wetlands (Code of Federal Regulations 40 CFR 122.2).

The CWA requires states to adopt water quality standards that must be approved by the U.S. Environmental Protection Agency (EPA) and requires NPDES permits for the discharge of pollutants in U.S. waters. In addition, the CWA gives authority to the EPA to (1) implement pollution control programs, including setting waste water standards and effluent limits on an industry-wide basis; and (2) authorize the NPDES Permit Program permitting, administration, and enforcement to state governments with oversight by the EPA.

Under Section 303(d) of the CWA, states (states, territories, and tribes) are required to develop lists of impaired and threatened waters. Impaired waters (e.g., rivers, streams, and lakes) are defined as those that do not meet water quality objectives because required pollution control mitigations are not sufficient to attain or maintain these standards. A 303(d) listing acts a "trigger" for states to monitor these waterbodies and develop Total Maximum Daily Loads (TMDLs) for each pollutant. The TMDL is a calculation of the maximum allowable amount of a pollutant impaired waters can receive without significant negative environmental effects, violation of water quality standards, and/or harm to beneficial uses. The TMDL process also provides an analysis of the linkages between pollutant reductions and the attainment of water quality objectives. The TMDL may also function as an action plan that provides management priorities and mitigation strategies for addressing water quality impairments. The EPA must approve a state's TMDL or, if denied, the EPA will prepare and implement its own.

Sections under "Title IV-Permits and Licenses" of the Clean Water Act regulate the permits and licenses required for any activity that could impair surface waters.

- Section 401, enforced by the SWRCB and RWQCBs, requires the discharger to obtain certification from the state that potential discharges will comply with approved effluent limits and water quality standards.
- Section 402 regulates the point- and non-point source discharges to surface waters through the NPDES permit program. The NPDES permit program is overseen by the SWRCB and administered by each RWQCB. A general (covers multiple facilities within a specific category) or individual NPDES permit is required for any municipal or industrial point-source discharge and nonpoint-source stormwater discharge. NPDES permits set limits on allowable pollutant emissions or effluent discharges, prohibit the discharges not specifically allowed by the NPDES permit, and provide the discharger with required mitigations to monitor and reduce potential point- and nonpoint-source pollutant discharges. NPDES permits issued for listed pollutants must be consistent with TMDL load allocations.
- Section 404, regulated by the U.S. Army Corps of Engineers (USACE), requires a permit prior to any activity that involves the discharge of dredged or fill material into waters of the U.S. at designated approved locations. Projects with impacts less than or equal to 0.5 acres may be approved through the Nationwide Permit Program (NWP).

Phase I and Phase II of the EPA stormwater program were promulgated under the CWA in order to further protect water quality, aquatic habitat, and beneficial uses from stormwater runoff. The EPA stormwater program requires that projects involving more than one acre of ground disturbance develop and obtain approval of a Stormwater Pollution Prevention Plan (SWPPP) prior to construction activities, and the implementation of best management practices (BMPs) to control runoff from construction sites during and after construction operations. A Notice of Intent (NOI) must be submitted to the SWRCB when a project is subject to a NPDES permit. Construction projects involving less than one acre of ground disturbance are exempt from these regulations.

SECTIONS 9 AND 10 OF THE RIVERS AND HARBORS ACT (33 U.S.C. 401 ET SEQ.)

Sections 9 and 10 of the Rivers and Harbors Act (33 U.S.C. 301 et seq.) are regulated by the USACE and require a permit for the construction of any structure within or over "navigable waters," including excavation, dredging, or deposition of material in or any obstruction or alteration of navigable waters. Navigable waters include coastal and inland waters, lakes, rivers, and streams that are wide and deep enough to provide passage; territorial seas; and wetlands adjacent to aforementioned navigable waters. A Section 10 Permit is also required in un-navigable waters, if the activity will have an influence on course, location, condition, or capacity of a navigable water body.

FEDERAL ANTIDEGRADATION POLICY (CODE OF FEDERAL REGULATIONS - TITLE 40: PROTECTION OF ENVIRONMENT 40 CFR 131.12)

The Federal Antidegradation Policy was issued in 1968 by the U.S. Department of the Interior to (1) ensure that activities will not lower the water quality of existing use, and (2) restore and maintain "high quality water." The federal policy maintains that states shall adopt a statewide antidegradation policy that includes the following conditions:

- Existing instream water uses and a level of water quality necessary to maintain those uses shall be maintained and protected.
- Water quality will be maintained and protected in waters that exceed water quality levels necessary for supporting fish, wildlife, recreational activities, and water quality, unless the State deems that water quality levels can be lowered to accommodate important economic or social development. In these cases, water quality levels can only be lowered to levels that support all existing uses.
- Where high quality waters constitute an outstanding national resource, such as waters of National and State parks and wildlife refuges and waters of exceptional

recreational or ecological significance, that water quality shall be maintained and protected.

PORTER-COLOGNE WATER QUALITY ACT (CAL. WATER CODE DIV. 7)

The Porter-Cologne Water Quality Act is a key element of California water quality control legislation. Under the Act, the SWRCB is given authority over state water rights and water quality policy, and the State's nine RWQCBs were established to regulate and oversee regional and local water quality issues. The RWQCBs are also responsible for developing and updating Basin Plans targeted toward (1) protecting waters designated with beneficial uses, (2) establishing water quality objectives for surface water and groundwater, and (3) determining actions necessary to maintain water quality standards and control point- and nonpoint-sources of pollution into the State's waters. Under the Act, proposed waste dischargers are required to file Reports of Waste Discharge (RWDs) to the RWQCB; and the SWRCB and RWQCBs are granted jurisdiction over the issuance and enforcement of Waste Discharge Requirements (WDRs), NPDES permits, and Section 401 water quality certifications.

CALIFORNIA STATE ANTIDEGRADATION POLICY (SWRCB RESOLUTION NO. 68-16, "POLICY WITH RESPECT TO MAINTAINING HIGHER QUALITY WATERS IN CALIFORNIA")

In 1968, the State of California adopted an antidegradation policy in response to directives under the Federal Antidegradation Policy. The antidegradation policy applies to high quality waters of the State, including surface waters and groundwater, and all existing and potential uses. The policy requires that high quality waters be maintained to the maximum extent possible and any proposed activities that can adversely affect high quality surface water and groundwater must (1) be consistent with the maximum benefit to the people of the State, (2) not unreasonably affect present and anticipated beneficial use of the water, and (3) not result in water quality less than that prescribed in water quality plans and policies.

4.5.1.2 REGIONAL WATER QUALITY CONTROL BOARDS

The affected area is comprised of nine Regional Water Quality Control Boards. The Regional Board boundaries are based on watersheds and water quality requirements are based on unique differences in climate, topography, geology and hydrology for each watershed. Regional board boundaries and overlapping CAL FIRE Unit and contract county boundaries are illustrated in Figure 4.5-1. Table 4.5-1 summarizes climatic, hydrologic, and water quality-related information for each Water Quality Region. Table 4.5-2 and Table 4.5-3 summarize the beneficial uses and water quality objectives for each Water Quality Region, respectively.

North Coast	San Francisco Bay	Central Coast	Los Angeles	Central Valley		Lahontan	Colorado River	San Diego	Santa Ana
HUU	LNU	BEU	SBC	SKU	BEU	LMU	BDU	RRU	BDU
SKU	MRN	SLU	VNC	LMU	TUU	NEU	RRU	ORC	RRU
LMU	CZU	SBC	LAC	SHU	SLU	BDU	MVU	MVU	ORC
SHU	SCU	VNC		TGU	VNC	LAC			
TGU		CZU		MEU	LAC	AEU			
MEU		SCU		NEU	AEU	KRN			
LNU		KRN		LNU	TCU				
MRN				BDU	SCU				
				FKU	KRN				
				MMU	BTU				

Figure 4.5-1 Regional Water Quality Control Board jurisdictional boundaries overlaid with CAL FIRE Unit and Contract County boundaries

NORTH COAST REGION – REGION 1

The North Coast Region receives more precipitation than any other part of California. Abundant in surface and groundwater resources, the North Coast Region constitutes only about 12 percent of the area of California but produces about 40 percent of the annual runoff. Encompassing some 19,390 square miles, including 340 miles of coastline and remote wilderness, urban and agricultural areas, the North Coast Region is divided into two natural drainage basins – the Klamath River Basin and the North Coast Basin.

Two distinct temperature zones characterize the Region. Along the coast, the climate is moderate and foggy, with little temperature variation. Inland seasonal temperatures can exceed 100°F. The numerous streams and rivers of the region contain anadromous fish, including coho and Chinook salmon and steelhead trout. The Region's few reservoirs support both cold and warm water fish.

Klamath River Basin

The Klamath River Basin covers approximately 10,830 square miles within northern California, and includes the Klamath, Trinity, Smith, Shasta, Scott, and Salmon River. The western portion of the Basin is within the Klamath Mountains and Coast Ranges geomorphic provinces, characterized by steep, rugged peaks ranging to elevations of 6,000 to 8,000 feet with relatively little valley area. The mountain soils are shallow and often unstable. Precipitation ranges from 60 to 125 inches per year. The eastern portion of the Basin includes predominantly high, broad valleys ranging from 4,000 to 6,000 feet in elevation. It receives low to moderate rainfall, typically 15 to 25 inches annually.

North Coastal Basin

The North Coastal Basin covers approximately 8,560 square miles along the north-central coast. Most of the Basin consists of rugged, forested coastal mountains dissected by the Eel, Russian, Mad, and Mendocino coastal rivers (Gualala, Garcia, Navarro, Big, and Noyo), as well as numerous smaller river systems. Soils are generally unstable and erodible, and rainfall is high. Major population areas center around Humboldt Bay to the north and Santa Rosa to the south.

SAN FRANCISCO BAY REGION – REGION 2

The San Francisco Bay Region, centrally located along our state's coastline, marks a natural topographic separation between the northern and central parts of the California

Coast Ranges geomorphic province. More than seven million people live in the 4,600-square-mile area. The San Francisco Bay estuarine system drains 40 percent of California and includes the Central Valley Region's Sacramento and San Joaquin Rivers, which account for 90 percent of freshwater flow into the bay. The San Francisco estuary is the largest estuary on the west coast of North and South America and forms the centerpiece of the nation's fifth largest metropolitan area, comprising San Francisco, Oakland, and San Jose.

The Region includes all or major portions of nine counties. With a Mediterranean climate of mild, wet winters and cool, dry summers, the Region encompasses a range of microclimates from the foggy coast to the dry inland. The mean annual precipitation varies from 14 to 49 inches. Flows are highly seasonal, with more than 90 percent of the annual runoff occurring between November and April. Many streams are dry during the summer months.

The land surrounding the San Francisco Bay is densely populated and highly urbanized, with channelized creeks and flood control structures, dams and reservoirs. A heavily industrialized corridor runs along the Contra Costa shoreline from Richmond to Pittsburg, home to major oil refineries and chemical companies. The land draining into the northern reaches of the estuary, which includes the San Pablo and Suisun bays, supports pockets of urbanization within open space and extensive crop and range land, including vineyards in Napa and Sonoma counties and dairies in Sonoma and Marin counties. The less developed coastal watersheds in Marin and San Mateo counties support listed populations of salmon and steelhead. Contaminants from urban runoff, mining and pesticide application are major concerns in this Region.

CENTRAL COAST REGION – REGION 3

The Central Coast Region includes all of Santa Cruz, San Benito, Monterey, San Luis Obispo and Santa Barbara counties and small portions of several other counties. The region contains 2,360 miles of streams, 99 lakes comprising 25,000 acres, and over 8,000 acres of wetlands and estuaries. Prime agricultural lands dominate the bottomlands of many watersheds, and upper watersheds are in rugged National Forest lands. The area ranges climatically from the extremely wet Santa Cruz Mountains to the very arid Carrizo Plain. Important marine resources have been afforded protection through two National Marine Sanctuary programs and the Morro Bay National Estuary Program.

LOS ANGELES REGION – REGION 4

With more than 10 million residents, the Los Angeles Region is the most densely populated region in the state. Agriculture and open space exist alongside urban, residential, commercial, and industrial areas. Open spaces in northern Los Angeles County are steadily giving way to residential communities. The Los Angeles Regional Board regulates over 1,000 point source discharges of wastewater.

The Region has designated 10 watershed management areas. The Los Angeles and San Gabriel River watersheds are heavily urbanized in their lower stretches but retain largely undeveloped open space areas in their upper portions. The Santa Monica Bay watershed contains a mixture of urbanized and more rural areas, all of which drain into Santa Monica Bay, a designated waterbody under the National Estuary Program. The Santa Clara River, Ventura River and Calleguas Creek watersheds contain many small urban centers, but also support large areas of agriculture. The Dominguez Channel Watershed is a heavily urbanized and industrialized area that drains into Los Angeles Harbor, and in combination with Long Beach Harbor, forms the largest industrial port on the West Coast.

The Los Angeles Region encompasses all of the coastal watersheds of Los Angeles and Ventura counties, along with small portions of Kern and Santa Barbara counties and the drainages of five coastal islands (Anacapa, San Nicolas, Santa Barbara, Santa Catalina, and San Clemente). The Region also includes all coastal waters within three miles of the continental and island coastlines.

Most precipitation in the Los Angeles Region occurs during just a few major storms each year, averaging from about 15 inches annually in Ventura County to almost 40 inches in certain mountainous areas. Average rainfall is slightly lower in Los Angeles County, but varies widely between valleys and mountains.

CENTRAL VALLEY REGION – REGION 5

The Central Valley Region is the State’s largest, encompassing 60,000 square miles, or about 40 percent of the State’s total area. Thirty-eight of California’s 58 counties are either completely or partially within the Central Valley Regional Board’s boundaries, formed by the crests of the Sierra Nevada on the east, the Coast Ranges and Klamath Mountains on the west, the Oregon border on the north, and the Tehachapi Mountains on the south. The Sacramento and San Joaquin Rivers, along with their tributaries, drain the major part of this large area through an inland Delta, before emptying into San Francisco Bay. The Delta is the focal point of the state’s two largest water conveyance projects, the State Water Project and the federal Central Valley Project. Together, the Sacramento and San Joaquin Rivers and the Delta furnish over half of the state’s water supply. The southern third of the Central Valley contains the Tulare Lake Basin, a closed hydrographic unit, except during extremely wet years.

The Central Valley Region provides over 50 percent of the state's managed water supply and contains approximately 77 percent of the state's irrigated agriculture. The Region contains 83,624 miles of rivers and streams; 504,350 acres of lakes, reservoirs, and ponds; and 400,000 acres of wetlands. Approximately 1,510 miles of waterways are dominated by agricultural discharge, and there are 19,812 miles of constructed agricultural drains.

LAHONTAN REGION – REGION 6

The Lahontan Region is the second largest region in California, spanning 33,000 square miles of eastern California from the Oregon border in the north to the Mojave Desert, San Bernardino Mountains, and eastern Los Angeles County in the south. The Region is nearly 600 miles long and includes the highest and lowest points in the contiguous United States (Mount Whitney at 14,494 feet and Badwater, Death Valley at -282 feet, respectively).

The Lahontan Region has more than 3,000 miles of streams, 1,581 square miles of groundwater basins, and more than 700 lakes, including two designated Outstanding National Resource Waters – Lake Tahoe and Mono Lake – and numerous other high-quality waterbodies that are eligible for the same status. Due to the enormity of the Region's north-south span and its variety of elevations, the Region contains diverse habitats, ranging from alpine mountain environments that receive heavy snowpack most years, to low-elevation, dry deserts. A great range of habitats, precipitation regimes and ecosystem types exist between the two elevation extremes. In addition, topography, past glaciation and climatic changes have led to the existence of "ecological islands" and the evolution of species, subspecies, and genetic strains of plants and animals in that are found nowhere else. Particularly notable are fish such as the Eagle Lake trout, Lahontan and Paiute cutthroat trout, Mojave tui chub, and several kinds of desert pupfish.

COLORADO RIVER REGION – REGION 7

The Colorado River Basin Region covers approximately 20,000 square miles in the southeastern corner of California, the most arid part of the state. The region includes all of Imperial County and portions of San Bernardino, Riverside and San Diego counties.

Altogether, the region has 250,000 acres of lakes and 900 miles of streams and rivers. Annual average rainfall varies from three to four inches.

The region is divided into three watersheds: the Lower Colorado River, Salton Sea Transboundary, and Desert Aquifers. The Desert Aquifers watershed has little surface water and hundreds of aquifers. The majority of the Region's surface waters are in the Imperial Valley and East Colorado River Basin planning areas.

The Salton Sea Transboundary watershed, encompassing the Coachella and Imperial Valleys, is the priority watershed for the Colorado River Basin, containing five of the six 303(d) listed impaired surface waterbodies in the Region. Water from the Colorado River has created an irrigated agricultural ecosystem throughout this watershed. Wildlife and aquatic species are dependent on habitat created and maintained through the discharge of agricultural return flows. Major water bodies in the watershed include the Salton Sea, Alamo River, New River, Imperial Valley Agricultural Drains, and Coachella Valley Storm Water Channel.

SANTA ANA REGION – REGION 8

Despite being the smallest of California's nine Regional Water Quality Control Boards (2,800 square miles), the Santa Ana Region is one of the most densely populated with five million residents. The Region includes most of Orange County and portions of Riverside and San Bernardino counties. The Mediterranean climate is generally dry in the summer, with wet mild winters. Average annual rainfall is approximately 15 inches, occurring largely between November and March. The Region contains 460 miles of streams; more than 17 lakes and reservoirs; 11 bays, estuaries and tidal prisms; and more than 10 wetlands.

The Region's two main rivers are the Santa Ana River and the San Jacinto River. The Santa Ana River originates in the San Bernardino Mountains and flows through San Bernardino, Riverside and Orange counties on its way to the ocean. It transports more than 125 million gallons per day of recycled water from Riverside and San Bernardino counties for recharge into the Orange County Groundwater Basin and satisfies approximately 40 percent of Orange County's water demand. The San Jacinto River, a major tributary to the Santa Ana, is ephemeral, flowing only during large storm events. The terminus of the San Jacinto River is typically Lake Elsinore during most storms. When large storm events occur, Lake Elsinore spills to join the Santa Ana River via Temescal Creek.

Except for coastal streams that empty directly into the ocean, the stream network in the Santa Ana Region is made up of first, second, third, and fourth order streams that empty directly into the Santa Ana River or the San Jacinto River. The Santa Ana Region is also home to significant coastal water resources, including several miles of beaches, Newport Bay, Upper Newport Bay Ecological Reserve, Anaheim Bay, Huntington Harbour, Bolsa Chica Ecological Reserve, and two State Water Quality Protection Areas.

The Region’s population density and resulting land use activities affect its water resources. Many of the Region’s surface waterbodies are included on the Clean Water Action Section 303(d) list, having impaired waterbodies due to excessive nutrients, excessive bacterial levels, and contamination due to legacy pesticide usage.

SAN DIEGO REGION – REGION 9

The San Diego Region stretches along 85 miles of coastline from Laguna Beach to the Mexican border and extends 50 miles inland to the crest of the Peninsular Ranges. It encompasses most of San Diego County, southwestern Riverside County, and southern Orange County. The Region’s semi-arid (average annual precipitation of 10-13 inches) Mediterranean climate is generally mild. Relatively little precipitation falls in much of the Region, with most falling from November through March. It occurs principally as rain, with snow rare except in the higher mountains. The Region’s population is more than three million.

The diverse water resources of the San Diego Region include the ocean, bays, estuaries, streams, freshwater wetlands, reservoirs, and groundwater. Altogether, there are 910 miles of streams, 19,220 acres of lakes, and 85 miles of coastline. All major drainage basins in the Region contain groundwater basins, which are generally relatively small in area and shallow. The Region has a variety of wetlands, including vernal pools, coastal salt marsh, freshwater marsh, and riparian woodlands. The Region’s streams include perennial and non-perennial reaches, with some segments flowing for only a few days or months each year.

The Region imports approximately 90 percent of its water supply from northern California and the Colorado River, and much of this water is stored in local reservoirs. Nearly all of the local groundwater basins in the Region have been intensively developed for municipal and agricultural supply purposes. Recycled water is a growing component of the Region’s water supply, and seawater desalination projects are planned or under construction.

Numerous waterbodies in the Region are known to be degraded due to several different stressors from various sources. Many of the region’s surface waters are included on the Clean Water Act Section 303(d) list of waters where water quality objectives are not met. Most wetland areas have been filled, dredged, fragmented, or otherwise lost or degraded. The ecosystems of many stream systems and coastal lagoons have been modified by dams, water diversions, channelization, transportation corridors, runoff from urban and agricultural areas, invasive species, and other anthropogenic factors.

BENEFICIAL USES AND WATER QUALITY OBJECTIVES

State policy for water quality control in California is directed toward achieving the highest water quality consistent with maximum benefit to the people of the state. Aquatic ecosystems and underground aquifers provide many different benefits to California's citizens. The State and Regional Water Boards are charged with protecting these uses from pollution and nuisance that may occur as a result of waste discharges in the state. Beneficial uses of surface waters, groundwaters, marshes, and wetlands presented in Table 4.5-2 are the basis for establishing water quality objectives and discharge prohibitions to attain these goals.

Beneficial use designations for any given water body do not rule out the possibility that other beneficial uses exist or have the potential to exist. Existing beneficial uses that have not been formally designated in Regional Water Board Basin Plans are protected whether or not they are identified.

There are two types of water quality objectives: narrative and numerical. Narrative objectives present general descriptions of water quality that must be attained through pollutant control measures and watershed management. They also serve as the basis for the development of detailed numerical objectives.

Historically, numerical objectives were developed primarily to limit the adverse effect of pollutants in the water column. Numerical objectives typically describe pollutant concentrations, physical/chemical conditions of the water itself, and the toxicity of the water to aquatic organisms. These objectives are designed to represent the maximum amount of pollutants that can remain in the water column without causing any adverse effect on organisms using the aquatic system as habitat, on people consuming those organisms or water, and on other current or potential beneficial uses.

The technical basis of a Region's water quality objectives include extensive biological, chemical, and physical partitioning information reported in the scientific literature, national water quality criteria, studies conducted by other agencies, and information gained from local environmental and discharge monitoring. Limited information exists in some cases, making it difficult to establish definitive numerical objectives.

Together, the narrative and numerical objectives define the level of water quality that shall be maintained within the region. In instances where water quality is better than that prescribed by the objectives, the state Anti-degradation Policy applies (State Board Resolution 68-16: Statement of Policy With Respect to Maintaining High Quality of Waters in California). This policy is aimed at protecting relatively uncontaminated aquatic systems where they exist and preventing further degradation. The state's Anti-degradation Policy is consistent with the federal Anti-degradation Policy, as interpreted by the State Water Resources Control Board in State Board Order No. 86-17.

When uncontrollable water quality factors result in the degradation of water quality beyond the levels or limits established herein as water quality objectives, the Regional Board will conduct a case-by-case analysis of the benefits and costs of preventing further degradation. In cases where this analysis indicates that beneficial uses will be adversely impacted by allowing further degradation, then the Regional Board will not allow controllable water quality factors to cause any further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the state and that may be reasonably controlled. The Regional Board establishes and enforces Waste Discharge Requirements (WDRs) for point and nonpoint source of pollutants at levels necessary to meet numerical and narrative water quality objectives. In setting WDRs, the Regional Board will consider, among other things, the potential impact on beneficial uses within the area of influence of the discharge, the existing quality of receiving waters, and the appropriate water quality objectives.

In general, the objectives are intended to govern the concentration of pollutant constituents in the main water mass. The same objectives cannot be applied at or immediately adjacent to submerged effluent discharge structures. Zones of initial dilution within which higher concentrations can be tolerated will be allowed for such discharges. Water quality objectives for surface waters are summarized in Table 4.5-3.

Table 4.5-1 General environmental characteristics and water quality issues by California's Regional Water Boards

Regional Water Quality Control Board	Precipitation	Runoff and Flood Hazard	Major Rivers & Waterbodies	Water Quality	Sedimentation	CAL FIRE Units within Regional Board Boundaries
North Coast - Region 1	Highest precipitation in the State with average annual precipitation of 50 inches. High intensity and long duration rainfall events are common during the winter period. Annual precipitation ranges from 15 inches in Modoc County to nearly 200 inches in northern Del Norte County. Heavy snowfall is limited to the higher elevations of the Klamath Mountains and Trinity Alps.	Highest peak discharge values in the State. Smaller coastal watersheds tend to exhibit rapid hydrograph response, with lower base flows and little snowmelt. In comparison, larger inland rivers experience slower hydrograph response, with higher base flows and significant snowmelt response.	Albion River Bear River Big River Bodega Harbor Eel River Garcia River Gualala River Humboldt Bay Klamath River Mad River Mattole River Navarro River Noyo River Redwood Creek Russian River Salmon Creek Scott River Shasta River Smith River Tenmile River Trinity River Van Duzen River.	Surface water issues: Erosion and sedimentation from timber harvesting, roads, and grazing; nonpoint source pollution from storm water runoff; channel modification, gravel mining and dairies; and MTBE, PCE, and dioxin contamination. Groundwater issues: Leaking underground tanks.	High rainfall, in combination with steep mountainous areas underlain in places by unstable geologies/soils, high uplift rates, and poor land use practices could result in higher peak discharges, erosion and sediment yields during storm events.	Humboldt Del-Norte, Lassen-Modoc, Mendocino, Shasta-Trinity, Siskiyou, Sonoma-Lake Napa.
San Francisco Bay - Region 2	Average precipitation for the Region is approximately 25 inches. Because of marine influences and rain shadows, the annual precipitation is 20-25 inches in the North Bay, 15-20 inches in the South Bay (east of the Santa Cruz Mountains), and more than 40 inches in the higher elevation west facing mountainous areas.	Small, steep watersheds are subject to high rainfall from short, intense storms. All rivers are prone to intense flooding during major storms events.	Alameda Creek, Corte Madera Creek, Coyote Creek, Green Valley Creek, Guadalupe River, Napa River, Novato Creek, Petaluma River, San Leandro Creek, San Lorenzo Creek, San Mateo Creek, San Pablo Creek, Sonoma Creek, Suisun Creek, Tomales Bay, Walnut Creek, Wildcat Creek.	Surface water issues: Erosion and sedimentation from timber harvesting, roads; agricultural runoff; nonpoint source pollution from storm water runoff; trace metals; toxic pollutants; habitat and wildlife degradation. Sources from irrigated agricultural runoff, sewage discharge, and industrial manufacturing. Groundwater issues: Drinking water impairment, salt water intrusion, and synthetic organics from irrigated agriculture and other nonpoint sources, overdraft, and industrial discharge.	Steep upland areas with unstable geologies are prone to erosion during large storm events and could deposit sediment in rivers and floodplains. Wildfires could result in sedimentation of rivers from increased surface erosion, rilling and gullying.	San Mateo-Santa Cruz, Santa Clara, Sonoma-Lake Napa.

Central Coast - Region 3	Primarily rainfall, insignificant snowfall. Average precipitation ranges between 12 and 42 inches per year. Interior southern valleys: 5-10 inches. Mountain areas: >50 inches.	All rivers in the region are prone to winter storm produced flooding. Small, steep watersheds are subject to short, intense floods. Limited seasonal base flow and no significant snowmelt runoff.	Big Sur River, Carmel River, Naciemento River, Salinas River, San Antonio River, San Benito River, Santa Maria River, Santa Ynez River.	Surface water issues: Erosion and sedimentation, wildlife and fisheries degradation, bacteria, eutrophication, metal from nonpoint surface runoff, and agricultural runoff. Groundwater issues: Drinking water impairment, nitrates, toxic pollutants, and saltwater intrusion caused by nonpoint surface runoff and groundwater overdraft.	Steep upland areas with unstable geologies are prone to erosion during large storm events and could deposit sediment in rivers and on floodplains. Wildfires could result in sedimentation of rivers from increased surface erosion, rilling, gullying, and subsequent debris flows.	San Benito-Monterey, San Luis Obispo, San Mateo-Santa Cruz, Santa Clara, Sonoma-Lake-Napa
Los Angeles - Region 4; Santa Ana - Region 8; San Diego - Region 9	Average annual precipitation is approximately 18 inches. Annual precipitation ranges from 10 inches in the valley areas to approximately 40 inches in the mountains.	Most rivers and creeks are intermittent or ephemeral with minor runoff from snowmelt. Short duration, intense winter storms in steep upland watersheds are the primary cause for flooding in these regions. Urbanization has resulted in drainages with high peak discharges and short lag times.	Carlsbad, Los Angeles River, Otay River, San Dieguito River, San Diego River, San Gabriel River, San Juan Creek, San Luis Rey River, Santa Ana River, Santa Clara River, Santa Margarita River, Santa Monica Bay, Sweetwater River, Tijuana River, Ventura River.	Surface water issues: Erosion and sedimentation from roads, ranching, and urban development; nonpoint source pollution from storm water runoff; erosion from inactive mines; agricultural runoff; mineral and gravel mining; nutrients; pathogens; heavy metals; hydromodification; and individual waste water systems. Groundwater issues: Drinking water impairment, salt water intrusion, toxic pollutants, and VOCs from industrial and agricultural runoff, overdraft, and underground storage and fuel tank leaks.	Typically low erosion and sediment yield due to urbanization. Steep channels and unstable geology, coupled with short duration, intense winter storms in steep upland watersheds can cause high rates of localized erosion and sediment yield from debris flows and mud flows.	Riverside, San Bernardino, San Diego.

Central Valley - Region 5	Annual average precipitation ranges from 13 inches in the Tulare Lake region to 37 inches in the Sacramento River watershed. Annual precipitation increases from south to north, and from west to east (i.e., valley floor to Sierra/Cascade crest). The high Sierra receives an average of approximately 35 inches in snowfall.	Major rivers receive high spring runoff from snowmelt from adjacent mountain streams and rivers. Snowmelt runoff and rain-on-snow events can cause erosion, sedimentation, and flooding. Flooding in the lowland areas is primarily related to large rain-on-snow events. Prolonged spring runoff can cause flooding in typically dry lakes in the southern portion of the region.	American River, Bear River, Butte Creek, Feather River McCloud River, Pitt River, Yuba River, Chowchilla River, Cosumnes River, Del Puerto Creek, Fresno River, Merced River, Mokelumne River, Orestimba Creek, Stanislaus River, Tuoloumne River, Kaweah River, Kern River, Kings River, San Joaquin River, Tulare Lake, Tule River.	Surface water issues: Erosion and sedimentation from timber harvesting, roads, grazing, rural development, dairies and agriculture; nonpoint source pollution from storm water runoff and individual waste water systems; impacts from historic mining (i.e., acid mine drainage and mercury. Groundwater issues: Drinking water impairment, salinity, toxic pollutants, VOCs from wastewater systems and septic tanks, irrigated agriculture and diary nonpoint sources, agricultural and industrial runoff, overdraft, and fuel tank leaks.	Erosion and sediment yields are generally low due to stable geologies and abundant vegetative cover. Although heavy storm rainfall and saturated soil conditions, coupled with land use practices (e.g., timber harvesting, grazing, agriculture, and poor road construction) could result in high erosion and sediment yields. Wildfires could result in sedimentation of rivers from increased surface erosion.	Amador-El Dorado, Butte, Fresno-Kings, Lassen-Modoc, Madera-Mariposa-Merced, Nevada-Yuba-Placer, Shasta-Trinity, Siskiyou, Sonoma-Lake-Napa, Tuolumne-Calaveras, Tulare, Tehama-Glenn.
Lahontan - Region 6	Average precipitation for the northern region is approximately 23 inches, primarily snowfall. Annual precipitation ranges from less than 5 inches in the valley areas of Lassen and Mono counties to more than 60 inches near the Sierra crest. Average precipitation in the south is approximately 8 inches, but varies considerably with rising elevation.	Lowland valley areas could experience high peak runoff in short and steep ephemeral drainages. Most watersheds are small and steep. Prolonged spring runoff and high base flow is typical of drainages on the east side of the Sierra Nevada. Many drainages are ephemeral and could experience rapid hydrograph response and resultant flooding.	Carson River, Surprise Valley, Susan River, Truckee River, Lake Tahoe, Walker River, Amargosa River, Antelope Valley, Mojave River, Mono Lake, Owens River.	Surface water issues: Erosion and sedimentation from logging, roads, and grazing; nonpoint source pollution from storm water runoff; acid drainage from inactive mines; individual waste water systems. Groundwater issues: Drinking water, salinity, and VOCs from mining drainage, overdraft, and fuel tank leaks.	Flashy storm flows with high peak discharge, lack of vegetation, poorly consolidated geology, and steep channel morphology could result in debris flows, erosion and sediment yield. Wildfires could result in sedimentation of rivers from increased surface erosion, rilling, and gullying.	Amador-Eldorado, Lassen-Modoc, Nevada-Yuba-Placer, San Bernardino.

Colorado River - Region 7	Lowest annual precipitation out of all the Regional Board areas. Average annual rainfall ranges from 3 to 6 inches.	Characterized by low annual rainfall and runoff, and sparse vegetation. Streams are typically low gradient and braided in valley areas and steep gradient in mountainous areas. Storms are generally of short duration and high intensity, and could result in flash floods in lowland alluvial fan areas. Ephemeral streams are prone to flooding during heavy rainfall events.	Alamo River, Colorado River, New River, Salton Sea, Whitewater River.	Surface water issues: Sedimentation, salinity, drinking water impairment, bacteria, pesticides, herbicides from agricultural runoff, wastewater, erosion, and diversions. Groundwater issues: Drinking water impairment and VOCs caused by groundwater overdraft and fuel tank leaks.	Erosion and sedimentation primarily from ravel, surface erosion, wind erosion, and as freeze-thaw. Short duration and high intensity storms could result in debris flows generated in steep mountainous areas. In comparison, lowland and valley areas tend to have lower erosion and sediment yields.	Riverside, San Bernardino, San Diego.

Table 4.5-2 Beneficial uses of water by Regional Water Quality Control Board. Acronyms are defined in the first column. Additional beneficial uses may occur for specific waterbodies within each Region.

North Coast	San Francisco	Central Coast	Los Angeles	Central Valley	Lahontan	Colorado River	Santa Ana	San Diego
Municipal and domestic supply (MUN)	AGR	MUN	MUN	MUN	AGR	MUN	MUN	MUN
Agricultural supply (AGR)	ASBS	AGR	AGR	AGR	AQUA	AGR	AGR	AGR
Industrial service supply (IND)	COLD	PROC	PROC	IND	BIOL	AQUA	IND	PROC
Industrial process supply (PROC)	COMM	IND	IND	PROC	COLD	IND	PROC	IND
Groundwater recharge (GWR)	EST	GWR	GWR	GWR	COMM	GWR	GWR	GWR
Freshwater replenishment (FRSH)	FRSH	FRSH	FRSH	FRSH	FLD	REC-1	NAV	FRSH
Navigation (NAV)	GWR	NAV	NAV	NAV	FRSH	REC-2	POW	NAV
Hydropower generation (POW)	IND	POW	POW	POW	GWR	WARM	REC-1	POW
Water contact recreation (REC-1)	MAR	REC-1	REC-1	REC-1	IND	COLD	REC-2	REC-1
Non-contact water recreation (REC-2)	MIGR	REC-2	LREC-1	REC-2	MIGR	WILD	COMM	REC-2
Commercial and sport fishing (COMM)	MUN	COMM	REC-2	COMM	MUN	POW	WARM	COMM
Aquaculture (AQUA)	NAV	AQUA	COMM	AQUA	RARE	FRSH	Limited warm freshwater habitat (LWRM)	AQUA
Warm freshwater habitat (WARM)	PROC	WARM	AQUA	WARM	REC-1	RARE		WARM
Cold freshwater habitat (COLD)	RARE	COLD	WARM	COLD	REC-2			COLD
Inland saline water habitat (SAL)	REC-1	SAL	COLD	EST	SAL		COLD	SAL
Estuarine habitat (EST)	REC-2	EST	EST	WILD	SPWN		BIOL	EST
Marine habitat (MAR)	SHELL	MAR	WET	BIOL	WARM		WILD	MAR
Wildlife habitat (WILD)	SPWN	WILD	MAR	RARE	NAV		RARE	WILD
Preservation of areas of special biological significance (ASBS)	WARM	BIOL	WILD	MIGR	POW		SPWN MAR	BIOL
Rare, threatened, or endangered species (RARE)	WILD	RARE	BIOL	SPWN	PROC		SHEL	RARE
Migration of aquatic organisms (MIGR)		MIGR	RARE	SHELL	WILD		EST	MIGR
Spawning, reproduction, and/or early development (SPWN)		SPWN	MIGR		WQE			SPWN
Shellfish harvesting (SHELL)		SHELL	SPWN					SHELL
Water quality enhancement (WQE)		ASBS	SHELL					
Flood peak attenuation/flood water storage (FLD)								
Wetland habitat (WET)								
Native American culture (CUL)								
Subsistence fishing (FISH)								

Table 4.5-3 Water quality objectives for surface waterbodies defined in the Water Quality Control Plans (Basin Plans) for the Regional Water Quality Control Boards.

North Coast	San Francisco Bay	Central Coast	Los Angeles	Central Valley	Lahontan	Colorado River	Santa Ana	San Diego
Color	Bacteria	Color	Ammonia	Ammonia	Ammonia	Bacteria	Algae	Iron
Bacteria	Bioaccumulation	Biostimulatory substances	Bacteria, Coliform	Bacteria	Bacteria, coliform	Aesthetic qualities	Ammonia, Un-ionized	Ammonia, un-ionized
Biostimulatory substances	Biostimulatory substances	Chemical constituents	Bioaccumulation	Biostimulatory substances	Biostimulatory substances	Biostimulatory substances	Bacteria, coliform	Biostimulatory substances
Chemical constituents	Chemical constituents	Dissolved oxygen	Biochemical oxygen demand	Chemical constituents	Chemical constituents	Chemical constituents	Boron	Boron
Dissolved oxygen	Color	Floating material	Biostimulatory substances	Color	Chlorine, total residual	Dissolved oxygen	Chemical oxygen demand	Chlorides
Oil and grease	Dissolved oxygen	Oil and grease	Floating material	Pesticides	Color	pH	Chloride	Color
Floating material	Floating material	Other organics	Chlorine, Total residual	Floating material	Dissolved oxygen	Pesticide wastes	Chlorine, residual	Dissolved oxygen
Pesticides	Oil and grease	Pesticides	Color	Mercury	Color	Radioactivity	Color	Floating material
pH	pH	pH	Dissolved oxygen	Methlymercury	Oil and grease	Sediment	Floatables	Fluoride
Radioactivity	Radioactivity	Radioactivity	Exotic vegetation	Oil and grease	Radioactivity	Toxicity	Hardness	Nitrate
Sediment	Suspended material	Sediment	Chemical constituents	Dissolved oxygen	Dissolved oxygen	Total dissolved solids	Dissolved soils, total	Suspended and settleable solids
Temperature	Salinity	Temperature	Habitat	pH	Pesticides	Temperature	Fluoride	Manganese
Toxicity	Sediment	Toxicity	Hydrology	Radioactivity	pH	Turbidity	Inorganic	Sediment
Tastes and odors	Settleable material	Tastes and odors	Methylene blue activated substances	Salinity	Floating materials	Suspended solids and settleable solids	Filterable residue, total	Inorganic chemicals
Suspended material	Sulfide	Suspended material	Mineral quality	Sediment	Sediment	Tainting substances	Metals	Oil and grease
Settleable material	Tastes and odors	Settleable material	Nitrogen	Settleable material	Settleable materials		Radioactivity	Organic chemicals
Turbidity	Temperature	Turbidity	Oil and grease	Turbidity	Taste and odor		Nitrate	Sulfate
	Toxicity		Pesticides	Tastes and odors	Temperature		Nitrogen, total inorganic	Pesticides
	Turbidity		pH	Temperature	Toxicity		Oil and grease	pH

North Coast	San Francisco Bay	Central Coast	Los Angeles	Central Valley	Lahontan	Colorado River	Santa Ana	San Diego
	Un-ionized ammonia		Polychlorinated biphenyls	Toxicity	Turbidity		Oxygen, dissolved	Phenolic compounds
	Population and community ecology		Priority pollutants	Suspended material	Suspended materials		pH	Radioactivity
			Radioactive substances		Non-degradation of aquatic communities and populations		Methylene blue-activated substances	Secondary drinking water standards
			Solid, suspended, or settleable materials				Sodium	Percent sodium and adjusted sodium adsorption ratio
			Taste and odor				Solids, suspended and settleable	Methylene blue-activated substances
			Temperature				Sulfate	Tastes and odors
			Toxicity				Sulfides	Temperature
			Turbidity				Surfactants	Total dissolved solids
							Taste and odor	Toxic pollutants
							Temperature	Toxicity
							Total dissolved solids	Trihalomethanes
							Total filterable residue	Turbidity
							Total inorganic nitrogen	Bacteria - total coliform, fecal coliform, e. coli, and enterococci
							Toxic substances	
							Turbidity	

IMPAIRED WATERBODIES

Section 303(d) of the Clean Water Act requires states to identify and develop a list of impaired waterbodies. The waterbodies on the list do not meet water quality standards. The state is required by EPA to prioritize the 303(d) list and to develop a Total Maximum Daily Load (TMDL), followed by an implementation plan, to improve water quality. States are required in even numbered years to review and update the 303(d) list. Further, under section 305(b) the State Water Resources Control Board (SWRCB) must report biannually to the EPA on the status of water quality across the State. Table 4.5-4 provides a summary of impaired waterbodies by Regional Board. Table 4.5-5 provides a tabular summary for each of the nine Regional Water Boards by pollutant category. A review of these tables and Figure 4.5-2 shows that the greatest extent of water quality impairments from forest activities is found in the North Coast (Region 1), the Lahontan Region (east side of the Sierra Nevada and Mojave Desert) (Region 6), and the Central Coast (Region 3). For rangeland, water quality impairments are also commonly occurring in the North Coast (Region 1), Lahontan (Region 6), and Central Coast (Region 3), as well as the Central Valley (Region 5). Typical water pollutants associated with forestry and range activities are sediment, water temperature, nutrients, and pathogens.

Table 4.5-4 Summary of impaired waterbodies by Regional Board Boundary.

Waterbody Size	North Coast	San Francisco	Central Coast	Los Angeles	Central Valley	Lahontan	Colorado River	San Gabriel	San Diego
Acres of Lake, Bays, and Estuaries	85706	3554626	67299	833041	708982	598212	1633422	40641	61035
Miles of Watercourses	47513	1538	8176	3646	11043	919	11920	612	2397

Table 4.5-5 Impaired waterbodies by generalized pollutant category and Regional Board boundaries. Acres reflect the size of lakes, bays and estuaries, whereas miles reflect the length of watercourses. Individual waterbodies may be listed for more than one pollutant.

Pollutant	Affected Size	North Coast	San Francisco	Central Coast	Los Angeles	Central Valley	Lahontan	Colorado River	San Gabriel	San Diego
Metals:	Acres	23453	621391	18096	16193	308365	123480	466680	6083	6202
	Miles	3282	64	368	474	2071	238	1614	193	28
Misc.:	Acres	29657	316916	2448	151104	55796			2865	6202
	Miles	2066	0	670	269	484			64	28
Nutrients:	Acres	199	141719	7687	2745	51139	227350	233340	9688	14325
	Miles	7697	184	1026	418	741	741	132	52	627
Other Inorganics:	Acres		54							1058
	Miles				175		27			48
Other Organics:	Acres	32150	1269558	385	171310	31413	31030		7358	2187
	Miles			99	116	333		1372	8	223
Pathogens:	Acres		11154	4523	175413	1635		233340	2187	2259
	Miles	662	197	1907	690	943	81.3	223	223	360
Pesticides:	Acres		955493	29760	175413	188080		466722	4883	1325
	Miles		512	1007	690	3410		7098	25	180
Salinity:	Acres		66339		29	28809	87978	233340		1058
	Miles	85		1531	418	370	195		21	185
Sediment:	Acres	247	8545	4129	344		87978		653	3660
	Miles	17366	203	791	101	28	120	1348	20	18
Temperature:	Acres									
	Miles	16355	76	269		441				
Toxicity:	Acres		47	155	163154	43742			6924	1319
	Miles		56	509	190	2220	60	66	6	10

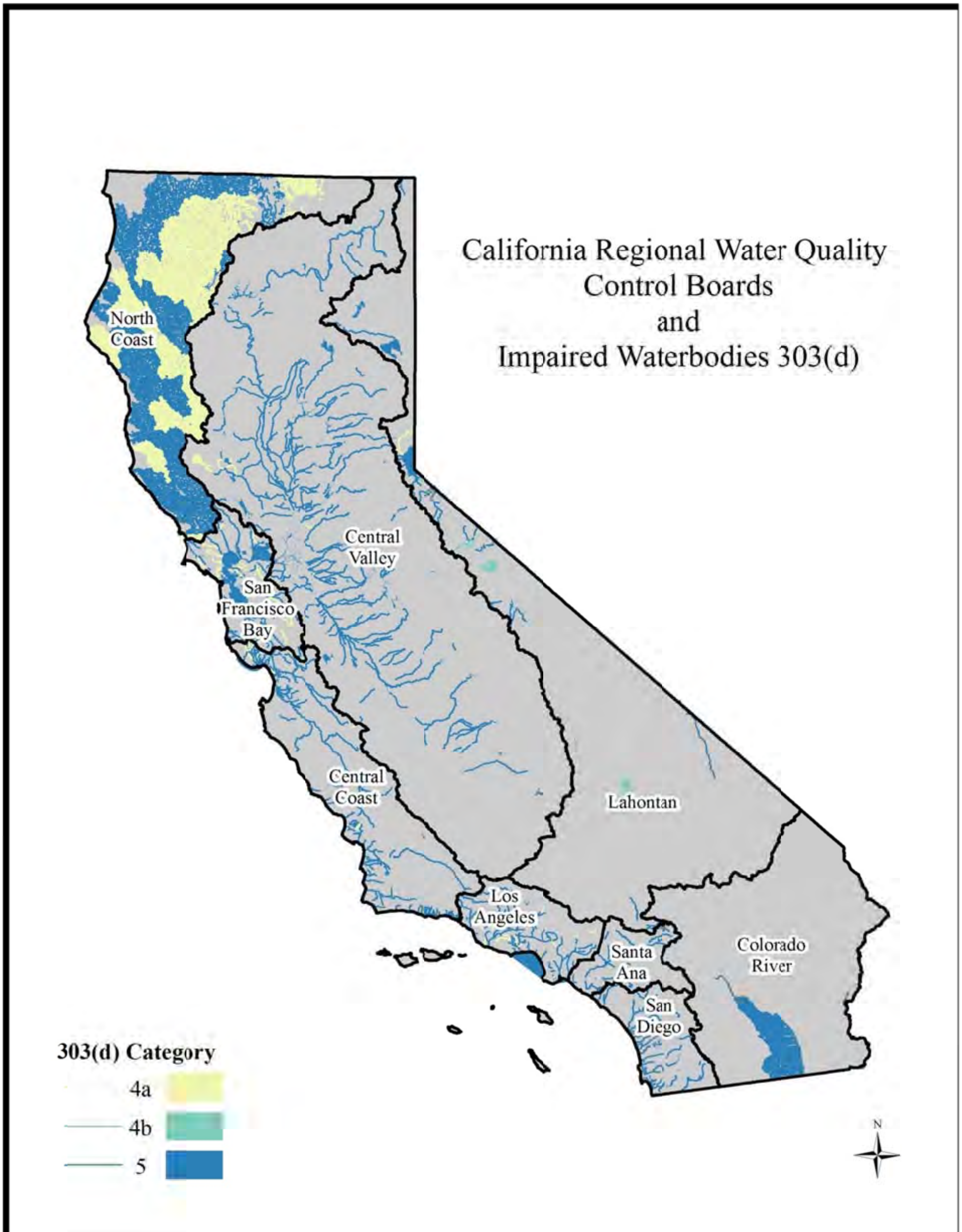


Figure 4.5-2 Impaired waterbodies by Regional Water Quality Control Board boundaries

4.5.2 IMPACTS

4.5.2.1 Significance and Threshold Criteria

The following significance criteria have been developed based on the "Hydrology and Water Quality" sections of CEQA Appendix G: Environmental Checklist Form of the State CEQA Guidelines. The impact of the Program on water quality would be considered significant if projects that qualify for implementation under the proposed Process would:

- Violate any water quality standards or waste discharge requirements
- Would substantially degrade water quality

The significance criteria related to hydrology that typically fall under "Hydrology and Water Quality" in CEQA Appendix G are covered in Section 4.3.

Water quality objectives relevant to potential Program activities are generally narrative in nature. Temperature and turbidity are generally the only water quality objectives with numerical standards. Regardless of this, modeling water quality impacts is too difficult given the data requirements necessary for model simulations, resulting in questionable accuracy in model predictions (Zheng and Keller, 2006).

This analysis will consider the characteristic impacts of the various fuels reduction activities (e.g., mechanical, fire) on water quality within the context of the Program and associated alternatives. Characteristic impacts are evaluated through process-based knowledge of cause-and-effect linkages between potential vegetation treatment activities and various water quality constituents. Since roads are used to access the project areas, and roads are well-noted for impacting water quality (e.g., Luce and Wemple, 2001), roads are also considered in this analysis.

4.5.2.2 GENERALIZED WATER QUALITY IMPACTS OF FUELS REDUCTION ACTIVITIES

Table 4.5-6 summarizes water quality impacts of the various fuels reduction activities. It is assumed that the highest likelihood for significant impacts will occur from prescribed fire, mechanical, and herbivory treatments. Prescribed fire and mechanical impacts have the potential to significantly impact sediment and turbidity. The highest likelihood for impacts is in shrub-dominated landscapes, due to the higher potential for increased soil burn severity during prescribed burning. Significant increases in pathogens may occur if herbivory is implemented. Road use during project operations may also result in significant impacts to sediment and turbidity.

Table 4.5-6 Impacts to water quality from fuels reduction activities.

Activity	Water Quality Constituent	Impact Type
Prescribed Fire	Nutrients	Fire can disrupt nutrient cycling and cause nutrient leaching, volatilizing and transformation (Stednick, 2010). Several constituents can increase after forest and grassland burning and these include nitrate (NO_3^-), phosphate (PO_4^{3-}), calcium (CA^{2+}), magnesium (Mg^{2+}) and potassium (K^+). Phosphorus binds to sediment and loading typically occurs in conjunction with sediment delivery. Ammonium pulses may occur, but increased fluxes in nitrogen compounds are typically associated with nitrate. Increased nitrogen mineralization lasts for 1 year in grasslands, 2 years in shrublands, and up to 5 years in forested areas (Hobbs and Schimel, 1984; Wan et al., 2001). However, increases in available nitrogen do not always translate into increased fluxes in nitrate to waterbodies (Stephens et al., 2004). Water pH may increase (i.e., become acidic) when ash is delivered to watercourses (Stednick, 2010). Organic compounds leaching into surface waters can also affect water color, taste, and smell (Stednick, 2010). Measures that reduce on-site erosion and buffer zones will minimize the effects of fire on water quality (Stednick, 2010).
	Sediment, Settleable Material & Turbidity	The major factor determining the effect of prescribed fire on runoff and erosion is the amount of disturbance to surface organic material (Robichaud et al., 2010). Low burn severity only removes some of the litter/duff, whereas high burn severity can remove all of the soil cover and adversely impact soil structure. Bare mineral soil is exposed to rain splash and overland flow, and water repellency may form in some vegetation and soil types (Robichaud et al., 2010; Stednick, 2010). High burn severity can increase erosion rates by 2 to 3 orders of magnitude, whereas low and moderate burn severities have a much smaller effect on runoff and erosion. Prescribed burning in California's conifer forests have showed little to no increase in erosion (Biswell and Schultz, 1965; MacDonald et al., 2004), whereas burning in chaparral vegetation can increase erosion significantly (DeBano and Conrad, 1976). The higher rates of erosion in chaparral are due to the fact that prescribed fire in chaparral burns at higher intensity, removes more surface organic material, and has a higher likelihood for post-fire water repellency.
	Temperature	Soil heating can kill vegetation, leading to decreased shade. Prescribed fires may burn vegetation adjacent to watercourses, leading to greater inputs of solar radiation. Temperature increases will be greatest in smaller and shallower watercourses.
Mechanical	Nutrients	Mechanical removal of vegetation alters the nutrient cycle, and may increase nitrogen flux and loss via stream flow (Stednick 2010), although most of these impacts are associated with clear cutting. Phosphorus loading may increase due to the increased potential for soil erosion from mechanically disturbed sites. In general, nutrient mobility from treated areas follows the order: nitrogen > potassium > calcium and magnesium > phosphorus. Increases in nutrient mobility are largest following complete vegetation removal (e.g., clear cutting). However, impacts have been found to be minimal in most cases (Stednick, 2010). Impacts are reduced by minimizing the area of site disturbance and the use of streamside buffers (Stednick, 2010).
	Sediment, Settleable Material & Turbidity	Mechanical treatments that disturb soils may increase soil erosion. The magnitude and type of erosion affected by commercial mechanical treatments depends on the amount of soil exposed by the project activities, the erodibility of the soil, hillslope steepness, weather conditions, and whether there are any follow up activities after the initial disturbance (Swank et al., 1989). Non-commercial mechanical treatments can often time increase soil cover, which reduces runoff and erosion. Overall, few studies have been completed that look at the effect of non-commercial mechanical treatments on water quality (Stednick 2010), but those that have reveal minimal impacts (Hatchett et al. 2006). However, runoff and erosion is minimized by decreasing equipment passes, avoiding steep slopes, and scattering woody material onsite.
	Temperature	Water temperature can increase when streamside vegetation canopy is removed. Factors that determine the magnitude of temperature increase include watercourse width and discharge, distance from shade vegetation to the watercourse, stream orientation, height and density of vegetation, leaf area of canopy, latitude, date, and time (Quigley 1981). Retention of watercourse adjacent vegetation can mitigate potential temperature changes, especially temperature maximums and minimums (Stednick 2010).

Manual Hand Treatments	All constituents	Hand felling can be accomplished by one person with a chainsaw, and the amount of soil disturbance from this activity generally is considered negligible (Robichaud et al., 2010). A comparison of clear cut and thinned plots to control plots showed that hand-felling without mechanized yarding caused minimal surface disturbance and no increase in erosion (McClurkin et al., 1987).
Herbivory	Dissolved oxygen	Fecal material from grazing animals contains organic matter, which provides an energy source for aerobic bacteria in watercourses. Increased metabolism of the organic waste can result in oxygen depletion if the rate of depletion exceeds the aeration rate of the stream (Hubbard et al., 2004).
	Nutrients	Grazing removes vegetation, increases rain splash, decreases soil organic matter, increases surface crusting, decreases infiltration rates, and increases erosion. This can increase nutrient flux. Animal feces can act as sources of nitrate and phosphate. However, nutrient concentrations do not appear to increase under properly implemented grazing systems except in some riparian zones (Stednick 2010). Grazing under best management practices does not adversely affect water quality (Stednick, 2010).
	Pathogens	Animal activity along watercourses can affect the bacterial quality of the water. Animal feces may significantly increase the bacterial concentration of water. However, bacteria counts drop to background levels quickly after the animals are removed (Johnson et al. 1978). Recent studies in National Forest lands in California show that nitrate, total phosphorus, and phosphate concentrations exceeded EPA nutrient limits 0, 2, and <1 percent of the time (Roche et al., 2013). Fecal coliform limits were exceeded between 18-83 percent of the time, with the highest level of exceedances in the Lahontan Region (Roche et al., 2013). E. coli limits for contact recreation were exceeded between 6-29 percent of the time. Fecal coliform standards are mainly exceeded during storm events (Dahlgren et al. 2001) These results suggest cattle grazing, recreation, and clean water can be compatible goals across National Forest lands (Roche et al., 2013).
	Sediment, Settleable Material & Turbidity	Increased runoff and bare erodible soil (Stednick 2010) increase the likelihood of rain splash, sheet wash, and rill erosion. Animal trails/paths can concentrate runoff and initiate gullying (Trimble and Mendel 1995). This can lead to increases of suspended sediment and turbidity. Chiseling by cattle hooves can cause streambank erosion, but BMPs such as exclosure fencing along streams can limit this impact,
	Temperature	Grazing can reduce vegetative cover and shade, with a resulting increase in stream temperature (Beschta, 1997).
Herbicides	Pesticides	Vegetation control through the use of herbicides can be a fuel management activity if the targeted vegetation is a significant component of the fuel load. In the context of fuels treatments, herbicides are used infrequently and are often a one-time treatment (Stednick 2010). On National Forest lands, pesticides have not been detected in sufficiently high concentrations to affect drinking water (Michael 2000). Detections are typically associated with direct spray to surface waterbodies.
Roads	Sediment, Settleable Material & Turbidity	Road surfaces, cut slopes and fill slopes are subject to rain splash, sheetwash, rill, and gully erosion (Robichaud et al., 2010). Surface erosion increases during rainy conditions and with increased traffic. Gullies and rills can initiate below drainage structures. Streams can be diverted at road-stream crossings, and can cause extensive gullying when routed to unarmored hillslopes. Roads can increase the risk of landsliding (Reid, 2010). These impacts can increase suspended sediment and turbidity.

4.5.2.2.1 GENERALIZED WATER QUALITY IMPACTS BY REGIONAL WATER QUALITY CONTROL BOARD BOUNDARY

This water quality analysis uses the Regional Water Quality Control Board boundary as a hierarchical unit for analyzing impacts from the Program and the alternatives. Table 4.5-1 summarizes each Regional Water Quality Control Board with regard to precipitation and runoff regime, general water quality issues, and the potential for sediment-related water quality impacts.

Higher erosion rates drive higher sediment delivery rates (Megahan and Ketcheson, 1996), and therefore a higher potential for water quality impacts related to sediment, settleable material, and turbidity. In turn, these can affect beneficial uses such as: municipal and domestic water supply; cold and warm water fisheries; rare, threatened, and endangered species; migration of aquatic organisms; spawning, reproduction, and early development. Figure 4.5-3 shows the potential for surface erosion using the Revised Universal Soil Loss Equation (RUSLE) by Regional Water Quality Control Board boundary. The figure indicates that the potential for significant impacts from surface erosion are highest for the North Coast and Central Coast Water Quality Control Board Regions. Mountainous and/or steep areas of the Central Valley, San Francisco Bay, Los Angeles, Santa Ana, and San Diego Water Quality Control Board Regions are also potentially subject to higher rates of surface erosion. In general, the lowest potential for significant impacts attributed to surface erosion is in the Lahontan and Colorado River Water Quality Control Board Regions, although localized areas of high erosion potential occurs in these Regions.

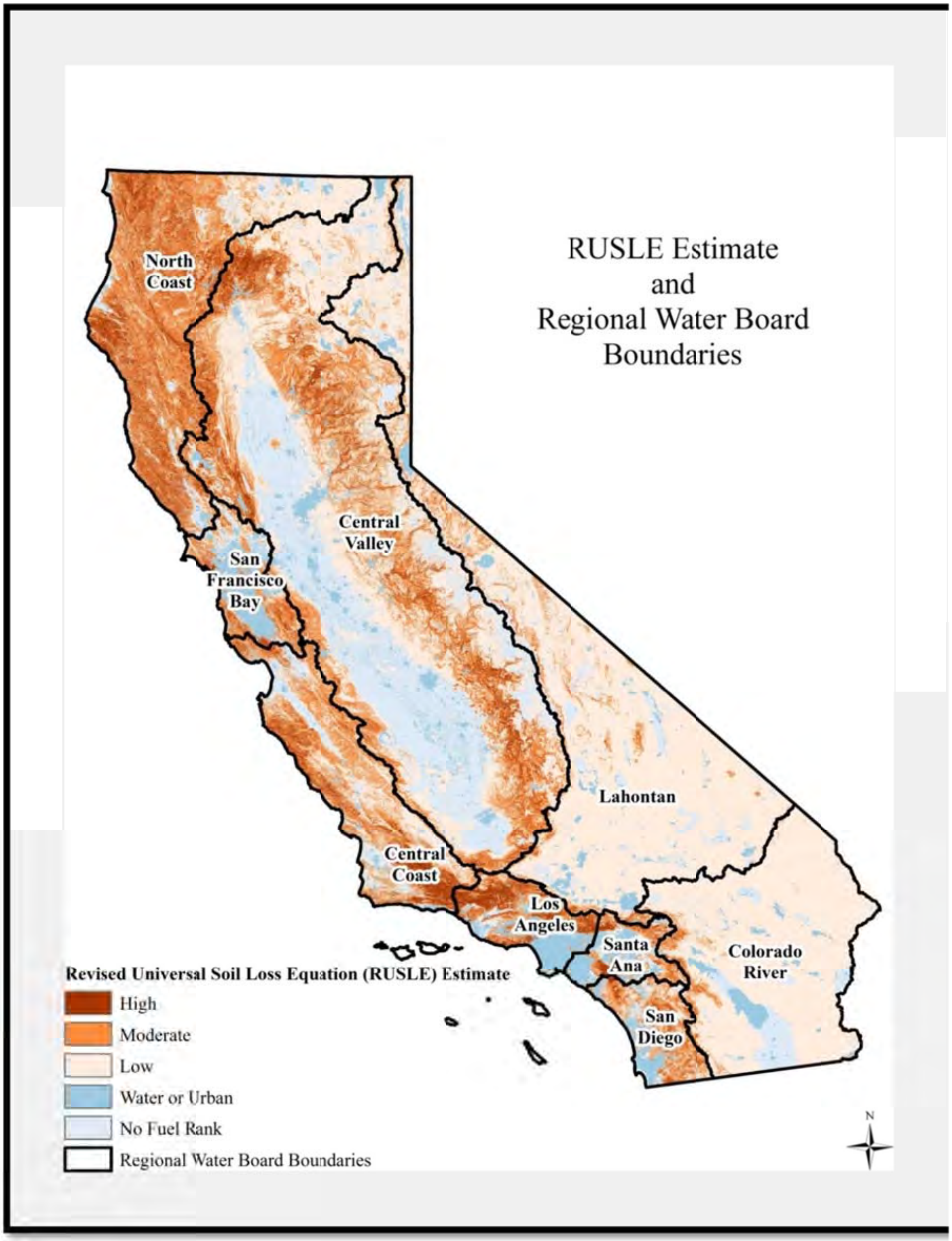


Figure 4.5-3 Estimated soil erosion using the Revised Universal Soil Loss Equation (RUSLE) by Regional Water Board boundaries. Low erosion varies from 1 to 8 tons per acre per year, moderate erosion varies from 9 to 50 tons per acre per year, and high is greater than 50 tons per acre per year.

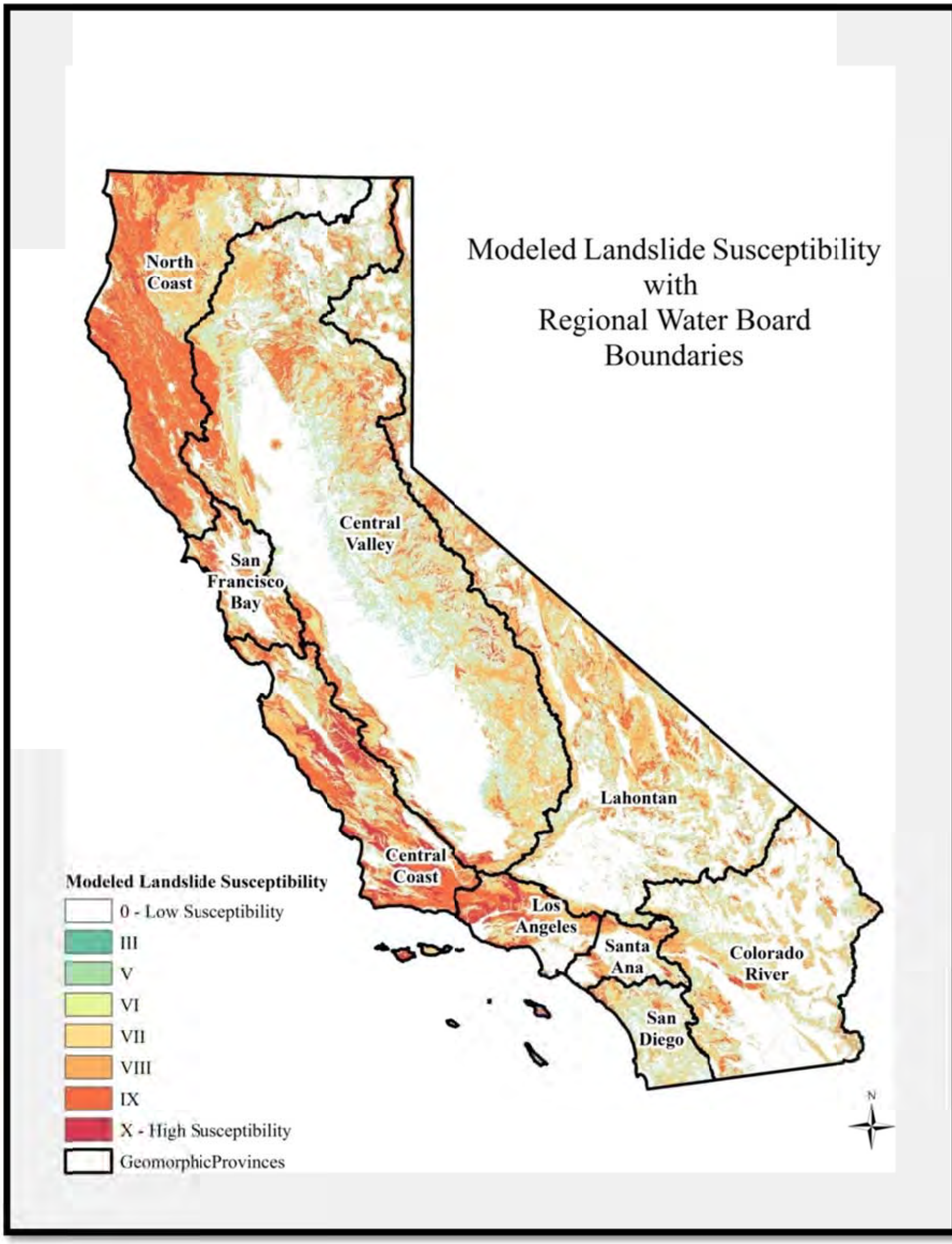


Figure 4.5-4 Modeled deep-seated landslide susceptibility by Regional Water Board boundary (CGS, 2011).

Landsliding can be an important cause of sediment-related water quality impacts in some areas (Neary et al., 2009). The potential for deep-seated landsliding is assessed using data from the California Geological Survey's Map Sheet 58 (CGS, 2011). The potential for deep-seated landsliding is highest in the North Coast, Central Coast, and Los Angeles Water Quality Control Board Regions (Figure 4.5-4). There is a moderate potential for deep-seated landsliding in the San Francisco Bay, Santa Ana, and Central Valley Water Quality Control Board Regions. In general, the lowest potential for deep-seated landsliding occurs in the San Diego, Colorado River, and Lahontan Regional Water Quality Control Board jurisdictions.

Figure 4.3-4 in the Geology, Hydrology, and Soils section shows the occurrence of slopes greater than 65 percent slope, and these slopes are generally more susceptible to shallow landsliding. Figure 4.3-4 indicates that the North Coast Water Quality Control Board Region has the highest abundance of slopes greater than 65 percent, and therefore the highest likelihood for water quality impacts related to shallow landsliding. Steeper, slide prone slopes also occur in mountainous portions of the other Water Quality Control Board Regions.

4.5.2.2.2 WATER QUALITY IMPACTS FROM THE PROGRAM AND ALTERNATIVES

Impacts from the Program and alternatives will be assessed by assuming implementation of SPRs and PSRs summarized in Table 4.5-7. In order to evaluate the potential for significant adverse impacts due to the Program and associated alternatives, it is necessary to determine which fuel reduction activity is most likely given the treatment type (i.e., WUI, fuel breaks, and ecological restoration) and vegetation type. To determine this, we surveyed CAL FIRE Registered Professional Foresters to determine which type of activity was most likely given a specific treatment and vegetation type (Table 4.5-8).

Results from the survey are shown in Table 4.5-8. In general, it shows that relatively more impactful prescribed burning will most likely be highly utilized for ecological restoration treatments in grass vegetation types, will be moderately utilized for fuel break and ecological restoration in forest vegetation, and moderately utilized for fuel break treatments in shrub vegetation. Mechanical treatments will be highly utilized for all treatment types in forest vegetation, and in WUI treatments in shrub vegetation types. Mechanical treatments will be moderately utilized for ecological restoration treatments in shrub vegetation types, and for WUI and fuel break treatments in grass vegetation types. Herbivory will most likely be used for fuel break and ecological restoration treatments in shrub and grass vegetation types (Table 4.5-8).

Table 4.5-7 Examples of SPRs and PSRs for each type of fuel reduction activity and water quality objective impact type. SPRs and PSRs from 4.4 and 4.5 will also be used to minimize water quality impacts to non-significance.

Activity	Impact Type	SPRs and PSRs to Minimize or Avoid Water Quality Impacts
All activities	Sediment, Settleable Material, Turbidity	Additional SPRs and PSRs to mitigate surface erosion and mass wasting related water quality impacts are found in Section 4.4.3.
Prescribed Fire	Nutrients, Sediment, Settleable Material, Turbidity, Temperature	A watercourse and lake protection zone (WLPZ) shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current CA Forest Practice Rules (Table 2.6.1). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation significant to maintenance of watercourse shade shall not be disturbed within Class I and II watercourses. Vegetation within and adjacent to Class III watercourses shall be retained, as feasible, to protect water quality, and additional equipment limitations recommended by the RWQCB shall be specified in the VTP Environmental Checklist as PSRs. Class IV watercourse protections shall be PSRs designed in conjunction with RWQCB staff. Buffers have been found effective in minimizing impacts from nutrients, sediment, and temperature from fuels treatments (Stednick, 2010).
		The potential impacts of prescribed fire on soil conditions (e.g., cover, water repellency, soil aggregate stability) will be mitigated by burning to achieve a low soil burn severity. The potential for management-induced runoff and erosion after low severity fire is relatively small (Robichaud et al., 2010).
		No direct ignition of project activity fuels shall be allowed within the WLPZs or ELZs. However, it is acceptable for backing fire to enter ELZs or WLPZs. Vegetation in buffers typically does not burn during prescribed fire operations due to higher soil moisture and live fuel moistures (Stednick, 2010).
		At the Calwater Planning Watershed scale, if the combined, appropriately-weighted acreage subjected to fuel treatments and logging exceed 20% of the watershed area within a 10-year timespan, a hydrologic analysis will be performed to determine the potential for hydrologically-induced significant impacts. Keeping total treated acreage below this threshold will minimize peak flow increases to undetectable levels (Grant et al., 2008) and will theoretically minimize the likelihood of sedimentary impacts.
Roads	Sediment, Settleable Material, Turbidity	Compacted and/or bare linear treatment areas (e.g., fire breaks, roads, or skid trails) capable of generating storm runoff shall be drained via water breaks using the spacing guidelines contained in 14 CCR § 914.6 [934.6, 954.6] (c) of the California Forest Practice Rules. Frequent road drainage will minimize erosion and sediment delivery (MacDonald and Coe, 2008).
		Compacted and/or bare linear treatment areas and roads shall be drained such that they are hydrologically disconnected from watercourses or lakes. Measures to hydrologically disconnect these areas shall be guided by consulting with Technical Rule Addendum #5 of the California Forest Practice Rules – Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings. Hydrological disconnection reduces sediment delivery (MacDonald and Coe, 2008).

Mechanical	Nutrients, Sediment, Settleable Material, Turbidity, Temperature	A watercourse and lake protection zone (WLPZ) shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current CA Forest Practice Rules (Table 2.6.1). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation significant to maintenance of watercourse shade shall not be disturbed within Class I and II watercourses. Vegetation within and adjacent to Class III watercourses shall be retained, as feasible, to protect water quality, and additional equipment limitations recommended by the RWQCB shall be specified in the VTP Environmental Checklist as PSRs. Class IV watercourse protections shall be PSRs designed in conjunction with RWQCB staff. Buffers have been found effective in minimizing impacts from nutrients, sediment, and temperature from fuels treatments (Stednick, 2010).
		Compacted and/or bare treatment areas shall be drained such that they are hydrologically disconnected from watercourses or lakes. Measures to hydrologically disconnect these areas shall be guided by consulting with Technical Rule Addendum #5 of the California Forest Practice Rules – Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings. Hydrological disconnection reduces sediment delivery (MacDonald and Coe, 2008).
		At the Calwater Planning Watershed scale, if the combined, appropriately-weighted acreage subjected to fuel treatments and logging exceed 20% of the watershed area within a 10-year timespan, a hydrologic analysis will be performed to determine the potential for hydrologically-induced significant impacts. Keeping total treated acreage below this threshold will minimize peak flow increases to undetectable levels (Grant et al., 2008) and will theoretically minimize the likelihood of sedimentary impacts.
	Oil and Grease	Prior to the start of onsite activities, all equipment will be inspected for leaks and regularly inspected thereafter until equipment is removed from the project area. All contaminated water, sludge, spill residue, or other hazardous compounds will be contained and disposed of outside the boundaries of the site, at a lawfully permitted or authorized destination.
		Staging areas shall be designated and located to prevent leakage of oil, hydraulic fluids, or other chemicals into watercourses or lakes.
		All heavy equipment parking, refueling, and service shall be conducted within designated areas outside of the WLPZ or ELZ.

Herbivory	Nutrients, Sediment, Settleable Material, Turbidity, Temperature	A watercourse and lake protection zone (WLPZ) shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current CA Forest Practice Rules (Table 2.6.1). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation significant to maintenance of watercourse shade shall not be disturbed within Class I and II watercourses. Vegetation within and adjacent to Class III watercourses shall be retained, as feasible, to protect water quality, and additional equipment limitations recommended by the RWQCB shall be specified in the VTP Environmental Checklist as PSRs. Class IV watercourse protections shall be PSRs designed in conjunction with RWQCB staff. Exclusion of animals from the WLPZ will minimize impacts to temperature and sediment-related water quality objectives. Buffers help to prevent impacts from sediment, nutrients, and temperature (Agouridis et al., 2005).
		Use of fencing, herding, and on-site water will minimize impacts (Trimble and Mendel, 1995; Hubbard et al., 2004).
Manual Hand Treatments	Nutrients, Sediment, Settleable Material, Turbidity, Temperature, Pathogens	A watercourse and lake protection zone (WLPZ) shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current CA Forest Practice Rules (Table 2.6.1). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation significant to maintenance of watercourse shade shall not be disturbed within Class I and II watercourses. Vegetation within and adjacent to Class III watercourses shall be retained, as feasible, to protect water quality, and additional equipment limitations recommended by the RWQCB shall be specified in the VTP Environmental Checklist as PSRs. Class IV watercourse protections shall be PSRs designed in conjunction with RWQCB staff. Buffers have been found effective in minimizing impacts from nutrients, sediment, and temperature from fuels treatments (Stednick, 2010).
		Compacted and/or bare linear treatment areas (e.g., fire breaks, roads, or trails) capable of generating storm runoff shall be drained via water breaks using the spacing guidelines contained in 14 CCR § 914.6 [934.6, 954.6] (c) of the California Forest Practice Rules. Frequent road drainage will minimize erosion and sediment delivery (MacDonald and Coe, 2008).

Herbicides	Pesticides	Prior to the start of herbicide treatment activities, CAL FIRE shall prepare a Spill Prevention and Response Plan (SPRP), pursuant to 40 CFR 112, for project coordinator approval to provide protection to onsite workers, the public, and the environment from accidental leaks or spills of vehicle fluids, herbicides, or other potential contaminants. This plan shall include (but not be limited to): a map that delineates VTP staging areas, where storage, loading, and mixing of herbicides and/or refueling, lubrication, and maintenance of equipment will occur; a list of items required in a spill kit onsite that will be maintained throughout the life of the project; procedures for the proper storage, use, and disposal of any solvents or other chemicals used in vegetation treatment; and identification of lawfully permitted or authorized disposal destinations outside of the project site. See Chapter 4.4.
		Applicators of herbicides shall follow all herbicide label requirements and refer to all other local, state, and federal regulations (including OSHA requirements) to protect sensitive resources and employee and public health during herbicide application. See Chapter 4.4.
		All pesticide use shall be implemented consistent with Pest Control recommendations prepared annually by a licensed Pest Control Advisor. See Chapter 4.4.
		All appropriate laws and regulations pertaining to the use of pesticides and safety standards for employees and the public, as governed by the EPA, the California Department of Pesticide Regulation (CDPR), and local jurisdictions shall be followed. All applications shall adhere to label directions for application rates and methods, storage, transportation, mixing, and container disposal. All contracted applicators shall be appropriately licensed by the state. CAL FIRE staff shall coordinate with the County Agricultural Commissioners, and all required licenses and permits shall be obtained prior to pesticide application. See Chapter 4.4.
		Herbicide applicators shall have or work under the direction of a person with a Qualified Applicator License or Qualified Applicator Certificate. See Chapter 4.4.
		CAL FIRE shall avoid herbicide treatment in areas adjacent to waterbodies, riparian areas, and primary drainage access per requirements set forth by CDPR. CAL FIRE shall follow all herbicide labels and directions in determining applications near water resources or riparian habitats and shall limit application to outside the WLPZ or greater than 50 feet for Class III and IV watercourses. Buffers will avoid direct spray of herbicides on surface waters, thereby minimizing impacts to water quality (Stednick, 2010)
		The following general application parameters shall be employed during herbicide use: application shall cease when weather parameters exceed label specifications, when wind at the site of application exceeds seven miles per hour (MPH), or when precipitation (rain) occurs or is forecasted with greater than a 40 percent probability in the next 24-hour period to prevent sediment and herbicides from entering the water via surface runoff; spray nozzles shall be configured to produce a relatively large droplet size; low nozzle pressures (30-70 pounds per square inch [PSI]) shall be observed; spray nozzles shall be kept within 24 inches of vegetation during spraying; drift avoidance measures shall be used to prevent drift in locations where target weeds and pests are in proximity to special status species or their habitat. Such measures can consist of, but would not be limited to, the use of plastic shields around target weeds and pests, and adjusting the spray nozzles of application equipment to limit the spray area. See Chapter 4.4.
		All herbicide and adjuvant containers will be triple rinsed with clean water at an approved site, and the rinsate shall be disposed of by placing it in the batch tank for application. Used containers shall be punctured on the top and bottom to render them unusable, unless said containers are part of a manufacturer's container recycling program, in which case the manufacturer's instructions shall be followed. Disposal of non-recyclable containers will be at legal dumpsites. Equipment will not be cleaned and personnel will not bathe in a manner that allows contaminated water to directly enter any body of water within the treatment areas or adjacent watersheds. Disposal of all pesticides shall follow label requirements and local waste disposal regulations. See Chapter 4.4.
		All storage, loading, and mixing of herbicides will be set back at least 300 feet from any aquatic feature or special status species or their habitat or sensitive natural communities. All mixing and transferring will occur within a contained area. Any transfer or mixing on the ground will be within containment pans or over protective tarps. See Chapter 4.4.

Table 4.5-8 The relative likelihood of using a fuel reduction activity type based on the desired treatment and dominant vegetation type. Likelihood determined through the averaging of surveyed CAL FIRE Registered Professional Foresters. L=Low likelihood; M=Moderate likelihood; H=High likelihood.

Activity	Forest			Shrub			Grass		
Type	WUI	Fuel break	Eco	WUI	Fuel break	Eco	WUI	Fuel break	Eco
Burning	L	M	M	L	M	L	M	M	H
Hand Treatments	H	M	M	M	M	M	L	L	L
Mechanical	H	H	H	H	L	M	M	M	L
Herbicide	M	M	L	L	M	L	L	L	L
Herbivory	L	L	L	L	M	L	L	M	M

The next step in evaluating the potential water quality impacts of the proposed Program and associated alternatives requires knowing where the projects will likely be located relative to Water Quality Control Board Regions. Knowing the treatable acreage under each treatment can also help to focus the impact assessment (Table 4.5-9), as the Alternatives are generally comprised of different combinations of the three treatment types. Figure 4.5-5 shows the treatable acreage by Regional Water Quality Control Board (Water Board) boundary and treatment type. Table 4.5-10, Table 4.5-11, and Table 4.5-12 show the treatable acreage by tree, shrub, and grass-dominated vegetation types, respectively.

Under the Proposed Program the highest likelihood for impacts will occur in the Central Valley, North Coast, and Central Coast Water Quality Control Boards Regions. This is due to the relatively high acreage available for treatment in each Region (Table 4.5-9), with 10.2, 3.3, and 3.1 million acres available for the Central Valley, North Coast, and Central Coast Water Board Regions, respectively. Available areas for treatment also coincide with mountainous topography associated with the Sierra Nevada, Coast Ranges, Cascade Range, and Klamath Mountains. These areas generally have a higher inherent potential for sediment-related water quality impacts due to the combination of steeper slopes and higher rainfall (see Chapter 4.3). The North Coast Water Board Region also has the highest number of impaired waterbodies under the 303(d) list with the potential for linkage to likely VTP activities (e.g., sediment, temperature, etc.). This means the North Coast Water Board Region has the highest overall potential for impacts from the Proposed Program. However, 70 percent of the treatable acreage with the North Coast Region is in tree-dominated vegetation types in the ecological restoration and WUI treatment types (Table 4.5-10, Table 4.5-11, and Table 4.5-12), and treatment activities in this vegetation type are typically of lower intensity (ladder fuel removal) when related to water quality impacts. The Central Valley Water Board Region is dominated by tree and grass vegetation types (88 percent of treatable acres for both), and most of the treatable acreage is designated as WUI (48 percent) and ecological restoration (38 percent).

The Central Coast and Lahontan Water Board Regions have 3.1 and 1.8 million acres available for treatments, respectively (Table 4.5-9). The majority of the treatable area in the Central Coast Water Board Region is in grass-dominated vegetation types (67 percent), with most treatments identified as WUI (55 percent) or ecological restoration (30 percent). The Lahontan Water Board Region has the majority of its treatable area (70 percent) as shrub dominated vegetation (Table 4.5-11); with almost an even split between WUI, fuel break, and ecological restoration treatments (Table 4.5-9).

Approximately 16 percent (3.5 million acres) of the total treatable area lies within the Colorado River (2.6 percent), Los Angeles (2.8 percent), San Diego (4.1 percent), San Francisco Bay (4.8 percent), and Santa Ana (1.6 percent) Water Quality Control Board Regions (Table 4.5-9). With the exception of the area covered by the San Francisco Bay Water Board, these Regions are dominated by shrub vegetation, ranging from 72 percent for the Los Angeles Water Board Region to 95 percent for the Colorado River Water Board Region (Table 4.5-10, Table 4.5-11, and Table 4.5-12). The San Francisco Bay Water Board Region is dominated by grass (66 percent) and tree (17 percent) vegetation types. More than 61 percent of the treatable lands in these Regions are identified as WUI treatments, although the Colorado River Water Board has the majority of treatable land classified as potential fuel break treatments (57 percent).

The Proposed Program proposes to treat 60,000 acres per year in a combination of WUI, fuel breaks, and ecological restoration treatments. By using Table 4.5-10, Table 4.5-11, and Table 4.5-12, and assuming that projects will occur in proportion to the area in a given Regional Board boundary, vegetation type, and treatment type, it is possible to determine how many projects are likely to occur in scenarios with a higher likelihood for water quality-related impacts. Approximately 26 projects per year have a high likelihood of utilizing burning in grass. The majority of projects utilizing prescribed fire in grass (i.e., ecological restoration) will be in the Central Valley Water Board Region, which is projected to have 16 projects of this type per year. There is a moderate likelihood of burning in shrub dominated vegetation for approximately 17 projects per year. Burning in forest vegetation types have a moderate likelihood of occurring in approximately 43 projects per year, with the majority occurring in the North Coast (n=15) and Central Valley Water Board Regions (n=23). Mechanical treatments have a high likelihood of occurring in 30 projects per year in forest vegetation types, primarily in the North Coast (n=9) and Central Valley (n=17) Water Board Regions. Projects with a higher likelihood of utilizing mechanical activities in shrub vegetation types will be associated with WUI treatments in the Central Valley Water Board (n=5), Lahontan Water Board (n=4), San Diego Water Board (n=5), Los Angeles Water Board (n=3), Central Coast Water Board (n=4), Colorado River Water Board (n=2), and Santa Ana Water Board Regions (n=2). There is a moderate likelihood that mechanical activities will be used on an additional 17 projects per year for ecological restoration in shrub lands, and 70 projects per year in grasslands (i.e., WUI and fuel breaks treatments).

Given the discussion above, the highest likelihood for significant water quality impacts will occur with prescribed fire and mechanical activities in portions of the North Coast, Central Coast, and Los Angeles Water Quality Control Board Regions dominated by shrub vegetation types. These activities have the potential to exceed water quality objectives for sediment, settleable material, and turbidity if not properly implemented. Exceedances related to sediment may also occur in waterbodies impaired for sediment. The use of herbivory in the Lahontan Water Quality Control Board Region also has a higher likelihood for significantly impacting water quality, due to the stringent requirements related to fecal coliform in this Region. In general, prescribed fire and mechanical treatments will have a higher likelihood for water quality impacts than other fuel reduction activities. The following discussion will make the determination of whether significant impacts to water quality standards (i.e., water quality objectives) would occur.

Impacts from the Proposed Program will be **less than significant** for sediment-related impacts (i.e., water quality objectives related to suspended sediment, settleable material, turbidity). This is due to the implementation of SPRs and PSRs that minimize soil disturbance, on-site erosion, and the potential for sediment delivery (Stednick, 2010). These SPRs include GEO-1, HYD-3, HYD-5, HYD-6, HYD-7, HYD-8, HYD-9, HYD-13, HYD-14, HYD-16, and HYD-17.

The Proposed Program will avoid prescription burning that will result in moderate to high soil burn severity (GEO-2), and will only allow backing fires into WLPZs and ELZs (HYD-4). The VTP Proposed Program also does not allow for road construction or reconstruction (HYD-13), which is a well noted source of sediment in wildland areas (Luce and Wemple, 2001). Proper drainage and hydrological disconnection of roads is also required within project areas (HYD-5 and HYD-6), thereby reducing sediment delivery from road surface erosion.

Impacts from the Proposed Program will be **less than significant** for nutrient-related impacts. The requirement for WLPZs and ELZs (HYD-3) and erosion control SPRs and PSRs will minimize impacts from prescribed fire (Stednick, 2010). Watercourse buffers are also effective in reducing nutrient impacts from mechanical activities (Stednick, 2010). The use of targeted grazing (HYD-17) along with the requirement for WLPZs and ELZs will also minimize nutrient-related impacts associated with herbivory.

Impacts from the Proposed Program will be **less than significant** for temperature-related impacts. Impacts are minimized due to the requirement for WLPZs. There will be no activities allowed in WLPZs with the exception of backing prescription fire. This will maintain the existing streamside vegetation, which is the key to maintaining watercourse temperature at existing levels (Stednick, 2010). The North Coast Water Quality Control Board Region has a high number of forested waterbodies 303-d listed for temperature. However, treatments associated with tree-dominated vegetation types will generally be understory fuel removal outside of the WLPZ. The general lack of overstory tree removal outside the WLPZs will also ensure that significant impacts will be avoided in temperature-listed forested waterbodies.

The impacts from the Proposed Program to water quality from oil and grease, herbicides, and other hazardous material will be **less than significant**. Impacts from oil, grease, and other hazardous material will be minimized through a combination of practices including routine equipment inspection and maintenance, and requirements for refueling, repair, and staging outside of WLPZs. Impacts from herbicides will be avoided through the prohibition of spraying within WLPZs (i.e., HAZ-8) (Stednick, 2010), and other spray-related SPRs and PSRs (see Hazardous Materials in Chapter 4.4).

The impacts from the Proposed Program to pathogen-related water quality impacts from herbivory will be **less than significant.** This is due to the use of WLPZs and the practice of targeted grazing. Together, these SPRs minimize pathogen-related impacts by directing grazing animals away from watercourses.

Altogether, the impacts from the Proposed Program will be **less than significant**. Required consultation with the affected Regional Water Quality Control Board will ensure that appropriate PSRs will be developed to avoid significant water quality impacts at the project scale.

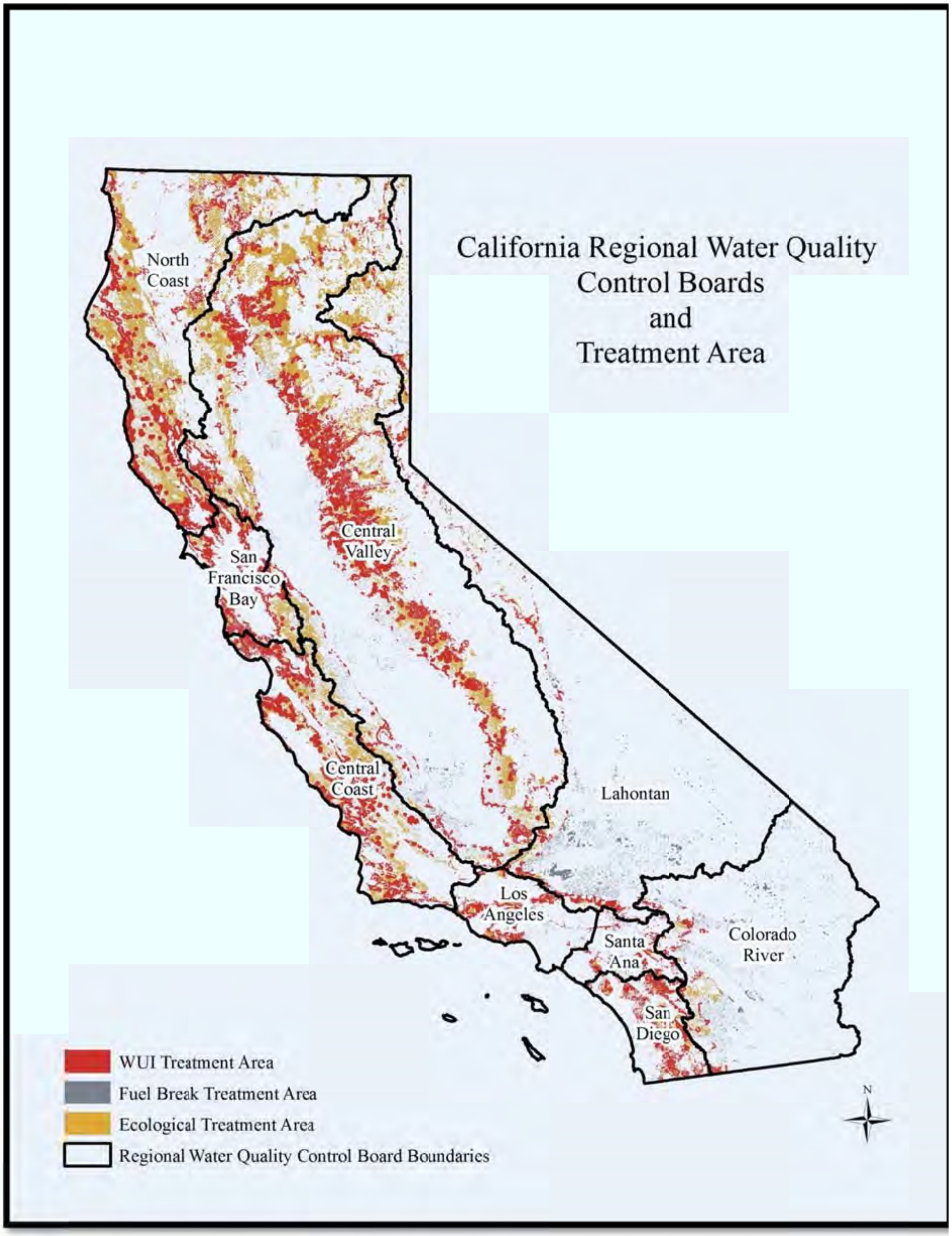


Figure 4.5-5 VTP treatments by Regional Water Quality Control Board boundaries.

Table 4.5-9 Treatable acreage by Water Board and treatment type under the Proposed Program.

WaterBoard	WUI	FUEL BREAK	ECO	Total by Water Board
Central Coast	1,717,397	475,311	942,294	3,135,002
Central Valley	4,871,539	1,458,574	3,854,527	10,184,639
Colorado River	175,290	332,089	72,237	579,617
Lahontan	559,747	674,953	597,729	1,832,430
Los Angeles	419,899	113,395	74,475	607,770
North Coast	1,347,104	499,897	1,480,124	3,327,126
San Diego	657,630	141,991	108,351	907,972
San Francisco Bay	667,996	163,439	232,328	1,063,762
Santa Ana	249,967	78,912	24,941	353,820
Total by Treatment	**10,666,570**	**3,938,562**	**7,387,007**	**21,992,138**

Table 4.5-10 Treatable tree-dominated acres under the Proposed Program.

WaterBoard	WUI	FUEL BREAK	ECO	Total by Water Board
Central Coast	121,892	21,739	38,462	182,093
Central Valley	1,610,835	417,036	1,805,574	3,833,445
Colorado River	6,567	1,884	8,566	17,017
Lahontan	108,602	35,634	157,501	301,737
Los Angeles	9,360	1,839	1,732	12,931
North Coast	830,300	308,238	1,198,087	2,336,625
San Diego	37,769	7,961	11,040	56,771
San Francisco Bay	107,070	20,149	49,607	176,826
Santa Ana	33,008	7,469	2,969	43,445
Total by Veg Type	**2,865,402**	**821,950**	**3,273,537**	**6,960,889**

Table 4.5-11 Treatable shrub-dominated acres under the Proposed Program.

WaterBoard	WUI	FUEL BREAK	ECO	Total by Water Board
Central Coast	416,273	139,487	312,307	868,066
Central Valley	498,678	273,413	477,783	1,249,874
Colorado River	162,280	328,993	62,428	553,700
Lahontan	387,262	493,490	399,799	1,280,550
Los Angeles	308,764	72,381	57,577	438,722
North Coast	140,383	72,190	143,235	355,809
San Diego	471,484	108,788	77,446	657,718
San Francisco Bay	95,261	52,602	35,242	183,105
Santa Ana	176,043	65,011	20,681	261,736
Total by Veg Type	**2,656,426**	**1,606,356**	**1,586,498**	**5,849,280**

Table 4.5-12 Treatable grass-dominated acres under the Proposed Program.

WaterBoard	WUI	FUEL BREAK	ECO	Total by Water Board
Central Coast	1,179,233	314,085	591,525	2,084,843
Central Valley	2,762,026	768,125	1,571,169	5,101,320
Colorado River	6,444	1,213	1,243	8,900
Lahontan	63,884	145,828	40,430	250,143
Los Angeles	101,776	39,175	15,166	156,117
North Coast	376,420	119,469	138,803	634,692
San Diego	148,377	25,242	19,865	193,483
San Francisco Bay	465,665	90,687	147,480	703,832
Santa Ana	40,917	6,431	1,291	48,639
Total by Veg Type	**5,144,741**	**1,510,255**	**2,526,972**	**9,181,969**

NO PROJECT

The “No Project” alternative is expected to have fewer impacts than the Proposed Program. This is primarily because the project acreage under this alternative is less than half of that under the Proposed Program (i.e., 27,000 acres per year; 104 projects per year). On a unit acre basis, the “No Project” alternative might be more impactful due to the fact that there are fewer best management practices utilized than those specified by the Proposed Program. Historically, the VMP relied on burning for 50 percent of its treatments, and burning is generally more impactful than most other forms of fuel reduction activities. However, fewer treated acres will generally result in fewer potential impacts. **The No Project alternative would result in no significant impacts to water quality.**

ALTERNATIVE A

Alternative A proposes to treat 60,000 acres per year solely in the WUI treatment type. This alternative will more than double the number of projects in the WUI from 108 projects per year to 231 projects per year. The same SPRs and PSRs will be utilized as in the Proposed Program. In general, WUI treatments will seldom utilize prescribed burning in shrub and forest-dominated vegetation, and will place an increased emphasis on mechanical and hand treatments in these areas. As such, fewer impacts from prescribed fire will occur using this alternative, but impacts from mechanical activities will increase. It is expected that impacts from Alternative A will be slightly less than those in the Proposed Program, despite the same amount of area being treated. **Alternative A would result in no significant impacts to water quality.**

ALTERNATIVE B

Alternative B would treat 60,000 acres per year between the WUI and fuel breaks treatment type. Projects in the WUI are projected to be 36 percent higher than the Proposed Program (n=147), and projects utilizing fuel breaks treatments are expected to increase by 80 percent relative to the Proposed Program. Burning for fuel breaks treatments in shrub dominated areas is expected to rise by 50 percent, and in general the use of mechanized fuel reduction activities will increase due to the increased focus on WUI and fuel breaks. It is expected that impacts from Alternative B will be comparable to those projected from the Proposed Program, with a slight increase in impacts to shrub dominated areas subjected to fuel breaks treatments. **Alternative B would result in no significant impacts to water quality.**

ALTERNATIVE C

Alternative C treats 60,000 acres per year in Very High Fire Hazard Severity Zones (VHFHSZ) only. This alternative utilizes all fuel reduction activities to achieve fuel hazard reduction. While this alternative treats the same acreage annually as the Proposed Program, Alternative A, and Alternative B, the distribution of VHFHSZ is more dispersed in nature. Dispersing activities will theoretically lessen impacts to geologic, hydrologic, and soil resources. As such, this alternative will have slightly less impact than the Proposed Program. **Alternative C would result in no significant impacts to water quality.**

ALTERNATIVE D

Alternative D treats 36,000 acres per year, but limits prescribed fire to only 6,000 acres annually. As such, this alternative would rely on mechanical, herbicide, hand treatment, and herbivory activities to implement WUI, fuel breaks, and ecological restoration treatments. The scale of this alternative is smaller than Alternatives A, B, or C, and therefore the potential for significant impacts is the lowest of any alternative other than the “no project” alternative. **Alternative D would result in no significant impacts to water quality.**

4.5.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Under this analysis there are no additional mitigations. SPRs and PSRs that are relevant to water quality are listed in the Chapters 4.3.3 and 4.4.3.

4.6 ARCHAEOLOGICAL, CULTURAL AND HISTORIC RESOURCES

This section addresses the archaeological, cultural, and historic environment that the impacts of the proposed project will be evaluated in context of. The material presented in 4.6 has been broken into three sections:

- **4.6.1 – Affected Environment**
  - The Affected Environment section discusses the regulatory framework that addresses the protection of archaeological, cultural, and historic environment that may be impacted by the proposed Program or Alternatives and an overview of California’s prehistoric, ethnographic and historic settlement patterns.
- **4.6.2 – Effects**
  - The Effects section outlines the potential impacts of implementing the proposed Program and the Alternatives.
- **4.6.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that will reduce the likelihood of the proposed Program causing significant adverse impacts to archaeological, cultural, and historic resources.

4.6.1 AFFECTED ENVIRONMENT

The following discussion of the prehistoric, ethnographic, and historic background provides a context for identifying the variety of artifacts and features that may be affected by the proposed Vegetation Treatment Program (VTP).

- Prehistoric Native American archaeological sites predating sustained Euro-American settlement in 1850.

- Historic districts as defined in Public Resources Code Section 5020.1(h), "a definable unified geographic entity that possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development."
- Historic archaeological sites typically dating from the period 1850-1964 (50 years of age is the general threshold for recognition of historic period resources).
- Historic period architectural features older than 50 years, such as building and structures.
- Traditional cultural places important to contemporary Native Americans who have heritage ties to the land.

4.6.1.1 **Regulatory Framework**

The California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) recognize that only those heritage resources determined per the respective state or federal criteria to be "significant" qualify for consideration of impacts in environmental impact analyses. The management of archaeological and historical resources for the VTP is designed to comply with requirements of CEQA (as amended), the State CEQA Guidelines, the Public Resources Code (Section 5020 et. seq.), the California Register of Historic Resources (14 CCR § 4850 et seq.), Executive Order W-26-92, and to conform with established CAL FIRE procedures (Foster and Pollack, 2010).

CEQA requires that state agencies must identify and examine significant adverse environmental effects on archaeological and historical resources before approving most discretionary projects. CEQA provides statutory requirements for establishing the significance of archaeological resources (Section 21083.2) and historical resources (Section 21084.1).

CEQA defines a significant heritage resource as a resource listed or eligible for listing on the California Register of Historical Resources (CRHR) (PRC §15064.5(a)(1)). For a heritage resource to be eligible for listing in the CRHR, it must meet one or more of the following criteria (PRC 5024.1(c)):

1) Is associated with events that have made a significant contribution to the broad patterns of California's history or cultural heritage;
2) Is associated with the lives of persons important in our past;
3) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values; or
4) Has yielded, or has the potential to yield, information important in prehistory or history.

Heritage resources determined eligible for or listed on the National Register of Historic Places (NRHP) are automatically included on the CRHR. The CRHR criteria are similar to those of the NRHP (36 CRF 60.4).

Additionally, PRC 21084.2 declares that a project that may cause a substantial adverse change to a tribal cultural resource, as defined in PRC 21074, is a project that may have a significant effect on the environment.

The California Forest Practice Rules (14 CCR 895.1, Definitions) reflect the criteria defined for the CRHP and the NRHP, as follows:

- *"Significant archaeological or historic site" means a specific location that may contain artifacts or objects, and where evidence clearly demonstrates a high probability that the site meets one or more of the following criteria:*

1) *Contains information needed to answer important scientific research questions;*
2) *Has a special and particular quality such as the oldest of its type or best available example of its type;*
3) *Is directly associated with a scientifically recognized important prehistoric or historic event or person;*
4) *Involves important research questions that historical research has shown can be answered only with archaeological methods; or*
5) *Has significant cultural or religious importance to Native Americans as defined in 14 CCR Section 895.1.*

These criteria must be addressed when evaluating the significance of archaeological, tribal, and historical resources under CEQA. The important aspect of this evaluation process is the identification of the characteristics held by the resource that qualifies it as being significant. These identified characteristics provide the basis for establishing whether or not a proposed project will cause a substantial adverse change to that resource.

Archaeological, tribal, and historical resources that are not deemed significant through formal evaluation must be noted in the initial study or project-level EIR (if one is prepared) along with the project effect, but need not be considered further in the CEQA process.

4.6.1.2 **Prehistoric California Background**

As a generalization, prehistoric California was settled during five distinct periods. Fredrickson (1974) identified these as the Paleo-Indian period (10,000 to 6,000 B.C.), the Lower Archaic period (6,000 to 3,000 B.C.), the Middle Archaic Period (3,000 to 1,000 B.C.), the Upper Archaic Period (1,000 B.C. to A.D. 500), and the Emergent period (A.D. 500-1,800). The discussion of these periods that follows below is adapted from Fredrickson (1974).

The first demonstrated entry and spread of humans into California took place during the Paleo-Indian period (10,000 to 6,000 B.C.). Social units during this period are thought to have been small and highly mobile; rather than exchanging resources with other social groups, the group moved to obtain needed resources. Sites have been identified in deposits under deep accumulations of recent alluvium along ancient pluvial lakeshores and coast lines. A summary of Paleo-Indian assemblages (Dillon, 1997) has shown sites from this period distributed throughout the state, often as surface deposits on arid, brush-covered slopes typical of areas treated under the VTP. These sites contain such characteristic hunting implements as the fluted projectile point and chipped stone crescentic. The period’s characteristic artifacts also occur as isolated finds along ancient lake shores (such as Borax, Tulare, and Buena Vista Lakes) and in other highly eroded contexts.

The beginning of the Lower Archaic period (6,000 to 3,000 B.C.) coincides with that of the climatic change during the mid-Holocene to generally drier conditions that caused the pluvial lakes to dry up. The hunter-gatherer populations of this period were composed of small, mobile social groups that foraged for subsistence and economic resources across a broad landscape. These populations focused on exploiting large game animals and plant communities that yielded abundant small, hard seeds. Distinctive artifact types are large dart points and the milling slab and handstone. Sites from this period have been found throughout the state. In the Central Coast and Southern California geographic regions, sites can occur as large, deep middens most notably containing burials furnished with shell beads and milling stones. Sites distinguished by large, square-stemmed points and the milling stone and handstone assemblage in the North Coast geographic region occur in the valleys and on high-elevation ridges and passes.

The Middle Archaic Period (3,000 to 1,000 B.C.) begins when the mid-Holocene climatic conditions became similar to those of the present. Sedentism appears to have become more fully developed along with general population growth and expansion. Broad regional patterns of foraging subsistence strategies give way to more intensive procurement strategies, possibly with the introduction of acorn processing technology, which is evidenced by infrequent occurrences of the bowl mortar and pestle. This shift in procurement strategies is manifest throughout the state with the establishment of year-round inhabited villages at the confluences of major waterways. Local variants of the cultures initiated in the previous period persist in marginal and upland areas throughout the state.

The growth of sociopolitical complexity marks the beginning of the Upper Archaic Period (1,000 B.C. to A.D. 500), including the development of status distinctions, greater complexity of exchange systems, and further development of sedentary settlement systems. This period retains the large dart points in different styles, but the bowl mortar and pestle replace the milling stone and handstone throughout most of the state. In the Shasta-Sierra geographic region and interior portions of the North Coast and Central Coast geographic regions, permanent villages are established in the foothills and large seasonal camps are established in higher elevations to take advantage of varied resources. A similar pattern is present along the coast in the North Coast, Central Coast, and Southern California geographic regions, where the populations emphasized both marine and terrestrial resources in their subsistence strategy, resulting eventually in a greater settlement of the interior valleys. Rock art first appears in this period, occurring as petroglyphs associated with hunting practices and territorial boundary definition in the Modoc and Southern California geographic regions and the southern portion of the Shasta-Sierra geographic region.

The Emergent period (A.D. 500 to 1,800) is distinguished by several technological and social changes. The bow and arrow are introduced, ultimately replacing the dart and atlatl. Territorial boundaries between groups are well established and exchange of goods between groups becomes more regularized. Petroglyph and pictograph rock art become manifest in the Southern California geographic region and in portions of the Central Coast and Shasta-Sierra geographic regions. In the latter portion of this period (A.D. 1,500 to 1,800), exchange relations become highly regularized and sophisticated, with specialists governing various aspects of production and exchange. Pottery appears in quantity for the first time in the Southern California geographic region.

Throughout the state, large organized villages in complex ecological zones are complemented by many smaller satellite villages situated in adjoining, less diverse ecological settings (e.g., tributary streams and creek valleys). These diverse village complexes are complemented by many smaller sites used for special purposes, such as acorn processing, shellfish collecting, stone quarrying, and ritual activities. Small task-specific groups continue to obtain seasonally available resources in higher elevations. Within the Shasta-Sierra geographic region and interior portions of the North Coast and Central Coast geographic regions, entire populations moved from their foothill villages during summer to seasonal camps in the mountains. In the Modoc geographic region, permanent villages are established in the valleys between major hills and mountains while the uplands remain the loci of special-purpose sites.

GENERAL TYPES OF PREHISTORIC RESOURCES

The following are general prehistoric resource types that may be present in areas treated under the VTP. Terms and definitions are adopted from Dillon (1997).

Village Site: Village sites are locations of continuous and concentrated habitation generally situated close to a source of fresh water and resource abundant ecological zones. These sites typically have a large, well-developed midden deposit containing abundant artifactual (flaked stone tools and debitage, ground and battered stone, bone, and shell) and ecofactual (floral, faunal, and molluscan) evidence. They may also contain burials, rock art, bedrock milling stations, or other features.

Temporary Camp Site: Temporary camp sites are locations occupied for short periods and generally display the same variety of cultural remains as village sites. Their deposits tend to be shallow, contain few artifacts, and have a poorly developed midden soil. Features and burials are normally few and isolated.

Burial Site: A burial site or cemetery is a location where intentional human interments are found in large numbers and close concentration. These locations typically lack evidence of other prehistoric activities.

Milling Site: This is a boulder or group of boulders or bedrock outcrops that contain at least one modified surface (mortar, slick, or metate) caused by the processing of food or other natural resources.

Quarry Site: A quarry is a geological deposit from which rock and mineral materials were extracted, leaving evidence of the extractive activities.

Lithic Workshop: A lithic workshop is a distribution of stone flakes and tool fragments reflecting purposeful modification of parent stone through percussion and/or pressure detachment. These sites typically have a shallow deposit.

Ceramic Scatter: A ceramic scatter consists of fragments of ceramic vessels and artifacts distributed over generally open, flat ground.

Shell Middens: Shell middens are locations with large amounts of marine shell that extend to an appreciable depth below ground surface. They are normally found in coastal contexts but are also present in fewer numbers in the interior.

Shell Scatter: Shell scatters contain small amounts of marine shell, generally limited to the ground surface, and lack other associated artifacts.

Rock Art: Rock art consists of designs or design elements on rock surfaces created by surface applications (pictographs) or by pecking or etching (petroglyphs). These are found on non-portable surfaces such as boulders, cave walls, or cliff walls.

Rock Shelters: These are natural caves or crevices in rock outcrops in which human use has left artifactual remains.

4.6.1.3 Ethnographic Background

California Native American societies and cultures were remarkably diverse in their adaptations to the immense variety of environmental conditions throughout the state. Landforms and hydrographic features of every description, the great numbers of plant and animal species, and varied climatic conditions produced microenvironments of immense variety and resource potential. The Native Americans were intimately familiar with their immediate environment and relied almost totally on natural resources. An estimated 300,000 people who spoke 90 separate languages, including hundreds of dialects, inhabited the state before historic-period contact.

Excluding cultures adapted to the desert region of California, three of the four major Native American culture regions are within portions of the state proposed for implementation of the VTP. At the northern end of the North Coast geographic region, adaptations were focused along deep and narrow river systems. Hamlets of 25-75 residents subsisted primarily by fishing for salmon, collecting shellfish, and gathering acorn. Native Americans also hunted for deer, elk, and sea mammals. In the Shasta-Sierra geographic region, the vast waterways of the valley and foothills supported communities ranging from 10-15 to several hundred inhabitants. Acorns were the staple food, but the diverse subsistence base also comprised of deer, elk, antelope, fish, waterfowl, and many plants. The Modoc geographic region and interior portions of the North Coast and Central Coast geographic regions offered similar subsistence resources but supported lower population densities. Along the coast of the Southern California geographic region and a portion of the Central Coast geographic region, subsistence strategies emphasized marine fishing, shellfish collecting, sea mammal hunting, and gathering of terrestrial resources. This maritime-based adaptation supported villages of as many as 1,000 people.

The principal settlements in each of these cultural regions were situated near sources of fresh water, generally along the coast, rivers, or major creeks or at springs. These settlements were generally established within grassland and woodland environments that contained abundant food resources exploited by the Native American groups. These environments are also the most likely to be treated under the VTP. Areas within conifer forest environments that were distant from sources of water generally did not support permanent settlements, but Native American groups visited or occupied these areas on a seasonal basis to gather available resources. Areas with high mountains, dense timber, rolling hills, and open plains also were not conducive to permanent settlements. Special features of the environment, such as a mountain peak, prominent rock outcrop, or particular bend in a stream, sometimes held special meaning in spiritual beliefs or myths of Native American groups.

GENERAL TYPES OF ETHNOGRAPHIC/CONTEMPORARY NATIVE AMERICAN RESOURCES

Resource Collection Location: This is a location where Native Americans have historically gone, and are known or believed to go today, to collect resources in accordance with traditional cultural rules of practice.

Spiritual Location: This is a location where Native American religious practitioners have historically gone, and are known or believed to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice.

Traditional Location: This is a location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world.

Cemetery: A cemetery is a location that has been selected for human burial or interment.

4.6.1.4 Historic Background

The post-contact history of California can be viewed as a succession of four periods that have left physical traces on the modern landscape. These are the Hispanic era (1542 to 1846), the Early American period (1847 to 1879), Settlement and Growth (1880 to 1929), and the Depression period (1930 to 1941). A discussion of each period follows.

The Hispanic era (1542-1846) can be subdivided into the Spanish and Mexican periods based on political history. Early coastal explorations left little trace in the archaeological record. Formal colonization began in 1769 with the construction of a mission and presidio (fort) at San Diego. Franciscan friars established a chain of 21 missions in Alta (or “Upper”) California that extended along the western margin of the North Coast, Central Coast, and Southern California regions from San Diego to Sonoma. Mission buildings were clustered generally in a quadrangle form, although several missions established outlying agricultural and ranching outposts within a half-day’s journey on foot. Many of the early trails used for delivering supplies were prehistoric trade routes adopted by the Spanish and, later, the Mexicans.

The Russian-American Company established a southern outpost for its Alaskan fur trading operations along the coast of the North Coast geographic region from 1805 to 1841. The post was established to exploit the numerous sea otter populations and to furnish food for the Alaskan installations, which were in desperate need of fresh fruits and vegetables. Their initial settlement was established at Bodega Bay, but a permanent site for settlement was established at present-day Fort Ross in 1812. Agriculture, fruit orchards, and the raising of stock developed around Ross, but the area was not well suited to agriculture and farms were established in the interior valleys. The colony never prospered, and the settlement was abandoned with the sale of moveable properties to John Sutter in 1841.

After 1822, the Mexican government administered California and granted lands to citizens as a reward for services. Settlers engaging in the lucrative hide and tallow trade established outlying ranchos, often building adobe structures, barns, fences, and other improvements. The grants were mostly along the coast and around San Francisco Bay within the North Coast, Central Coast, and Southern California geographic regions, but some extended into Mendocino County and up the Central Valley to Redding. This type of settlement produced a rural, agrarian lifestyle that was disrupted in 1848 with the discovery of gold at Sutter's Mill and the subsequent influx of people.

The Early American period (1847-1879) had its origins as early as the 1820s when Euro-Americans began to filter into California. With the discovery of gold at Sutter's Mill near Sacramento in 1849, California's Euro-American population grew; settlers established regular exchange routes and sold their surplus goods to newly arriving immigrants. Mining activities, mostly in the North Coast and Shasta-Sierra regions, have left behind many archaeological features, including pits, hydraulic cuts, shafts, and (probably most common) water conveyance systems (e.g., ditches, canals, and flumes).

Small towns grew up throughout these two regions to serve the needs of miners with mercantile stores, blacksmith shops, restaurants, hotels, and saloons. Churches and schools soon followed. Under the Homestead Act of 1862, 160-acre farms were made available on unappropriated public land. Homesteaders settled in all portions of the state in areas with abundant water and grazing lands. Agriculture, logging, and transportation systems also developed but were limited largely to local enterprises that relied on human and animal power. The ranching industry continued to dominate the economy of the Southern California region.

Settlement and growth of transportation systems were the focus of the period from 1880 to 1929. During the first decades of this period, cycles of economic boom and bust occurred as California's population and the number of economic enterprises continued to increase. Economic growth was aided by the development of new power sources for machinery. The completion of the Transcontinental Railroad in 1869, powered by the steam locomotive, stimulated construction of railway lines across the state during the next two decades. These lines provided the means to connect California agriculture and industry with markets in the east. Other large-scale enterprises such as logging, electrical power generation, and irrigation systems were undertaken in mountainous, forested portions of the state. These endeavors employed large numbers of workers, at least for initial project construction, and therefore required work camps, employee housing areas, workshops, logistical centers, and transportation networks.

Urban centers along the railroads became more important, although rural patterns for homesteading and agricultural enterprises were also well established throughout the state. The pervasive pattern of small-scale settlements, including farms and ranches, has resulted in building and structure foundations, trash dumps, and the remains of ranching and irrigation systems. In the latter part of this period, the development of the gasoline-powered automobile and its ability to attain higher speeds initiated the development of paved highway systems throughout the state.

During the Depression period (1930-1941), the Civilian Conservation Corps and the Works Progress Administration performed an unprecedented amount of infrastructure construction (e.g., sidewalks, sewer lines, roads, and dams) throughout the nation. Both agencies set up many temporary camps across California. Gold mining increased, primarily from small-scale lode mines. Some larger companies operated bucket-line and drag-line dredges. These mines primarily used existing water conveyance systems built in the previous decades, and they frequently reworked tailings piles left over from hydraulic mining activities of the 1870s and 1880s.

GENERAL TYPES OF HISTORIC-PERIOD RESOURCES-GENERAL DEFINITION OF TERMS

Buildings: A building is a structure created to shelter any form of human activity (e.g., house, barn, church, and hotel).

Structure: A structure is a work made up of interdependent and interrelated parts in a definite pattern of organization. Constructed by humans, it is often an engineering project or large in scale (e.g., bridges, dams, lighthouses, water towers, radio telescopes).

Foundation: These are structural footings or lineal alignments made from wood, brick, or rock to support a building or structure.

Landscaping: This constitutes evidence of modification to the ground surface through such activities as contouring the land or planting vegetation (e.g., hedgerow, orchards, terraces, ponds).

Refuse Deposit: These are discrete areas such as ground surface, drainage embankments, earth pits, or other receptacles that contain artifact concentrations of glass, ceramic, metal, bone, or other material reflecting the purposeful discard of those materials (e.g., privies, dumps, trash scatters).

Linear Resource: Linear resources are mostly long, narrow constructions, either depressed, elevated, or at ground level. These include any device constructed to transport water (e.g., flumes, pipes, ditches, canals, dams, and tunnels), corridors designed to facilitate the transportation of people, vehicles, or information (e.g., roads, trails, railroad grades, and telegraph/telephone lines), and barriers constructed to separate adjoining areas (e.g., stone fences, retaining walls, post-cairns, walls, and fences).

Mine: This includes excavations and associated structures and tailings built into the earth to extract natural resources.

Cemetery: As with Native American cemeteries, these are locations that appear to have been selected for human interment and include any single or multiple burials.

4.6.2 EFFECTS

This section summarizes the impacts to prehistoric, historic, ethnographic, and paleontological resources from implementing either the Proposed Program or any of the alternatives. Generally, in this section these resources will collectively be referred to as "cultural resources", except where a distinction needs to be drawn for analysis purposes.

4.6.2.1 Significance and Threshold Criteria

The management of archaeological and historical resources for the VTP is designed to comply with requirements of CEQA (as amended), the State CEQA Guidelines, the Public Resources Code (Section 5020 et. seq.), the California Register of Historic Resources (14 CCR § 4850 et seq.), and Executive Order W-26-92, and to conform to established CAL FIRE procedures (Foster and Pollack, 2010).

The CEQA Environmental Checklist specifies that the Program and Alternatives would have a significant adverse effect to prehistoric, historic, and paleontological resources if any of them would:

a) Cause a substantial adverse change in the significance of a historical resource, as defined in Section 15064.5 of the CEQA Guidelines (Bass et al., 1999)
b) Cause a substantial adverse change in the significance of an archaeological resource, pursuant to Section 15064.5 of the CEQA Guidelines
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature
d) Disturb any human remains, including those interred outside of formal cemeteries

In addition to prehistoric and historic archaeological sites, cultural resources also include those used for traditional cultural practices, or "ethnographic" resources. The term "traditional" refers to those beliefs, customs, and practices of a living community of people that have been passed down through generations, usually orally, or through practice. The term "cultural" refers to those attributes that are important to support the traditions, practices, lifeways, arts, crafts, or social institutions of a community, Indian Tribe, or other local ethnic group. The traditional cultural significance of a historic resource, then, is derived from the role the site plays in a community's historically rooted beliefs, customs, and practices (USDI BLM, 2005). Examples of traditional sites possessing such significance include:

- Locations which are associated with the traditional beliefs of local Native American communities about their origin or cultural history, or the nature of the world
- Locations where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice
- Locations where Native Americans have traditionally carried-out economic, artistic, or other cultural practices important in maintaining their historical identity (e.g., gathering sites for basketry materials or medicinal herbs)

Determination Threshold

The Program and Alternatives would have a significant effect to cultural resources if treatments ultimately result in:

a) A substantial adverse change in the characteristic(s) contained in that resource which qualify it as being significant
b) An adverse change to locations associated with the traditional beliefs of Native Americans, including areas used or assumed to be used for ceremonial activities
c) An adverse change to locations and or resources used by Native Americans to carry out or support economic, artistic, or other cultural practices

State law and regulation requires that any proponent of a VTP project must follow a defined methodology to determine the potential to affect cultural resources, including measures to avoid or mitigate adverse impacts to these resources (Foster and Pollack, 2010). This *Archaeological Review Process for CAL FIRE Projects* is described below and included in Appendix E.

The significance of a historical resource is materially impaired when a project demolishes or materially alters in an adverse manner the physical characteristics of a historical resource so that it would no longer be included in the California Register of Historic Places or a local register of historical resources (Bass et al., 1999).

An adverse change to an ethnographic resource is one that would lessen the ability of Native Americans to access traditional sites, or to utilize such sites or the resources therein for their traditional purposes.

A “substantial adverse change” in the significance of an historical resource means physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired.

4.6.2.2 **Data and Assumptions**

One of the primary goals of the Vegetation Treatment Program is to reduce the potential for high severity fires by restoring and maintaining a range of native fire-adapted plant communities through periodic low intensity treatments within the appropriate vegetation types (Chapter 2.2, Objective 4). Before contact with Europeans, the indigenous Indian inhabitants of California conducted seasonal burning in order to manage for various amenities, including ease of travel, observation of the landscape, improvement of forage for game species, pest suppression (e.g., burning to reduce acorn worms), maintenance of grasslands for seed gathering, stimulating the production of basket materials, and others. These practices allowed for the development of healthy mixed-species and all-aged forests, with a high proportion of large conifers that could withstand repeated fire.

European intrusion greatly curtailed burning by Native Americans, but it continued on a limited scale. Seasonal burning was also commonly practiced by ranchers through the mid to late 1800s, but was suppressed by the USFS or other government entities during the widespread institution of fire suppression that began in the early 1900s. With the suppression of burning, the older trees became progressively older and more senescent, and timber stands became crowded with smaller trees and brush that had formerly been periodically removed by burning (Round Valley Indian Tribes, 2006).

Comparison of photographs (including aerial photographs) from the mid-1900s to the 1990s or later shows a decrease in grassland area as shrubs and trees encroached upon prairies. Today, due to the accumulation of fire-prone vegetation types and the seasonally fire prone Mediterranean climate of California, there is an elevated risk of high intensity wildfire across much of California. Fires that are more intense than those that occurred in the pre-contact landscape have the potential to degrade or destroy not only prehistoric cultural remains, but historical features and sites as well. While fire is often compatible with the lifeway values of current-day Indian people (such as production of basketry material), very intense fires can alter native plant communities and lead to infestation by non-native invasive plants. Restoration of natural fire regimes and removal of invasive vegetation can decrease the risk of high intensity wildfire while contributing to the restoration and maintenance of historic and ethnographic features (USDI National Park Service, 2003).

However, vegetation treatment techniques and methods pose their own risks to cultural resources. The use of heavy equipment or hand treatments to construct fire lines and safety zones, or as the primary treatment for vegetation, did not occur in the pre-contact period and has greater potential to disturb cultural resources.

Because of the abundance of cultural resources within the state and the potentially destructive nature of many vegetation treatments, implementation of the Proposed Program or any of the Alternatives has high potential to cause adverse impacts to cultural resources. This potential for harm, however, is balanced to a large extent by the protocol that CAL FIRE has instituted to avoid adverse impacts, as described below and included in Appendix E. When impacts to cultural resources are possible, the VTP contains an Archaeological Survey Report with a signature line whereby a professional archaeologist provides specific project approval.

LEGAL REQUIREMENTS

The *Archaeological Review Process for CAL FIRE Projects* (Foster and Pollack, 2010) summarizes the legal requirements for archaeological responsibilities of the agency, as below:

- ***"Legal Requirements:*** *A number of state laws and regulations require CAL FIRE to identify and protect cultural resources. Section 106 of the National Historic Preservation Act and its implementing regulations also apply to some CAL FIRE projects when federal funds are being used. The primary mandate requiring archaeological review of CAL FIRE projects is found in the California Environmental Quality Act (CEQA). This state law requires CAL FIRE to identify potential impacts to archaeological resources during our assessment of environmental impacts from CAL FIRE projects, and to change the project or develop mitigation measures to eliminate or reduce the severity of those impacts. Additional state agency requirements pertaining to the management of cultural resources on state-owned lands are found in Public Resources Code (PRC) Section 5024. Environmental Impact Reports (EIRs) for CAL FIRE's California Forest Improvement Program (CFIP), Vegetation Management Program (VMP), State Forest Management Plans, and our statewide Management Plan for Historic Buildings and Archaeological Sites contain specific requirements we must follow. California Executive Order W-26-92 directs CAL FIRE to develop programs for the preservation of the state's heritage resources throughout our* *jurisdiction. CAL FIRE also receives funding from several federal agencies to support our programs. This brings in a suite of federal laws and regulations pertaining to the protection of cultural resources. In 1996, CAL FIRE entered into a Programmatic Agreement (PA) with the U.S. Forest Service (USFS), State Office of Historic Preservation, and the Advisory Council on Historic Preservation that specifically addresses CAL FIRE's responsibilities for archaeological review of CAL FIRE projects funded by the USFS. This PA was superseded by a new PA in 2004 that is broader in scope to include CAL FIRE projects utilizing federal funds provided by the Bureau of Land Management (BLM) and United States Department of the Interior, Fish and Wildlife Service (FWS) in addition to the USFS. The procedures outlined in this document are intended to satisfy all of these legal requirements. A more complete listing of applicable laws and regulations is presented in CAL FIRE's Reference Manual and Study Guide for the CAL FIRE-CLFA Archaeological Training Program for Registered Professional Foresters and Other Resource Professionals."*

STANDARD CAL FIRE PROTOCOL

CAL FIRE protocol for protecting cultural resources is based on the CAL FIRE Manual for the *Archaeological Review Procedures for CAL FIRE Projects* (Foster and Pollack, 2010). A description of this protocol follows. A complete copy is included in Appendix E, including a flow chart showing the review process for cultural resources for each CAL FIRE project as well as a detailed description of each of these steps.

For every project, a Preliminary Study to determine the potential for cultural resource impacts will be conducted by the project manager in collaboration with a CAL FIRE archaeologist or his/her designee. Based on recommendations from the Preliminary Study, further protective measures may be applied, including an on-the-ground cultural resources survey, notification of Native Americans, pre-field research, development of protective measures, recording of sites, and completion of an archaeological reconnaissance report. For projects funded with federal dollars, consultation with the State Historic Preservation Office (SHPO) under the requirements of Section 106 is required where significant archaeological or historic resources are identified.

If the Preliminary Study reveals the potential to affect cultural resources, the CAL FIRE project manager (or his/her designee) will conduct an intensive cultural resource survey of the project area. In most situations, this survey will include all of the procedural steps shown on the *Cultural Resource Review Procedures* flow chart included in Appendix E. Barring an unusual exception, the list of tasks specified in *Cultural Resource Survey Procedures* must be completed as part of the cultural resource review for every CAL

FIRE project that is determined to have the potential to affect cultural resources. During the review of certain projects, the CAL FIRE project manager may determine that one or more of the procedural steps could be omitted. However, the concurrence of a CAL FIRE Archaeologist must be obtained in order to bypass any of these steps.

CAL FIRE has established a list of practices determined to have little potential to adversely affect cultural resources (Foster and Pollack, 2010). Barring unusual circumstances (such as consideration for Native American traditional gathering areas), if the proposed project includes only those activities, an archaeological (field) survey will not be required. If ground-disturbing activities are part of a proposed project, then an archaeological survey will be required. For projects that do not include ground-disturbing activities, this requirement can usually be waived. All forms of burning, including broadcast burning and the burning of piled brush, will usually require archaeological survey.

Although Program Environmental Impact Reports (Program EIRs) such as this one discuss the broad aspects of environmental impacts, specific project impacts are identified and mitigations are developed through the Environmental Checklist process, which includes a structured component for archaeological resources. That structure involves the actions of Unit Foresters, sometimes assisted by a consulting Registered Professional Forester (RPF) and/or VMP Coordinator, working in close consultation with a CAL FIRE Archaeologist, who completes, assists, or oversees the archaeological survey work and impact analysis. Almost all Unit Foresters, VMP Coordinators, and consulting RPFs have completed CAL FIRE’s Certified Archaeological Training Course and provide valuable assistance to the CAL FIRE Archaeologist in completing this work. This process has been in place long enough that close working relationships have been developed, resulting in a well-coordinated and highly efficient archaeological review process that leads to the timely completion of archaeological clearance for the project and adequate protection for cultural resources (Foster and Robertson, 2005).

CAL FIRE’s archaeological review procedures apply well to CAL FIRE projects where CAL FIRE is the lead agency and a certified Program EIR covers the results of the review. Once the VTP Program EIR is certified, projects must comply with the PSA, which will dictate procedures. Other agencies that rely on this document will need to ensure that their procedures meet or exceed the requirements this Program EIR requires, including a field archaeological survey, as needed.

If archaeological review procedures indicate that a project site has low potential for containing significant resources, the project may proceed without ongoing oversight by the CAL FIRE archaeologist. In such cases, if an unknown site is discovered during project operations, the project proponent is required by the VTP Contract to immediately halt all operations that could damage the site, and contact the local CAL FIRE Archaeologist for an evaluation of the significance of the site.

If potentially significant cultural resources are identified within the project boundaries, the project may proceed if the project manager and archaeologist incorporate site-specific protective measures. Such measures may include: 1) soil will not be disturbed in areas where disturbance would harm the resources; 2) specific sites will be left unburned if burning would tend to degrade the resources; 3) crews will be carefully supervised to avoid unauthorized collecting or other disturbance of the site; and/or 4) areas will be designated for avoidance by machinery, hand crews, and/or fire.

The effectiveness of the CAL FIRE procedure relies on the consultation and collaboration of the CAL FIRE project manager and the in-house expertise of the CAL FIRE Archaeologist. Project manager compliance is tracked through inclusion of questions specific to cultural resources in the PSA. CAL FIRE maintains a cadre of professional archaeologists who are assigned to review projects under CAL FIRE jurisdiction. There are 12 Cultural Resources Information Centers located around the state, which provide information on archeological and historical resources, allowing for ready identification of recorded cultural resources. Professional archaeologists on CAL FIRE staff have expertise regarding the multitude of factors that indicate the likely presence of an unknown site; this knowledge may also be supplemented by pre-project research. If a cultural site is potentially located within a proposed project area, a CAL FIRE certified surveyor will conduct an on-the-ground cultural resources survey. Based on the results of that survey, the project may be allowed to proceed without hindrance, or protective measures may be instituted to protect any potentially significant site, including cancellation or major redesign of the project.

4.6.2.3 **Bioregion Specific Effects**

BIOREGIONAL VARIATION IN CULTURAL RESOURCES OR EFFECTS FROM TREATMENTS

Certain regions within California contain notable concentrations of cultural resources, such as the historic resources associated with the Gold Rush in the Sierra Nevada foothills. Prehistoric resources, on the other hand, are common across the entire state, and are represented in each major vegetation type (timber, shrub, and grass). They tend to be associated with geographical features such as gentle terrain and water or lithic sources. Ethnographic, or traditional, resources are generally known to contemporary Native Americans; for instance, the California Indian Basketweavers Association (CIBA) actively manages many gathering areas on tribal and non-tribal lands, and the Hupa, Yurok, and Karuk people maintain and protect many village sites dating back thousands of years. Paleontological resources, though not as common as prehistoric resources, are found in many places statewide. For instance, Mount Diablo and Anza Borrego State Parks contain particularly rich and varied concentrations of fossils.

However, although certain areas are known or can be assumed to contain concentrations of cultural resources, the likelihood of the VTP program adversely affecting such resources cannot reasonably be differentiated by bioregion or major vegetation type. Prehistoric resources, in particular, are equally likely to occur in any bioregion or vegetation type due to the multi-millennia long occupation of the state by Native Americans during the prehistoric period. Cultural resources of many types may occur within any bioregion and any number of vegetative types. While a proposed treatment in the Sierra foothills may be more likely to affect historic resources than in the Central Coast, there is nevertheless almost always potential for some type of cultural resource to occur within a proposed project area within any bioregion or environmental setting. For this reason, the analysis in this chapter will cover the entire state, and will focus on identification and protection measures to protect all significant sites, as prescribed by State law and regulation.

DIRECT EFFECTS COMMON TO ALL BIOREGIONS

Prehistoric, historic, and paleontological resources are fixed in place. Therefore, the effects on any of these resources located within the 60,000 acres annually treated by the proposed Program or Alternatives depend on whether the cultural resource sites are identified before significant degradation has occurred. Effects to both known and unknown sites are mitigated by the standard practices of applying the standard CAL FIRE protocol for VTP projects (see above and Appendix E). CAL FIRE has proposed Standard Project Requirements (SPRs) (see Section 2.5 for a complete list) applicable to all VTP projects and the additional ability to require Project Specific Requirements to address site specific concerns. Several SPRs specifically reduce the risk of impacts to archaeological and cultural resources from VTP projects. These include CUL-1 that requires a current records check to identify known sites in the project vicinity, and CUL-2 which requires notification of Native American groups of the project activities and location, and a request for information regarding cultural resources. CUL-3 identifies the criteria for conducting an archaeological survey, and CUL-4 and CUL-5 require consultation with a CAL FIRE archaeologist to develop protection measures or avoidance strategies for sites. Finally, ADM-1 and ADM-2 require any necessary protection measures to be flagged in the field and discussed with the contractor prior to the start of operations.

No threshold is proposed for the number of sites that could be degraded so as to diminish their significance as a result of the Program: any such degradation would be considered a potentially significant effect of the program and would require development and application of mitigation measures. Applying SPRs, the standard CAL FIRE protocol in Appendix E, and any PSRs will result in a **less than significant impact** to archaeological, cultural, and historic resources.

4.6.2.4 **Effects by Program Activity**

Program activities describe the treatment methods that will be used to modify vegetation within the project area to achieve the desired management objectives. These are fully described in Chapter 2.2. Vegetation activities may be applied singularly or in any combination needed for a particular vegetation type. The method, or methods, used will be those that are most likely to achieve the desired objectives while protecting natural resource values. Each activity and its potential impact on cultural resources are discussed individually below.

PRESCRIBED FIRE

Prescribed fire can produce a variety of changes to cultural resources that can be adverse, neutral, or beneficial depending on the intensity of the burn, types of materials comprising the resource, and history of previous fires. The relationship between these factors must be taken into consideration to adequately assess the effect of burning on specific characteristics of these resources and to identify appropriate mitigation measures.

Burn intensity is a product of combustion temperature, duration of heat, and heat penetration into the soil (Lentz et al., 1996). These, in turn, are dependent on environmental variables such as type and quantity of woody fuels, soil moisture content, wind, and air temperature. Studies typically describe these effects in terms of low, moderate, and high intensity burn categories that generally correspond to those defined by Eininger (1990):

- Low intensity burns—212-482°F, temperatures in soil do not exceed 212°F at a depth of 1-2 cm
- Moderate intensity burns—572-752°F, temperatures in soil will reach 392-572°F at a depth of 1 cm
- High intensity burns—932-1,382°F, temperatures in soil can reach 662-842°F at a depth of 1-2 cm and 212°F at 5 cm

The elevated temperatures for each of these categories are confined primarily to the ground surface, with little heat transferred below the first few centimeters of the soil.

Preliminary studies show that when fuels are allowed to burn at a single location (e.g., such as a large log or stump) for an extended time, subsurface temperatures can become elevated substantially (Deal, 1997; Lentz et al., 1996).

Burn intensity can be correlated to some degree with typical fuels reported for specific vegetation types (Skinner and Chang, 1996). A summary of the relative effects of low, moderate, and high fire intensity to a variety of cultural resources, as well as dating techniques is in Table 4.6-1.

Table 4.6-1 Effects from Low, Moderate, and High Intensity Fire on cultural resources (Knight 1992)

Intensity	Associated Fuel Types	Cultural Materials Potentially Damaged	Surface vs. Subsurface Damage	Dendro-chronology	Thermo-luminescent dating of pottery and Archaeo-magnetic dating	Hydration Values
Low	Grassland, Forests with thin duff	Organic materials: Wood, Bone, Plant, Antler	Surface only	Negatively affected	None to light damage	Largely Unaffected
Moderate	Mixed Grass Prairie, Pinõn-Juniper,Younger Chaparral	Organic materials including pollen. Surface stone tools, glass bottles, marine shell, bone, pottery, lead, glass	Surface; subsurface with heavy fuels	Negatively affected	None to light damage	Moderate damage
High	Mature Chaparral, Ponderosa Pine, Pinõn Pine/Juniper	Same as moderate, also fossils, rock art, construction materials, ground stone items, sandstone masonry blocks.	Sub-surface likely damaged	Likely destroyed	Negatively affected	Not measurable, greatly damaged.

Because of the variability in burn conditions (e.g., fuel load, wind, humidity, and air temperature) it is difficult to make an absolute correlation of burn intensity with any particular vegetation type. This is especially true for areas in which fire suppression practices have allowed fuels to accumulate in higher concentrations than under pre-fire suppression conditions. SPR FBE-1 requires the burn prescription to limit fire intensity to that designed to only consume surface and ladder fuels. FBE-3 requires this to be verified through modelling to estimate consumption of fuels and tree mortality, among other parameters.

POST-BURN EFFECTS

The loss of ground cover after a prescribed burn can result in increased visibility of the ground surface, exposing site constituents to collection by the public and by uninformed fire crew personnel. The loss of water-holding capabilities of vegetation and litter create increased erosion hazard. These effects from surface erosion are more severe on slopes of higher gradient than those of lower gradient (Knight, 1992). Removal of vegetation by burning also removes vegetation that has aided in stabilizing masonry and dry-laid walls (Traylor, 1981). These effects are generally short term, and slow as vegetation cover is re-established (Kelley and Maburry, 1980; Knight, 1992).

If an area has been burned within the past 75 years or so, most of the perishable items may have been destroyed. However, archaeological and historical resources should be evaluated in relation to the following conditions:

- The potential for cumulative loss of information from repeated impacts
- The potential for future burn intensity to be more intense than past fire events (e.g., low versus high fuel buildup)
- The potential for recent surface exposure of artifacts or features from bioturbation and erosional processes

Beneficial effects as well can result from controlled burning practices. Reducing heavy fuel loads through controlled, prescribed burns will result in lower fire intensity in future natural or prescribed burns. Prescribed burning can be used to reestablish the historic environmental context of significant archaeological and historical resources. For example, fire can be used to combat the recent invasion of forest or chaparral vegetation into original grassland settings of a region, or remove overgrown brush from historic trails. For traditional Native American practices, burning can be used to promote the growth of certain plants used for spiritual practices (e.g., *Angelica* root) food, medicine, or craft manufacture. Post-fire surveys will reveal sites previously hidden by duff and slash, and better ground visibility will allow refinement of boundaries of previously identified resources, aiding in the future management of these resources.

MECHANICAL

Mechanical treatment poses the greatest risk to cultural resources of any VTP treatment method. Use of heavy equipment may adversely affect the physical integrity of cultural resources by physical destruction or damage, displacement, covering, uncovering and exposing resources to the elements, and/or to unauthorized collection. Impacts on resources could occur from disking, bulldozing, and driving across sites, or from covering sites with slash or chips from chipping operations. Clearing of vegetation reduces soil cover, exposing artifacts and facilitating surface erosion. Felling and removal of trees and other vegetation can also expose the ground surface and displace or expose cultural resources.

HAND TREATMENTS

Hand clearing can damage artifacts and their spatial distributions within resource areas in many of the same ways as mechanical clearing, though not typically to the degree caused by mechanical treatments. However, work crews and other project personnel may be tempted to collect artifacts.

HERBIVORY

The effects of herbivory on cultural resources can include trampling, artifact breakage, soil compaction (which can disturb soil profiles and affect dating), reduced ground cover, and destabilization of stream banks, leading to erosion and displacement of artifacts (USDA Forest Service, 2013). Grazing animals, especially large, heavy animals such as cattle, can dislodge and damage cultural resources (Osborn et al., 1987). Vegetation reduction by prescribed grazing may reduce flame lengths and thus fire severity. The clearing of vegetation may also expose cultural resources to the elements and to unauthorized collection. Fewer persons are involved with hand clearing than are on site during grazing activities, however, so the risk of collection is lower than for hand clearing. In Mexico, grazing on archaeological sites has led to erosion and unauthorized collection by herders (Garcia, trans. 2000). However, controlled grazing under the VTP would be much less likely to cause either of these effects. Herbivory using browsers, such as goats, could conceivably reduce vegetation (such as hazel shoots or bear grass) utilized by Indian basket weavers. Overall, negative effects of herbivory are considered lower than for mechanical or hand clearing.

HERBICIDES

Application of herbicides alone is unlikely to cause any direct effects to prehistoric, historic, or paleontological resources. However, herbicides could harm traditional use plants or threaten the health of the people gathering, handling, or ingesting recently treated plants, fish, or wildlife that are contaminated with herbicides. Since roots and other plant materials harvested by Native peoples may be found in close proximity to vegetation treatment areas, the potential exists for herbicides to drift from treatment areas onto gathering areas used by Native peoples. In some cases, vegetation important to Native peoples, including juniper, may be treated in areas where these plants are invasive and crowding out native vegetation (USDI BLM, 2005).

The use of herbicides on private and public lands is of utmost concern to California Indian basket weavers because of the potential harmful effects their use may have on the health of Native plant gatherers and communities, as well as the health and vitality of the environment. A weaver may be exposed to herbicides by making skin contact while gathering. In addition, most of the materials a weaver collects are passed through his or her mouth in preparing it for weaving. The plants that are eliminated by herbicide spraying because of their lack of commercial value are often the same plants that provide Native people with traditional foods and teas, and that are used in baskets, for healing, and for ceremonial and other traditional purposes (Kallenbach, 2009).

4.6.2.5 **Indirect Effects Common to All Bioregions of Implementing the Program**

OFF-SITE PROJECT IMPACTS

The Standard Project Requirements included in Section 4.6.3 below are focused on the project area; therefore, indirect effects of implementing the Program or the Alternatives could potentially occur if off-site operations of the project were to impact a cultural site outside of the project area. For instance, effects might occur if project equipment were parked on an adjacent area that had not been evaluated as part of the project, or if an access road ran through an unknown site. These impacts are considered transitory and unlikely; nevertheless, indirect impacts can be addressed by requiring the project proponent or state archaeologist to assess the potential for sites to exist on off-site areas that might be used for parking, crew campsites, transportation, etc.

EFFECTS FROM REDUCTION OF WILDFIRE INTENSITY

As discussed in more detail below, wildfire can have detrimental effects to cultural resources. Generally, the more intense the fire, the more potential there is to degrade cultural resources. The Proposed Program can therefore be expected to have a beneficial effect to cultural resources to the degree that wildfire intensity is decreased, thereby helping protect the integrity of the resources.

4.6.2.6 **Determination of Significance**

As long as the CAL FIRE archaeological protocol is followed throughout all the stages of each VTP project, including involvement of a professional archaeologist for evaluation and clearance of the project (CUL-4 and CUL-5), the VTP program will have a **less**

than significant impact on prehistoric, historic, or paleontological state cultural resources. The safeguards that are in place must be supported by personnel and funding adequate to perform their stated intention, and include training of CAL FIRE personnel that design VTP projects, review and approval by the CAL FIRE archaeologist, including a determination that there will be no significant adverse effects by signing off on the Archaeological Survey Report for every project, and notification, review, and continued consultation and communication with Native American persons or groups who may have an interest in any project (CUL-2 and CUL-4). This protocol is codified in this Program EIR via inclusion in the Standard Project Requirements below and within Appendix E.

The No Project and Alternatives A-D treat the same acreage or less as the Proposed Program and therefor are also not likely to cause significant impacts to the archaeological, cultural, and historic resources. However, the goals of the Vegetation Treatment Program would not be met by utilizing these alternatives.

4.6.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Each project will incorporate SPRs designed to protect and manage cultural resources, including prehistoric and historic archaeological resources and resources important to maintenance of American Indian traditional cultures. Procedures for protecting cultural resources will follow the most current edition of the CAL FIRE manual *Archaeological Review Procedures for CAL FIRE Projects* (January, 2003, updated November, 2006 and April, 2010). For every VTP project, a preliminary study to determine the potential for cultural resource impacts will be conducted by CAL FIRE/applicant in collaboration with a CAL FIRE archaeologist or his/her designee. Based on recommendations from the preliminary study, further protective measures may be applied, including an on-the-ground cultural resources survey, notification of Native Americans, prefield research, development of protective measures, recording of sites, and completion of an archaeological reconnaissance report. For projects funded with federal dollars, consultation with the State Historic Preservation Office (SHPO) under the requirements of Section 106 is required where significant archaeological or historic resources are identified.

4.6.3.1 Archaeological, Cultural, and Historic Resource-Related Standard Project Requirements

Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design.

CUL-1: The project coordinator or designee shall order a current records check as per the most current edition of “Archaeological Review Procedures for CAL FIRE Projects”

(CAL FIRE, 2010, see Appendix H). The project coordinator may contact landowners within the project area who might have already conducted a records check for a Timber Harvest Plan or other project on their land to limit costly redundant records searches. Records checks must be less than five years old at the time of project submission.

CUL-2: Using the latest Native Americans Contact List from the CAL FIRE website, the project coordinator or designee shall send all Native American groups in the counties where the project is located a standard letter notifying them of the project. The letter shall contain the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- A request for information regarding potential cultural impacts from the proposed project.

CUL-3: The project coordinator or designee shall contact a CAL FIRE Archaeologist or CAL FIRE Certified Archaeological Surveyor to arrange for a survey of the project area if necessary. The specific requirements need to comply with the most current edition of “Archaeological Review Procedures for CAL FIRE Projects” (CAL FIRE, 2010).

CUL-4: Protection measures for archaeological and cultural resources shall be developed through consultation with a CAL FIRE archeologist. If new archaeological sites are discovered, the project coordinator or designee shall notify Native American groups of the resource and the protection measure with the standard second letter (see Appendix H). Locations of archaeological resources should not be disclosed on a map to the members of the public, including Native American groups.

CUL-5: If an unknown site is discovered during project operations, operations within 100 feet of the identified boundaries of the new site shall immediately halt, and the project will avoid any more disturbances. A CAL FIRE Archaeologist shall be contacted for an evaluation of the significance of the site. In accordance with the California Health and Safety Code, if human remains are discovered during ground disturbing activities, CAL FIRE and/or the project contractor(s) shall immediately halt potentially damaging activities in the area of the burial and notify the County Coroner and a qualified professional archaeologist to determine the nature and significance of the remains.

ADM-1: Prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using standard project requirements (SPRs). If burning operations are done with CAL FIRE personnel, the

Battalion Chief and/or their Company Officer designee shall meet with the project coordinator onsite prior to operations to discuss resource protection measures. Additionally, the project coordinator shall specify the resource protection measures and details of the burn plan in the incident action plan (IAP) and shall attend the pre-operation briefing to provide further information.

ADM-2: All protected resources shall be flagged, painted or otherwise marked prior to the start of operations by someone knowledgeable of the resources at risk, their location, and the applicable protection measures to be applied. This work shall be performed by a Registered Professional Forester (RPF), or his/her supervised designee, for any project in a forested landscape as defined in PRC § 754.

PSA Item 4.6-1 Would archaeological, cultural, or historical resources be adversely affected by this project? *[Include Archaeological reviews and/or surveys in confidential addendum]*

PSA Item 4.6-2 Will the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

PSA 4.6-3 Will the project disturb any human remains, including those interred outside of formal cemeteries?

4.7 NOISE

The projects implemented under this proposed Program and Alternatives have the potential to create noise impacts. The evaluation of noise impacts has been broken up into three sections:

- **4.7.1 – Affected Environment**
  - The Affected Environment section discusses the regulatory framework that establishes limits on noise generation as well as sensitive receptors to noise in California.
- **4.7.2 – Effects**
  - The Effects section outlines the potential impacts of implementing the proposed Program and the Alternatives.
- **4.7.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that will reduce the likelihood of the proposed Program causing significant adverse impacts to noise.

4.7.1 AFFECTED ENVIRONMENT

The purpose of the Noise section is to identify, describe, and evaluate noise sources and potential land use conflicts related to environmental noise. In addition, this section summarizes the impacts due to noise from implementing either the Proposed Program or any of the Alternatives.

The Vegetation Treatment Program (VTP) is a statewide program and while typically would be operating in rural forested and range settings, it also likely to operate in the WUI where communities are developing in areas with high fuel loads. These are predominately rural areas that can be characterized as generally quiet, but can frequently experience increased noise levels for a short duration that are associated with timber/forestry operations, ranching and related farm equipment, recreation activities, motor vehicles, and wildlife. Ambient (background) sources of natural noise range from short-term soft sounds, as in the sound of rustling trees (20-30 decibels), to short-term loud cracks and rumbles, as in the sound of air conditioning units or vacuum cleaners (60-80 decibels). Ambient noise can also be loud and constant, such as when using an outboard motor (100 decibels). Community noise or "ambient" noise includes background noise from traffic, machines, and people. Ambient forest and range noise comes from both natural and man-caused sources. Noise associated with VTP activities vary with treatment type. Some noise is short-term; some is constant, but any potential impacts should be of a limited duration. The following is a description of the various sources of man-made ambient noise that could be associated with the VTP program:

- Vehicle traffic (adjacent highways and access roads)
- Aircraft noise
- Equipment usage for VTP activities (machines, chain saws, chippers, etc.)
- Livestock, if herbivory is used
- Conversational noise

Vehicle Traffic–Traffic noise is a function of the receptor's distance from roads, which cannot be adequately assessed at the programmatic level. Rather, it requires consideration during project level review.

Equipment Usage–Construction noise is similar to that of VTP equipment usages; essentially it is the sound of machinery at work. Machinery may include chainsaws, chippers, back-up beepers, yarding tooters, diesel motors, cable yarders, helicopters, and other power tools and engines.

4.7.2 EFFECTS

4.7.2.1 Significance and Threshold Criteria

As previously stated, the California Code of Regulations (CCR), section 65302(f) requires that Counties contain a noise element in their General Plans. In addition, California Department of Health Services (1987) has developed noise guidelines for noise elements in local General Plans. The State guidelines also recommend that local jurisdictions consider adopting local nuisance noise control ordinances. Because CAL FIRE is the proponent and lead agency for this Program EIR, compliance with local standards is not required. However, the State considers local noise standards as they relate to the compatibility between the Program and various land uses adjacent to project sites. Thus, local noise standards are used as guidelines for what the CAL FIRE considers as acceptable noise levels in noise-sensitive areas.

Noise impacts would be considered significant if the Program and the Alternatives would cause:

a) Exposure of persons to or the generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies
b) Exposure of persons to, or the generation of, excessive ground-borne vibration or ground-borne noise levels
c) Substantial permanent increase in ambient noise levels in the project vicinity (above levels existing without the project)
d) Substantial temporary increase in ambient noise levels in the project vicinity (above levels existing without the project)

Determination Threshold

The proposed Program and Alternatives are considered to create a significant effect when a treatment or treatments creates:

a) Noise in excess of 90 dBA at 50’, or in excess of 65 dBA at 1,600’ at sensitive receptor locations (schools, residential units, churches, libraries, commercial lodging facilities, and hospitals or care facilities).
b) Noise levels in excess of 70 dBA L_{dn}
c) The Program and Alternatives are considered to create moderately adverse effects when noise levels are between 60 and 70 dBA L_{dn} according to the State Office of Noise Control.

4.7.2.2 **Impacts from Implementing the Program/Alternatives**

IMPACT A - EFFECTS TO HUMAN HEALTH AND COMMUNITY WELL-BEING

Noise is often defined as unwanted sound, and thus is a subjective reaction to characteristics of a physical phenomenon. In addition, noise impacts apply only if the noise is heard or felt. The vegetated nature and often high relief of the treatment areas can create an environment in which topographical features and vegetation dampen much of the noise. However, VTP treatments, particularly helicopter-assisted prescribed fire, most mechanical treatments, and hand treatments using chainsaws can present a source of significant temporary noise.

The human response to environmental noise is subjective and varies considerably from individual to individual. Noise in the community has often been cited as a health problem, not in terms of actual physiological damage, such as hearing impairment (though hearing loss can occur at high noise intensity levels), but in terms of inhibiting general wellbeing and contributing to undue stress and annoyance. The health effects of noise arise from interference with human activities, including sleep, speech, recreation, and tasks demanding concentration or coordination. When noise interferes with human activities or contributes to stress, public annoyance with the noise source increases.

The vast majority of the noise generated from proposed Program treatments will be located in relatively unpopulated parts of the state where sensitive receptors such as hospitals, schools, libraries, churches, etc., are often miles from the treatment site. The exception is likely to be WUI treatments, where operations might take place immediately adjacent to residential homes. Typically, operations immediately adjacent to structures would utilize hand equipment (e.g. chainsaws).

Noise can have a negative effect on people’s recreational experience if operations are conducted on or near public lands such as near campgrounds and trails (e.g. State Parks). The vast majority of the treatable acreage is composed of private land where private landowners themselves propose the treatments.

Disturbances associated with mechanical treatments would be substantial, though short in duration. Equipment associated with mechanical treatments can generate noise levels ranging from approximately 75 to 90 dBA at 50 feet, depending upon the equipment being used, although mobile chippers can reach sound levels of 115 dBA. Typical operating cycles may involve two minutes of full-power operation, followed by three or four minutes of operation at lower levels. In addition, treatment activities are carried out in stages, during which the character and magnitude of noise levels surrounding the treatment area changes as work progresses, as different equipment is used and the location of the noise-generating work moves throughout the treatment area.

Properly maintained equipment produces noise levels near the middle of the indicated ranges. Activities such as tractor piling, masticating, chipping, falling of small trees/shrubs with chainsaws, etc., are the most common noise generators. As a result, proposed Program equipment and tools typically will generate noise levels of 70–90 dBA at a distance of 50 feet.

The sounds from heavy equipment are often dampened or attenuated by the surrounding vegetation and soft ground surface. This type of attenuation would not occur with helicopter treatments, since air does not attenuate sounds the same way the ground surface does. As a result, helicopter sounds can carry unobstructed for many miles because they often fly above the natural sound barriers.

Chapter 4.10 describes the likely number of vehicles used daily to carry workers to and from the treatment site that would also contribute to noise. Generally, the noise from vehicles carrying workers to treatment sites is likely to be less than the noise created by the treatments themselves.

The potential effects due to implementing the Program or Alternatives will be of short duration (less than 10 weeks per project on average) and limited to typical workday hours (approximately 7AM to 7PM).

It is unlikely that a single residential or commercial area will be affected by the noise from more than one project annually. Even for an area where multiple treatments occur within one year, the odds of all treatments occurring simultaneously are low. Therefore, at most and only in rare cases would the nearest residential or commercial area to a VTP-treated area be affected by two simultaneous projects.

Table 4.7-1 Number of projects by activity for the proposed program

	RX Burn Helicopter	Mechanical	Manual	Herbicides	Herbivory
dBA Maximum Likely	90	90	90	70	65
Weeks/260 acre treatment	0	5-10	5-10	5-10	5
Bioregion	**Number of Projects Per Year**				
Bay Area/Delta	11	5	2	2	2
Central Coast	17	7	3	3	3
Colorado Desert	2	1	0	0	0
Klamath/North Coast	22	9	4	4	4
Modoc	14	6	3	3	3
Mojave	5	2	1	1	1
Sacramento Valley	5	2	1	1	1
San Joaquin Valley	4	1	1	1	1
Sierra Nevada	26	10	5	5	5
South Coast	10	4	2	2	2
Total	**115**	**46**	**23**	**23**	**23**

See Appendix F for more information regarding equipment dBA.

The amount of noise associated with prescribed fire treatments above in Table 4.7-1is based on all treatments being implemented via helicopter. In reality, many (50 percent or more) treatments would be implemented using hand ignition so that noise associated with prescribed fire will often be far less than estimated above.

Most treatments take place in rural areas. For example, within approximately 230 projects that might be implemented per year, 135 (57 percent) of the projects will take place in rural bioregions such as the North Coast/Klamath, Modoc, Sacramento Valley, San Joaquin, Mojave, and Colorado Desert.

Assuming that half of all prescribed fire treatments are conducted using hand ignition, about 105 of the 230 projects conducted yearly would be conducted at noise levels of around 65-70 dBA, while the balance of the projects would have periods during the day when sound levels could reach 90 dBA within 50 feet of the treatment equipment. About 126 projects would be implemented across approximately 38 million acres of jurisdiction lands where sound levels could reach 90 dBA at particular times between 7AM and 7PM, five days per week for periods as long as ten weeks. However, as noted above, peak noise levels are rarely continuous over periods of more than two minutes at a time due to equipment maneuvering, chainsaw operators moving to the next piece, etc.

Implementation of the proposed VTP includes six Standard Project Requirements that reduce noise impacts to a less than significant level. Noise SPRs NSE 1, 2, and 4 implement standard industry practices that reduce noise from powered or motorized equipment. NSE-3 ensures noise-generating equipment is located as far as possible from nearby noise-sensitive land uses and NSE-5 requires notification of those sensitive receptors of a project in the area. NSE-3 and 5 ensure that sensitive receptors are aware of any projects nearby and not affected by noise impacts.

Operation of heavy equipment can generate ground-based vibration, particularly operations by dozers. Rubber tired skidders, masticators, mowers, roller choppers, etc., usually do not develop the amount of ground based vibration that a 45,000 pound or larger (D7 or equivalent) dozer can. However, while dozer operations might take place within several hundred feet of sensitive receptor locations, vibrations from such operations are expected to be short duration, consistent with the operational performance times noted above. In addition, only about 20 percent of annual treatments within any bioregion would be mechanical, and then, not all of those would use a dozer. Implementation of the Program will not generate or expose persons to excessive ground-borne vibration because the extent and intensity of such treatments is of short duration. As a result, the Proposed Program would not create a substantial adverse effect and the impacts are expected to be **less than significant**.

Implementation of the Program could generate or expose persons at sensitive receptor sites to noise levels of 90 dBA at 50 feet or in excess of 65 dBA at 1,600 feet, or 70 dBA L_{dn}, and therefore potentially create a significant effect. However with adoption of the SPRs below, the effect is **less than significant**.

It is not possible to make a determination as to whether implementation of the proposed Program would be in excess of standards established in the revised noise elements of County General Plans or applicable standards of other agencies because the specific location of Proposed Program treatments is not known. However, with adoption of SPRs in 4.7.3 and any PSRs developed as a result of a Project Scale Analysis, the potentially substantial adverse effects are expected to be **less than significant**.

Because of the transitory nature of VTP projects, implementation of the Program will not result in a permanent increase in ambient noise levels above levels existing without the project, and therefore would not create a substantial adverse effect resulting in a **less than significant impact** to the environment.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant impacts to human health and community well-being due to noise.

Alternative A would treat a smaller landscape as the Proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A is more likely to result in simultaneous projects occurring in or near a particular community, and therefore more likely to cause significant noise impacts to human health and community well-being.

Similarly, Alternative B would treat a smaller landscape but the same number of acres as the Proposed Program, but only allow WUI and fuel break projects. Due to the limited types of projects that could be implemented, it is more likely that, under Alternative B, a community would have more than one simultaneous fuel reduction project occur, and therefor noise impacts to human health and community well-being would be significant.

Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program. This Alternative would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because this Alternative would exclusively focus projects in areas of high hazard and not human development (as in Alternatives A and B), with the SPRs proposed below Alternative C would not result in significant noise impacts to human health and community well-being.

Alternative D would treat the same landscape as the Proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. Although the maximum likely dBA of prescribed fire projects is the highest of all treatment methods, prescribed fire using helicopter has the shortest duration of all treatment methods. Since noise affects individuals differently, different people will be bothered by loud noise over a short period or moderate noise over a longer period. However, the reduction in prescribed fire is not replaced entirely by increases in other treatment methods, and so the overall noise impacts are less. Because of the overall smaller treatment area proposed, and with the SPRs proposed below, Alternative D would not result in significant noise impacts to human health and community well-being.

IMPACT B - EFFECTS ON SENSITIVE RECEPTORS

Treatments near sensitive receptors are more likely to occur in the Sierra Nevada, Bay Area, Central Coast and South Coast bioregions than the other bioregions. Otherwise, noise effects in these bioregions are expected to be similar to the other bioregions. Although prescribed fire using helicopters is applied more often in these bioregions, especially in the Sierra Nevada and Central Coast, there is a potential that somewhat less noise might be generated compared to the other bioregions. Helicopters generate more noise during operation than hand ignition but the duration of these projects (and thus total noise effects) is shorter. It is common for an entire 260 acre project to be burned in one day using a helicopter compared to several days or more utilizing hand ignition.

There are potential indirect effects to human health and to wildlife associated with noise from the Proposed Program. Indirect effects to human health and to the health of wildlife arise in terms of inhibiting general wellbeing and contributing to undue stress and annoyance. However, projects are of a temporary nature, and should not result in any long-term noise-related indirect effects specific to any bioregion.

Most of the Proposed Program treatments are far removed from sensitive receptor sites such as schools, churches, hospitals, and libraries. Noise associated with the Proposed Program will temporarily increase noise levels from project activities including production of noise levels of 90 dBA at 50 feet or in excess of 65 dBA at 1,600 feet, or 70 dBA L_{dn}, and thus these effects could create substantial adverse effects. The severity of such impacts will be temporary and the effects are dependent on the number of individual projects that might occur simultaneously. Adoption of the SPRs below will reduce these potentially substantial adverse effects to **less than significant**.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant impacts to sensitive receptors due to noise.

Alternative A would treat a smaller landscape as the Proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A is more likely to result in simultaneous projects occurring in or near a particular community, and therefor likely to cause significant noise impacts to sensitive receptors.

Similarly, Alternative B would treat a smaller landscape but the same number of acres as the Proposed Program, but only allow WUI and fuel break projects. Due to the limited types of projects that could be implemented, it is more likely that, under Alternative B, a community would have more than one simultaneous fuel reduction project occur, and therefor noise impacts to sensitive receptors would be significant.

Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program. This Alternative would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because this Alternative would exclusively focus projects in areas of high hazard and not human development (as in Alternatives A and

B), with the SPRs proposed below Alternative C would not result in significant noise impacts to sensitive receptors.

Alternative D would treat the same landscape as the Proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. Although the maximum likely dBA of prescribed fire projects is the highest of all treatment methods, prescribed fire using helicopter has the shortest duration of all treatment methods. Since noise affects individuals differently, different people will be bothered by loud noise over a short period or moderate noise over a longer period. However, the reduction in prescribed fire is not replaced entirely by increases in other treatment methods, and so the overall noise impacts are less. Because of the overall smaller treatment area proposed, and with the SPRs proposed below, Alternative D would not result in significant noise impacts to sensitive receptors.

4.7.2.3 Similar Effects Described Elsewhere

The effects of noise to wildlife are described in chapter 4.2.

4.7.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design.

NSE-1: All powered equipment shall be used and maintained according to manufacturer's specifications.

NSE-2: Equipment engine shrouds shall be closed during equipment operation.

NSE-3: All heavy equipment and equipment staging areas shall be located as far as possible from nearby noise-sensitive land use (e.g., residential land uses, schools, hospitals, places of worship).

NSE-4: All motorized equipment shall be shut down when not in use. Idling of equipment or trucks shall be limited to 5 minutes.

NSE-5: Public notice of the proposed project shall be given to notify noise-sensitive receptors of potential noise-generating activities.

4.8 RECREATION

Recreation has been broken up into three sections:

- **4.8.1 – Affected Environment**
    - The Affected Environment section discusses the ownership patterns of recreational land in the state and the geographic extent of recreational land in each bioregion.

- **4.8.2 – Effects**
  - The Effects section outlines the potential impacts of implementing the proposed Program and the Alternatives.
- **4.8.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that will reduce the likelihood of the proposed Program causing significant adverse impacts to recreational resources.

4.8.1 AFFECTED ENVIRONMENT

This section discusses recreational resources that could be affected by the proposed program. The recreation analysis focuses on recreational opportunities within state parks, public and private trails, and other recreational facilities. The VTP program has the potential to operate on state parks and has the potential to affect recreational use. In addition, this section summarizes the impacts to recreation due to implementing either the Proposed Program or any of the Alternatives.

Outdoor recreation is an important attribute for all public forests and rangelands as well as some private forest and rangelands in California. In addition to the scenic value of these lands, various types of outdoor recreation on forests and rangelands are a significant component of the quality of life for many Californians and a major attraction for many out-of-state visitors. With over half of all land in California in public ownership and available for recreation, Californians have a wide array of opportunities.

The major suppliers of outdoor recreation on forests and rangelands in California include the U.S. Forest Service (USFS), the National Park Service (NPS), U.S. Bureau of Land Management (BLM), California State Park System, and local governments. Other minor public providers include the U.S. Bureau of Reclamation (BOR), U.S. Army Corps of Engineers (USACE), public utility companies, and various departments of the California Natural Resources Agency. Local, county, and regional providers are another source for wildland outdoor recreation but the boundaries between wildland recreation and urbanized recreation become hard to define. With urban areas containing over 81 percent of the California's population, these local areas are a dominant provider of recreation, especially open space aesthetics. Table 4.8-1 provides a summary of area available for wildland recreation by bioregion.

Table 4.8-1 Public land available for wildland recreation (CPAD, 2014)

Bioregion	Tree	Grass	Shrub	Water	Wetlands	Total
Bay Area/Delta	273,079	395,041	243,227	61,279	33,568	1,006,195
Central Coast	391,686	840,708	1,303,386	28,437	2,217	2,566,434
Colorado Desert	81,394	4,495	3,894,457	207,756	45	4,188,148
Klamath/North Coast	5,563,668	1,680,960	1,712,521	80,623	14,571	9,052,344
Modoc	2,126,118	117,514	2,175,547	103,843	43,447	4,566,469
Mojave	454,378	71,459	12,963,648	8,508	7,835	13,505,827
Sacramento Valley	15,846	7,724	14,723	19,703	28,879	86,876
San Joaquin Valley	80,699	478,055	92,817	15,158	19,568	686,297
Sierra Nevada	6,965,247	2,977,048	16,482	227,936	81,120	10,267,832
South Coast	555,829	157,248	1,710,573	37,334	6,594	2,467,579
By Habitat Type	**16,507,943**	**6,730,253**	**24,127,381**	**790,577**	**237,845**	**48,393,999**

4.8.1.1 Setting

The treatable acreage includes land open to public recreation that are owned by state agencies including CAL FIRE, Parks, Fish and Wildlife, Conservancies, Water Resources, and others. These approximately 1.9 million acres of land constitute the vast majority of lands whose recreational opportunities could be affected by VTP projects. Assuming that these lands have an equal probability of receiving VTP projects as other lands within CAL FIRE jurisdiction allows extrapolation of Table 2.5-6 to estimate the percentage of state-owned recreational lands that are likely to be affected by VTP treatments annually under the Proposed Program (Table 4.8-2).

Table 4.8-2 Treatable Acres Under State Ownership in acres (FRAP, 2013)

Bioregion	Tree	Grass	Shrub	Total
Bay Area/Delta	119,637	67,727	131,211	318,575
Central Coast	124,136	48,417	13,365	185,919
Colorado Desert	644	323,576	48,654	372,873
Klamath/North Coast	16,576	25,956	283,328	325,860
Modoc	41,321	55,682	21,323	118,326
Mojave	1,958	30,632	14,764	47,353
Sacramento Valley	55,459	1,298	3,040	59,797
San Joaquin Valley	120,565	8,348	10,716	139,628
Sierra Nevada	50,108	41,888	84,353	176,349
South Coast	31,697	124,118	31,747	187,563
By Treatable Acres	**562,101**	**727,642**	**642,501**	**1,932,244**

Recreational areas near metropolitan areas receive more use than remote recreational areas. It is assumed that likelihood of VTP treatments occurring is equal between high and low use recreation areas, but VTP treatments in high use areas would be likely to directly and indirectly affect more people than treatments in remote areas.

4.8.2 EFFECTS

4.8.2.1 Significance and Threshold Criteria

Appendix G of the CEQA Guidelines, the CEQA Environmental Checklist, poses the following to be considered in determining whether the Program or Alternatives would cause significant impacts to recreation. The Program and Alternatives would create significant effects if they would:

- Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?
- Include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?

Determination Threshold

Because the proposed Program does not impact the use of parks or recreational facilities, or require the construction or expansive of recreational facilities, alternative determination thresholds have been developed to analyze the impacts of the proposed Program and Alternatives. An effect is considered significant if it would:

a) Close a significant portion of public recreational areas because of VTP treatments during the peak visitor season over a calendar year.

b) Severely reduce visual quality (more than 80 percent burned and black, cleared of vegetation, or comprised of dead plants) on more than 10 percent of the area of any one state park, private recreation area or other publicly accessible recreational area, during the peak visitor season over a calendar year.

IMPACT A – RECREATIONAL AREA CLOSURES

It is likely that lands subject to VTP treatments would be closed to recreational use for the duration of the project, which is not likely to exceed two weeks. The area affected for recreational use may exceed the boundaries of the project area for prescribed burning projects due to smoke generation. For non-burning treatments, the area affected for recreational use is not likely to exceed the project boundaries. Except in the Colorado Desert, treatable recreation areas are 10 percent or less of the total treatable acreage in each bioregion (Appendix G). Additionally, not all projects under this Program EIR in each bioregion will take place on state owned recreational lands, nor would they take place within the same calendar year.

In the Colorado Desert Bioregion, 74 percent of the treatable acreage under this program is recreational lands. However, it is estimated that only 3 percent of the program’s treatments will take place in this bioregion. It is unlikely that all the recreational treatable acres will be treated, and it is not likely that projects would occur simultaneously or entirely during peak visitor season. Thus, it is very unlikely that VTP projects would close a significant amount of recreational areas in the Colorado Desert or any other bioregion simultaneously due to VTP projects.

Implementation of VTP projects is likely to be spread over the entire year, with many projects occurring in non-peak visitation months. Peak visitor use tends to occur during the summer months for many recreational areas. Prescribed fire, which is the most common treatment type, is most commonly implemented in fall, winter and spring, which are off-peak months for recreational use.

The below PSA items will be included to address project-specific recreational impacts that are not detected at the scale of the bioregion. With the application of the SPRs in Chapter 2.5 and any PSRs identified through the analysis questions, effects to recreational access due to implementing the Proposed Program are likely to be small scale, short term, and **less than significant.**

IMPACT B – RECREATIONAL VIEWSHED

A potential effect to recreational use includes decreased visual quality for users due to presence of recently treated VTP projects in their viewshed. For tree vegetation types it is unlikely that any VTP treatment would result in a viewshed where more than 80 percent of the area was burned and black, cleared of vegetation, or comprised of dead plants. For grass and shrub vegetation types it is possible that VTP treatments could result in more than 80 percent of the project area burned and black, cleared of vegetation, or comprised of dead plants. However, most of the treatments will take place in the spring, fall, or winter, which are non-peak visitor months. Clearing understory vegetation is likely to improve the recreational resource in many cases due to increased visibility and access.

Only the Bay Area/Delta, Colorado Desert, and South Coast Bioregions are dominated by grass and shrub vegetation types within which more than 5 percent of the bioregion's treatable acreage is recreational acreage. Thus, recreation is more likely to be indirectly affected in these three bioregions due to decreased visual quality, compared to the other bioregions. However, there is low likelihood that more than 10 percent of a given recreational area (state park, conservancy, etc.) would be treated in a single year, unless the recreational area was very small.

Additionally, in the Bay Area/Delta, Colorado Desert, and South Coast Bioregions, it is anticipated that only 7, 3, and 6 percent of the proposed program acreage would be treated in those bioregions, so it is unlikely that 10 percent or more of a recreational area in that bioregion would be treated at once.

The below PSA will be included to address project-specific recreational impacts that cannot be detected at the scale of the bioregion. With the application of the SPRs in Chapter 2.5 and any PSRs identified through the PSA questions, effects to recreational viewsheds due to implementing the Proposed Program are likely to be small scale, short term, and **less than significant.**

The No Project Alternative and Alternatives A-D treat the same acreage or less as the Proposed Program and therefor are also not likely to cause significant adverse effects to the recreational resource. However, the goals of the Vegetation Treatment Program would not be met by utilizing these alternatives.

IMPACTS DUE TO IMPLEMENTING ANY OF THE ALTERNATIVES

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant impacts to recreational closures or viewsheds.

Alternative A would treat a smaller landscape as the Proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A would drastically reduce the number of projects on recreational land, since any treated recreational land would have to exist in the WUI area. This Alternative would result in less than significant impacts to recreational closures or viewsheds.

Similarly, Alternative B would treat a smaller landscape but the same number of acres as the Proposed Program, but only allow WUI and fuel break projects. Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program, but would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because these Alternatives continue to focus the VTP on areas that do not necessarily overlap with recreational areas (human development and very fire hazard, respectively), there is an overall less than significant impact to recreational closures or viewsheds due to Alternatives B and C.

Alternative D would treat the same landscape as the Proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. Because of the overall smaller treatment area proposed and the reduction in the use of prescribed fire, Alternative D would not result in significant impacts to recreational area closures or viewsheds.

4.8.2.2 Similar Effects Described Elsewhere

Impacts to visual and aesthetic resources are described in Section 4.13.

4.8.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

No mitigation measures or standard project requirements are required. However, the following checklist items will be included in the environmental checklist.

PSA Item 4.8-1 Will the proposed project result in a significant portion of the recreational area being closed to recreational use during peak visitor season over a calendar year, or more than 10 percent of the recreational area in a condition of decreased visual quality during peak visitor season?

4.9 UTILITIES AND ENERGY

Utilities and Energy has been broken up into three sections:

- **4.9.1 – Affected Environment**
  - The Affected Environment section discusses the origins and use of power in California and the regulations that govern utilities and energy in the state.
- **4.9.2 – Effects**
  - The Effects section outlines the potential impacts of implementing the proposed Program and the Alternatives.
- **4.9.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that will reduce the likelihood of the proposed Program causing significant adverse impacts to utilities and energy.

4.9.1 AFFECTED ENVIRONMENT

This section describes the environmental setting for Utilities and Energy. The Utilities section of the Program EIR explains the distribution of the utilities used within California and those potentially affected by the VTP program. These include electricity, water, and renewable energy sources that include biomass, hydro, wind, and geothermal. Figure 4.9-1 below shows the location of power plants by type in California.

Utilities (transmission lines, substations, etc.) and water supply facilities are at risk from wildfires. Wildfires have the potential to damage or destroy transmission lines. Depending on the extent of the damage the impact to transmission lines from a wildfire could have a cascading effect across the energy grid. High severity wildfires as well as prescribed fire have the potential to affect the capacity of water storage through accelerated erosion and sedimentation. Through fuel reduction and brush removal the Vegetation Treatment Program can reduce the risk of high severity fires occurring in areas that are likely to impact utilities or water supply. The following is a summary of key issues regarding the importance of the VTP to protect utilities and enhance energy production from a renewable source.

- Utilities such as transmission lines, substations, wind generation and potentially geothermal facilities are assets at risk, threatened by wildfire and escaped prescribed fire.
- Hydro facilities generate electricity as well as store water. Vegetation management can increase runoff, which is favorable to electricity generation and storage, but it can also cause sedimentation that fills in reservoirs and block generators.
- Mechanical treatment of vegetation generates biomass. Some can be used for electricity generation or thermal applications that offset fossil fuel use.

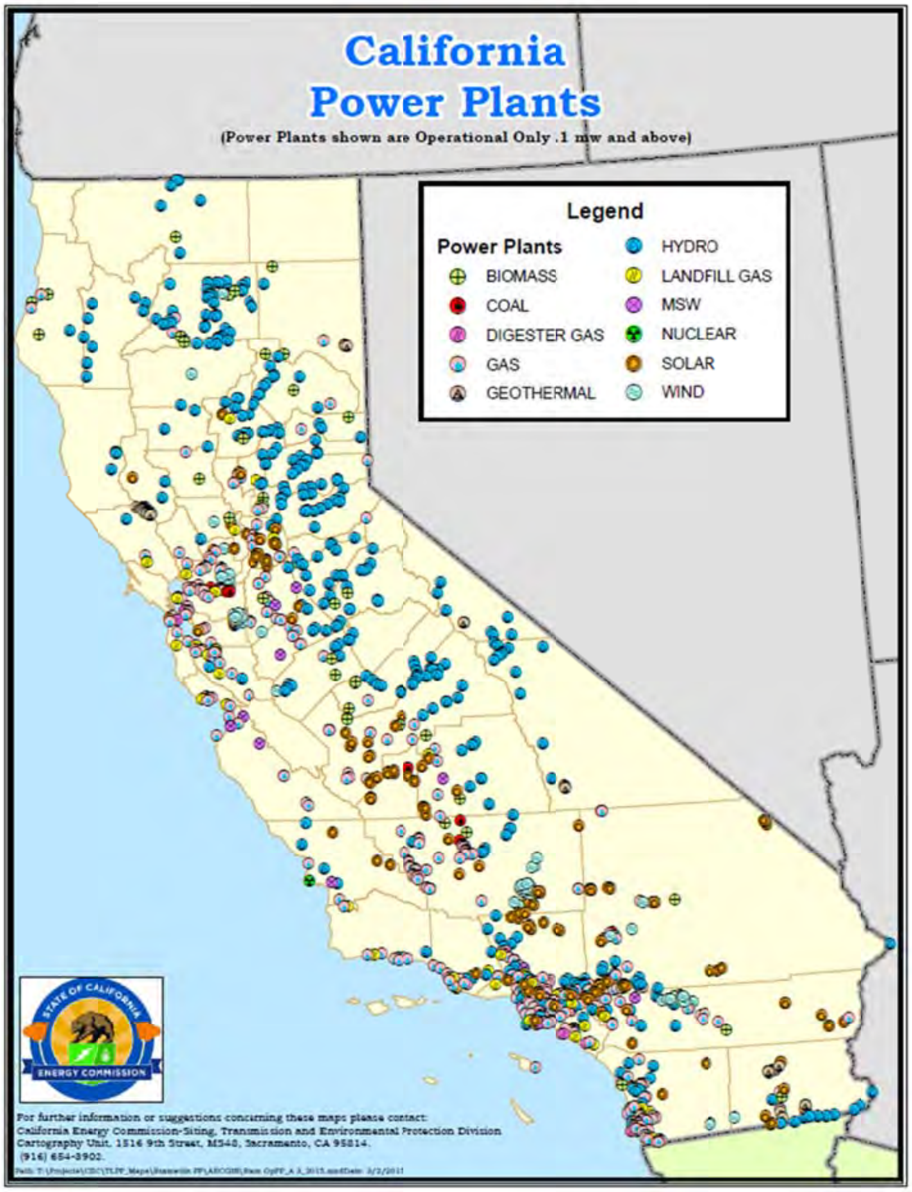


Figure 4.9-1California Power Plants by type (CEC, 2013)

4.9.1.1 **Regulatory Setting**

A number of different agencies regulate utilities and energy production in California. These agencies do not have direct oversight over the Vegetation Treatment Program. However, their oversight and policy decisions can influence infrastructure needs which in turn may indirectly have a greater influence on the VTP. This would be particularly true if policy decisions lead to a greater emphasis on biomass and other renewable energy sources.

Potential Responsible Agencies include:

- California Energy Commission is the State's primary energy policy and planning agency. The Commission has major responsibilities that include: forecasting future energy needs, licensing thermal power plants 50 megawatts or larger, promoting energy efficiency, developing energy technologies and supporting renewable energy, and planning for and directing state response to energy emergency
- Public Utilities Commission (PUC) for projects requiring permits to construct an electric transmission line, a water utility, a radio-telephone utility, or facilities for operating a passenger transportation service.
- California Electricity Oversight Board ensures transmission reliability through overseeing operations of the California Independent System Operator (CAISO), ensures fair market prices, and monitors daily market variations.
- California ISO is the impartial link between power plants and the utilities that serve more than 30 million consumers. The ISO provides equal access to the grid for all qualified users and strategically plans for the transmission needs of this vital infrastructure.
- California Integrated Waste Management Board would be a Responsible Agency (or any other applicable enforcement agency) for projects requiring permits to operate a transfer, disposal, or waste-to-energy facility.

4.9.1.2 **Electricity and Transmission Lines**

California's electrical transmission and distribution system consists of power plants, substations, transmission lines, electric utility service areas, and electrical transmission busses. Power lines are a critical infrastructure of California's energy system. Right-of-way corridors associated with transmission lines are normally between 150 to 300 feet wide (CEC, 2013). With about 54 thousand miles of transmission line in California (Figure 4.9-2), they represent a prominent and expanding infrastructure on the landscape. Table 4.9-1 Gross system electricity production by resource type (CEC, 2013) provides a summary of the length of transmission lines by bioregion. With the increasing interest in renewable energy resources it is likely that additional transmission lines will need to be located in forest and range lands across the state. Wildfires have the potential to damage or destroy transmission lines. Depending on the extent of the damage the impact to transmission lines from a wildfire could have a cascading effect across the energy grid. Vegetation around utility facilities, especially transmission lines, is managed by the utility company to prevent tall trees and other vegetation from interacting with conductors and interfering with providing safe and reliable transmission of electricity.

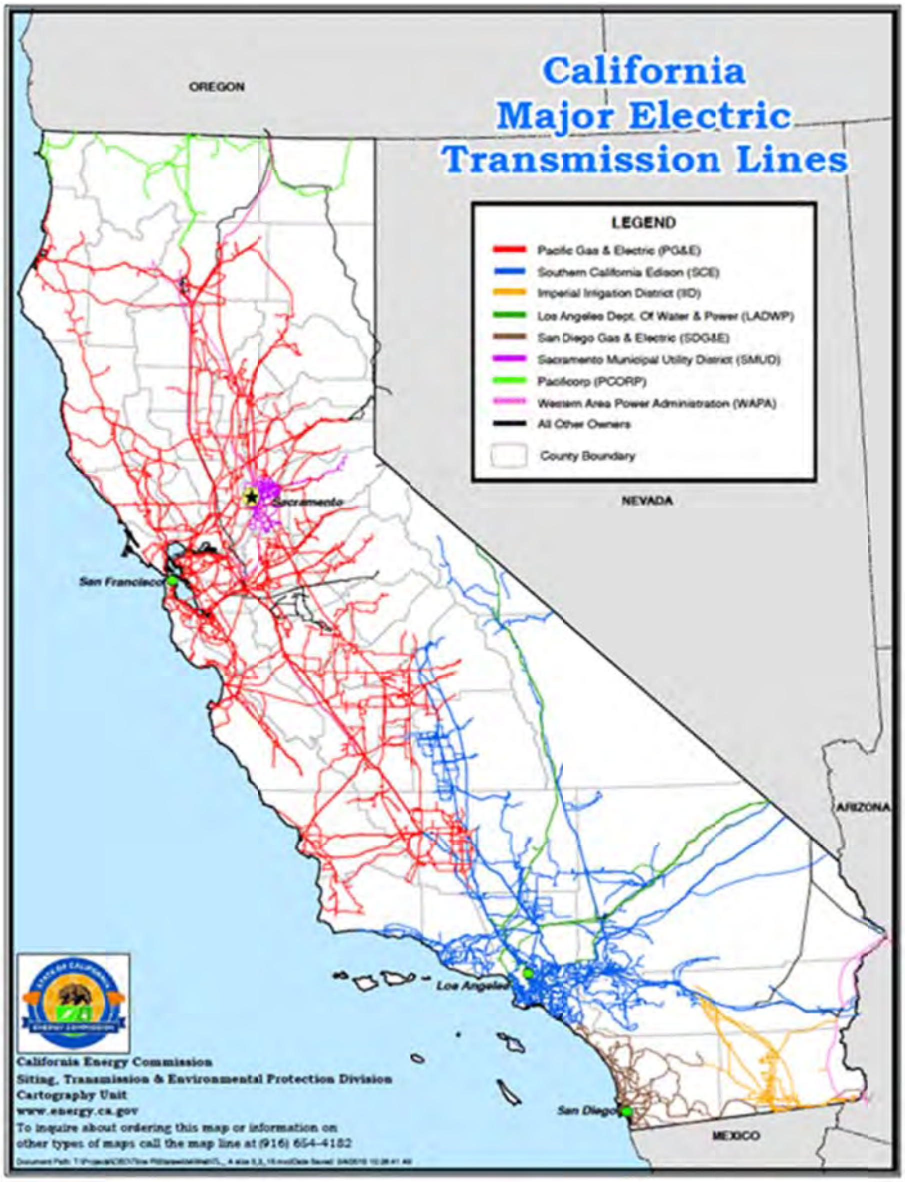


Figure 4.9-2 California's Major Electric Transmission Lines (CEC, 2014)

4.9.1.3 Water Infrastructure

To accommodate a large population and to account for highly variable rainfall, California has a highly developed water supply infrastructure. The California State Water Project consists of an extensive storage and conveyance system that includes pumping and power plants, reservoirs, lakes, storage facilities, aqueducts, canals, and pipelines that distribute water through 29 different water agencies. The location of dams, reservoirs, and canals reflects the spatial distribution of precipitation. Many of the dams are located in forest landscapes (Figure 4.9-3Figure 4.9-3 California dams and their power status.

(CEC, 2015)). The State's water is concentrated in the north; 75 percent of precipitation occurs north of Sacramento, but the majority of the urban population and much of the irrigated agriculture are in the south. California's water storage meets multiple objectives that include: compensating for annual and seasonal variations in water supply, providing fire protection, and providing recreational opportunities.

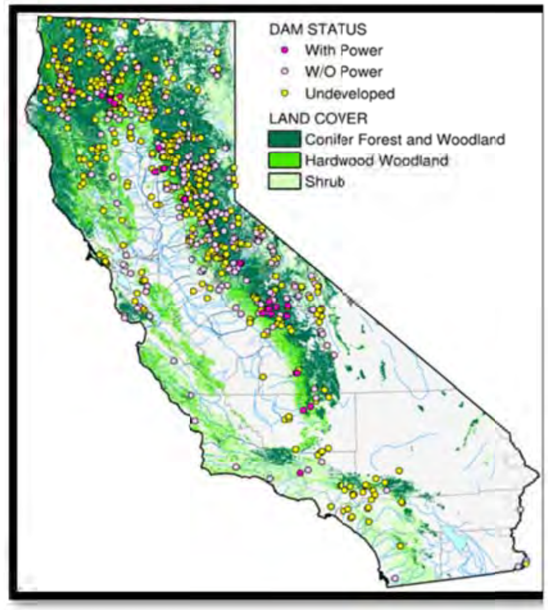


Figure 4.9-3 California dams and their power status. (CEC, 2015)

The two major water projects in California are the State Water Project and the Central Valley Water Project. The Oroville Dam is the main storage facility for the State Water Project. The two main storage facilities for the Central Valley Water Project are the Shasta Dam and the Friant Dam. In addition, there are an estimated 1,200 nonfederal dams with a reservoir capacity of 20 million acre feet (MAF) (Mount, 1995). Combined with 181 federal reservoirs, the total capacity is roughly 42 MAF and captures almost 60 percent of runoff. The water from these dams is distributed across the state through a complex system of canals and aqueducts that stretches for several thousand miles across the state. High severity wildfires have the potential to affect the capacity of water storage through accelerated erosion and sedimentation.

4.9.1.4 **Energy Production and Use**

With its large and growing population California consumes more energy (264,740 Gigawatt hours) than any other state. It is also a world leader in electricity created by renewable energy resources and energy conservation. California has the second-lowest per capita energy consumption of any of the 50 states (US EIA, 2012). This section describes the environmental setting for energy production that is developed on forest and range lands and is potentially affected by fuel reduction projects and wildfires.

California's forests and rangelands provide electrical generation from several sources. These include electricity from hydropower, geothermal, wind, biomass, and solar. Urban wood wastes also contribute to production of electricity to the extent they are buried in landfills and landfill gas is captured and used to help generate electricity.

California relies on three sources of energy—petroleum, natural gas, and electricity. California's power generation system is owned by numerous entities, with about 44 percent of total generation owned by investor-owned and municipal utilities plus other entities (CEC, 2001a).

The two largest suppliers for forest and rangeland areas are Pacific Gas and Electric (PG&E) and Southern California Edison (SCE). However, most of the existing power plants once owned by PG&E, San Diego Gas and Electric (SDG&E), and SCE were sold. New plant owners, as well as new plants that will be built in California, are not required to provide electricity to the State. Since deregulation in 1996, the CEC has approved applications for new large power plants that will generate about 20,000 megawatts (MWs). Another 20,000 MWs of proposed capacity is under review by the CEC or may be submitted by developers in the near future.

4.9.1.5 **Forest and range related energy industry structure**

California's electric generation comes from multiple sources (Table 4.9-2). In 2013, natural gas, coal, large hydro, and nuclear power comprised 80 percent of the fuel type used to generate electricity, while renewable sources (biomass, geothermal, small hydro, solar, and wind) accounted for 19 percent.

Energy contributions from forests and rangelands are primarily associated with electricity from hydropower, geothermal, wind, and biomass. Large hydro is not considered to be renewable and is defined as any facility employing one or more hydroelectric turbine generators, the sum capacity of which exceeds 30 MWs (CEC, 2001c). In contrast, small hydro (any facility employing one or more hydroelectric turbine generators with a sum capacity of 30 MW or less) is considered renewable. In 2001, renewables contributed 10.5 percent of California's electrical generation. Renewables include small hydro, biomass, geothermal, wind, and solar sources (Figure 4.9-4). The most significant contributions come from geothermal and biomass.

Hydro (both large and small), geothermal, biomass, and wind energy sources are related to forest and range resources. Over the last two decades, the relative importance of hydro, wind, biomass, and geothermal has varied. However over the last five years, the relative contribution of hydro has declined. Table 4.9-2 and Table 4.9-3 summarize the amount and percent of megawatts produced from renewable sources.

In 2013, hydroelectric power accounted for roughly half of total renewable energy that was produced by in-state power plants. Other significant sources of in-state renewable energy are biomass (18 percent), geothermal (7 percent), wind (1 percent), and solar (28 percent).

Table 4.9-1 Gross system electricity production by resource type (CEC, 2013).

Fuel Type	California In-State Generation (GWh)	Percent of California In-State Generation	Northwest Imports (GWh)	Southwest Imports (GWh)	California Power Mix (GWh)	Percent California Power Mix
Coal	1,018	0.51%	812	21,363	23,193	7.82%
Large Hydro	20,754	10.39%	96	2,159	23,009	7.76%
Natural Gas	120,863	60.50%	1,241	9,319	131,423	44.31%
Nuclear	17,860	8.94%	0	8,357	26,217	8.84%
Oil	38	0.02%	0	0	38	0.01%
Other	14	0.01%	0	0	14	0.00%
Renewables	39,236	19.64%	13,187	3,256	55,679	18.77%
Biomass	6,423	3.21%	1,485	21	7,929	2.67%
Geothermal	12,485	6.25%	212	495	13,192	4.45%
Small Hydro	3,343	1.67%	470	0	3,813	1.29%
Solar	4,291	2.15%	58	1,040	5,389	1.82%
Wind	12,694	6.35%	10,962	1,700	25,356	8.55%
Unspecified Sources of Power	N/A	N/A	19,750	17,305	37,055	12.49%
Total	199,783	100.00%	35,086	61,759	296,628	100.00%

**Amount of electricity produced from coal includes out-of- State power plants that are either owned by California utilities or have long term contracts to supply electricity solely to California. This electricity produced from these coal-fired plants is not designated as an "import" even though the plants are located outside the State. The 15 small coal-fired power plants located within California have a name plate capacity of only 550 MWs; less than one percent of total State capacity. (CEC, 2013).*

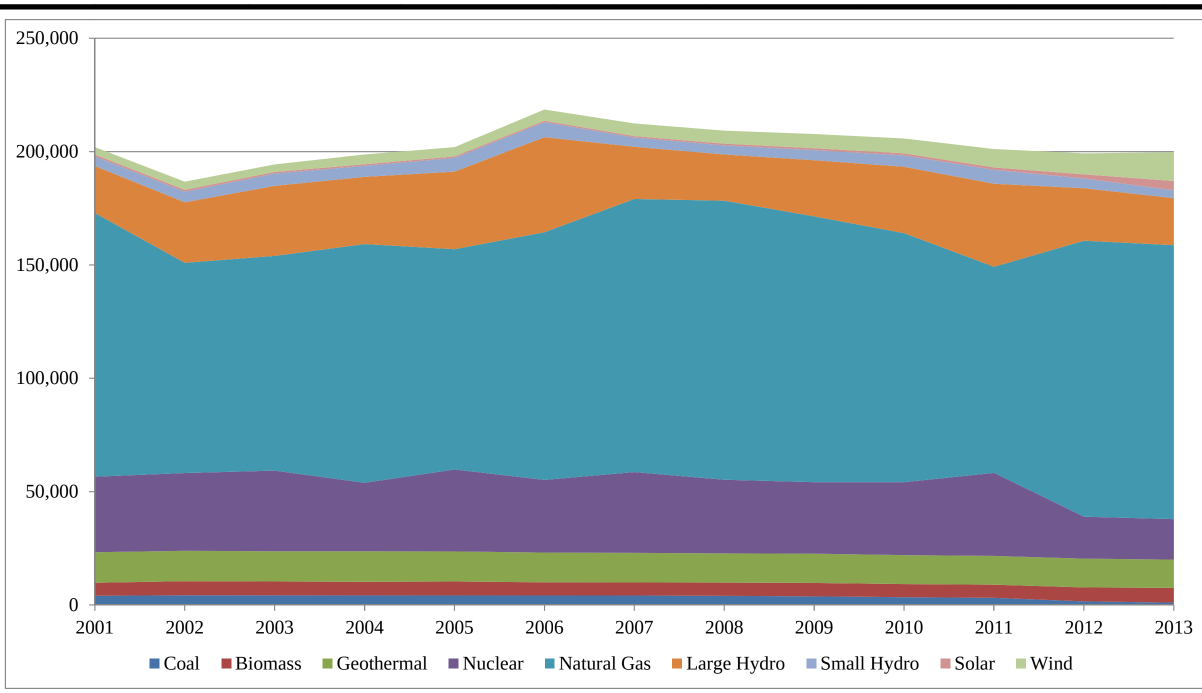


Figure 4.9-4 State wide annual total power generation by type (CEC, 2013)

Table 4.9-2 Megawatt production from online power plants by bioregion and plant type (CEC, 2013).

Bioregions	Geothermal	Hydro	Wind	Solar	Biomass	Bioregion Total
Bay Area/Delta	17	2	0	72	50	141
Central Coast	0	5	0	13	13	31
Colorado Desert	27	15	0	3	0	45
Klamath/North Coast	9	75	0	5	9	98
Modoc	0	1	0	0	2	3
Mojave	9	47	0	42	14	112
Sacramento Valley	0	44	0	46	11	101
San Joaquin Valley	0	26	0	15	2	43
Sierra Nevada	8	166	1	54	18	247
South Coast	0	42	0	22	58	122
Total by Power Plant	**70**	**423**	**1**	**272**	**177**	**943**

Table 4.9-3 Megawatt percentages from online power plants by bioregion and plant type (CEC, 2013).

Bioregions	Geothermal	Hydro	Wind	Solar	Biomass	Bioregion Total
Bay Area/Delta	24%	0%	0%	26%	28%	14.95%
Central Coast	0%	1%	0%	5%	7%	3.29%
Colorado Desert	39%	4%	0%	1%	0%	4.77%
Klamath/North Coast	13%	18%	0%	2%	5%	10.39%
Modoc	0%	0%	0%	0%	1%	0.32%
Mojave	13%	11%	0%	15%	8%	11.88%
Sacramento Valley	0%	10%	0%	17%	6%	10.71%
San Joaquin Valley	0%	6%	0%	6%	1%	4.56%
Sierra Nevada	11%	39%	100%	20%	10%	26.19%
South Coast	0%	10%	0%	8%	33%	12.94%

4.9.2 EFFECTS

4.9.2.1 Significance Criteria and Determination Thresholds

An impact to utilities and energy is considered to be significant if the proposed program or Alternatives would:

a) Cause substantial alterations to water, wastewater, or power systems.
b) Cause substantial disruption in utility service or access to public facilities.
c) Cause substantial damage to utilities, utility service or public facilities within the project area.

4.9.2.2 Data & Assumptions

The proposed Program or Alternatives do not fund any building projects or the development of any permanent facilities requiring power or water, and the implementation of the proposed Program does not require substantial disruptions to utility services. It is anticipated that some material generated by the proposed program might be removed to a biomass plant concurrent with program operation. Because the cost to remove such fuel is high, it is anticipated that no more than 10 percent of mechanical treatments might generate biomass, and only then when the material is chipped on site and only when the projects are near an existing biomass plant. Removal of material for commercial purposes is not covered under the Program EIR.

4.9.2.3 Direct Effects Common to all Bioregions from Implementing the Program/Alternatives

The primary mechanism by which the VTP program could have a significant adverse effect would be through an escaped prescribed burn damaging a water or energy facility. The mechanical, hand, herbicide, and herbivory treatments would all be confined to the project area. The effects of implementing the No Project or Alternatives A-D are expected to be similar to the effects associated with implementing the Proposed Program but on scales equating to less acres. No water or energy facilities would be directly damaged by any of the Alternatives; however the goals of the Program EIR would not be achieved under any of the Alternatives. Determination of Significance

No significant impacts that would damage water or energy facilities from a project are expected from implementing the proposed Program. Significant effects are not expected as the odds of a prescribed fire escaping are very low, and the Project Scale Analysis will identify local impacts that are not detected at the scale of the bioregion.

No water or energy facilities would be directly damaged by any of the Alternatives; there are no significant impacts from implementing the No Project Alternative or Alternatives A-D.

4.9.2.4 Similar Effects Described Elsewhere

Impacts to wastewater treatment facilities due to erosion from projects are addressed in the water quality section 4.5. Impacts to transportation-related infrastructure can be found in Section 4.10.

4.9.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

No mitigation measures or standard project requirements are required. However, the following questions will be included in the Project Scale Analysis and may result in Project Specific Requirements.

PSA Item 4.9.1 Are there any transmission lines or other electrical, telecommunications, or water supply facilities in or near the project area? Protective measures need to be taken and may include installation of firebreaks using hand treatments around sensitive equipment.

PSA Item 4.9.2 If treatments will include digging below the surface of the ground to a depth of greater than 2 feet, project manager should contact local utilities to determine location of buried underground utilities.

4.10 TRANSPORTATION & TRAFFIC

Transportation and Traffic has been broken up into three sections:

- **4.10.1 – Affected Environment**
  - The Affected Environment section discusses the transportation setting in California as well as potential issues associated with transportation and traffic.
- **4.10.2 – Effects**
  - The Effects section outlines the potential impacts of implementing the proposed Program and the Alternatives.
- **4.10.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that will reduce the likelihood of the proposed Program causing significant adverse impacts to transportation and traffic.

4.10.1 AFFECTED ENVIRONMENT

The purpose of the Transportation and Traffic section is to describe existing and future traffic circulation and parking patterns, and to evaluate the impact of the proposed project on these conditions. This evaluation should also consider project impacts on public transportation and alternative modes of transportation, such as bicycles, shuttles, and walkways. The VTP does not typically result in the construction of new roads or the modification of existing roads to conduct projects. However, the following section provides a brief discussion of the existing transportation system that the program operates under.

4.10.1.1 Responsible Agencies

The California Department of Transportation (Caltrans) would be a Responsible Agency for projects requiring permits for encroaching on land within its jurisdiction. Caltrans reviews projects to ensure that the proposed encroachment is compatible with the primary uses of the state highway system, and to protect the state's investment in the highway facility.

4.10.1.2 Setting

According to the Institute of Transportation Studies California has an extensive road network that supports a growing population that is projected will increase from 33.9 million residents in 2000 to about 48.6 million in 2025, a 44 percent increase. Table 4.10-1 identifies the miles of transportation within each bioregion. Local road systems make up the majority of all accountable transportation systems (87 percent); state and U.S. highways only equate to 7 percent of the total. The amount of public roads in California is nearly equally divided between rural and urban areas (Table 4.10-1). With only 8 percent of California's population, rural areas comprise 94 percent of the land area. There are roughly 80,000 miles of rural roads in California. California's growing population places an increased demand on its transportation system. In the thirteen years between 1984 and 1997, at least 26,000 lane-miles of streets and highways were added to the entire road network statewide (California Research Bureau, Federal Highway Administration, and California Department of Transportation). The Interstate highway system grew by five percent and freeways and expressways off the Interstate system increased by 26 percent. Over that same period California's population grew 28 percent and the amount of driving increased by 45 percent.

Table 4.10-1 Extent of transportation system by bioregion (Source: Census, 2000)

Bioregion	Total Miles	Local Roads	Other	State Highways	US Highways	Trails	Rail
Bay Area/Delta	36,640	32,639	1,538	1,055	1,025	381	1323
Central Coast	25,246	20,510	1,470	1,163	712	1,390	428
Colorado Desert	13,251	11,291	253	601	431	675	531
Klamath/North Coast	42,165	37,549	1,258	1,159	554	1,637	680
Modoc	21,842	18,912	259	597	225	1,849	646
Mojave	39,995	34,650	415	1,404	694	2,832	1014
Sacramento Valley	18,035	16,258	586	555	383	252	692
San Joaquin Valley	40,426	34,425	3,600	1,333	822	246	1221
Sierra	48,416	41,418	1,828	2,168	810	2,192	591
South Coast	64,776	58,119	1,985	1,794	1,971	906	1447
Total	**350,791**	**305,772**	**13,194**	**11,829**	**7,628**	**12,361**	**8573**

In California's major metropolitan areas, where a majority of the State's residents live, new roadway capacity expansions have actually kept pace with population growth over the last fifteen years (while California's metropolitan areas' population has increased 28 percent since 1984, road capacity has increased by 24 percent). In reality, much of what has driven the recent growth in traffic congestion is an even sharper increase in driving (vehicle miles traveled), an exponential increase that cannot be explained by population expansion alone. Rather, the trend towards an increasing number of miles driven primarily reflects the trend towards lower-density residential and commercial development patterns that force people to drive more frequently over longer distances.

Rural areas in California face different transportation issues than urban areas. Rural areas comprise more than 90 percent of the land area, contain roughly half of the road miles in California, but represent less than 10 percent of the population (Caltrans, 2005; Table 4.10-2). As such, the burden of maintaining the transportation system across rural regions in California is greater.

Table 4.10-2 California Public Road Length, Miles By Functional System

	1995	2000	2005	2010	2012
Total rural and urban	170,389	168,076	169,906	172,139	175,499
Rural	87,869	83,428	84,473	82,046	80,870
Interstate	1,346	1,357	1,325	1,275	1,279
Other principal arterial	3,691	3,701	3,601	3,519	3,529
Minor arterial	6,911	6,969	6,727	6,685	6,681
Major arterial	13,058	13,100	12,470	12,837	12,615
Minor collector	9,114	8,781	8,371	8,206	7,865
Local	53,749	49,520	51,979	49,525	48,901
Urban	82,520	84,648	85,433	90,092	94,629
Interstate	1,076	1,096	1,135	1,178	1,174
Other freeways and expressways	1,328	1,343	1,494	1,526	1,497
Other principal arterial	5,860	5,939	6,198	6,476	6,687
Minor arterial	10,292	10,435	10,456	10,776	10,980
Collector	10,034	10,039	11,028	11,374	11,696
Local	53,930	55,796	55,122	58,763	62,594

4.10.1.3 Environmental Issues

Air quality and greenhouse gas emissions are the predominant environmental impacts associated with transportation. This is closely tied to energy consumption by cars, trucks, and other modes of transportation. The transportation sector accounts for roughly 33.6 percent of all energy used in California; the burning of fossil fuels for transportation is estimated to represent 61.9 percent of all greenhouse gases (Davis et al, 2015). A growing population combined with a trend toward longer commutes will likely further degrade air quality without changes in fuel consumption and our dependence on petroleum as a primary source of energy, and current modes of transportation. Other environmental impacts associated with transportation include:

- Water Quality – can be degraded through storm water runoff from roads and other impermeable surfaces.

- Vegetation – can be impacted through direct removal due to new roads as well as impairments from transportation generated air pollution.
- Wildlife habitat – road systems increase fragmentation and can degraded existing habitat.
- Open space – transportation can either directly or indirectly (i.e. growth induced) lead to losses in the amount of open space.

4.10.2 EFFECTS

This section summarizes the impacts on transportation and traffic due to implementing either the proposed Program or any of the Alternatives. Only the effects of traffic volume were analyzed. Issues related to road design, parking, air traffic patterns, or alternative transportation are not applicable to the potential effects from VTP treatments.

4.10.2.1 Significance and Threshold Criteria

An effect will be considered significant if results of the analysis indicate that any of the following criteria will be met due to implementation of the Program or Alternatives:

a) An increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections).
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways.

Determination Threshold

The following threshold is used to determine whether there is a significant impact to local residential or commercial development resulting from traffic generated by the Program or any of the Alternatives:

a) Traffic increases in excess of 10 percent Average Daily Trips (ADT) of the capacity of roads that serve residential and/or commercial areas appurtenant to the project.

4.10.2.2 Impacts on Transportation and Traffic from Implementing the Program or Alternatives

The potential effects on traffic and transportation resulting from implementing the Program or Alternatives are expected to be of short duration (less than 2 weeks) and limited to the time periods during which work is actually occurring on the project(s). Most projects occur in remote areas and background traffic levels on these roads is generally far below the capacity of the roads. Therefore the effects of increased traffic levels due to VTP projects were analyzed relative to the communities in nearest proximity to the potentially treated areas. Consequently, there were negligible effects from prescribed fire, mechanical, manual, herbicide, and herbivore treatments through all of the bioregions.

It is unlikely that a single residential or commercial area will be affected by the traffic from more than one treatment annually. Furthermore, in an area where multiple treatments could occur within one year, the likelihood of all treatments occurring simultaneously is low. Therefore at most, the nearest residential or commercial area to a VTP treated watershed would be affected by two simultaneous projects.

The number of vehicles required for each treatment type is expected to vary from one to two light trucks every few days for a prescribed herbivory treatment, up to 10 vehicles per day for a large prescribed burn or hand thinning treatment. Most of the vehicles used on VTP projects will be used for transporting people or fire equipment, with a small number of heavy trucks required at the beginning and end of some projects to transport heavy machinery (dozers, masticators, etc.) or livestock. There will not be regular heavy truck traffic to transport logs, as few if any logs will be removed from VTP projects in most all cases. Most projects will likely have 5-10 vehicles traveling to and from the work site each day, for total of 10-20 ADT per project.

The areas' most sensitive to the increased traffic levels from VTP projects are likely to be two-lane, low volume roads that pass through residential and commercial areas to and from project sites. Low volume roads are typically designed to handle less than 400 ADT (AASHTO, 2001). Assuming that the same road carries the traffic for two VTP projects simultaneously, 20-40 ADT would be generated. This would not result in a greater than 10 percent increase in the maximum capacity of the typical low volume road that is likely to service most VTP projects sites. Traffic levels on the wide variability of low volume roads statewide cannot be accurately predicted, however, traffic levels/patterns occurring on VTP projects are expected to be similar statewide.

The potential impacts to communities may be different between bioregions, depending on existing traffic levels. Predominantly rural bioregions such as the Colorado Desert, Modoc, and Mojave have lower existing traffic volumes than predominantly urban bioregions like the South Coast and Bay Area/Delta. Nevertheless, at the bioregion scale, VTP projects are not expected to result in a net increase in traffic volumes. Most vehicles used in VTP projects will be traveling to the site from within the same bioregion and were likely already in use somewhere else in the bioregion prior to working on the VTP project. Project evaluation through the Project Scale Analysis will identify any local significant impacts that are not detected at the scale of the bioregion.

4.10.2.3 Determination of Significance

The impacts to transportation and traffic from the proposed Project and any of the Alternatives are expected to be **less than significant** with the application of the SPRs below and any identified PSRs. SPRs TRA-1 and TRA-2 keep roadways clear of dust and smoke during any prescribed fire operations. TRA-1 informs road users of the prescribed fire project in the area, keeping them alert for smoke, and TRA-2 requires traffic control operations be implemented if dust or smoke impair roadway visibility. Traffic control operations ensure the safety of road users throughout the project implementation period.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant impacts to transportation and traffic.

Alternative A would treat a smaller landscape as the Proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A is more likely to result in simultaneous projects occurring in or near a particular community, and therefor likely to cause significant transportation and traffic impacts.

Similarly, Alternative B would treat a smaller landscape but the same number of acres as the Proposed Program, but only allow WUI and fuel break projects. Due to the limited types of projects that could be implemented, it is more likely that, under Alternative B, a community would have more than one simultaneous fuel reduction project occur, and therefor impacts to transportation and traffic are likely to be significant.

Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program. This Alternative would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because this Alternative would exclusively focus projects in areas of high hazard and not human development (as in Alternatives A and B), with the mitigation measures proposed below Alternative C would not likely result in significant transportation and traffic impacts.

Alternative D would treat the same landscape as the Proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. However, the reduction in prescribed fire is not replaced entirely by increases in other treatment methods, and so the overall transportation and traffic impacts are less. Because of the overall smaller treatment area proposed, and with the mitigation measures proposed below, Alternative D would not result in significant transportation and traffic impacts.

4.10.2.4 Similar Effects Described Elsewhere

Traffic and transportation effects are also described in Section 4.11, Population, Employment, Housing, and Socio-economic Wellbeing.

4.10.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design.

TRA-1: Public road ways leading into project area shall be signed to warn traffic of the project activities that are taking place. Road signage shall be posted the morning prior to the commencement of burning operations and shall remain until all operations are completed.

TRA-2: Direct smoke and dust impacts to roadway visibility and the indirect distraction of operations shall be considered during burning operations. Traffic control operations shall be implemented if weather conditions inhibiting smoke and dust dispersion have the potential to impact roadway visibility to motorists.

4.11 POPULATION, EMPLOYMENT, HOUSING, AND SOCIO-ECONOMIC WELLBEING

Population, Employment, Housing and Socio-Economic Wellbeing has been broken up into three sections:

- **4.11.1 – Affected Environment**
  - The Affected Environment section discusses the demographic setting of California and projected changes.
- **4.11.2 – Effects**
  - The Effects section outlines the potential impacts of implementing the proposed Program and the Alternatives.
- **4.11.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that will reduce the likelihood of the proposed Program causing significant adverse impacts to population, employment, housing, or socio-economic wellbeing.

4.11.1 AFFECTED ENVIRONMENT

This section describes the environmental setting for population, employment, housing, and socio-economic wellbeing. Demographic trends across California can greatly affect natural resource availability and use. In addition, increasing population in the foothill counties of the Sierra and rural forested areas in Southern California has increased the likelihood of exposure of people and homes to wildland fires. In addition, this section summarizes the impacts to population, employment, housing, and socio-economic wellbeing due to implementing either the Proposed Program or any of the Alternatives.

California is comprised of 58 counties and has a population estimated at 37,253,956 (California DOF, 2013). Of the 50 States, California is the most urban, with 95 percent of its population living in the urban area that comprises about five percent of the land. Urban lands can be incorporated or unincorporated areas, with the unincorporated areas generally being less populated and on the fringe of metropolitan areas. Approximately 17 percent of the population lives in unincorporated areas, which constitute roughly 80 percent of the total land area (California DOF, 2013). In recent history, California's population has dwarfed that of all other states, and the population growth has consistently outpaced the rest of the United States. California is home to seven of the nation's ten most densely populated urban areas. The nation's most densely populated area is Los Angeles-Long Beach-Anaheim, populated by close to 7,000 people per square mile. This is followed by San Francisco-Oakland (6,266 people per square mile), San Jose (5,820 people per square mile, and Delano (5,483 people per square mile) (California DOF, 2013). The following section describes population trends statewide and for each of the bioregions in California. Although there have been some trends towards increasing population in the interior portions of California (i.e. Central Valley) the majority of the population (about 80 percent) still resides in coastal counties.

4.11.1.1 Population growth and extent

California is the most populous state in the nation and continues to grow. Over the past decade the state has grown by 10 percent, slightly outpacing the 9.7 percent average growth nationwide. However, since the economic downturn of 2008, its rate of growth has slowed considerably. In fact, net figures show that 1.5 million more people left the state than immigrated to it over the past decade. According to the Pew Hispanic Center (April 2012) there has been a significant drop in illegal and legal immigration from Mexico due to a weak U.S economy, lack of jobs, increased deportation, increased border patrols, and decreased birth rates. Thus the recent growth in population has been due solely to natural increase – more in-state births than deaths. While the vast majority of Californians live in urban areas, a large portion of the state resides in rural counties. These rural cities and counties are in some cases growing at a faster rate than the major urbanized areas.

As residential and commercial land use continues to encroach on natural landscapes, population growth will influence the state's natural ecosystems in several ways. First, continued population growth necessitates the use and development of increasing areas of forests and particularly rangelands for people to live and work in. Second, the greater ethnic diversity, an aging population, and increasing incomes further drive new and varied demands for open space, outdoor recreation, natural reserves, and working landscapes that provide employment opportunities. Third, most Californians live in urban areas. This urban population drives attitudes and preferences that influence the willingness to support management goals and investment in forests and rangelands.

The majority of Californians live in areas characterized by dense development. As of 2010, about 80 percent of California's 37.3 million people lived within the boundaries of census blocks averaging at least one housing unit per acre (U.S. Census Bureau, 2015). In 2011, California had 18 cities with a population over 200,000 and 69 cities exceeding 100,000. The California Department of Finance (DOF) reports that roughly one quarter of all Californians (9.4 million) live in the ten largest cities (California Department of Finance, 2013). California has experienced continuing population growth of about 10 percent from 2000 to 2010 (on average about a 1 percent annual growth rate).

California's population growth over the past decade has not been equally distributed across all bioregions. Of the 58 counties in the State, 55 had population growth during the time period of 2000-2010, and three counties, all in the Sierra bioregion, experienced population declines over the decade. On a bioregion level, the Mojave, Sierra, Colorado Desert, and San Joaquin bioregions all experienced overall growth rates that equaled or exceeded 20 percent over that period, or about twice the state average (Table 4.11-1).

Table 4.11-1 Past population growth in California by bioregion and county 2000-2010 (California DOF, 2013).

Bioregion/ County	2000	2010	Percent Change
California	**33,871,653**	**37,253,956**	**9.99%**
Bay Area/Delta			
Alameda	1,443,741	1,510,271	4.61%
Contra Costa	948,816	1,049,025	10.56%
Marin	247,289	252,409	2.07%
Napa	124,279	136,484	9.82%
San Francisco	776,733	805,235	3.67%
San Mateo	707,163	718,451	1.60%
Santa Clara	1,682,585	1,781,642	5.89%
Solano	394,542	413,344	4.77%
Sonoma	458,614	483,878	5.51%
	6,783,762	7,150,739	5.41%
Central Coast			
Monterey	401,762	415,057	3.31%
San Benito	53,234	55,269	3.82%
San Luis Obispo	246,681	269,637	9.31%
Santa Barbara	399,347	423,895	6.15%
Santa Cruz	255,602	262,382	2.65%
Ventura	753,197	823,318	9.31%
	2,109,823	2,249,558	6.62%
Colorado Desert			
Imperial	142,361	174,528	22.60%
	142,361	174,528	22.60%
Klamath/North Coast			
Del Norte	27,507	28,610	4.01%
Humboldt	126,518	134,623	6.41%
Lake	58,309	64,665	10.90%
Mendocino	86,265	87,841	1.83%
Siskiyou	44,301	44,900	1.35%
Trinity	13,022	13,786	5.87%
	355,922	374,425	5.20%
Modoc			
Lassen	33,828	34,895	3.15%
Modoc	9,449	9,686	2.51%
	43,277	44,581	3.01%
Mojave			
Riverside	2,194,933	2,323,527	5.86%
San Bernardino	2,039,040	2,116,461	3.80%
	4,233,973	4,439,988	4.87%

Bioregion/ County	2000	2010	Percent Change
Sacramento Valley			
Butte	203,171	220,000	8.28%
Colusa	18,804	21,419	13.91%
Glenn	26,453	28,122	6.31%
Sacramento	1,223,499	1,418,788	15.96%
Shasta	163,256	177,223	8.56%
Sutter	78,930	94,737	20.03%
Tehama	56,039	63,463	13.25%
Yolo	168,660	200,849	19.09%
Yuba	60,219	72,155	19.82%
	1,999,031	2,296,756	14.89%
San Joaquin Valley			
Fresno	799,407	930,450	16.39%
Kern	661,645	839,631	26.90%
Kings	129,461	152,982	18.17%
Madera	123,109	150,865	22.55%
Merced	210,554	255,793	21.49%
San Joaquin	563,598	685,306	21.59%
Stanislaus	446,997	514,453	15.09%
Tulare	368,021	442,179	20.15%
	3,302,792	3,971,659	20.25%
Sierra Nevada			
Alpine	1,208	1,175	-2.73%
Amador	35,100	38,091	8.52%
Calaveras	40,554	45,578	12.39%
El Dorado	156,299	181,058	15.84%
Inyo	17,945	18,546	3.35%
Mariposa	17,130	18,251	6.54%
Mono	12,853	14,202	10.50%
Nevada	92,033	98,764	7.31%
Placer	248,399	348,432	40.27%
Plumas	20,824	20,007	-3.92%
Sierra	3,555	3,240	-8.86%
Tuolumne	54,504	55,365	1.58%
	700,404	842,709	20.32%
South Coast			
Los Angeles	9,519,338	9,818,605	3.14%
Orange	2,846,289	3,010,232	5.76%
San Diego	2,813,833	3,095,313	10.00%
	15,179,460	15,924,150	4.91%

The top ten fastest growing counties between 2000 and 2010 had average annual growth rates ranging from 2 percent in Yuba to 4.2 percent in Riverside County. While most of the fastest growing counties have extensive areas of forest and rangeland, three forest and rangeland counties did not grow – Plumas, Sierra and Alpine counties all experienced declining populations over the period.

In the last decade, California's ten largest cities experienced population changes ranging from -2.2 to 40.7 percent, while a number of small to moderate-sized cities experienced the highest relative growth rates. The ten fastest growing cities had average annual percentage changes ranging from 7.9 to 28.2 percent, with an average of 12.9 percent growth (Table 4.11-2). City annexations and housing construction prior to 2008 are due in part to these high growth rates. Each year, these factors combine to result in a different set of small and medium sized cities experiencing high growth.

Table 4.11-2 Percentage change of the top ten fastest growing California cities (California DOF, 2013)

	Total Population		Change, 2000-2010	
State / County / City	April 1, 2000	April 1, 2010	Number	Percent
Lincoln city	11,205	42,819	31,614	282.1%
Beaumont city	11,384	36,877	25,493	223.9%
Murrieta city	44,282	103,466	59,184	133.7%
Brentwood city	23,302	51,481	28,179	120.9%
American Canyon city	9,774	19,454	9,680	99.0%
Imperial city	7,560	14,758	7,198	95.2%
Perris city	36,189	68,386	32,197	89.0%
San Jacinto city	23,779	44,199	20,420	85.9%
Victorville city	64,029	115,903	51,874	81.0%
Lake Elsinore city	28,928	51,821	22,893	79.1%

4.11.1.2 Population projections

California's total population has grown consistently since the 1850s, and projections show that strong growth will likely continue (Figure 4.11-1). Between 2010 and 2020, population is projected to grow at about 1.4 percent per year, with the result that California is projected to have about 40 million residents by the end of the decade (California DOF, 2013).

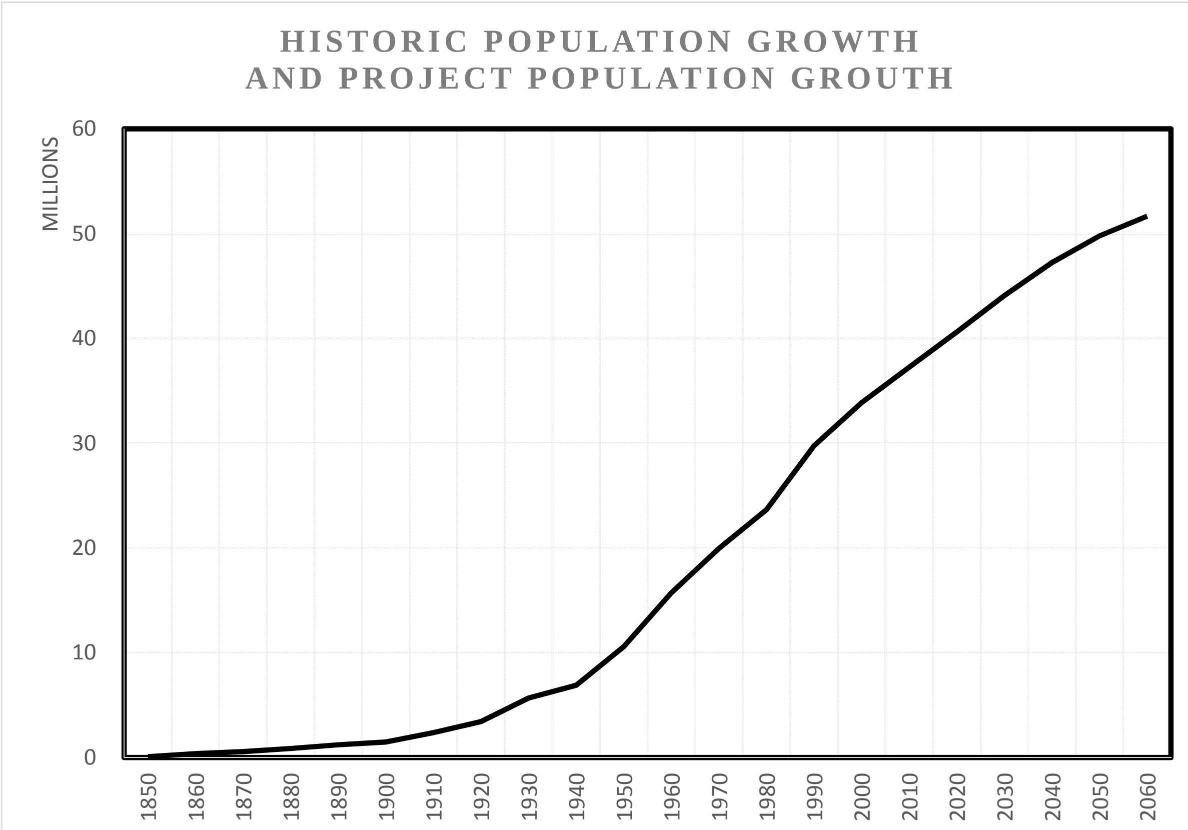


Figure 4.11-1 Historic and projected population growth in California, 1850-2050 (California DOF, 2013).

The population in forest and rangeland counties increased from 5.6 million people to 6.3 million (about 13.4 percent) between 2000 and 2010, and is expected to increase to over 7.8 million in 2020. This is an average annual rate of 2.0 percent per year, or about double that for the state taken as a whole. While the Sierra Bioregion overall is growing at a higher rate than the statewide average, there is significant variation among the counties that make up that bioregion. In Figure 4.11-2, counties in orange and red are projected to grow at a faster rate.

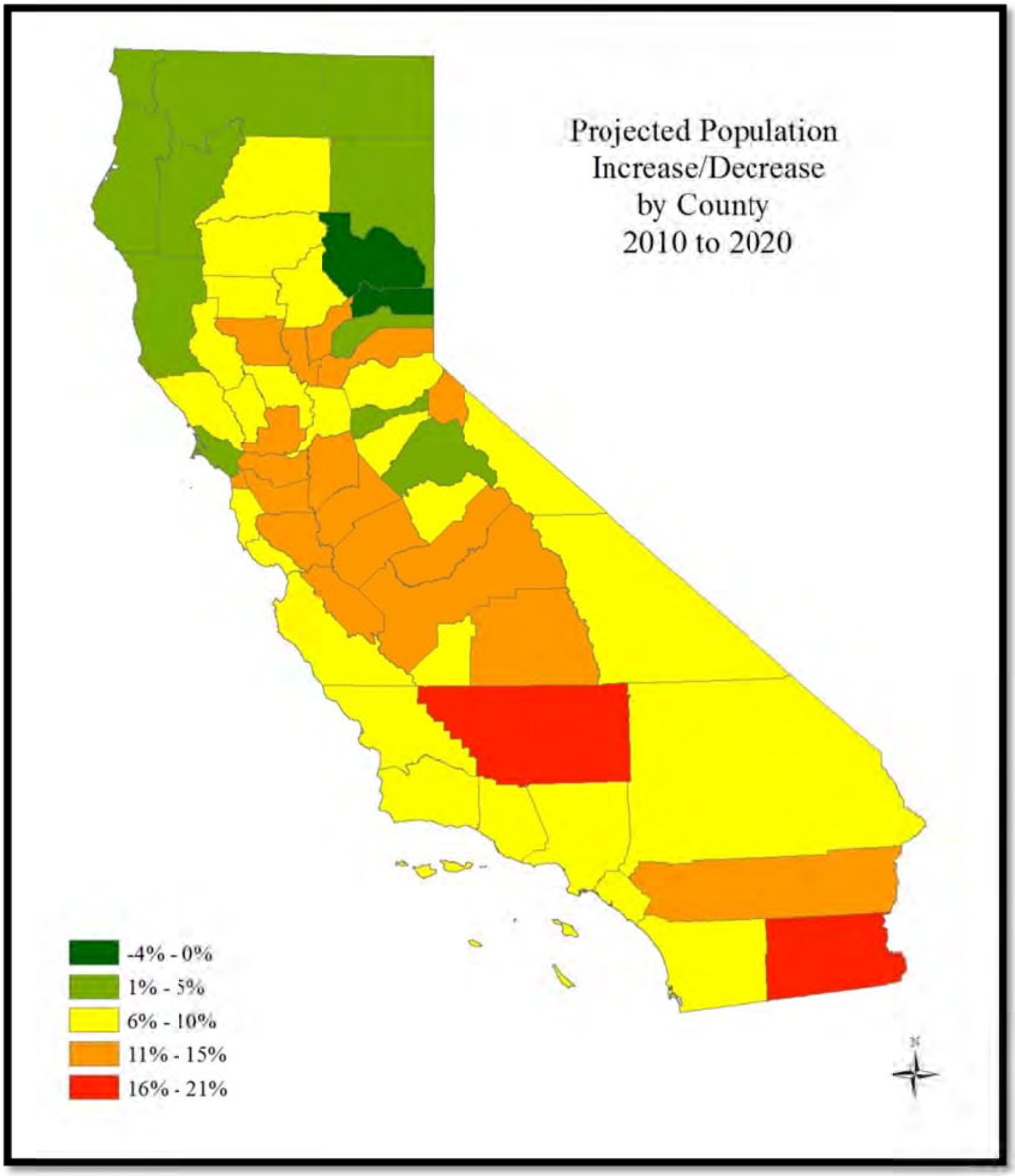


Figure 4.11-2 Projected rate of county population increase/decrease 2010-2020. (California DOF, 2013)

Counties were grouped into bioregions to determine population projections on a regional basis (Figure 4.11-3). For example, the Sierra Nevada bioregion is an area where a rapidly growing population will have impacts on the extensive forests and rangelands. In the next decade, the Sierra bioregion population is expected to increase 21 percent from 843,000 to 1.02 million people. Table 4.11-3 shows the projected county-based population increases from 2010 to 2020 for all bioregions in the state. Overall, growth is projected to be greatest away from the coast, in interior bioregions with much forest and rangeland.

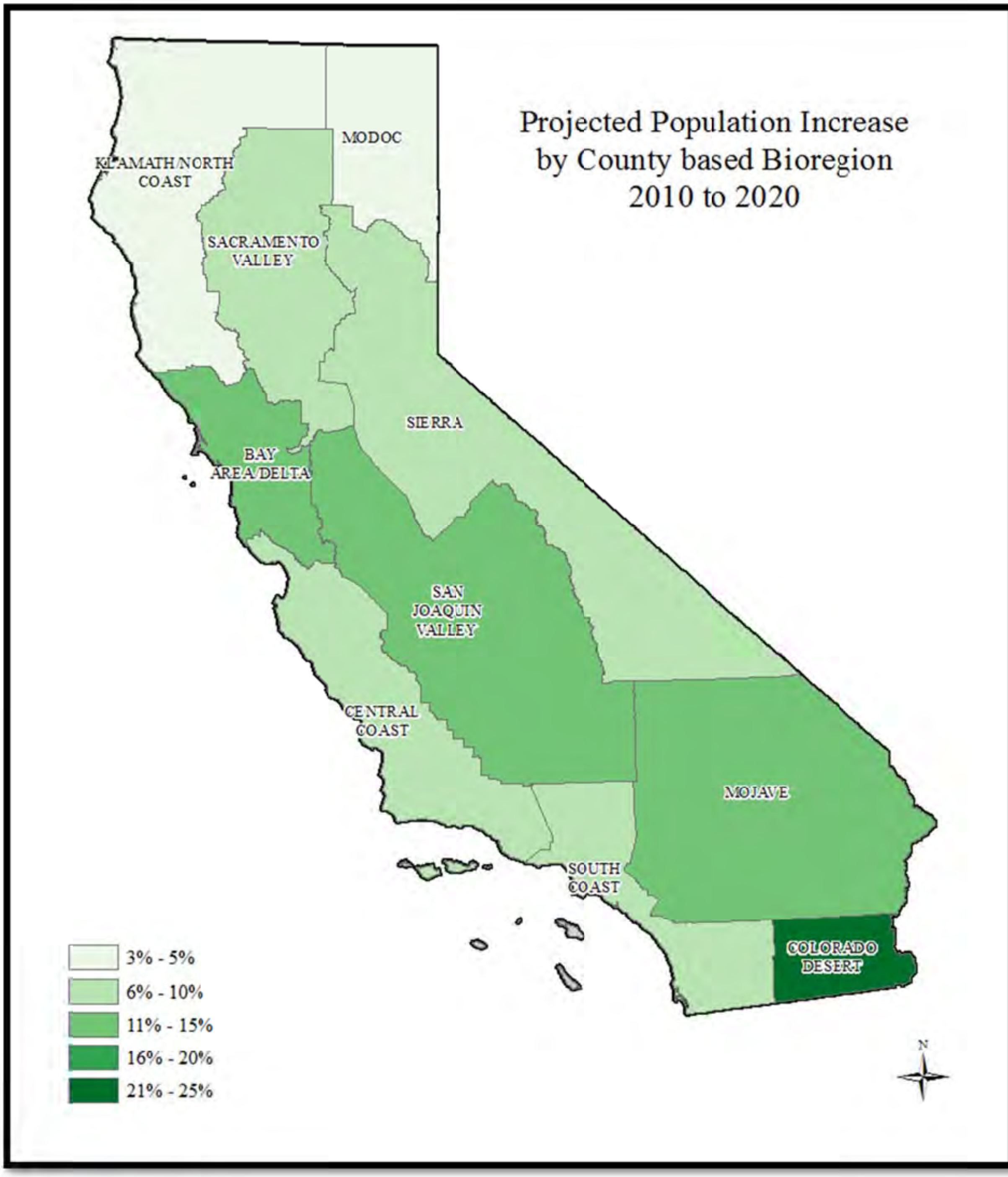


Figure 4.11-3 Projected rate of population increase by county-based bioregion 2010 t0 2020 (DOF, 2013).

Table 4.11-3 Projected population growth by bioregion and county 2010-2020 (California DOF, 2013).

Bioregion/ County	2010	2020	Percent Change
California	**37,253,956**	**40,619,346**	**9.03%**
Bay Area/Delta			
Alameda	1,510,271	1,682,348	11.39%
Contra Costa	1,049,025	1,166,670	11.21%
Marin	252,409	259,794	2.93%
Napa	136,484	146,869	7.61%
San Francisco	805,235	891,493	10.71%
San Mateo	718,451	777,088	8.16%
Santa Clara	1,781,642	1,970,828	10.62%
Solano	413,344	454,800	10.03%
Sonoma	483,878	523,615	8.21%
	7,150,739	7,873,505	10.11%
Central Coast			
Monterey	415,057	446,258	7.52%
San Benito	55,269	63,418	14.74%
San Luis Obispo	269,637	283,667	5.20%
Santa Barbara	423,895	455,858	7.54%
Santa Cruz	262,382	281,870	7.43%
Ventura	823,318	876,124	6.41%
	2,249,558	2,407,195	7.01%
Colorado Desert			
Imperial	174,528	211,973	21.46%
	174,528	211,973	21.46%
Klamath/North Coast			
Del Norte	28,610	29,146	1.87%
Humboldt	134,623	139,033	3.28%
Lake	64,665	70,690	9.32%
Mendocino	87,841	90,411	2.93%
Siskiyou	44,900	46,217	2.93%
Trinity	13,786	14,234	3.25%
	374,425	389,731	4.09%
Modoc			
Lassen	34,895	36,386	4.27%
Modoc	9,686	9,691	0.05%
	44,581	46,077	3.36%
Mojave			
Riverside	2,189,641	2,478,059	13.17%
San Bernardino	2,035,210	2,227,066	9.43%
	4,224,851	4,705,125	11.37%

Bioregion/ County	2010	2020	Percent Change
Sacramento Valley			
Butte	220,000	236,936	7.70%
Colusa	21,419	24,291	13.41%
Glenn	28,122	30,466	8.34%
Sacramento	1,418,788	1,554,022	9.53%
Shasta	177,223	187,524	5.81%
Sutter	94,737	105,107	10.95%
Tehama	63,463	67,336	6.10%
Yolo	200,849	219,415	9.24%
Yuba	72,155	81,467	12.91%
	2,296,756	2,506,564	9.13%
San Joaquin Valley			
Fresno	930,450	1,055,106	13.40%
Kern	839,631	989,815	17.89%
Kings	152,982	167,465	9.47%
Madera	150,865	173,146	14.77%
Merced	255,793	288,991	12.98%
San Joaquin	685,306	766,644	11.87%
Stanislaus	514,453	573,794	11.53%
Tulare	442,179	498,559	12.75%
	3,971,659	4,513,520	13.64%
Sierra Nevada			
Alpine	1,175	1,296	10.30%
Amador	38,091	39,108	2.67%
Calaveras	45,578	48,957	7.41%
El Dorado	181,058	190,850	5.41%
Inyo	18,546	19,622	5.80%
Mariposa	18,251	19,316	5.84%
Mono	14,202	15,147	6.65%
Nevada	98,764	101,767	3.04%
Placer	348,432	396,203	13.71%
Plumas	20,007	19,284	-3.61%
Sierra	3,240	3,174	-2.04%
Tuolumne	55,365	55,993	1.13%
	842,709	910,717	8.07%
South Coast			
Los Angeles	9,818,605	10,435,991	6.29%
Orange	3,010,232	3,243,261	7.74%
San Diego	3,095,313	3,375,687	9.06%
	15,924,150	17,054,939	7.10%

4.11.1.3 Housing Issues and Trends

During the 1980s and 1990s, construction of new housing units showed a long-term overall decline in California. New construction picked up during the housing and real estate boom of the early 2000s. With the collapse of the housing market and subsequent economic recession, beginning in the years 2007-2008, California was hit very hard in numerous areas, and recovery in the construction industry since then has been stalled or slow. Still over the decade, California added 1.5 million new housing units (2010 Census Briefs: Housing Characteristics).

In the years just prior to the collapse, inflated housing prices fueled booms in home sales and prices, as well as new home construction. Prior to the bust, in 2004, nearly 213,000 new homes and apartments were built – the highest level since 1989 (DOF, 2013). June of 2006 still saw over 13,000 new housing starts. But just two years later in that same month, the number had plummeted to around 4,000 – a nearly 70 drop. New starts have continued to decline significantly, and in 2011 have hovered between one thousand and two thousand per month.

In California there has been a trend towards increased development in rural communities (FRAP, 2002). A total of 11.8 million homes are located in the Wildland Urban Interface (WUI). Of this, 4.9 million housing units (42 percent) are exposed to High or greater Fire Threat. Furthermore, of these, 4.1 million homes (84 percent) are from urban areas, where density of housing units exceeds one unit per acre. Thus while the land area considered WUI is dominated by areas of relatively low development density, the majority of houses at risk come from urbanized areas.

Table 4.11-4 provides a county-based summary of acres by housing density and land use class for each Bioregion. Using the 2010 census data housing unit density was classified into the following four categories, where all classes other than wildlands would be considered as potential WUI:

- Wildland (less than 1 unit per 20 acres)
- Rural (1 or more units per 20 acres and less than one unit per 5 acres)
- Interface (1 or more units per five acres and less than one unit per acre)
- Urban (1 or more units per acre)

Table 4.11-4 Acres by Housing Density and Land Use Classes (Census, 2010)

Bioregion/ County	Wildland	Rural	Interface	Urban	Total
California	93,685,359	3,158,387	1,748,394	2,642,052	101,234,192
Bay Area/Delta					
Alameda	405,109	6,640	22,334	90,666	524,749
Contra Costa	354,152	18,721	42,312	99,766	514,951
Marin	327,050	6,171	16,430	29,330	378,981
Napa	447,603	35,955	10,796	11,465	505,819
San Francisco	49,204	245	705	18,724	68,878
San Mateo	273,644	13,237	20,185	46,302	353,368
Santa Clara	633,427	49,945	38,973	113,567	835,912
Solano	512,812	20,133	14,203	34,998	582,146
Sonoma	794,017	122,615	68,892	39,836	1,025,360
	3,797,018	273,662	234,830	484,654	4,790,164
Central Coast					
Monterey	1,996,860	63,648	34,274	25,531	2,120,313
San Benito	861,772	2,012	4,124	3,527	871,435
San Luis Obispo	2,004,781	55,921	40,442	23,759	2,124,903
Santa Barbara	1,673,285	32,421	21,978	31,581	1,759,265
Santa Cruz	162,438	71,311	33,334	18,556	285,639
Ventura	1,052,757	36,736	33,543	63,402	1,186,438
	7,751,893	262,049	167,695	166,356	8,347,993
Colorado Desert					
Imperial	2,824,527	20,271	11,220	11,858	2,867,876
	2,824,527	20,271	11,220	11,858	2,867,876
Klamath/North Coast					
Del Norte	625,271	11,206	10,779	1,835	649,091
Humboldt	2,200,757	56,590	23,627	12,619	2,293,593
Lake	791,250	33,346	18,769	8,302	851,667
Mendocino	2,150,641	64,958	28,298	4,766	2,248,663
Siskiyou	4,011,886	33,188	14,002	3,810	4,062,886
Trinity	2,018,988	28,025	5,654	714	2,053,381
	11,798,793	227,313	101,129	32,046	12,159,281
Modoc					
Lassen	2,992,600	20,571	3,780	2,418	3,019,369
Modoc	2,679,819	7,774	1,627	712	2,689,932
	5,672,419	28,345	5,407	3,130	5,709,301
Mojave					
Riverside	4,105,397	195,151	159,343	212,303	4,672,194
San Bernardino	12,340,160	192,102	153,442	181,117	12,866,821
	16,445,557	387,253	312,785	393,420	17,539,015

Bioregion/ County	Wildland	Rural	Interface	Urban	Total
Sacramento Valley					
Butte	939,689	76,565	33,459	23,462	1,073,175
Colusa	729,184	6,896	2,143	1,717	739,940
Glenn	830,882	13,209	3,227	1,917	849,235
Sacramento	420,093	57,414	38,567	119,813	635,887
Shasta	2,294,910	111,626	37,955	17,610	2,462,101
Sutter	356,779	19,124	5,789	7,775	389,467
Tehama	1,811,024	64,885	15,271	3,725	1,894,905
Yolo	618,598	13,776	6,550	14,972	653,896
Yuba	350,946	49,014	6,459	5,683	412,102
	8,352,105	412,509	149,420	196,674	9,110,708
San Joaquin Valley					
Fresno	3,558,866	178,380	41,215	68,666	3,847,127
Kern	5,015,742	84,407	54,475	71,659	5,226,283
Kings	852,356	22,625	5,286	10,406	890,673
Madera	1,268,466	71,503	30,074	8,181	1,378,224
Merced	1,173,009	59,101	15,517	17,746	1,265,373
San Joaquin	739,625	97,244	27,214	47,640	911,723
Stanislaus	827,165	87,615	15,469	39,384	969,633
Tulare	2,942,268	95,025	27,467	33,660	3,098,420
	16,377,497	695,900	216,717	297,342	17,587,456
Sierra Nevada					
Alpine	470,754	1,955	969	313	473,991
Amador	335,091	32,685	17,118	2,534	387,428
Calaveras	579,082	58,785	19,818	5,328	663,013
El Dorado	730,266	147,388	49,481	18,403	945,538
Inyo	6,535,860	5,691	2,219	2,070	6,545,840
Mariposa	882,793	47,421	4,297	470	934,981
Mono	1,991,958	5,749	3,261	2,844	2,003,812
Nevada	471,470	103,210	36,238	11,915	622,833
Placer	775,031	87,077	60,147	37,700	959,955
Plumas	1,634,012	24,853	11,928	2,827	1,673,620
Sierra	610,414	3,376	1,543	322	615,655
Tuolumne	1,379,327	47,078	24,460	6,832	1,457,697
	16,396,058	565,268	231,479	91,558	17,284,363
South Coast					
Los Angeles	1,846,856	98,794	134,874	533,829	2,614,353
Orange	268,514	10,956	30,918	201,138	511,526
San Diego	2,154,122	176,067	151,920	230,047	2,712,156
	4,269,492	285,817	317,712	965,014	5,838,035

4.11.1.4 Employment

The 2013 annual average non-seasonally adjusted unemployment rate in California was 8.9 percent, down significantly from its height during the recession of 12.2 percent in 2010. However most of the rural counties are still experiencing unemployment rates higher than the state annual average, see Figure 4.11-4 below.

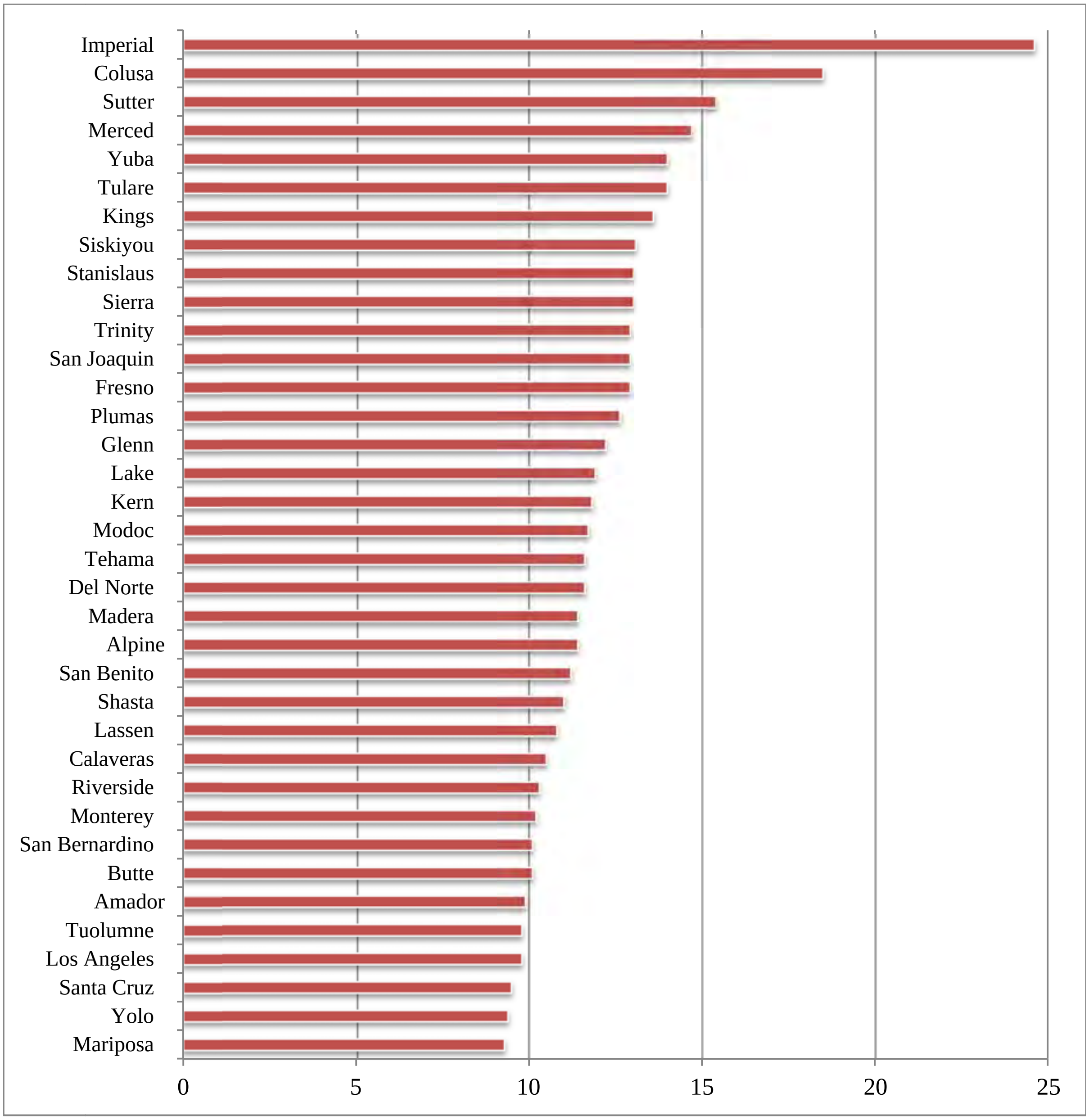


Figure 4.11-4 California Counties unemployment rates that exceed the California Annual Non-Seasonally Adjusted Unemployment Rate (BLS, 2015)

Overall wages in California have been increases in California, regardless of unemployment rates (Figure 4.11-5). Average annual wages hit $60,000 in 2013 and are expected to continue to increase as new minimum wage laws go into effect July 1, 2014 and January 1, 2016. By January 1, 2016 minimum wage in the State of California will be $10/hour.

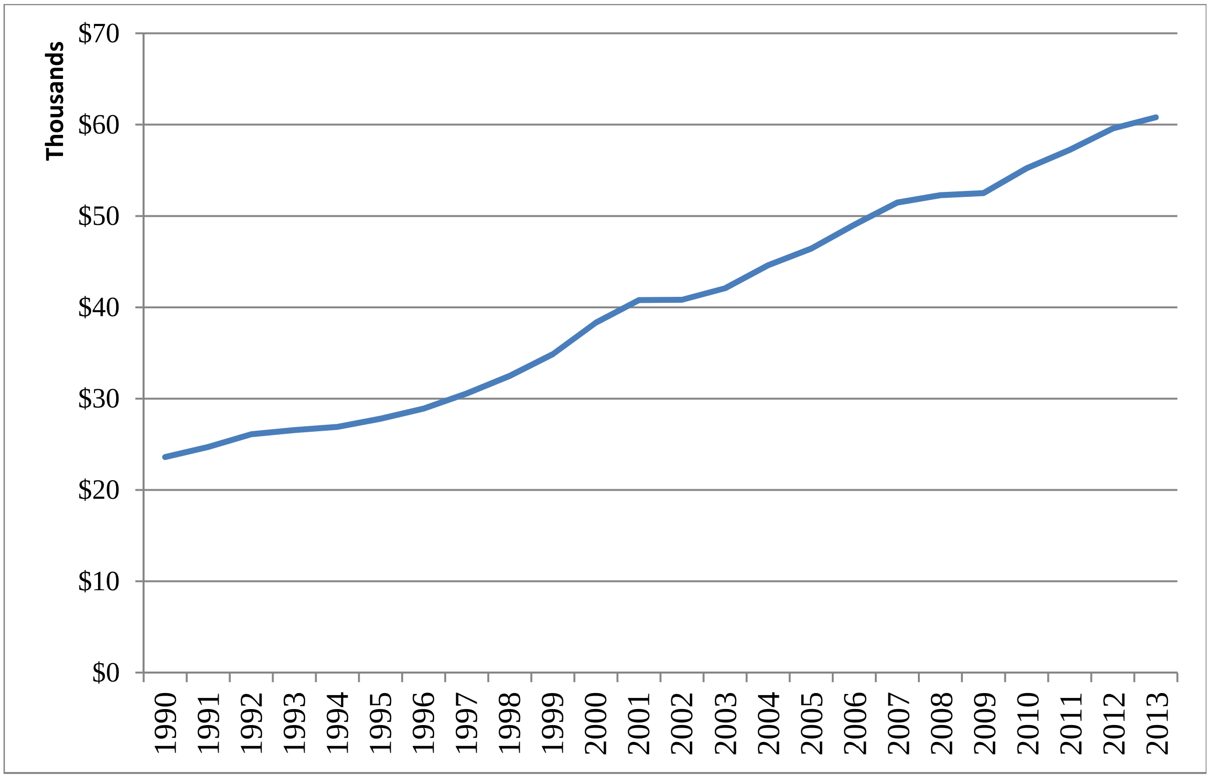


Figure 4.11-5 Average Annual Wages in the Thousands of Dollars 1990-2013 (EDD, 2014).

4.11.2 EFFECTS

4.11.2.1 Significance and Threshold Criteria

Appendix G of the CEQA Guidelines, the CEQA Environmental Checklist, contains only one question which is relevant to the VTP program. The Program and Alternatives would be considered to create a significant effect if treatments:

- Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).

Determination Threshold

While there is no accepted percentage population increase to be used as a threshold, population change less than a certain amount can easily be considered negligible. The impact would be considered less than significant if an increase in population less than 0.5 percent in the bioregion resulted from implementation of the program.

4.11.2.2 Data & Assumptions

Implementation of VTP projects within a bioregion will not temporarily increase the population of that region. Workers are part of crews that do not live on or near the project site and move back and forth between a project site and their established camp or base.

4.11.2.3 Impacts of Implementing the Program/Alternatives

The potential change in population resulting from implementation of the proposed program is less than significant in all bioregions, because the proposed Program does not require the long-term or permanent migration of workers into the project area. Implementation of the program will not induce sufficient population change to cause a need for new housing, roads or infrastructure. The No Project Alternative or Alternatives A-D would not induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure) for the same reason. The impacts to population remain below the 0.5% threshold and are considered **less than significant**.

4.11.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

No mitigation measures or standard project requirements are required under this analysis for Population, Employment, Housing and Socio-Economic wellbeing.

4.12 AIR QUALITY

Vegetation treatment activities proposed by this program have the potential to generate emissions identified by the state and federal governments as pollutants of concern. This section describes existing air quality conditions, applicable federal and state regulations, and includes an analysis of potential impacts to air quality.

4.12.1 AFFECTED ENVIRONMENT

4.12.1.1 Regulatory Framework

4.12.1.1.1 FEDERAL PLANS, POLICIES, REGULATIONS, AND LAWS

CLEAN AIR ACT

The U.S. Environmental Protection Agency (EPA) implements national air quality programs at the Federal level. EPA's air quality mandates are drawn primarily from the federal Clean Air Act (CAA), which was enacted in 1970 and amended by Congress in 1990. The CAA requires EPA to establish national ambient air quality standards (NAAQS), which are presented in Table 4.12-1 below. EPA has established primary and secondary NAAQS for the following criteria air pollutants: ozone, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and lead, with primary standards aimed at protecting public health and secondary standards protecting public welfare. EPA maintains and publishes National Area Designation Maps that display the most current data of national attainment status throughout California. The most recent revision was completed in January 30, 2015 (EPA 2015).

The CAA also requires each state to prepare an air quality control plan referred to as a State Implementation Plan (SIP). The federal Clean Air Act Amendments of 1990 (CAAA) added requirements for states with nonattainment areas to revise their SIPs to incorporate additional control measures to reduce air pollution. The SIP is modified periodically to reflect the latest emissions inventories, planning documents, and rules and regulations of the air basins as reported by their jurisdictional agencies. EPA reviews all SIPs to determine whether they conform to the mandates of the CAA and its amendments and whether implementing them will achieve air quality goals. If EPA determines a SIP to be inadequate, a Federal Implementation Plan that imposes additional control measures may be prepared for the nonattainment area. If the state fails to submit an approvable SIP or to implement the plan within the mandated time frame, sanctions may be applied to transportation funding and stationary air pollution sources in the air basins.

Table 4.12-1 Ambient Air Quality Standards and Designations

Pollutant	Averaging Time	California Standards [1, 3]	National Standards [2] Primary [3]
Ozone	1-hour	0.09 ppm (180 µg/m^3)	–
	8-hour	0.070 ppm (137 µg/m^3)	0.075 ppm (147 µg/m^3)
Carbon Monoxide (CO)	1-hour	20 ppm (23 mg/m^3)	35 ppm (40 mg/m^3)
	8-hour	9 ppm (10 mg/m^3)	9 ppm (10 mg/m^3)
	8-hour (Lake Tahoe)	6 ppm (7 mg/m^3)	–
Nitrogen Dioxide (NO_2)[4]	Annual Arithmetic Mean	0.030 ppm (57 µg/m^3)	0.053 ppm (100 µg/m^3)
	1-hour	0.18 ppm (339 µg/m^3)	100 ppb (188 µg/m^3)
Sulfur Dioxide (SO_2)[5]	Annual Arithmetic Mean	–	0.030 ppm (for certain areas)[5]
	24-hour	0.04 ppm (105 µg/m^3)	0.14 ppm (for certain areas)[5]
	3-hour	–	0.5 ppm (1300 µg/m^3)[6]
	1-hour	0.25 ppm (655 µg/m^3)	75 ppb (80 µg/m^3)
Respirable Particulate Matter (PM_{10})[7]	Annual Arithmetic Mean	20 µg/m^3	–
	24-hour	50 µg/m^3	150 µg/m^3
Fine Particulate Matter ($PM_{2.5}$)[7]	Annual Arithmetic Mean	12 µg/m^3	12 µg/m^3
	24-hour	–	35 µg/m^3
Lead [8, 9]	30-day Average	1.5 µg/m^3	–
	Calendar Quarter	–	1.5 µg/m^3 (for certain areas)[8]
	Rolling 3-Month Avg.	–	0.15 µg/m^3
Sulfates	24-hour	25 µg/m^3	No National Standards
Hydrogen Sulfide	1-hour	0.03 ppm (42 µg/m^3)	
Vinyl Chloride[9]	24-hour	0.01 ppm (26 µg/m^3)	
Visibility-Reducing Particle Matter	8-hour	Extinction coefficient of 0.23 per kilometer —visibility of 10 mi or more	

Notes: µg/m^3 = micrograms per cubic meter; ppm = parts per million; ppb = parts per billion; CAAQS = California ambient air quality standards

[1] California standards for ozone, CO (except 8-hour Lake Tahoe), SO_2 (1- and 24-hour), NO_2, PM, and visibility-reducing particles are values that are not to be exceeded. All others are not to be equaled or exceeded. CAAQS are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

[2] National standards (other than ozone, PM, and those based on annual arithmetic mean) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest 8-hour concentration measured at each site in a year, averaged over 3 years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m^3 is equal to or less than one. For $PM_{2.5}$, the 24 hour standard is attained when 98 percent of the daily concentrations, averaged over three years, are equal to or less than the standard. Contact the U.S. EPA for further clarification and current national policies.

[3] Concentration expressed first in units in which it was promulgated [i.e., parts per million (ppm) or micrograms per cubic meter (µg/m^3)]. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

[4] To attain the 1-hour national standard, the 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 100 ppb. Note that the national 1-hour standard is in units of ppb. California standards are in ppm. To directly compare the national 1-hour standard to the California standards the units can be converted from ppb to ppm.
[5] On June 2, 2010, a new 1-hour SO_2 standard was established and the existing 24-hour and annual primary standards were revoked. To attain the 1-hour national standard, the 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 75 ppb. The 1971 SO_2 national standards (24-hour and annual) remain in effect until one year after an area is designated for the 2010 standard, except that in areas designated nonattainment for the 1971 standards, the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved. Note that the national 1-hour standard is in units of ppb. California standards are in ppm. To directly compare the national 1-hour standard to the California standards the units can be converted from ppb to ppm.
[6] Secondary Standard.
[7] On December 14, 2012, the national annual $PM_{2.5}$ primary standard was lowered from 15 μg/m^3 to 12.0 μg/m^3. The existing national 24-hour $PM_{2.5}$ standards (primary and secondary) were retained at 35 μg/m^3, as was he annual secondary standard of 15 μg/m^3. The existing 24-hour PM_{10} standards (primary and secondary) of 150 μg/m^3 also were retained. The form of the annual primary and secondary standards is the annual mean, averaged over 3 years.
[8] The national standard for lead was revised on October 15, 2008 to a rolling 3-month average. The 1978 lead standard (1.5 μg/m^3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
[9] ARB has identified lead and vinyl chloride as toxic air contaminants with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

Source: ARB 2013c.

CLEAN AIR ACT AMMENDMENTS OF 1990 (CAAA)

The CAAA revised the CAA to address curb three major threats that had not previously been addressed: acid rain, urban air pollution, and toxic air emissions. Title III of the CAAA directed EPA to issue national emissions standards for hazardous air pollutants (HAPs), which may be different for major sources than for area sources of HAPs. Major sources are defined as stationary sources with potential to emit more than 10 tons per year (TPY) of any HAP or more than 25 TPY of any combination of HAPs; all other sources are considered area sources. The EPA has programs for identifying and regulating HAPs.

The CAAA also requires the EPA to issue vehicle or fuel standards containing reasonable requirements for exhaust emissions of TACs. Performance criteria were established to limit mobile-source emissions of toxics, including benzene, formaldehyde, and 1, 3-butadiene.

AP 42 COMPILATION OF AIR POLLUTANT EMISSION FACTORS

Since 1972, the EPA has been publishing *AP-42 Compilation of Air Pollutant Emission Factors*, as the primary compilation of EPA’s emissions factor information. It contains emission factors of process information for more than 200 air pollution source categories. The emission factors have been developed and compiled from source test data, material balance studies and engineering estimates. The Fifth Edition of AP-42 was published in January 1995 and since that time the EPA has published a number of supplements and updates. Chapter 13.1 of AP42’s Fifth Edition sets forth guidelines for computing air quality emissions for prescribed fire. Regarding wildfire and prescribed burning, the EPA acknowledges that there is a significant difference between emissions, primarily due to less “available fuel” (combustible material that will be consumed by fire under specific climatic conditions) during prescribed burning.

FEDERAL ADVISORY COMMITTEE ACT (FACA) – OZONE, PM, REGION HAZE IMPLEMENATION: WILDLAND FIRE ISSUES GROUP

Established through a charter, the purpose of the FACA Wildland Fire Issues Group was to provide the EPA with recommendations for revising its policies for implementing the current PM-10 standard and any new fine PM NAAQS, with respect to prescribed fire and its impact. Although the charter for the FACA for Ozone, Particulate Matter, and Regional Haze has expired, the findings of the Wildland Fire Issues Group still pertain to prescribed fire in relation to Air Quality. Most importantly the *Interim Air Quality Policy on Wildland and Prescribed Fires* was produced by the group is the national standard when local guidelines have not been established. The document outlines Smoke Management Programs (SMPs), who is accountable when prescribed fire exceeds the federal air quality thresholds, and overall objectives for prescribed fire in relation to air quality.

PRESCRIBED FIRE SMOKE MANAGEMENT GUIDE

In 2001 the National Wildfire Coordinating Group’s (NWCG) Fire Use Working Team sponsored the creation of the *Smoke Management Guide for Prescribed and Wildland Fire*. The guide outlines why fire is important to the ecosystem, regulations that impact smoke management, best management practices for reducing emissions in prescribed fire, and ways to monitor air quality during prescribed fires. The EPA advises consulting this guide when calculating emissions for prescribed fire.

4.12.1.1.2 STATE PLANS, POLICIES, REGULATIONS, AND LAWS

CALIFORNIA AIR RESOURCES BOARD (ARB)

The California Air Resources Board (ARB) was created in 1967 when the California Motor Vehicle Pollution Control Board and the Bureau of Air Sanitation and its Laboratory where merged together by Governor Ronald Regan through the Mulford Air Resource Act. ARB oversees local air district compliance with federal and state laws, approving local air quality plans, submitting SIPs to EPA, monitoring air quality, determining and updating area designations and maps, and setting emissions standards for new mobile sources, consumer products, small utility engines, off-road vehicles, and fuels. ARB is also responsible for specifying each day of the year as a permissive burn day, marginal burn day, or a no-burn day for each air basin or other specified area. These decisions determine when agricultural and prescribed wildland burning may occur based on weather and air quality conditions (ARB 2011). For permission to burn, however, individuals are required to receive daily approval from their local air quality management district, which has information on local conditions, including fire danger.

ARB has authority to approve local smoke management programs. Elements of these programs include permitting requirements for agricultural and prescribed burns, meteorological and smoke management forecasting, and a daily burn authorization system (ARB 2000).

Wildfires that contribute to exceedances of air quality standards may be considered exceptional events by the ARB. Impacts to air quality from these events may last days, weeks, or even months after ignition and are beyond regulatory control. ARB reports a total of 288 wildfires greater than 300 acres in size that may have contributed to higher than normal particulate matter concentrations from 2007 through 2013, with an average of 41 events per year during this time period (ARB, 2015). The *California Wildfire Smoke Response Coordination*, prepared under the auspices of ARB's California Air Response Planning Agency (CARPA) and the California Interagency and Smoke Council, provides useful information and resources seeking assistance in protecting the public's health from the impacts of smoke during catastrophic fires (CARPA 2008).

CALIFORNIA CLEAN AIR ACT (CCAA)

ARB coordinates and oversees state and local programs for controlling air pollution in California and implements the CCAA, which was adopted in 1988. The CCAA requires ARB to establish California ambient air quality standards (CAAQS), which are presented above in Table 4.12-1. In addition to establishing CAAQS for ozone, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and lead, ARB has established CAAQS for sulfates, hydrogen sulfide, vinyl chloride, visibility-reducing particulate matter as well. In most cases, the CAAQS are more stringent than the NAAQS. Differences in the standards are generally explained by the health effects studies considered during the standard-setting process and the interpretation of the studies. In addition, the CAAQS incorporate a margin of safety to protect sensitive individuals.

TANNER AIR TOXICS ACT AND THE AIR TOXICS HOT SPOTS INFORMATION AND ASSESSMENT ACT

TACs in California are regulated primarily through the Tanner Air Toxics Act (Assembly Bill [AB] 1807, Chapter 1047, Statutes of 1983) and the Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588, Chapter 1252, Statutes of 1987). AB 1807 sets forth a formal procedure for ARB to designate substances as TACs. Research, public participation, and scientific peer review are required before ARB can designate a substance as a TAC. To date, ARB has identified more than 21 TACs and adopted U.S. EPA's list of HAPs as TACs. Most recently, PM exhaust from diesel engines (diesel PM) was added to ARB's list of TACs.

Once a TAC is identified, ARB then adopts an airborne toxics control measure for sources that emit that particular TAC. If a safe threshold exists for a substance at which there is no toxic effect, the control measure must reduce exposure below that threshold. If no safe threshold exists, the measure must incorporate best available control technology for toxics to minimize emissions.

The Hot Spots Act requires that existing facilities that emit toxic substances above a specified level prepare an inventory of toxic emissions, prepare a risk assessment if emissions are significant, notify the public of significant risk levels, and prepare and implement risk reduction measures.

ARB has adopted diesel exhaust control measures and more stringent emissions standards for various transportation-related mobile sources of emissions, including transit buses, and off-road diesel equipment (e.g., tractors, generators). Over time, the replacement of older vehicles will result in a vehicle fleet that produces substantially lower levels of TACs than under current conditions. Mobile-source emissions of TACs (e.g., benzene, 1-3-butadiene, diesel PM) have been reduced significantly over the last decade and will be reduced further in California through a progression of regulatory measures (e.g., Low Emission Vehicle/Clean Fuels and Phase II reformulated gasoline regulations) and control technologies. With implementation of ARB's Risk Reduction Plan, it is expected that diesel PM concentrations will be 85 percent less in 2020 in comparison to year 2000. Adopted regulations are also expected to continue to reduce formaldehyde emissions from cars and light-duty trucks. As emissions are reduced, it is expected that risks associated with exposure to the emissions will also be reduced.

CALIFORNIA CODE OF REGULATIONS TITLE 17

Title 17 of the California Code of Regulations (CCR) addresses public health issues. Division 3 of Title 17 specifically addresses issues related to air resources. Topics most relevant to projects conducted under the VTP include: Air Basins and Air Quality Standards (Subchapter 1.5), Smoke Management Guidelines for Agricultural and

Prescribed Burning (Subchapter 2), Toxic Air Contaminants (Subchapter 7), and Climate Change (Subchapter 10).

The ARB oversees California's Smoke Management Program, which addresses potentially harmful smoke impacts from agricultural, forest, and range land management burning operations. The legal basis of the program is found in *17 CCR § 80100 et. seq., Smoke Management Guidelines for Agricultural and Prescribed Burning,* adopted by ARB on March 23, 2000 (ARB 2011). Under these guidelines, air districts implement a daily burn authorization system under which they specify the amount, timing, and location of burns for the purpose of minimizing smoke impacts on sensitive areas, avoid cumulative smoke impacts, and prevent public nuisance from occurring. Through the burn authorization system, the air district authorizes no more burning on a daily basis than is appropriate considering meteorological and air quality conditions (ARB, 2000).

Adoption of the amendments to the Smoke Management Guidelines for Agricultural and Prescribed Burning by the ARB on March 23, 2000 triggered a CEQA analysis. The ARB concluded that adoption of these guidelines would not cause significant adverse environmental impacts. They further concluded, in regard to air quality impacts, that compliance with the guidelines should result in reduced smoke impacts, improved air quality, and progress towards achievement of CAA and CCAA requirements, and go on to speculate that potential benefits from the program may accrue from a reduction in risk of catastrophic wildland fires from increased prescribed burning activities (ARB, 2000).

CALIFORNIA AIR BASINS

California is divided geographically in 15 separate air basins for the purpose of managing air resources for the State of California on a regional basis. Air basins generally have meteorological and geographical similarities allowing for a more customized approach for each region’s air quality decision making. Air pollution can generally move freely within each air basin, and in some cases can move between adjacent air basins.

Figure 4.12-1 California Air Basins (ARB, 2014)

CALIFORNIA'S SMOKE MANAGEMENT PROGRAM

As discussed earlier, the ARB oversees California's Smoke Management Program. California established a statewide Smoke Management Program in March of 2000, which was approved by the EPA in August of 2003. California's Smoke Management Program meets the 7 program elements described in the *Interim Air Quality Policy on Wildland and Prescribed Fires.* Four of the seven elements include:

- Registering and permitting of agricultural and prescribed burns
- Meteorological and smoke management forecasting

- Daily burn authorization
- Eenforcement

This Smoke Management Program is implemented by the local air districts and is discussed in greater detail below.

4.12.1.1.3 LOCAL PLANS, POLICIES, REGULATIONS, AND LAWS

CALIFORNIA AIR DISTRICTS

There are 35 air pollution control districts or air quality management districts (air districts) across California. The CCAA requires that all local air districts in the state work towards achieving and maintaining the CAAQS by the earliest practical date. The act specifies that local air districts should focus particular attention on reducing the emissions from transportation and area wide emission sources, and provides districts with the authority to regulate indirect sources.

Air districts attain and maintain air quality conditions in their respective jurisdictions through a comprehensive program of planning, regulation, enforcement, technical innovation, and promotion of the understanding of air quality issues. The clean air strategy implemented by air districts includes the preparation of plans for the attainment of CAAQS and NAAQS, adoption and enforcement of rules and regulations concerning sources of air pollution, and issuance of permits for stationary sources of air pollution. Air districts also inspect stationary sources of air pollution and respond to citizen complaints, monitor ambient air quality and meteorological conditions, and implement programs and regulations required by the CAA, CAAA, and the CCAA.

The CCAA requires all local air quality management districts and air pollution control districts (air districts) in the state to achieve and maintain the CAAQS by the earliest practical date. The CCAA specifies that local air districts should focus particular attention on reducing the emissions from transportation and area wide emission sources. Area wide sources have emissions spread out over wide areas. Prescribed burning is categorized by the ARB as an area wide source under the miscellaneous processes category (ARB, 2009) and is managed through the local districts burn authorization system. The CCAA provides districts with the authority to regulate indirect sources.

Each air quality district maintains its own specific regulations regarding open burning. Open burning regulations encompass both agricultural burning and prescribed wildland burning. The air quality district controls emissions by regulating the amount, timing and location of burn events to minimize air quality impacts from smoke. All open burning is restricted to burn days, marginal burn days, or through variances permitted by the local district. The ARB and local districts use information on existing air quality conditions and meteorological predictions to determine whether to allow burning, and if so, the volume and locations of burning it will allow on any given day. Each air district, fire control agency, or burning permit agency has the authority to be more restrictive than ARB to avoid air quality impacts. Land managers conducting prescribed burns must register yearly or seasonally with the local district and, when applicable, submit a smoke management plan (SMP) for approval prior to burning. Projects requiring a SMP, even on otherwise permissive burn days, require the land manager or his/her designee conducting the prescribed burn to ensure that all conditions and requirements agreed to in the approved smoke management plan are met on the day of the burn event prior to ignition [17 CCR §80160(j)].

Figure 4.12-2- California Air Quality Management Districts and Air Pollution Management Districts

SMOKE MANAGEMENT PLANS

Under the California Smoke Management Program each local district is required to regulate prescribed burning through adoption of a Smoke Management Program within their respective district that adheres to the overall objectives and goals of the California Smoke Management Program. Each local district requires a Smoke Management Plan (SMP) be submitted by land managers conducting prescribed burning that meets certain specifications. A SMP is required for any prescribed fire activity under this VTP (SPR AIR-12). An example SMP is located in Appendix J.

All prescribed burning must comply with the local districts burn authorization system, and larger projects are subject to tiered requirements for submission and approval of SMPs. Burn projects over 10 acres in size or estimated to produce more than one ton of particulate matter are required to include the location, types, and amounts of material to be burned, expected duration of the fire, identification of responsible personnel, and identification of all smoke sensitive areas in the SMP. Burn projects greater than 100 acres or estimated to produce more than 10 tons of particulate matter require additional information in the SMP, including meteorological conditions necessary for burning, projections of where the smoke is expected to travel (both day and night), and contingency actions to be taken if smoke impacts occur or meteorological conditions deviate from those specified in the SMP. Projects greater than 250 acres or near smoke sensitive areas must also include a monitoring component to the SMP (17 CCR §80160).

It is through this real time, site specific burn authorization system and associated SMP that prescribed burning is treated differently from other potential treatment alternatives proposed by the VTP. The local air district becomes the ultimate arbiter in whether the project can occur as proposed, in a limited capacity, or must be postponed based on the predicted transport and placement of pollutants from the project relative to sensitive receptors that may be impacted by the project. Prescribed fire projects need not only an authorization from the local air district, but also must ensure that the conditions set forth in the approved SMP are met prior to ignition of a prescribed fire. That is, even with authorization from the local district to conduct the prescribed burn, if the conditions and requirements of the SMP are not met on site, ignition is prohibited [17 CCR §80160(j)].

4.12.1.2 Environmental Setting

4.12.1.2.1 Topography, Meteorology, Climate

California has a wide range of geophysical features including mountains, valleys, oceans, and deserts. The Pacific Ocean forms the state’s western boundary, stretching more than 1,200 miles. The Central Valley is located in the middle of the state and surrounded by various mountain ranges. Multiple coastal mountain ranges lie to the west of the Central Valley; the Sierra Nevada to the east, the Cascade Range to the north, and the Tehachapi Mountains to the south. California also has expansive deserts, such as the Mojave Desert located in southern California, and vast forests of redwood and Douglas fir located in the northwest portion of the state (ARB 2013d). Major rivers include the Sacramento, San Joaquin, and Colorado. Major Lakes include Lake Tahoe, Salton Sea, and Owens Lake. Elevation varies greatly in California from Mount Whitney at 14,494 (highest mountain in the contiguous 48 states) to 282 feet below sea level at Death Valley (lowest elevation in the United States).

The landform features of the state affect the direction of air flow and, thus, directly affect the distribution and transportation of air pollutants. For example, air above low-lying land that is surrounded by mountains is often more atmospherically stable, which can result in it collecting more air pollutants.

California has a Mediterranean climate characterized by hot, dry summers and cool, more rainy winters, with some portions of the state experiencing more extreme temperature differences than others. Coastal portions of the state often experience summer fog as a result of the cool marine currents from the Pacific Ocean, and more moderate temperatures, whereas inland portions of the state, such as the high desert, southern San Joaquin Valley, or northern Sacramento Valley experience more extreme temperature differences. Precipitation in California generally occurs in the winter months and typically the northern regions of the state experience more average annual rainfall than the southern portions of the state (NSTATE 2014).

4.12.1.2.2 Existing Air Quality

CRITERIA AIR POLLUTANTS

Ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), respirable particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), and lead concentrations are used to indicate the quality of the ambient air. Because extensive documentation on health-effects criteria is available for these air pollutants, they are commonly referred to as “criteria air pollutants” (CAPs). CAPs are also the most prevalent indicators of how air pollution is detrimental to human health. Brief descriptions of each CAP by emission source types and health effect is provided below in Table 4.12-2.

Table 4.12-2 Sources and Health Effects of Criteria Air Pollutants

Pollutant	Sources	Acute[1] Health Effects	Chronic[2] Health Effects
Ozone	Secondary pollutant resulting from reaction of ROG, a subset of VOC, and NO_X in presence of sunlight. ROG emissions result from incomplete combustion and evaporation of chemical solvents and fuels; NO_X results from the combustion of fuels	Increased respiration and pulmonary resistance; cough, pain, shortness of breath, lung inflammation	Permeability of respiratory epithelia, possibility of permanent lung impairment
Carbon monoxide (CO)	Incomplete combustion of fuels; motor vehicle exhaust	Headache, dizziness, fatigue, nausea, vomiting, death	Permanent heart and brain damage
Nitrogen dioxide (NO_2)	Combustion devices; e.g., boilers, gas turbines, and mobile and stationary reciprocating internal combustion engines	Coughing, difficulty breathing, vomiting, headache, eye irritation, chemical pneumonitis or pulmonary edema; breathing abnormalities, cough, cyanosis, chest pain, rapid heartbeat, death	Chronic bronchitis, decreased lung function
Sulfur dioxide (SO_2)	Coal and oil combustion, steel mills, refineries, and pulp and paper mills	Irritation of upper respiratory tract, increased asthma symptoms	Insufficient evidence linking SO_2 exposure to chronic health impacts
Respirable particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$)	Fugitive dust, soot, smoke, mobile and stationary sources, construction, fires and natural windblown dust, and formation in the atmosphere by condensation and/or transformation of SO_2 and ROG	Breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular diseases, premature death	Alterations to the immune system, carcinogenesis
Lead	Metal processing	Reproductive/ developmental effects (fetuses and children)	Numerous effects including neurological, endocrine, and cardiovascular effects

Notes: NO_X = oxides of nitrogen; VOC= Volatile Organic Compounds; ROG = reactive organic gases.
[1] "Acute" refers to effects of short-term exposures to criteria air pollutants, usually at relatively high concentrations.
[2] "Chronic" refers to effects of long-term exposures to criteria air pollutants, even at relatively low concentrations.
Source: EPA 2014.

OZONE

Ozone is a photochemical oxidant (a substance whose oxygen combines chemically with another substance in the presence of sunlight) and the primary component of smog. Most ground-level ozone is not directly emitted into the air but is formed through complex chemical reactions between precursor emissions of reactive organic gases (ROG) and oxides of nitrogen (NO_X) in the presence of sunlight. ROG is a subset of volatile organic compounds (VOC) and its emissions result primarily from incomplete combustion and the evaporation of chemical solvents used primarily in coating and adhesive processes, as well as evaporation of fuels. ROG is also continually released biogenically in large quantities from plant and trees. NO_X are a group of gaseous compounds of nitrogen and oxygen that result from the combustion of fuels. Ozone has also been known to cause significant damage to crops, forestland, and other ecosystems.

According to the California Air Resources Board's (ARB's) *2013 California Almanac of Emissions and Air Quality*, which provides state-wide air quality trends, emissions of ozone precursors ROG and NO_X have decreased over the past several years because of more stringent motor vehicle standards and cleaner burning fuels. Compared with 1990, ozone concentrations are about 10 to 50 percent lower throughout California, with some of the largest decreases occurring in areas with the worst ozone air qualities (ARB 2013d: p. 1-5). However, most counties in California are in nonattainment for ozone. Refer to Table 4.12-3 below for details regarding the attainment status of ozone throughout California.

Table 4.12-3 Summary of California Air Quality Standards Attainment Status by County

County	Ozone	Respirable Particulate Matter (PM_{10})	Fine Particulate Matter ($PM_{2.5}$)	County	Ozone	Respirable Particulate Matter (PM_{10})	Fine Particulate Matter ($PM_{2.5}$)
Alameda	N	N	N	Orange	N	N	N
Alpine	U	N	A	Placer	N	N	N_P
Amador	N	U	U	Plumas	U	N	N_P
Butte	N	N	N	Riverside	N	N	N_P
Calaveras	N	N	U	Sacramento	N	N	A
Colusa	A	N	A	San Benito	N	N	A
Contra Costa	N	N	N	San Bernardino	N	N	N_P
Del Norte	A	A	A	San Diego	N	N	N
El Dorado	N	N	N_p	San Francisco	N	N	N
Fresno	N	N	N	San Joaquin	N	N	N
Glenn	A	N	A	San Luis Obispo	N	N	A
Humboldt	A	N	A	San Mateo	N	N	N
Imperial	N	N	A	Santa Barbara	N	N	U
Inyo	N	N	A	Santa Clara	N	N	N
Kern	N	N	N_P	Santa Cruz	N	N	A
Kings	N	N	N	Shasta	N	N	A
Lake	A	A	A	Sierra	U	N	U
Lassen	A	N	A	Siskiyou	A	A	A
Los Angeles	N	N	N_P	Solano	N	N	U
Madera	N	N	N	Sonoma	N_P	N_P	N_P
Marin	N	N	N	Stanislaus	N	N	N
Mariposa	N	U	U	Sutter	N_T	N	A
Mendocino	A	N	A	Tehama	N	N	U
Merced	N	N	N	Trinity	A	A	A
Modoc	A	N	A	Tulare	N	N	N
Mono	N	N	A	Tuolumne	N	U	U
Monterey	N	N	A	Ventura	NX	N	A
Napa	N	N	N	Yolo	N	N	U
Nevada	N	N	U	Yuba	N_T	N	A

Notes:

N = Nonattainment; NT = Nonattainment-Transitional (i.e., A subcategory of the nonattainment designation that signals progress and implies the area is nearing attainment.); NP = Some portion of the county is classified as Nonattainment; A = Attainment; U = Unclassified (i.e., Any area that cannot be classified on the basis of available information as meeting or not meeting the California ambient air quality standards (CAAQS))

All counties in California are designated as unclassified or in attainment with the CAAQS for CO and visibility reducing particles. All counties in California are designated as in attainment with the CAAQS for NO2, SO2, sulfates, and lead. All counties in California are designated as unclassified or in attainment for hydrogen sulfide, except for portions of San Bernardino County which is in nonattainment. Source: ARB 2013b

NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) is a brownish, highly reactive gas. The major human-made sources of NO_2 are combustion devices, such as boilers, gas turbines, and mobile and stationary reciprocating internal combustion engines. Combustion devices emit primarily nitric oxide (NO), which reacts through oxidation in the atmosphere to form NO_2. The combined emissions of NO and NO_2 are referred to as NO_x and are reported as equivalent NO_2. NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. Because NO_2 is formed and depleted by reactions associated with photochemical smog (ozone), the NO_2 concentration in a particular geographical area may not be representative of the local sources of NO_X emissions (EPA 2014a and ARB 2013d: p.1-22).

PARTICULATE MATTER

Respirable particulate matter with an aerodynamic diameter of 10 micrometers or less is referred to as PM_{10}. PM_{10} consists of particulate matter emitted directly into the air, such as fugitive dust, soot, and smoke from mobile and stationary sources, construction equipment, fires and natural windblown dust, and particulate matter formed in the atmosphere by reaction of gaseous precursors. Fine particulate matter ($PM_{2.5}$) includes a subgroup of smaller particles that have an aerodynamic diameter of 2.5 micrometers or less. Area-wide sources account for about 65 and 83 percent of the statewide emissions of directly emitted $PM_{2.5}$ and PM_{10}, respectively. The major area-wide sources of $PM_{2.5}$ and PM_{10} are fugitive dust, especially dust from unpaved and paved roads, agricultural operations, and construction and demolition. PM is the principal pollutant of concern from smoke from fire in the short-term (ARB 2008: p. 4). Sources of PM_{10} include crushing or grinding operations, and dust stirred up by vehicles traveling on roads. Sources of $PM_{2.5}$ include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes. Due to an overall reduction in area-wide source emissions, PM_{10} emissions are projected to decrease through 2035. $PM_{2.5}$ are also projected to decrease through 2035 as a result of reduced stationary source and area-wide source emissions. Emissions of $PM_{2.5}$ are dominated by the same sources as emissions of PM_{10} (ARB 2013d: p. 2-4).

EMISSIONS INVENTORY

Figure 4.12-3 summarizes emissions of CAPs within California for various source categories in 2013. According to California's emissions inventory, mobile sources are the largest contributor to the estimated annual average for air pollutant levels of VOC, which contains ROG, and NO_x, accounting for approximately 43 percent and 83 percent respectively, of the total emissions. Area wide sources account for approximately 83 percent and 65 percent of California's PM_{10} and $PM_{2.5}$ emissions, respectively (ARB 2013c).

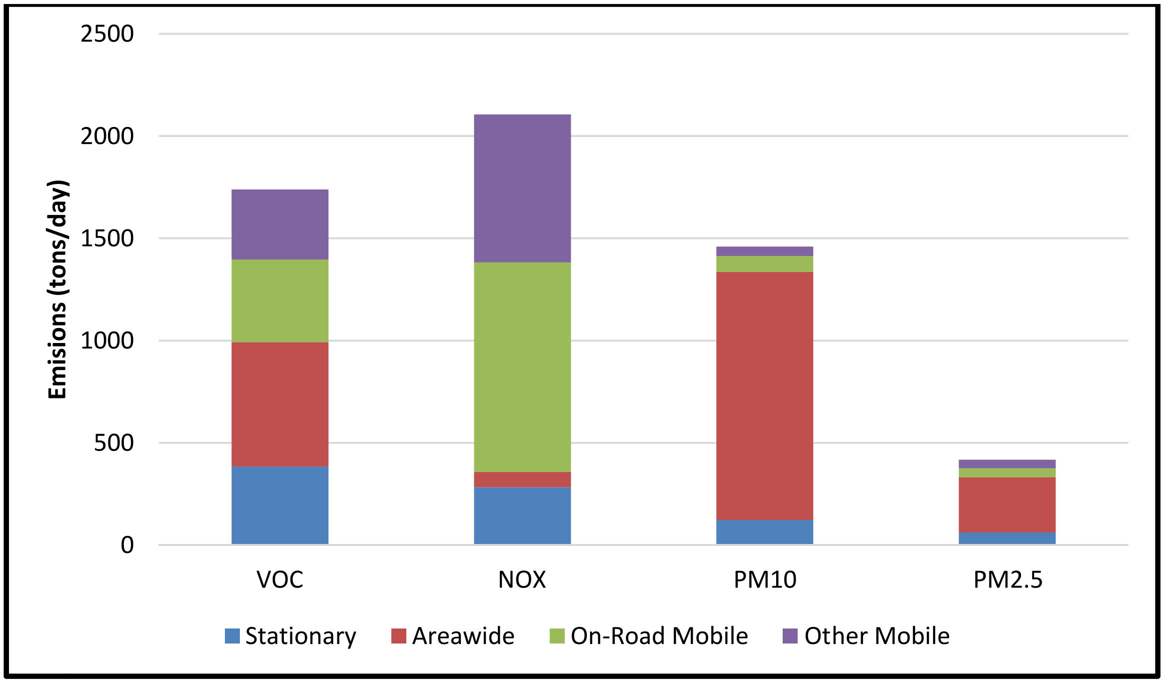


Figure 4.12-3 California 2012 Emissions Inventory

Source: ARB 2013c

4.12.1.2.3 Toxic Air Contaminants

Concentrations of toxic air contaminants (TACs) are also used to indicate the quality of ambient air. A TAC is defined as an air pollutant that may cause or contribute to an increase in mortality or in serious illness, or that may pose a hazard to human health. TACs are usually present in minute quantities in the ambient air; however, their high toxicity or health risk may pose a threat to public health even at low concentrations.

According to ARB's *2013 California Almanac of Emissions and Air Quality*, the majority of the estimated health risks from TACs can be attributed to relatively few compounds, the most predominant being particulate-exhaust emissions from diesel-fueled engines (diesel PM). Diesel PM differs from other TACs in that it is not a single substance, but rather a complex mixture of hundreds of substances. Although diesel PM is emitted by diesel-fueled internal combustion engines, the composition of the emissions varies depending on engine type, operating conditions, fuel composition, lubricating oil, and whether an emissions control system is being used. Unlike some TACs, no ambient monitoring data are available for diesel PM, because no routine measurement method exists. However, ARB has made preliminary concentration estimates based on a PM exposure method. This method uses the ARB emissions inventory's PM_{10} database, ambient PM_{10} monitoring data, and the results from several studies to estimate concentrations of diesel PM. In addition to diesel PM, the TACs for which data are available that pose the greatest existing ambient risk in California are benzene, 1, 3-butadiene, acetaldehyde, carbon tetrachloride, hexavalent chromium, para-dichlorobenzene, formaldehyde, methylene chloride, and perchloroethylene.

Diesel PM poses the greatest health risk among these 10 TACs mentioned. Since 1990, the health risk associated with diesel PM has been in California has reduced by 52 percent. Overall, levels of most TACs, except para-dichlorobenzene and formaldehyde, have decreased since 1990 (ARB 2009: Chapter 5).

4.12.1.2.4 Odors

Odors are generally regarded as an annoyance rather than a health hazard. However, manifestations of a person's reaction to foul odors can range from psychological (e.g., irritation, anger, or anxiety) to physiological (e.g., circulatory and respiratory effects, nausea, vomiting, and headache).

The human nose is the sole sensing device for odors. The ability to detect odors varies considerably among people and human response to odors is subjective. Some individuals have the ability to smell very minute quantities of specific substances; others may not have the same sensitivity but may have sensitivities to odors of other substances. In addition, people may have different reactions to the same odor; an odor that is offensive to one person may be perfectly acceptable to another (e.g., fast food restaurant). It is important to also note that an unfamiliar odor is more easily detected and is more likely to cause complaints than a familiar one. This is because of the phenomenon known as odor fatigue, in which a person can become desensitized to almost any odor with repeated exposure and recognition only occurs with an alteration in the intensity.

Quality and intensity are two properties present in any odor. The quality of an odor indicates the nature of the smell experience. For instance, if a person describes an odor as flowery or sweet, then the person is describing the quality of the odor. Intensity refers to the strength of the odor. For example, a person may use the word strong to describe the intensity of an odor. Odor intensity depends on the odorant concentration in the air. When an odorous sample is progressively diluted, the odorant concentration decreases. As this occurs, the odor intensity weakens and eventually becomes so low that the detection or recognition of the odor is quite difficult. At some point during dilution, the concentration of the odorant reaches a detection threshold. An odorant concentration below the detection threshold means that the concentration in the air is not detectable by the average human.

4.12.1.2.5 Naturally Occurring Asbestos

Naturally occurring asbestos (NOA) was identified as a TAC in 1986 by ARB. NOA is located in many parts of California, and is commonly associated with ultramafic rocks (i.e., dark-colored igneous rocks that are typically rich in minerals containing magnesium and iron ["mafic" minerals] and lesser amounts of silica, such as serpentinite), according to a special publication published by the California Geological Survey (Churchill and Hill 2000). Asbestos is the common name for a group of naturally occurring fibrous silicate minerals that can separate into thin but strong and durable fibers. Ultramafic rocks form in high-temperature environments well below the surface of the earth. By the time they are exposed at the surface by geologic uplift and erosion, ultramafic rocks may be partially to completely alter into a type of metamorphic rock called serpentinite. Sometimes the metamorphic conditions are right for the formation of chrysotile asbestos or tremolite-actinolite asbestos in the bodies of these rocks, along their boundaries, or in the soil.

NOA can be released from serpentinite or other ultramafic rocks, if the rock is broken or crushed. Natural weathering and erosion processes act on asbestos-bearing rock and soil, increasing the likelihood for asbestos fibers to become airborne if disturbed. Asbestos could also be released into the air by human activities, such as construction and vehicular traffic on unpaved roads on which asbestos-bearing rock has been used as gravel. At the point of release, asbestos fibers could become airborne, causing air quality and human health hazards (USFS 2008: p. 2; ATSDR 2010).

4.12.1.2.6 Wildfire versus Prescribed Fire Emissions

There are important differences between wildfire and prescribed fire in relation to the emissions that are produced. As discussed by the EPA in the AP 42, emissions from both wildfire and prescribed fire are driven by the kinds of vegetation consumed, the moisture content of the vegetation, meteorological conditions, and weight of consumable fuel per acre (fuel load). The significance of both fuel type and fuel load cannot be overstated (EPA 1995). The primary difference between wildfire and prescribed fire is that prescribed fire is a planned event and wildfire is an unplanned event. Since a prescribed fire activity is a planned event, emissions impacts can be reduced by burning only when specific fuel conditions (specifically fuel moistures of the live and dead fuels) and meteorological conditions are present, thereby controlling the quantity and location of smoke, and the time spent in each combustion phase. The local air district takes into account the meteorological conditions, other emissions within the air basin and/or district, and the distribution of burns throughout the air basin on a daily basis when permitting specific prescribed burn projects within their jurisdiction.

Emissions can be further controlled through the utilization of emission reduction techniques that involve controlling the combustion process, these practices can be found in the National Wildfire Coordinating Group (NWCG) 2001 Smoke Management Guide and are discussed in the AP 42. According to the AP 42, the efficiency or inefficiency of the combustion process can directly affect the emissions produced; with the flaming phase being the most efficient creating minimal emissions and the smoldering phase being the least efficient creating substantially more emissions (EPA 1995). The Smoke Management Guide states that, “emission reduction techniques may reduce emissions from a given prescribed burn area by as much as about 60 percent to as little as virtually zero” (NWCG, 2001). Emission reduction techniques outlined by the NWCG 2001 Smoke Management Guide include reducing the burn area (burn concentrations, isolating fuels, mosaic burning), scheduling burning before new fuel appears (burning before fall litter, burning before green-up), increasing combustion efficiency (burning piles and windrows, backing fires, dry conditions, rapid mop-up, aerial ignition/mass ignition), and redistributing emissions (burn when dispersion is good, sharing the airshed, avoiding sensitive areas, burning smaller units, burning more frequently).

Wildfire events cannot be controlled in the same manner, as the variables affecting fire behavior are not controlled or managed, and resources are typically not available onsite when ignition occurs. However the amount of emissions from wildfire can be reduced overtime as fuel loads are reduced through vegetation treatment programs; the reduction of fuel loads and the increased resilience of vegetation to fire will not only reduce wildfire emissions over time but may also enhance ecosystem resiliency to other biotic and abiotic stressors (ex. pests, disease, drought, etc.).

4.12.2 EFFECTS

4.12.2.1 Significance and Threshold Criteria

For this analysis, significance criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines. Based on the following, an air quality impact is considered significant if treatment activities for the VTP would do any of the following:

- Conflict with or obstruct implementation of the applicable air quality plan; or
- Violate any air quality standard or contribute substantially to an existing or projected air quality violation; or
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors); or
- Expose sensitive receptors to substantial pollutant concentrations; or
- Create objectionable odors affecting a substantial number of people.

Multiple air districts in California have published their own recommended CEQA guidance with specific quantitative thresholds for construction projects to determine whether emissions from individual projects would be considered significant in the context of CEQA. Appendix G states the significance criteria established by air districts may be relied upon to make air quality impact significance determinations. Due to the diversity of projects within the VTP, the construction quantitative thresholds will be utilized to analyze the impacts of the VTP for mechanical, manual, herbivory, and herbicide activities. Because the project would be implemented statewide, this analysis considers specific quantitative thresholds from each of the 35 local air districts in the state (see Table 4.12-5), and compares the maximum simultaneous project emissions that may occur in each local air district under the previously described activities against these thresholds.

Emissions from prescribed fire projects are fundamentally different from general construction related emissions and are treated through separate programs by local air districts as indicated above. The EPA indicates general support for treating prescribed fires as temporary activities in their Interim Policy on Air Quality on Wildland and Prescribed Fires. The EPA recognize that PM emissions from prescribed fire differ from those from most other sources because they occur infrequently at any specific location (once every 5 to 20 years) and are of short duration (approximately 1-2 days) when they do occur (EPA, 1998). The ARB refers to this analysis in the development of the amendments to the agricultural burning requirements that incorporated the Smoke Management Program into their Title 17 regulations (ARB, 2000). Due to unique nature of prescribed fire activities and the distinction that the California Air Board makes for those emissions through its Smoke Management plan, the significant criteria for prescribed fire activities is based upon identical acreage being consume by wildfire.

For the following threshold analysis these differences in emissions for the air quality impacts from prescribed fire and construction related activities have been separated and are evaluated against different thresholds.

4.12.2.2 Thresholds

To avoid understating the environmental effects of the VTP, this analysis conservatively estimates the spatially distribution of projects throughout the air basins and districts to see where the greatest potential concentration of simultaneous impacts could occur. This program level impact is then compared to the project level thresholds for pollutants of the local air districts. In this way, if the program level emissions can be judged to be less than the applicable thresholds, the emissions from any given project that falls under the scope of the VTP will also not create emissions above the applicable thresholds. The air district is considered the appropriate scale for analysis because they are the local jurisdiction having authority over any individual VTP project, and each local district considers emissions from adjacent districts in the air basin when setting emission thresholds. Project level mass emission thresholds recommended by air districts are typically expressed in units of pounds per day (lb./day) or TPY. The recommended mass emission thresholds for projects vary by air district and pollutant class (see Table 4.12-5).

Air Quality impacts from the VTP are divided into two kinds of emission producing categories: construction emissions and prescribed fire emissions. Construction emissions encompass the mechanical, manual, herbicide, and herbivory activities within the VTP, accounting for both worker trip and mechanical equipment emissions. Prescribed fire emissions include the emissions from the vegetation expected to be consumed by the prescribed fire, as well as the worker trip and mechanical equipment emissions associated with the activity. Construction emissions are subject to the daily CAAQS thresholds set forth for construction projects (Table 4.12-5) while prescribed fire emissions are managed by the local air districts through the burn authorization program and smoke management plans discussed above in section 4.12.1.1.3. Table 4.12-4: Air Quality Emission Models discusses in more detail the types of emissions and how they are analyzed within the VTP.

Impact number two in the analysis below proposes that a prescribed fire would have a significant impact on air quality if it would produce emissions greater than those produced by a wildfire burning the same acre. This threshold recognizes that the baseline disturbance for most vegetation types in California is fire and that periodic emissions are expected to occur naturally outside of VTP treatment. Section 4.1.3 has an extensive discussion about fire return intervals and general fire characteristics of each of the major vegetation types. Treatment through the VTP is expected to reduce the amount of those periodic emissions, and shift them to a time when the impacts on air quality can be controlled. Local air districts permit the number, acres and location of burning within their jurisdiction on a daily basis consistent with the local meteorological conditions and pollution levels on that day (ARB, 2000) with no set standard for maximum allowable emissions for any single project. With lack of guidance from the ARB or local districts about numerical thresholds from prescribed fire emissions to judge projects against, a reduction in emissions from the baseline condition of periodic disturbance by wildfire has been judged to be an acceptable threshold. Participation in the local air districts burn authorization program and adherence to the terms of the approved SMP will prevent projects that would exceed local air quality standards from occurring.

Thus for this analysis implementation of the vegetation treatment activities under the VTP would result in significant air quality impacts if projects were to:

1. Produce construction-generated or long-term regional CAPs or precursor emissions that would exceed the local air district daily significance thresholds during mechanical, manual, herbivory, and herbicide activities (Table 4.12-5).
2. Produce fire emissions that exceed those produced by a wildfire in the same vegetation type and of the same size as the prescribed fire project (Table 4.12-6).
3. Expose sensitive receptors to TAC emissions that would be estimated to increase of cancer contractions by 10 in 1 million people for the Maximally Exposed Individual (MEI) and/or a non-carcinogenic Hazard Index of 1 for the MEI.
4. Create objectionable odors affecting a substantial number of people.
5. Expose sensitive receptors to fugitive dust emissions containing naturally occurring asbestos (NOA).

Table 4.12-4: Air Quality Emission Models

Construction Emission Model	Prescribed Fire Emission Model
Most current EIRs analyze emissions through a Construction Emission Model. Every Air District within California has a Significance Threshold Criteria for Construction Emissions. Emissions from this model are derived from exhaust combustion sources (i.e. Heavy Equipment, Vehicles, etc.) This model sufficiently predicts emissions for projects that are construction like in nature. Within the VTP the following exhaust combustion emission aspects of activities could be accurately captured: • Mechanical • Manual • Herbicide • Herbivory • Prescribed Fire Under the Construction Emission Model the following emissions are the regulated: • Carbon Monoxide (CO) • Oxides of Nitrogen (NO_X) • Reactive Organic Gasses (ROG) • Particulate Matter (PM_{10} and $PM_{2.5}$) However this model does not sufficiently take into the account the emissions created by prescribed fire.	No current Programmatic EIRs, that analyze Air Quality, have a prescribed fire element. The Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) both acknowledge the benefit of prescribed fire emissions in combating wildfire emissions. However, there are no Threshold Criteria for Prescribed Fire Emissions like those outlined for Construction Emissions. All determinations about Prescribed Fire emission significance is made privately by the California Air Resources Board taking into account current weather and air conditions. Therefore there is no standard Prescribed Fire Emission Model that has been developed for EIRs. Prescribed Fire Emissions regulations are concerned with the following emissions: • Particulate Matter (PM_{10} and $PM_{2.5}$) • Carbon Monoxide (CO) • Volatile Organic Compounds (VOC) However prescribed fire accounts for the largest amount of emissions produced within the VTP and this model does not accurately account for emissions produced by exhaust combustion sources.
VTP-EIR Emission Model	
Due to the diversity of activities under the VTP, two project types emerge under air quality emission standards thresholds: construction and prescribed fire. Therefore the VTP analyzes all emissions produced by Prescribed Fire under a Prescribed Fire Emission Model, where significance is determined by the same acre burning in wildfire. The VTP then analyzes all emissions produced by Mechanical, Manual, Herbicide, and Herbivory activities under a Construction Emission model. Using the Prescribed Fire Emission Model only for Prescribed Fire activities allows the CEQA analysis to accurately account for and determine significance using realistic criteria. The Construction Emission model provides a more representative criterion to accurately account for and determine significance for Mechanical, Manual, Herbicide, and Herbivory activities under the VTP. While not all activities under the Construction Emission model fit perfectly, it provides a basis for the analysis under CEQA and is the best fit under the available models.	

Table 4.12-5 Summary of California Ambient Air Quality Standards by Local Air District

			Daily Threshold of Significance for CEQA Construction Projects (lbs/day)				
Air Basin	# of Cal Fire Units in District	AQMD or AQPD	Carbon Monoxide (CO)	Oxides of Nitrogen (NOx)	Volatile Organic Compounds (VOC)	Particulate Matter (PM10)	Particulate Matter (PM2.5)
North Coast	3	North Coast Unified	500	50	50	80	50
	1	Mendocino	125 TPY	54	54	82	54
	1	Northern Sonoma	125 TPY	54	54	82	54
Northeast Plateau	1	Siskiyou	500	50	50	80	50
	1	Modoc	500	50	50	80	50
	1	Lassen	500	50	50	80	50
Sacramento Valley	2	Shasta	*	137	137	137	*
	1	Tehama	*	137	137	137	*
	1	Glenn	*	137	137	137	*
	1	Butte	*	137	137	80	*
	1	Colusa					
	1	Feather River	*	25	25	80	*
	1	Yolo Solano	*	10 TPY	10 TPY	80	*
	1	Sacramento Metropolitan	*	85	*	*	*
Lake County	1	Lake	*	54	54	82	54
Mountain Counties	2	Northern Sierra	*	136	136	136	*
	1	Placer	*	82	82	82	*
	1	El Dorado	*	82	82	*	*
	1	Amador	*	82	82	384	*
	1	Calaveras	*	150	150	150	*
	1	Tuolumne	1,000	1,000	1,000	1,000	*
	1	Mariposa	*	136	136	136	*
San Francisco Bay	4	Bay Area	*	54	54	82	54
North Central Coast	2	Monterey Bay Unified	550	137	137	82	*
South Central Coast	1	San Luis Obispo	*	137	137	7	*
	1	Santa Barbara	*	240	240	80	*
	1	Ventura	*	25	25	*	*

Air Basin	# of Cal Fire Units in District	AQMD or AQPD	Carbon Monoxide (CO)	Oxides of Nitrogen (NOx)	Volatile Organic Compounds (VOC)	Particulate Matter (PM10)	Particulate Matter (PM2.5)
San Joaquin Valley	7	San Joaquin Valley Unified	100	10	*	15	15
Great Basin Valleys	2	Great Basin Unified	550	137	137	82	82
Mojave Desert	2	Mojave Desert	548	137	137	82	82
	1	Eastern Kern	*	137	137	*	*
	1	Antelope Valley	548	137	137	82	82
South Coast	5	South Coast	550	55	55	150	55
San Diego County	2	San Diego	550	250	137	100	*
Salton Sea	1	Imperial	550	55	55	150	*
	1	South Coast	550	55	55	150	55

Table 4.12-6 Daily Calculated Emission from Wildfire (assumes same acreage as treated by prescribed fire)

DAILY WILDFIRE EMISSIONS						
		tons/day				
			Particulate			
Formation	Acres/Day	Carbon Monoxide	PM 10	PM 2.5	VOC	NOx
TREE	433	2,224	234	210	158	33
SHRUB	433	599	78	67	64	14
GRASS	650	27	4	4	3	1
		2,850	316	281	224	48

Assumes same acres per day as prescribed fire, see Appendix H for further explantations. Calculator provided by Calfiornia Air Resources Board Coorcination and Communication for Natually Ignited Fires (2011).

4.12.2.3 Impact Analysis Methods

This environmental impact analysis quantifies CAPs and precursor emissions associated with each type of vegetation treatment activity proposed under the VTP. The five vegetation treatment activities considered are: prescribed fire, mechanical, manual, prescribed herbivory, and herbicides. Please refer to Section 4.1.4 of this EIR for a full description of these treatment types.

The VTP includes a mix of vegetation treatment activities that would be implemented by CAL FIRE Units. Units are organized to address fire suppression over a geographic area, and are divided by region--North or South. CAL FIRE has 21 Units; each Unit consists of one or more counties. As described in Chapter 2, Project Description, the CAL FIRE Units would annually propose a set of vegetation treatment projects. Individual projects, once implemented, would be complete and would not result in on-going emissions; however, as a program with a planning horizon of 10 years, emissions from VTP activities would occur each year at the rates described in Chapter 2, Project Description (i.e., an estimated 60,000 acres per year for 10 years). For purposes of this analysis, the annual emissions from proposed VTP activities are considered to be construction emissions because each project is temporary and geographically discrete, with no ongoing daily emissions after project completion. Therefore, the construction emission thresholds described above are used to make significance determinations for the VTP air quality impacts.

The VTP recognizes a baseline condition of 30,000 acres per year that have in the past been subjected to vegetation treatment activities and proposes a 100 percent increase in the acres to be treated, i.e., to 60,000 acres per year (see Chapter 2 for details). This analysis estimates emissions associated with treatment activities on a daily basis, in lb/day. The VTP breaks down the proposed 60,000 treatable acres by number of projects for each treatment activity, as well as by vegetation type (i.e., tree dominated, grass dominated, shrub dominated).

Because treatment activities related to the VTP are not traditional land use projects with construction and operational phases, typical computer modeling tools are not relevant to generate daily emission rates. Instead, the California Emissions Estimator Model (CalEEMod) version 2013.2.2 was used to derive one-hour emission factors in lb./day for mechanical equipment employed in the treatment activities. Emissions from the combustion of vegetation by prescribed fire were estimated by using CONSUME version 3.0. This model is designed to assist resource managers to estimate fuel consumption and pollutant emissions from prescribed fire, and wildfire, in major fuel types throughout the U.S. CONSUME was used to analyze emissions on the highest emission producing fuel type within each vegetation type. See Appendix H for a more detailed breakdown of both emission models.

Because of the statewide nature of this Program EIR, the analysis quantifies emissions of an estimated, typical 260-acre project for each of the five treatment activities under the VTP, accounting for any changes to the activity based on vegetation type. Typical project size was derived by information presented in the Project Description (Chapter 2) and Section 4.1. Based on the proposed total acreage, total number of projects by vegetation type, and percentage breakdown by treatment activities, the number of proposed projects and acres by treatment activity and vegetation type were calculated (See Table 4.12-7). Emissions in this analysis were derived from the calculations in Table 4.12-7 as well as from the varying types of equipment used and the number of worker trips involved in a typical treatment activity project. Emissions attributed to prescribed fire projects are reported and analyzed separately (see Table 4.12-9), accounting for both the prescribed fire emissions and the equipment emissions associated with the activity. To conservatively estimate emissions from prescribed fire projects, all projects were modelled as broadcast burn. Pile and burning projects would have lower emissions than those estimated in this analysis.

Table 4.12-7 Summary of Proposed Projects and Acreage by Treatment Activity and Vegetation Type

Vegetation Type	Projects*	Acres*
Prescribed Fire (50%)		
Tree-Dominated	40	10,384
Shrub-Dominated	28	7,199
Grass-Dominated	48	12,417
Total Prescribed Fire	**115**	**30,000**
Mechanical (20%)		
Tree-Dominated	16	4,154
Shrub-Dominated	11	2,880
Grass-Dominated	19	4,967
Total Mechanical	**46**	**12,000**
Manual (10%)		
Tree-Dominated	8	2,077
Shrub-Dominated	6	1,440
Grass-Dominated	10	2,483
Total Manual	**23**	**6,000**
Prescribed Herbivory (10%)		
Tree-Dominated	8	2,077
Shrub-Dominated	6	1,440
Grass-Dominated	10	2,483
Total Herbivory	**23**	**6,000**
Herbicides (10%)		
Tree-Dominated	8	2,077
Shrub-Dominated	6	1,440
Grass-Dominated	10	2,483
Total Herbicides	**23**	**6,000**
Total	**115**	**60,000**

* Not all numbers will total correctly due to rounding

Emissions were calculated to estimate the maximum daily emissions that could be generated in an air district if each CAL FIRE Unit simultaneously operated no more than five VTP projects and no more than one prescribed fire per unit. These numbers were chosen based on the maximum capacity of CAL FIRE to perform multiple projects at the Unit level. This analysis conservatively represents the highest concentration of projects that may occur under the VTP in a single air basin concurrently to avoid the risk of understating environmental impacts. The actual emissions on any day from implementation of the VTP would likely be less than those presented below. For more details regarding the specific assumptions used in quantifying these emissions, see Appendix H.

TAC emissions associated with vegetation treatment activities are also discussed qualitatively based on the potential for projects to result in increased exposure to sensitive receptors (e.g., residences, schools) to high concentrations of TACs. This discussion addresses the types of TAC-emitting activities that could occur, such as diesel PM from treatment activity equipment, NOA-containing fugitive dust emissions from treatment activities near sensitive receptors, and the potential for long-term exposure.

The potential for vegetation treatment activities to create objectionable odors affecting a substantial number of people is also discussed qualitatively with a focus on the types of odor sources, their intensity, and their proximity to sensitive receptors.

4.12.2.4 Impacts Analysis

The following discussion analyzes the significance of the VTP's potential air quality impacts. The four impacts analyzed below for each analysis are based on significance criteria established in Appendix G of the State CEQA Guidelines as well as quantitative thresholds established by various air districts throughout the state. See the Impacts Analysis Methods section above for more detail regarding significance criteria and quantitative thresholds used in this analysis.

IMPACT 1 – TREATMENT ACTIVITY-GENERATED EMISSIONS OF CRITERIA AIR POLLUTANTS AND PRECURSORS: CONSTRUCTION LIKE EMISSIONS

Construction emissions related to vegetation treatment projects under the VTP would be generated by all five vegetation treatment activities. Emissions generated from vegetation treated by prescribed fire are calculated separately in Impact 2 below. Table 4.12-8 summarizes the daily emissions of CAPs and precursors per air district based on number of CAL FIRE Units within the air district. Emissions are represented in lb./day below based on the assumptions outlined above (no more than 5 simultaneous projects per Unit).

Table 4.12-8 Summary of Maximum Expected Emissions (lb./day) by Air District based on number of CAL FIRE Units within the District.

Number of Units in an Air District	Carbon Monoxide (CO)	Oxides of Nitrogen (NOx)	Reactive Organic Gasses (ROG)*	Particulate Matter (PM10)	Particulate Matter (PM2.5)
7	30.44	29.76	4.57	6.13	2.90
4	16.84	17.53	2.63	3.44	1.67
2	10.10	10.91	1.58	2.11	1.05
1	5.05	5.45	0.79	1.05	0.52

Construction Emissions for Mechanical Equipment excluding Prescribed Fire

Vegetation treatment activities associated with the VTP would include using mechanical equipment (both light and heavy-duty) that would generate short-term exhaust emissions of ROG, NO_X, PM_{10}, and $PM_{2.5}$. Exhaust emissions would also be generated by worker commute trips. Fugitive dust emissions, including emissions of PM_{10} and $PM_{2.5}$, vary as a function of soil silt content, soil moisture, wind speed, and the area of disturbance. Dust emissions would be generated by ground disturbance and vegetation clearing strategies (i.e., plowing land, using rotary mowers, tractors to clear land), and operation of equipment on unpaved roadways and over open land. The following subsections go into more detail regarding emissions for each of the specific vegetation treatment activities.

Mechanical Treatment Activities

Mechanical treatment activities would include using heavy equipment to clear the land of vegetation. Equipment needed for this activity would include chisel plows, rotary mowers, chipping equipment, and crawler-type tractors. This equipment is expected to result in max daily emissions statewide of approximately 7 lb./day of ROG, 33 lb./day of CO, 59 lb./day of NO_X, 8 lb./day of PM_{10}, and 5 lb./day of $PM_{2.5}$. Assuming most of the work is done mechanically, crew sizes are smaller for this activity, and daily worker trip emissions would result in max daily emissions statewide of approximately 1 lb./day of ROG, 19 lb./day of CO, 1.6 lb./day of NO_X, 3.2 lb./day of PM_{10}, and 1 lb./day of $PM_{2.5}$. While the equipment mix for this treatment activity would include the use of heavier exhaust emitting equipment, average project duration would be longer and would range from two weeks to two months.

Manual Treatment Activities

Because manual treatment activities require larger crew sizes and the use of handheld power tools, there would be very few daily emissions from equipment. Most of the emissions would come from the need for larger crews and more cars to get to and from the project site. Daily worker trip emissions would account for approximately 4 lb./day of ROG, 18 lb./day of CO, 23 lb./day of NO_X, 3 lb./day of PM_{10}, and 1 lb./day of $PM_{2.5}$.

Prescribed Herbivory Treatment Activities

Prescribed herbivory treatment activities would involve hauling livestock to a project site to graze the vegetation targeted for treatment. The main equipment involved with this activity would be the use of trucks to carry the livestock to and from the site. Crew sizes tend to be smaller with this activity, needing on average only three workers onsite for the typical two week project. As a result, equipment and worker trip daily emissions are combined in the estimate method and would account for no more 1 lb./day of ROG, 5 lb./day of CO, 1 lb./day of NO_X, 1 lb./day of PM_{10}, and 1 lb./day of $PM_{2.5}$.

Herbicide Treatment Activities

Herbicide treatment activities would not involve the use of any exhaust-emitting, motorized equipment, because all herbicides are applied manually using backpack and/or bottle applicators. As a result, only worker trip emissions are calculated. With an average crew size of 15 workers per project, worker trip daily emissions would account for 1 lb./day of ROG, 14 lb./day of CO, 1 lb./day of NO_X, 2 lb./day of PM_{10}, and 1 lb./day of $PM_{2.5}$.

Summary of all Treatment Activities

Vegetation treatment activities associated with the VTP would include using mechanical equipment (both light and heavy-duty) that would generate short-term exhaust emissions of ROG, NO_X, PM_{10}, and $PM_{2.5}$. Exhaust emissions would also be generated by worker commute trips. Fugitive dust emissions, including emissions of PM_{10} and $PM_{2.5}$, vary as a function of soil silt content, soil moisture, wind speed, and the area of disturbance. Dust emissions would be generated by ground disturbance and vegetation clearing strategies (i.e., plowing land, using rotary mowers, tractors to clear land), and operation of equipment on unpaved roadways and over open land.

The maximum expected daily program level construction emissions of CAPs and precursors associated with vegetation treatment activities are summarized in Table 4.12-8. Under the methodology described above, daily construction emissions of CAPs and precursors from the four treatment activities, considered together, would not exceed the Significance Thresholds identified in Table 4.12-3 for project level emissions of

ROG, PM_{10}, $PM_{2.5}$, or CO. The maximum expected daily program level emissions of NOx would exceed the significance threshold only in the San Joaquin Valley Unified Air Quality Management District. The maximum expected daily emissions of NO_X would be compliant within the identified standards set by all other Air Districts.

Table 4.12-9 Detailed Summary of Maximum Expected Emissions (lb./day) by Air District based on number of CAL FIRE Units within the District.

Number of Units in an Air District	Type of Emissions	Carbon Monoxide (CO)	Oxides of Nitrogen (NOx)	Reactive Organic Gasses (ROG)	Pariculate Matter (PM_{10})	Pariculate Matter ($PM_{2.5}$)
7	Equipment Emissions	13.35	20.90	3.33	2.90	1.88
	Worker Trip Emissions	17.09	8.86	1.24	3.23	1.02
	Total Emissions	30.44	29.76	4.57	6.13	2.90
4	Equipment Emissions	7.95	12.49	1.97	1.74	1.13
	Worker Trip Emissions	8.90	5.05	0.67	1.70	0.54
	Total Emissions	16.84	17.53	2.63	3.44	1.67
2	Equipment Emissions	5.09	8.14	1.21	1.15	0.75
	Worker Trip Emissions	5.02	2.77	0.37	0.96	0.30
	Total Emissions	10.10	10.91	1.58	2.11	1.05
1	Equipment Emissions	2.54	4.07	0.61	0.58	0.37
	Worker Trip Emissions	2.51	1.38	0.19	0.48	0.15
	Total Emissions	5.05	5.45	0.79	1.05	0.52

These projected emissions would be minimized through the implementation of a number of SPRs. First, each project proposed by an Operational Unit would be required to calculate the proposed CAP emissions associated with proposed treatment activities and compare those emission levels with the thresholds of the local Air District (AIR-2). If the proposed emissions would not exceed the thresholds of the local Air District, then no significant impacts would occur. If the emissions exceed the thresholds, then according to SPR AIR-2, the project's construction related emissions would be subject to additional SPRs AIR-5 through AIR-11, as described below. Exhaust emissions from off-road heavy duty equipment would be reduced with SPRs AIR-10 and AIR-11, where equipment would be properly maintained and equipment greater than 50 hp would be required to not exceed 16 hours of equipment hours per day. In addition, fugitive dust PM_{10} and $PM_{2.5}$ emissions would be limited by the dust control measures required by SPRs AIR-5, AIR-6, AIR-7, and AIR-8. AIR-12 restricts the number of simultaneous projects that can occur in a unit based off the number of units in an air district. Further mitigations for projects in the San Joaquin Valley Unified Air Quality Management District are included in Mitigation Measure AIR-1 below.

Mitigation Measure AIR-1

To achieve compliance with local air district emission thresholds in the San Joaquin Valley Unified Air Quality Management District, simultaneously projects within that air district will be constrained to appropriate number as not to exceed air quality standards. As a result, the Program shall implement the following:

- CAL FIRE shall not allow more than 7 simultaneous treatment activities to occur in the San Joaquin Valley Unified Air Quality Management District.

Significance after Mitigation

Implementation of SPRs and Mitigation Measure AIR-1 (MM AIR-1) would reduce CAP and precursor emissions below the threshold set by each local air district (see Table 4.12-5), therefore the impact to air quality from VTP emissions are considered to be less **than significant.**

IMPACT 2 – TREATMENT ACTIVITY-GENERATED EMISSIONS OF CRITERIA AIR POLLUTANTS AND PRECURSORS: PRESCRIBED FIRE EMISSIONS

Fire emissions within the VTP account for the most significant emission source of the entire VTP. Prescribed fire emissions are comprised of equipment emissions and emissions from vegetation combustion. Table 4.12-10 summarizes the daily emissions of CAPs and precursors for one prescribed fire burning in each air basin simultaneously.

Table 4.12-10 Summary of maximum daily emissions from prescribed fire activity (includes fire and equipment emissions).

DAILY PRESCRIBED FIRE EMISSIONS						
		lbs/day				
			Particulate			
Formation	Acres/Day	Carbon Monoxide	PM 10	PM 2.5	VOC*	NOx**
TREE	433	771,345	95,336	78,001	286,002	185
SHRUB	433	268,670	34,667	34,667	156,000	73
GRASS	650	39,015	13,003	2	4	35
		1,079,030	143,006	112,670	442,006	293
		tons/day				
			Particulate			
Formation	Acres/Day	Carbon Monoxide	PM 10	PM 2.5	VOC*	NOx**
TREE	433	386	48	39	143	0.09
SHRUB	433	134	17	17	78	0.04
GRASS	650	20	7	0	0	0.02
		540	72	56	221	0.15

*VOC includes ROG **NOx Calculated using the EPA standard, CONSUME does not provide NOx value.

Emissions from Construction Related Activities

Prescribed fire treatment activities would include both pile and broadcast burning. Under the VTP, half of the proposed 60,000 acres per year is expected to be treated using prescribed fire, with the majority of prescribed fire treatments occurring in grass-dominated vegetation. Mechanical equipment needed for this activity would include tractors, as well as a variety of torches depending on the vegetation type. Helicopters are expected to be used on occasion for aerial burns in shrub-dominated areas. This equipment is estimated to result in daily emissions of approximately 7 lb./day of ROG, 55 lb./day of CO, 54 lb./day of NO_X, 10 lb./day of PM_{10}, and 1 lb./day of $PM_{2.5}$. Taking into account the number of workers needed on average per project and assuming that workers would carpool and each car would take one round trip a day to the project site (25 miles each way), daily emissions for all prescribed fire treatment activities would be approximately 221 tons/day of VOC, 540 tons/day of CO, 0.15 tons/day of NO_X, 72 tons/day of PM_{10}, and 56 tons/day of $PM_{2.5}$.

Emissions from Combustion of Vegetation

Prescribed fire has four major pollutants CO, PM_{10}, $PM_{2.5}$, and VOCs. The amount of emission produced by a prescribed fire is dependent upon the level of combustion that is occurring during the event. Emissions for fire are estimated for each vegetation type, taking into account the average fuel loads of the vegetation, or how much of the fuel would be consumed in the fire under specific conditions. The EPA uses a weighted average that assumes for their emission calculations that 33 percent of the time will be spend in a flaming phase, while 67 percent of the time will be spent in a smoldering phase. The total emissions from a project can be greatly reduced by achieving a longer flaming period and shorter smoldering duration.

It is important to note that the VTP impacts to CAPs and precursors may actually be less than what is described above. As described in Chapter 2, the purpose of the VTP program is to modify wildland fire behavior to help reduce losses to life, property, and natural resources. The intended outcome is to have less frequent, smaller (i.e., less acres burned), and shorter duration wildfires over time. Therefore, the emissions from the prescribed burning activities would to some degree be replacing and potentially reducing total emissions from wildfires that would occur to a greater degree and duration without fuel modification. While there is not currently a direct correlation between implementation of a vegetation treatment project and a proportionate reduction in numbers of fires or acres burned, it is reasonable to acknowledge that while the VTP program would result in substantial emissions of CAPs as a result of prescribed fire, it would likely result in some reduction in the numbers of fires and/or burned acres from wildfires and, therefore, would avoid some emissions associated with those fires. The

VTP also shifts those emissions to authorized burn days as determined by the local air district, limiting the air quality impacts of those emissions to sensitive receptors.

SPR AIR-12 requires a Smoke Management plan for projects that are 10 acres or are estimated to produce more than one ton of particulate matter. SPR AIR-3 requires that all burning be done in compliance with the local air district's burn authorization program. These SPRs will limit the use of prescribed fire to those times and locations that the air basin can accommodate the pollutant load without exceeding air quality thresholds.

Daily emissions of CAPs and precursors associated with prescribed fire vegetation treatment activities are summarized in Table 4.12-10. Under the methodology described above, daily emissions of CAPs and precursors from the prescribed fire emissions would not exceed the wildfire emissions set forth in Table 4.12-5 Daily Wildfire Emissions. As a result, this impact would be **less than significant**.

IMPACT 3 – EXPOSURE OF SENSITIVE RECEPTORS TO EXHAUST EMISSIONS OF TOXIC AIR CONTAMINANTS

Vegetation treatment activities that would be implemented under the VTP would not result in the operation of new stationary sources of TACs and would not include development of any new sensitive receptors (e.g., residences, schools, hospitals). Equipment emissions from certain treatment activities could, however, result in short-term exhaust emissions of diesel PM from on-site heavy-duty equipment such as plows, rotary mowers, and tractors used to clear land. Diesel PM has been identified as a TAC by ARB since 1998.

The dose to which receptors are exposed is the primary factor used to determine health risk (i.e., in this case, potential exposure to TAC emission levels that exceed SJVAPCD standards of increasing cancer contractions by 10 in 1 million people for the MEI and/or a noncarinogenic Hazard Index of 1 for the MEI). Dose is a function of the concentration of a substance in the environment and the duration of exposure to the substance. Dose is positively correlated with time, meaning that a longer exposure period would result in a higher exposure level for the exposed individual. Thus, the risks estimated for an exposed individual are higher if a fixed exposure occurs over a longer period. According to the Office of Environmental Health Hazard Assessment (OEHHA), Health Risk Assessments, which determine the exposure of sensitive receptors to TAC emissions, should be based on a 70-year exposure period; however, such assessments should be limited to the duration of exposure (2001). The use of motorized equipment for vegetation treatment activities under this VTP would be infrequent and temporary, meaning exhaust emissions from this equipment would dissipate with increasing distance from the source and exposure time would be limited (Zhu et al. 2002). Also, because of the nature of this program and the likelihood that treatment activities would occur in area that are less populated, rural, or undeveloped, it is not anticipated that mechanical equipment would operate at the same location for any extended length of time. Moreover, several of the SPRs would limit exposure of sensitive receptors to emissions of TACs from construction-related activities. SPR AIR-10 would limit operation time of large diesel or gasoline-powered activity equipment to 16 equipment-hours per day. SPR AIR-11 would ensure that all diesel and gasoline-powered equipment is properly maintained to comply with all state and federal emissions requirements. SPRs NSE-4 would require construction staging areas and construction activities to be located away from any nearby sensitive receptors, and SPR NSE-5 would reduce idling time of all motorized equipment to five minutes. For these reasons, treatment activity-related emissions of TACs would not expose sensitive receptors to substantial emissions of TACs and would not be expected to increase cancer contractions by 10 in 1 million people for the MEI and/or a non-carinogenic Hazard Index of 1 for the ME. As a result, this impact would be **less than significant**.

IMPACT 4 – EXPOSURE OF SENSITIVE RECEPTORS TO ODORS

Vegetation treatment activities could include the temporary generation of objectionable odors associated with diesel equipment exhaust. However, multiple SPRs would limit exposure of sensitive receptors to excessive levels of odorous emissions generated by vegetation treatment-related activities. SPR AIR-10 would limit operation time of large diesel or gasoline-powered construction equipment to 16 equipment-hours per day. SPR AIR-11 would also ensure that all diesel and gasoline-powered equipment are properly maintained to comply with all state and federal emissions requirements. SPR NSE-4 would require all heavy equipment and equipment staging areas to be located as far as possible from nearby sensitive receptors. Also, SPR NSE-5 would reduce idling time of equipment or trucks to five minutes. Further, treatment activities would occur in areas that are generally less populated, rural, or undeveloped. Because every treatment type project approved under this VTP would be subject to the above SPRs, all treatment activity-related odor sources would be sufficiently dispersed and would not be expected to adversely affect a substantial number of off-site receptors.

Furthermore, treatment activities approved under the VTP would not include the development of any new sensitive land uses or of any new major odor sources (e.g., wastewater treatment plant, landfill). Therefore, vegetation treatment activities would not result in exposure of a substantial number of people to objectionable odors. As a result, this would impact would be **less than significant**.

IMPACT 5 - EXPOSURE OF SENSITIVE RECEPTORS TO FUGITIVE DUST EMISSIONS CONTAINING NATURALLY OCCURRING ASBESTOS

As stated in the setting above, some areas of California contain serpentinite or other ultramafic rock and soil that could potentially contain NOA. These types of rock and soil contain thin veins of asbestos fibers that can become airborne when disturbed. Thus, vegetation treatment activities approved through this VTP could result in dust-generating activities in areas where NOA-containing materials are exposed at the surface, if they occur in areas where NOA is present. Re-entrainment of NOA-containing dust may result from ground disturbing activities during treatment activities, including vehicle travel on unpaved surfaces, plowing, mowing, and tractor use.

The CGS, formerly the California Department of Conservation Division of Mines and Geology published *A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos (*Churchill and Hill 2000*).* SPR AIR-9 requires that before any ground disturbing treatment activities take place, this publication, or any other recommendation by CGS at the time, be used to determine the risk for NOA at the treatment site. If, it is determined that NOA could be present at the project site, then SPR AIR-9 requires that an Asbestos Dust Control Plan be developed and implemented. The Asbestos Dust Control Plan would comply with Section 93105 of the California Health and Safety Code and would ensure appropriate controls are in place to reduce exposure to airborne NOA during vegetation treatment activities. Because all ground disturbing treatment activities would be subject to SPR AIR-9, the potential for sensitive receptors to be exposed to NOA would be minimized. As a result, this impact would be **less than significant**.

4.12.2.5 Level of significance after mitigation

Impacts from TAC emissions, NOA-containing fugitive dust emissions, and objectionable odors associated with the proposed vegetation treatment activities would be less than significant, so no mitigation would be required.

Construction emission would be less than significant in all air districts except the San Joaquin through the implementation of AIR-1, AIR-2, AIR-5, AIR-6, AIR-7, AIR-8, AIR 10, AIR-11 and AIR-12. Through the implementation of MM AIR-1 construction emission would be reduced below individual air quality district's thresholds of significance in all air basins, as a result impact on air quality would be **less than significant after mitigation.**

Through implementation of AIR-1, AIR-3, and AIR-4 no prescribed fire activities will allow be allowed to exceed overall daily air quality thresholds. As a result impact on air quality from prescribed fire emissions would be **less than significant after mitigation**.

4.12.2.6 Air Quality Impact Analysis for Alternatives Considered

Four alternatives are considered under this analysis: Alternative A: WUI Only, Alternative B: WUI and Fuel Breaks, Alternative C: Projects Limited to Very High Fire Hazard Severity Zones, and Alternative D: Treatments that Minimize Potential Impacts to Air Quality. Alternative A proposes to limit fuel reduction projects to WUI areas only, while Alternative B would combine Alternative A with the option to create fuel breaks outside of the WUI. Under Alternative C, vegetation treatment activities would be focused in areas with the highest hazard classification of very high fire hazard severity zones (VHFHSZ). Alternative D reduces the numbers of acres treated under the VTP to 36,000, by reducing the numbers of acres treated through prescribed fire activities by 80 percent.

For Alternatives A, B, and C, the scale of the project remains the same as the proposed VTP at 60,000 treated acres per year for ten years, with the same vegetation treatment activities by vegetation type expected to occur. Geographically, the areas expected to be treated are similar to that proposed under the VTP. Because the nature of treatment activities are expected to be the same and the scale of the program is similar to that of the VTP, it is reasonable to assume that emissions and impacts associated with the VTP would be similar under each of these alternatives. As a result, impacts from CAP emissions, TAC emissions, NOA-containing fugitive dust emissions, and objectionable odors from vegetation treatment activities under Alternatives A, B and C would have a similar impact to the project and would be required to implement the same SPR's and mitigation measures. Overall, impacts would be similar to the project for Alternatives A, B, and C.

Under Alternative D, the scale of the project would be reduced compared to the proposed VTP, from 60,000 acres to 36,000 acres treated per year for ten years. The same vegetation treatment activities by vegetation type are expected to occur, but a reduction in acres treated through prescribed fire treatments is proposed to reduce air quality impacts. The reduction in acres treated through prescribed fires would be reduced by 80 percent, or 24,000 acres as compared to the proposed VTP. Geographically, the areas expected to be treated are similar to that proposed under the VTP.

Because CAP emissions related to prescribed fire treatment activities are the highest for all treatment activities, it is reasonable to assume that a reduction of 80 percent, or 24,000 acres, under this Alternative would reduce emissions significantly. Emissions related to other treatment activities would be expected to be the same as the proposed VTP because the same number of acres are expected to be treated using mechanical, manual, prescribed herbivory, and herbicides treatment activities. As a result, overall impacts related to CAPs would be expected to be reduced.

While the number of acres has been reduced under Alternative D, the same type of treatment activities are expected to occur in the same areas, therefore impacts from TAC emissions, NOA-containing fugitive dust emissions, and objectionable odors would have similar impacts as the proposed VTP project and would be required to implement the same SPR's. Overall, Alternative D would result in less air quality impacts compared to the Proposed Program.

4.12.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

The following SPRs and mitigation measure are designed to minimize the air pollutant emissions that could be associated with implementation of projects under the VTP. These SPRs are based on emissions reduction measures required or recommended by air districts in California. Modeling further determined the level of emissions-generating activity (e.g., number of vehicle trips per day) that could result in exceedance of the most conservative mass emission thresholds established by air districts in California.

AIR-1: The project shall comply with all local, state, and federal air quality regulations and ordinances. The local Air Pollution Control District (APCD) or Air Quality Management District (AQMD) will be contacted to determine local requirements.

AIR-2: Prior to approval of an CAL FIRE Unit project under the VTP, the project coordinator shall model the project's Criteria Air Pollutant (CAP) emissions and compare the projected emissions levels to the thresholds identified by the local air district. If emissions levels exceed air district thresholds, consultation of the air district will occur.

AIR-3: In accordance with CCR Section 80160(b), all burn prescriptions shall require the submittal of a smoke management plan for all projects greater than 10 acres or are estimated to produce more than 1 ton of particulate matter. Burning shall only be done in compliance with the burn authorization program of the local air district having jurisdiction over the project area. Example of a smoke management plan is in Appendix J.

AIR-4: Fire emissions and fire behavior shall be planned, predicted, and monitored in accordance with SPRs FBE-1, FBE-2, and FBE-3 with the goal of minimizing air pollutant emissions.

AIR-5: Dust control measures shall be implemented in accordance with SPRs Hyd-9 with the goal of minimizing fugitive dust emissions.

AIR-6: The speed of activity-related trucks, vehicles, and equipment traveling on dirt areas shall be limited to 15 miles per hour (mph) to reduce fugitive dust emissions.

AIR-7: In areas where sufficient water supplies and access to water is available, all visible dust, silt, or mud tracked-out on to public paved roadways as a result of project treatment activities shall be removed at the conclusion of each work day, or at a minimum of every 24 hours for continuous fire treatment activities.

AIR-8: Ground-disturbing treatment activities, including land clearing and bull dozer lines, shall be suspended when there is a visible dust transport outside the project boundary.

AIR-9: Ground-disturbing treatment activities shall not be performed in areas identified as "moderately likely to contain naturally occurring asbestos (NOA)" according to maps and guidance published by the California Geological Survey (CGS), unless an Asbestos Dust Control Plan is prepared by the Operational Unit and approved by the air district(s) with jurisdiction over the project site. This determination would be based on a CGS publication titled *A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos* (Churchill and Hill 2000), or whatever more current guidance from CGS exists at the time the VTP project is evaluated. Any NOA-related guidance provided by the applicable local air district shall also be followed. If it is determined that NOA could be present at the project site, then an Asbestos Dust Control Plan shall be prepared and implemented in accordance with Title 17 of the Public Health CA Code of Regulations of Section 93105.

AIR-10: Operation of each large diesel- or gasoline-powered activity equipment (i.e., greater than 50 horsepower [hp]) shall not exceed 16 equipment-hours per day, where an equipment-hour is defined as one piece of equipment operating for one hour (daily CAPs, TACs, GHGs).

AIR-11: All diesel- and gasoline-powered equipment shall be properly maintained according to manufacturer's specifications, and in compliance with all state and federal emissions requirements. Maintenance records shall be available for verification.

AIR-12: A CAL FIRE Unit shall not conduct more than five simultaneous VTP activities on any day within an air district when multiple units reside within the same air district boundary. When a single CAL FIRE Unit resides within an air district boundary, one day total activity emission estimates will not exceed the current air district's Threshold of Significance. No more than one of these projects shall be a prescribed burn, unless additional prescribed burns have been approved by the local air district having authority over the project area.

Mitigation Measure AIR-1

To achieve compliance with local air district emission thresholds in the San Joaquin Valley Unified Air Quality Management District, simultaneously projects within that air district will be constrained to appropriate number as not to exceed air quality standards. As a result, the Program shall implement the following:

- CAL FIRE shall not allow more than seven simultaneous treatment activities to occur in the San Joaquin Valley Unified Air Quality Management District, regardless of the number of CAL FIRE units in the district.

Figure 4.12-4 California AQMD, APMD and CAL FIRE Units

4.13 AESTHETICS AND VISUAL RESOURCES

Aesthetics and Visual Resources have been broken up into three sections:

- **4.13.1 – Affected Environment**
  - The Affected Environment section discusses the resources that may be affected by the implementation of this proposed Program or its Alternatives.
- **4.13.2 – Effects**
  - The Effects section outlines the potential impacts of implementing the proposed Program and the Alternatives.
- **4.13.3 – Mitigations**
  - The Mitigation section provides the standard program requirements and project specific requirements that will reduce the likelihood of the proposed Program causing significant adverse impacts to aesthetic and visual resources.

4.13.1 AFFECTED ENVIRONMENT

This section discusses visual resources that could be affected by the proposed program. The visual resources analysis includes a discussion of viewsheds along highways that are designated or eligible for designation as scenic highways.

4.13.1.1 Background

Public and private lands contain many outstanding scenic landscapes. Visual resources in these landscapes consist of land, water, vegetation, wildlife, and other natural or manmade features visible on public lands. Vast areas of grassland, shrubland, canyon land, and mountain ranges on public lands provide scenic views to recreationists, visitors, adjacent landowners, and those just passing through. Roads, rivers, and trails on public lands pass through a variety of characteristic landscapes where natural attractions can be seen and where cultural modifications exist. Activities occurring on these lands, such as recreation, mining, timber harvesting, grazing, or road development, for example, have the potential to disturb the surface of the landscape and impact scenic and recreational values.

Visual importance of landscape elements is described with respect to their position relative to the viewer. Foreground elements are those features nearest to the viewer, and background elements are features at a great distance from the viewer. The middle ground of a view is intermediate between the foreground and background. Generally, for this analysis, the closer a resource is to the viewer, the more dominant and important it is to the viewer. Most of CAL FIRE’s vegetation projects are not discernible at far distances.

The aesthetic effects of a project are more likely to be significant if they are highly visible to large numbers of the public over an extended period of time. Projects occurring within sight of major roads or within the WUI may impact the aesthetics for large numbers of people. Projects that are adjacent to rural residential properties may impact only small numbers of people but over a longer period of time. Projects in remote portions of the landscape, behind locked gates, or obscured by vegetation or ridgelines are less likely to significantly impact aesthetics. Changes to views that are seen by limited numbers of people or for only limited duration may be found to be less than significant.

The magnitude of change necessary to create a significant impact to aesthetics is greater in a disturbed or non-unique environment than in a pristine or rare environment. In wildland environments, vegetation manipulation is not generally presumed to have a significant adverse effect on aesthetics, whereas the same treatment in a managed state park may be significant.

Projects that are small in size or minimal in their physical changes to the environment are unlikely to cause a significant impact to aesthetics. Aesthetic changes associated with an individual project under the proposed Program (approximately 260 acres) may appear significant, but in the context of the entire bioregion may be relatively minor. Treatments which remove the primary vegetation layer such as mechanical shrub removal or prescribed fire in chaparral will have a much greater impact than those treatments only affecting the understory. Changes to aesthetics where the visual change is minor may be found to be less than significant.

Based on these factors, aesthetic effects on a programmatic scale were analyzed by assessing which treatments by themselves have an adverse visual effect and then determining how much of these treatments would occur in the viewshed of scenic highways. In order to calculate the potential treatment acreage in the viewshed, it was assumed that treatments are proportionally distributed between the viewshed of scenic byways and the remainder of the landscape in the bioregion.

4.13.1.2 **Setting**

The proposed program for vegetation treatment will include projects that occur on private and state lands throughout California. It is assumed that visual impacts will be most noticeable from roads and trails. The duration of the impact to visual or aesthetic resources will vary with both the treatment type and with the vegetation being treated. For example, because treatments in tree vegetation retain the natural character of that vegetation type, it will not have as great an impact on visual or aesthetic resources as treatments in grass or shrub types (Figure 4.13-1).

Figure 4.13-1 Example of the visual changes to an area following a Fuel Reduction project near Pollock Pines, California in 2003.

California's extensive road system consists of over 23,000 miles of interstates and highways (Figure 4.13-1). Highways designated as scenic represent a small fraction of the total highway system, but should be considered most sensitive to visual impacts. California has over 2,000 miles of roadways that are officially designated as scenic (Caltrans, 2013). The California Scenic Highway Program was created by the California State Legislature in 1963 to preserve and protect scenic highway corridors from changes that would diminish the aesthetic value of lands adjacent to them. The scenic highway designation is based on how much of the natural landscape can be seen by travelers, the scenic quality of the landscape, and the extent to which development intrudes on travelers' enjoyment of the view (CalTrans, 2008). Table 4.13-2 provides a summary of the combined State and Federal miles of scenic roads by bioregion and an estimate of the viewshed area by vegetation type. The viewshed represents the visible area surrounding a scenic road, as interpreted from a Digital Elevation Model (DEM) and ignoring the influence of trees, buildings, or other possible obstructions. The viewshed analysis assumes a maximum viewing distance of two miles.

Table 4.13-1 Miles of Roads by Bioregion

Bioregion	Interstate	Highways	Total
Bay Area/Delta	1,706	1,416	3,123
Central Coast	433	1,152	1,586
Colorado Desert	527	805	1,332
Klamath/North Coast	547	1,693	2,240
Modoc	0	1,064	1,064
Mojave	768	1,279	2,047
Sacramento Valley	688	888	1,577
San Joaquin Valley	1,077	1,542	2,619
Sierra Nevada	346	2,558	2,904
South Coast	3,054	1,784	4,838
Total by Treatment	**9,146**	**14,182**	**23,328**

Table 4.13-2 Scenic Road Miles and View shed Acres by Vegetation Type

Bioregion	Scenic Road Miles	Viewshed Acres		
		Tree	Shrub	Grass
Bay Area/Delta	337	87,279	57,850	110,233
Central Coast	312	23,003	62,187	228,244
Colorado Desert	56	2,760	79,263	29
Klamath/North Coast	122	98,674	34,598	4,627
Modoc	260	181,755	18,266	1,891
Mojave	82	425	8,958	0
Sacramento Valley	0	0	0	0
San Joaquin Valley	83	17	0	10,312
Sierra Nevada	654	171,401	102,623	11,011
South Coast	190	16,598	23,114	4,673
Bioregion Totals	**2,097**	**581,910**	**386,860**	**371,020**
		Total Viewshed Acres		**1,339,790**

4.13.2 EFFECTS

This section will summarize the impacts to visual and aesthetic resources due to implementing either the Proposed Program or any of the Alternatives.

4.13.2.1 Significance and Threshold Criteria

According to Appendix G of the CEQA Guidelines: the CEQA Initial Study Environmental Checklist, an aesthetic impact would be considered significant if the Program and Alternatives would:

a) Have a substantial adverse effect on a scenic vista,
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway,
c) Substantially degrade the existing visual character or quality of the site and its surroundings,
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area.

Determination Threshold

Visual effects from the program would be considered significant if the acreage of treatments causing adverse and long term effects, as determined through the analysis process, exceeds more than 10 percent of the scenic byways viewshed acreage within that bioregion in any 10-year period.

4.13.2.2 Direct Effects Common to all Bioregions From Implementing the Program/Alternatives

Potential visual effects are determined by the aesthetics of the landscape after a treatment is completed – i.e., what is the condition and configuration of the remaining natural vegetation. Tree vegetation types normally have treatments that primarily remove understory vegetation and reduce overall density. Because treatments in this type retain most of the existing overstory canopy and retain the natural character of the vegetation type, visual effects from all treatments in tree vegetation types are considered less than significant.

A shrub or grass area blackened from prescribed fire or mechanically disturbed by heavy equipment within the viewshed of a scenic highway is considered a potentially significant effect. This effect would be short-term (less than two years) in grass but longer-term in shrub. It could take up to ten years for shrub types to visually recover from these treatments. Herbicides would have a similar effect resulting in standing dead vegetation. Herbivory and manual treatments do not result in a fire scarred landscape or ground disturbance from heavy equipment that can be aesthetically unappealing; therefor, changes in visual quality are less than significant.

Even though in shrub and grass types the project level effects from prescribed fire, mechanical, and herbicides are potentially significant impacts, they do not cover enough of the viewshed in each bioregion to be considered significant at the programmatic level. Table 4.13-3 shows the proportion of the scenic highway viewshed potentially affected by grass or shrub treatments for each bioregion. It is only in the Colorado Desert where over 10 percent of the total program acres in that bioregion may be shrub or grass treated acres in a viewshed (Table 4.13-3). For this bioregion, project planning should take into account the location and treatment activity choices to consider cumulative scenic viewshed impacts via the Project Scale Analysis.

Table 4.13-3 Percent of Program Acres That Are Affected Scenic View shed Acres

Bioregion	Total Program Acres	Shrub and Grass Vegetation Acres in Viewshed	Percent of Scenic Viewshed Affected
Bay Area/Delta	2,146,135	168,084	8%
Central Coast	3,263,733	290,430	9%
Colorado Desert	362,077	79,291	22%
Klamath/North Coast	4,270,334	39,225	1%
Modoc	2,629,835	20,157	1%
Mojave	942,962	8,958	1%
Sacramento Valley	866,478	0	0%
San Joaquin Valley	688,137	10,312	1%
Sierra Nevada	4,915,658	113,634	2%
South Coast	1,907,557	27,787	1%
Totals	**21,992,906**	**757,880**	**3%**

Given that for the majority of bioregions, shrub and grass viewshed acres are less than 2 percent of the overall potentially treated acres, it is unlikely that the acreage of prescribed fire, mechanical, or herbicides treatments causing aesthetic effects would exceed more than 10 percent of the scenic byways viewshed acreage within any bioregion in any 10-year period. The rest of the bioregions have too small a proportion of their scenic viewshed treated to cause a significant adverse effect at the program scale either annually or within a decade. The PSA may uncover project-specific aesthetic and visual impacts that are not detected at the scale of the bioregion. With the application of the SPRs below and in Chapter 2.5 and any PSRs identified through the PSA questions, effects to aesthetic and visual resources due to implementing the Proposed Program are likely to be **less than significant**.

As described in Section 4.12 Air Quality, prescribed fire could increase the amount of smoke in and adjacent to the treatment area. Smoke in the area could temporarily limit visibility and could modify views from scenic highways, state parks, and other visually important areas. For all prescribed burns, however, a burn plan will be required that includes a smoke management plan (SMP). The SMP will minimize public exposure to smoke generated by prescribed burns. Because only a small amount of smoke would remain in the treatment area for a short period during and after the prescribed burn, this impact is considered **less than significant** and no mitigation is required.

As described in Section 4.6 Archaeological, Cultural, and Historic Resources, protections are in place to reduce damage to scenic resources such as historic buildings via the use of CAL FIRE Archaeologists and the *Archaeological Review Procedures for CAL FIRE Projects* (Foster and Pollack, 2010). The impact to scenic resources of this type is considered **less than significant.**

Due to the activities described as part of the Proposed Program and Alternatives under this Program EIR, there would not be any new sources of substantial light or glare which would adversely affect day or nighttime views in the area. The land management activities described in this Program EIR would not involve the construction involving materials that may produce light or glare. This impact is considered **less than significant**.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant impacts to aesthetic and visual resources.

Alternative A would treat a smaller landscape as the Proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A would drastically reduce the number of prescribed fire and mechanical projects in grass or shrub, since any treated land would have to exist in the WUI area. Similarly, Alternative B would treat the same number of acres as the proposed Program across a smaller landscape, but only allow WUI and fuel break projects. The overlap of those project types, grass or shrub vegetation, a scenic viewshed and WUI area or fuel break need is unlikely to occur often, and Alternatives A and B would cause a less than significant impact to aesthetic and visual resources.

Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program. This Alternative would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because this Alternative would exclusively focus projects in areas of high hazard, the required overlap of prescribed fire or mechanical treatment, grass or shrub vegetation, a scenic viewshed, and VHFHSZ is unlikely to occur often. Alternative C will have a less than significant impact to aesthetic and visual resources.

Alternative D would treat the same landscape as the Proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. However, the reduction in prescribed fire is not replaced entirely by increases in other treatment methods, and so the overall visual impacts are less. Because of the overall smaller treatment area proposed, and with the mitigation measures proposed below, Alternative D would not result in significant aesthetic and visual resources impacts.

4.13.2.3 Similar Effects Described Elsewhere

Impacts to recreational resources are described in Section 4.8 and impacts to archaeological, cultural, and historic resources are described in Section 4.6.

4.13.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design. SPRs are required for shrublands in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, and San Bernardino counties.

AES-1: See **BIO-5** for shrublands in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, and San Bernardino counties.

BIO-5: Vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties shall:

- Be designed to prevent vegetation type conversion.
- Not take place in vegetation that has not reached the age of median fire return intervals.
- Not re-enter treatment areas for maintenance in an interval shorter than the median fire return interval outside of the wildland urban interface and excluding fuel break maintenance.
- Not take place in old-growth chaparral without consultation regarding the potential for significant impacts with the CDFW and the CNPS.
- Take into account the local aesthetics, wildlife, and recreation of the shrub-dominated subtype during the planning and implementation of the project.
- During the project planning phase provide a public workshop or public notice in a newspaper that is circulated locally describing the proposed project during the project planning phase for projects outside of the WUI. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

4.14 CLIMATE CHANGE/GREENHOUSE GAS

Vegetation treatment activities proposed by the VTP have the potential to generate greenhouse gas (GHG) emissions. This discussion presents a summary of applicable federal and state regulations, the current state of climate change science and GHG emissions sources in California, and a description of project-generated GHG emissions and their contribution to global climate change.

4.14.1 AFFECTED ENVIRONMENT

4.14.1.1 Regulatory Setting

4.14.1.1.1 Federal Plans, Policies, Regulations, and Laws

The U.S. Environmental Protection Agency (EPA) is the federal agency responsible for implementing the Clean Air Act (CAA). On April 2, 2007, the U.S. Supreme Court ruled that CO2 is an air pollutant as defined under the CAA, and that the EPA has the authority to regulate emissions of GHGs. In response to the mounting issue of climate change, EPA has taken the following actions to regulate, monitor, and potentially reduce GHG emissions.

PREVENTION OF SIGNIFICANT DETERIORATION AND TITLE V GREENHOUSE GAS TAILOR RULE

The CAA requires that new major stationary emissions sources and major modifications at existing stationary sources obtain an air pollution permit before commencing construction. On May 13, 2010, EPA issued the Prevention of Significant Deterioration and Title V Greenhouse Gas Tailor Rule (EPA 2011). This final rule sets thresholds for GHG emissions that define when permits under the New Source Review Prevention of Significant Deterioration (PSD) and Title V Operating Permit programs are required for new and existing industrial facilities.

PSD permitting requirements cover new construction projects that emit GHG emissions of at least 100,000 tons CO2e (90,718 MT) per year even if they do not exceed the permitting thresholds for any other pollutant. Modifications at existing facilities that increase GHG emissions by at least 75,000 tons (68,039 MT) per year will be subject to permitting requirements, even if they do not significantly increase emissions of any other pollutant. Title V Operating Permit requirements apply to sources based on their GHG emissions even if they would not apply based on emissions of any other pollutant. Facilities that emit at least 100,000 tons (90,718 MT) per year of CO2e will be subject to Title V permitting requirements.

As part of this rule, the U.S. EPA undertook another rulemaking on June 29, 2012. This action issued a final rule that continues to focus permitting on the largest emitters. The U.S. EPA did not revise the GHG permitting thresholds that were established by the GHG Tailoring Rule. Therefore, at this time, PSD and Title V permitting requirements are not applicable to additional, smaller sources of GHG emissions (EPA 2011).

MANDATORY GREENHOUSE GAS REPORTING RULE

On September 22, 2009, EPA issued a final rule for mandatory reporting of GHGs from large GHG emissions sources in the United States. In general, this national reporting requirement will provide EPA with accurate and timely GHG emissions data from facilities that emit 25,000 metric tons (MT) or more of CO_2 per year. This publicly available data will allow the reporters to track their own emissions, compare them to similar facilities, and aid in identifying cost-effective opportunities to reduce emissions in the future. Reporting is at the facility level, except that certain suppliers of fossil fuels and industrial greenhouse gases along with vehicle and engine manufacturers will report at the corporate level. An estimated 85 percent of the total U.S. GHG emissions, from approximately 10,000 facilities, are covered by this final rule.

ENERGY POLICY AND CONSERVATION ACT

On September 15, 2009, EPA and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) proposed a new national program that would reduce GHG emissions and improve fuel economy for all new cars and trucks sold in the United States. EPA proposed the first-ever national GHG emissions standards under the CAA, and NHTSA proposed Corporate Average Fuel Economy standards under the Energy Policy and Conservation Act. This proposed national program would allow automobile manufacturers to build a single light-duty national fleet that satisfies all requirements under both federal programs and the standards of California and other states.

ENDANGERMENT AND CAUSE OR CONTRIBUTE FINDINGS

On December 7, 2009, EPA adopted its Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the CAA (Endangerment Finding). The Endangerment Finding is based on Section 202(a) of the CAA, which states that the Administrator (of EPA) should regulate and develop standards for "emission[s] of air pollution from any class or classes of new motor vehicles or new motor vehicle engines, which in [its] judgment cause, or contribute to, air pollution that may reasonably be anticipated to endanger public health or welfare." The rule addresses Section 202(a) in two distinct findings. The first addresses whether or not the concentrations of the six key GHGs (i.e., CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) in the atmosphere threaten the public health and welfare of current and future generations. The second addresses whether or not the combined emissions of GHGs from new motor vehicles and motor vehicle engines contribute to atmospheric concentrations of GHGs and, therefore, the threat of climate change.

The Administrator found that atmospheric concentrations of GHGs endanger the public health and welfare within the meaning of Section 202(a) of the CAA. The evidence supporting this finding consists of human activity resulting in “high atmospheric levels” of GHG emissions, that are very likely responsible for increases in average temperatures and other climatic changes. Furthermore, the observed and projected results of climate change (e.g., higher likelihood of heat waves, wild fires, droughts, sea-level rise, and higher intensity storms) are a threat to the public health and welfare. Therefore, GHGs were found to endanger the public health and welfare of current and future generations.

The Administrator also found that GHG emissions from new motor vehicles and motor vehicle engines are contributing to air pollution, which is endangering public health and welfare. EPA’s final findings respond to the 2007 U.S. Supreme Court decision that GHGs fit within the CAA definition of air pollutants. The findings do not in and of themselves impose any emission reduction requirements but rather allow EPA to finalize the GHG standards proposed earlier in 2009 for new light-duty vehicles as part of the joint rulemaking with the U.S. Department of Transportation.

TASK FORCE ON CLIMATE PREPAREDNESS AND RESILIENCE

Activities are already underway across the Federal Government to build adaptive capacity and increase resilience to climate change. These activities include efforts to improve understanding of climate science and impacts, to incorporate climate change considerations into policies and practices, and to strengthen technical support and capacity for adaptive decision making. Some efforts are large collaborative undertakings involving Federal and non-Federal partners while others are smaller and at the program-level. On November 1, 2013, President Obama signed an Executive Order that established a Task Force on Climate Preparedness and Resilience, made up of state, local, and tribal leaders across the country to advise the Administration on how the Federal Government can respond to the needs of communities nationwide that are dealing with the impacts of climate change (CEQ 2013).

4.14.1.1.2 State Plans, Policies, Regulations, and Laws

ARB coordinates and oversees State and local air pollution control programs in California and implements the California Clean Air Act (CCAA), which was adopted in 1988. Various statewide initiatives are aimed to reduce the State’s contribution to GHG emissions.

EXECUTIVE ORDER S-3-05

In 2005, Governor Schwarzenegger signed Executive Order S-3-05, which proclaims that California is vulnerable to the impacts of climate change due to increased temperatures that could reduce the Sierra Nevada snowpack, exacerbate California's air quality problems, and potentially cause a rise in sea level. The executive order established total GHG emission targets to combat these concerns. Specifically, emissions are to be reduced to the 2000 level by 2010, the 1990 level by 2020, and to 80 percent below the 1990 level by 2050.

ASSEMBLY BILL 32: THE CALIFORNIA GLOBAL WARMING SOLUTIONS ACT OF 2006

In September 2006, Governor Arnold Schwarzenegger signed AB 32, the California Global Warming Solutions Act of 2006. AB 32 establishes regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and a cap on statewide GHG emissions. It requires that statewide GHG emissions be reduced to 1990 levels by 2020. This reduction will be accomplished through an enforceable statewide cap on GHG emissions that began in 2012. To effectively implement the cap, AB 32 directs ARB to develop and implement regulations to reduce statewide GHG emissions from stationary sources.

AB 32 requires that ARB adopt a quantified cap on GHG emissions that represents 1990 emissions levels and to disclose how it arrived at the cap; institute a schedule to meet the emissions cap; and develop tracking, reporting, and enforcement mechanisms to ensure that the State achieves the reductions in GHG emissions necessary to meet the cap. AB 32 also includes guidance to institute emissions reductions in an economically efficient manner and conditions to ensure that businesses and consumers are not unfairly affected by the reductions.

AB 32 CLIMATE CHANGE SCOPING PLAN AND FIRST UPDATE

In December 2008, ARB adopted its Climate Change Scoping Plan, which contains the main strategies California will use to reduce GHGs. These strategies proposed a reduction of 169 MMT of CO_2e, or approximately 28 percent from the State's projected 2020 emission level of 596 MMT of CO_2e under a business-as-usual scenario. This equates to a 2020 emissions limit (or 1990 level) of 427 MMT of CO2e. These targets were approved by the Board in December 2007 (ARB 2008).

ARB's original 2020 business-as-usual projection was revised to 545 MMT of CO2e, to better take into account the economic downturn that occurred in 2008 (ARB 2011: p.1). In August 2011, the Scoping Plan was re-approved by ARB, and includes the Final Supplement to the Scoping Plan Functional Equivalent Document (FED), which further-examined various alternatives to Scoping Plan measures. The Scoping Plan also includes ARB-recommended GHG reductions for each emissions sector of the State's GHG inventory. ARB estimates the largest reductions in GHG emissions to be achieved by implementing the following measures and standards (ARB 2011: p.2-3):

- Improved emissions standards for light-duty vehicles (estimated reductions of 26.1 MMT CO2e)
- The Low-Carbon Fuel Standard (15.0 MMT CO2e)
- Energy efficiency measures in buildings and appliances (11.9 MMT CO2e)
- A renewable portfolio and electricity standards for electricity production (23.4 MMT CO2e)

The First Update to the Climate Change Scoping Plan was approved by the ARB Board on May 22, 2014. This first update builds upon the initial Scoping Plan with new strategies and recommendations. It defines ARB's climate change priorities for the next five years, and also sets the groundwork to reach long-term goals set forth in Executive Order S-3-05. The update also highlights California's progress toward meeting the 2020 GHG emissions reduction target. Additionally, due to the fact that most national and international climate change organizations are moving to IPCC's Fourth Assessment Report, which updated the global warming potential of GHGs, especially methane and HFCs, ARB is proposing to update the number for the 2020 limit, from 427 to 431 MMT of CO2e, which is a one percent increase from the 427 MMT CO2e limit adopted by the Board in 2007 and outlined in the original Scoping Plan (ARB 2014b: p. 92).

The Scoping Plan and First Update both recognize the role of California's Natural and Working Lands (previously the Forest Sector) in meeting California's GHG reduction goals. These lands include both forests and rangelands and can act as both source and sink, with the levels of each fluctuating widely from year to year based on climatic and biotic factors that impact vegetative growth. The First Update recognizes that some actions taken to address ecosystem health may result in temporary, short-term reductions in sequestration but are necessary to maintain forest health and reduce losses due to wildfire. The goals set forward for these landscapes include prevented conversion to other uses and reducing vegetative fuels.

EXECUTIVE ORDER S-1-07

Executive Order S-1-07 was signed by Governor Schwarzenegger in 2007, and proclaims that the transportation sector is the main source of GHG emissions in California, at over 40 percent of statewide emissions. It establishes a goal that the carbon intensity of transportation fuels sold in California should be reduced by a minimum of 10 percent by 2020. This order also directed ARB to determine whether this Low Carbon Fuel Standard could be adopted as a discrete early action measure after meeting the mandates in AB 32. ARB adopted the Low Carbon Fuel Standard on April 23, 2009.

CAL FIRE GHG EMISSIONS REDUCTION STRATEGIES

CAL FIRE is a member of the Governor's Climate Action Team and has been implementing actions to reduce and mitigate GHG emissions. Activities include reforestation, forest conservation, forest health management, fuels management and biomass electricity generation, and urban forestry. CAL FIRE has coordinated with ARB during the preparation and update of the Scoping Plan to identify GHG reduction strategies for the Forestry Sector. Strategy descriptions, status, projected GHG reductions, costs, and co-benefits have been prepared and regularly reviewed for updating according to new models and information (CAT 2008).

Beginning in 2014, CAL FIRE has been allocating grants for GHG reduction projects through the Greenhouse Gas Reduction Fund (GGRF). Examples of projects financed by GGRF grants include forest health improvements, fuel hazard reduction, carbon sequestration projects, reforestation of degraded land, and conservation of forest land. The goal of the program is to help California forests continue to serve their carbon storage ecosystem function (CAL FIRE 2015).

SENATE BILL 1368

SB 1368 is the companion bill of AB 32 and was signed by Governor Schwarzenegger in September 2006. SB 1368 required the California Public Utilities Commission (CPUC) to establish a GHG performance standard for base load generation from investor-owned utilities by February 1, 2007. The California Energy Commission (CEC) was required by SB 1368 to establish a similar standard for local publicly owned utilities by June 30, 2007. These standards could not exceed the GHG emission rate from a base load combined-cycle natural gas–fired plant. The legislation further requires that all electricity provided to California, including imported electricity, must be generated from plants that meet the standards set by the CPUC and CEC.

SENATE BILL 1078 AND 107 AND EXECUTIVE ORDER S-14-08

SB 1078 (Chapter 516, Statutes of 2002) requires retail sellers of electricity, including investor-owned utilities and community choice aggregators, to provide at least 20 percent of their supply from renewable sources by 2017. SB 107 (Chapter 464, Statutes of 2006) changed the target date to 2010. In November 2008, Governor Schwarzenegger signed Executive Order S-14-08, which expands the State's Renewable Energy Standard to 33 percent renewable power by 2020.

SENATE BILL 97

As directed by SB 97, the Natural Resources Agency adopted amendments to the State CEQA Guidelines for GHG emissions on December 30, 2009. On February 16, 2010, the Office of Administrative Law approved the amendments, and filed them with the Secretary of State for inclusion in the California Code of Regulations. The amendments became effective on March 18, 2010, and require analysis of a projects impact on climate change and greenhouse gas for CEQA compliance.

SENATE BILL 375

SB 375, signed in September 2008, aligns regional transportation planning efforts, regional GHG emission reduction targets, and land use and housing allocation. SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS), which will prescribe land use allocation in that MPO's Regional Transportation Plan (RTP). ARB, in consultation with MPOs, will provide each affected region with reduction targets for GHGs emitted by passenger cars and light trucks in the region for the years 2020 and 2035. These reduction targets will be updated every eight years, but can be updated every four years if advancements in emissions technologies affect the reduction strategies to achieve the targets. ARB is also charged with reviewing each MPO's SCS or APS for consistency with its assigned targets. If MPOs do not meet the GHG emission reduction targets, transportation projects would not be eligible for funding programmed after January 1, 2012.

EXECUTIVE ORDER S-13-08

Sea-level rise is a foreseeable indirect environmental impact associated with climate change, largely attributable to thermal expansion of the oceans and melting polar ice. As discussed above in the environmental setting (subheading “Adaptation to Climate Change”), sea-level rise presents impacts to California associated with coastal erosion, water supply, water quality, saline-sensitive species and habitat, land use compatibility, and flooding. Arnold Schwarzenegger signed Executive Order S-13-08 on November 14, 2008. This executive order directed the California Natural Resources Agency (CNRA) to develop the 2009 California Climate Adaptation Strategy (CNRA 2009)), which summarizes the best known science on climate change impacts in seven distinct sectors—public health, biodiversity and habitat, ocean and coastal resources, water management, agriculture, forestry, and transportation and energy infrastructure—and provides recommendations on how to manage against those threats. This executive order also directed OPR, in cooperation with the CNRA, to provide land use planning guidance related to sea-level rise and other climate change impacts by May 30, 2009, which is also provided in the 2009 California Climate Adaptation Strategy (CNRA 2009) and OPR continues to further refine land use planning guidance related to climate change impacts.

Executive Order S-13-08 also directed CNRA to convene an independent panel to complete the first California Sea-Level Rise Assessment Report. This report is to be completed no later than December 1, 2010. The report is intended to provide information on the following:

- Relative sea-level rise projections specific to California, taking into account issues such as coastal erosion rates, tidal impacts, El Niño and La Niña events, storm surge, and land subsidence rates
- The range of uncertainty in selected sea-level rise projections
- A synthesis of existing information on projected sea-level rise impacts to State infrastructure (such as roads, public facilities and beaches), natural areas, and coastal and marine ecosystems
- A discussion of future research needs regarding sea-level rise for California

All State-funded construction projects in areas vulnerable to sea-level rise will consider a range of sea-level rise scenarios for the years 2050 and 2100. The scenarios should assess projected sea-level rise vulnerability and develop methods to reduce foreseeable incompatibilities (i.e., risks). However, this planning process is voluntary for projects that have filed a Notice of Preparation on or before November 14, 2008, are programmed for construction funding during the next five years, or are considered routine maintenance projects.

CALIFORNIA CLIMATE ADAPTATION STRATEGY

California's overall plan for climate adaptation is expressed in Safeguarding California (CNRA 2014). The plan provides policy guidance for state decision-makers, and is part of continuing efforts to reduce impacts and prepare for climate risks. This plan, which updates the 2009 California Climate Adaptation Strategy (CNRA 2009), highlights climate risks in nine sectors in California, discusses progress to date, and makes realistic sector-specific recommendations. One of the key sectors is forestry, where the emphasis is on preparing for increased wildfire hazards, including treatment of hazardous fuels, and improving forest management approaches in a changing climate (CNRA 2014).

CAL FIRE CLIMATE ADAPTATION STRATEGIES

Climate risk projections indicate a substantial increase in the risk of wildfires as a result of climate change. Forests are vulnerable to climate impacts, additional to increased fires, such as drought stress, invasive species, and changes in forest productivity. Efforts to implement forest adaptation are important to both ecosystem values (such as wildlife habitat, watersheds and streams, clean air and water, and soils) and human values (such as property, life safety, and wood products). Extensive research has been conducted by CAL FIRE, other state agencies, universities, and the federal government to understand forest- and rangeland-related climate risks and potential adaptation approaches. Identification and evaluation of CAL FIRE's adaptation strategies are included the Fire and Resource Assessment Program (FRAP). The 2010 FRAP assessment describes recommendations for climate threats and opportunities, including carbon sequestration, assessment of climate vulnerabilities, and protection of ecosystem functions of healthy forest and rangeland (FRAP 2010).

EXECUTIVE ORDER B-30-15

On April 29, 2015, Governor Brown signed Executive Order B-30-15 to establish a GHG reduction target of 40 percent below 1990 levels by 2030. This is set as an interim target for reaching the ultimate goal of reducing statewide GHG emissions to 80 percent below 1990 levels by 2050, as established by Executive Order S-3-05 (discussed above). Executive Order B-30-15 directs state agencies with jurisdiction over sources of GHG emissions to implement measures, within their statutory authority, to meet these targets. To monitor the progress towards these goals, the California Natural Resources Agency is directed to update the state's climate adaptation strategy, Safeguarding California, every three years.

4.14.1.2 Environmental Setting

GHG emissions have the potential to adversely affect the environment because such emissions contribute, on a cumulative basis, to global climate change. A discussion of cumulative impacts is the proper context for CEQA analysis, because although emissions of one single project would not result in global climate change, GHG emissions from multiple projects around the world could result in a cumulative impact with respect to global climate change. In turn, global climate change has the potential to result in rising sea levels, which can inundate low-lying areas; to affect rainfall and snowfall, leading to changes in water supply; to affect habitat, leading to adverse effects on biological resources; and to change the frequency and duration of droughts, which can affect wildfire hazards and forest health.

Cumulative impacts are the collective impacts of one or more past, present, and future projects, that, when combined, result in adverse changes to the environment. Although the impact of GHGs is inherently cumulative, it is different from typical cumulative impact analyses. GHG emissions are generated by anthropogenic (i.e., human-made) and biogenic (i.e., natural-process) sources throughout the world, and no project alone would reasonably contribute to a noticeable change to global climate change. However, legislation and executive orders on the subject of climate change in California have established a statewide context for and a process for developing an enforceable statewide cap on GHG emissions. Given the nature of environmental consequences from GHGs and global climate change, CEQA requires that lead agencies consider evaluating the cumulative impacts of GHGs, even relatively small (on a global basis) additions. Small contributions to this cumulative impact (from which significant effects are occurring and are expected to worsen over time) may be potentially considerable and significant. Therefore, this issue is presented at some depth, and focuses on the potential contribution to this global impact from the types of treatment activities and treatment types that could be implemented under the VTP.

4.14.1.2.1 Attributing Climate Change – Physical Science Basis

In the earth's atmosphere, certain gases classified as GHGs, play a critical role in determining the earth's surface temperature. Solar radiation enters the earth's atmosphere from space, with a portion of the radiation absorbed by the earth's surface, and a smaller portion of this radiation reflected back towards space. Radiation absorbed by the earth's surface is then emitted from the earth as low-frequency infrared radiation. The frequencies at which bodies emit radiation are proportional to temperature. The earth has a much lower temperature than the sun; therefore, the earth emits lower frequency radiation. Most solar radiation passes through GHGs; however, infrared radiation is absorbed by these gases. As a result, radiation that otherwise would have escaped back into space is instead "trapped," resulting in a warming of the atmosphere. This phenomenon, known as the greenhouse effect, is responsible for maintaining a habitable climate on Earth. Without the greenhouse effect, Earth would not be able to support life as we know it.

Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a trend of unnatural warming of the earth's climate, known as global climate change or global warming. Climate scientists agree that global warming trends and other shifts in the climate system observed over the past century are almost certainly attributed to human activities and are proceeding at a rate that is unprecedented when compared with climate change that human society has lived through to date (ARB 2014b).

Climate change is a global problem. Unlike criteria air pollutants and toxic air contaminants, GHGs are global pollutants that are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (about one day), GHGs have long atmospheric lifetimes (one year to several thousand years). GHGs persist in the atmosphere for long enough time periods to be dispersed around the globe. Although the exact lifetime of any particular GHG molecule is dependent on multiple variables and cannot be pinpointed, it is understood that more CO2 is emitted into the atmosphere than is sequestered by ocean uptake, vegetation, and other forms of sequestration. Of the total annual human-caused CO2 emissions, approximately 54 percent is sequestered through ocean uptake, uptake by northern hemisphere forest regrowth, and other terrestrial sinks within a year, whereas the remaining 46 percent of human-caused CO2 emissions remains stored in the atmosphere (Seinfeld and Pandis 1998).

Similarly, impacts of GHGs are borne globally, as opposed to localized air quality effects of criteria air pollutants and toxic air contaminants. The quantity of GHGs that it takes to ultimately result in climate change is not precisely known; suffice it to say, the quantity is enormous and no single project alone would measurably contribute to a noticeable incremental change in the global average temperature, or to global, local, or micro climate. From the standpoint of CEQA, GHG impacts related to global climate change are inherently cumulative.

4.14.1.2.2 Attributing Climate Change – Greenhouse Gas Emission Sources

Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with transportation, industrial/manufacturing, utility, residential, commercial and agricultural emissions sectors (ARB 2014a).

Emissions of CO2 are byproducts of fossil fuel combustion. CH4, a highly potent GHG, results from off-gassing (the release of chemicals from nonmetallic substances under ambient or greater pressure conditions) is largely associated with agricultural practices and landfills. N2O is also largely attributable to agricultural practices and soil management. CO2 sinks, or reservoirs, include vegetation and the ocean, and absorb CO2 through sequestration and dissolution, respectively, two of the most common processes of CO2 sequestration.

CO2 equivalent (CO2e) is a measurement used to account for the fact that different GHGs have different potential to retain infrared radiation in the atmosphere and contribute to the greenhouse gas effect. This potential, known as the global warming potential of a GHG, is dependent on the lifetime, or persistence, of the gas molecule in the atmosphere. For example, as described in Appendix C, Calculation References, of the General Reporting Protocol of the California Climate Action Registry (CCAR), now called The Climate Registry (CCAR 2009); 1 ton of CH4 has the same contribution to the greenhouse effect as approximately 21 tons of CO2. Therefore, CH4 is a much more potent GHG than CO2. Expressing emissions in CO2e takes the contributions of all GHG emissions to the greenhouse effect and converts them to a single unit equivalent to the effect that would occur if only CO2 were being emitted.

4.14.1.2.3 State Greenhouse Gas Emission Inventory

The California Air Resource Board (ARB) is responsible for maintaining and updating California's GHG Inventory. The latest edition was completed in May 2014 and includes emissions estimates for the years 2000 to 2012. Based on the California GHG Inventory, California produced 459 million metric tons (MMT) of CO2e in 2012. This translates to a decrease of 1.7 percent from 2000 to 2012, with emissions 2012 increasing for the first time since 2007. This increase was driven largely by the increased natural gas-generation of in-state electricity due to the closure of the San Onofre Nuclear Generating Station as well as dry hydrological conditions in 2012 causing a drop in the in-state hydropower generation (ARB 2014b). While, emissions have decreased over the years, the transportation sector is still the largest emitter of

GHGs in 2012, accounting for 37 percent of emissions. Industrial and electricity generation (in state and imports) are the next highest emitter, accounting for 22 percent and 21 percent, respectively (ARB 2014a). Aside from the electric power sector, which increased from the previous year, emissions from all other sectors have remained relatively constant since 2000 (ARB 2014b).

4.14.1.2.3.1 Wildfire versus Prescribed Fire Emissions

Similar to the discussion about emissions relating to Air Quality in Section 4.12, greenhouse gasses emissions are also effected by the combustion process. Revisiting AP 42, the efficiency or inefficiency of the combustion process can directly affect the emissions produced; with the flaming phase being the most efficient creating minimal emissions and the smoldering phase being the least efficient creating substantially more emissions. Fuel consumption during the smoldering phase is greatest when fuel moisture is low, and is minimized when fuel moistures are high as fires generally extinguish rapidly in these conditions. In general, the net emissions from prescribed fire are considered to be of relatively smaller quantity than those that would be produced by wildfire (EPA 1995). See Section 4.12.1.2.6 for further discussion.

4.14.2 EFFECTS

4.14.2.1 Significance and Threshold Criteria

For this analysis, significance criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines. Based on the following, GHGs or climate change impacts are considered significant if implementation of the VTP would do any of the following:

1) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment; or
2) Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases; or
3) Result in a substantial increase in vulnerability of lands in CAL FIRE's responsibility area due to the effects of climate change.

An individual project typically does not generate enough GHG emissions by itself to significantly influence global climate. However, a project participates in this potential cumulative impact to the extent that its incremental contribution combined with the related contributions of other sources of GHGs, when taken together, result in global climate changes.

Only a few of the 35 air districts in California (i.e., including air quality management districts and air pollution control districts) have established thresholds of significance for

GHG emissions generated by construction projects or stationary sites. The Sacramento Metropolitan Air Quality Management District (SMAQMD) has established quantitative thresholds for operational GHG emissions from projects in its jurisdiction regardless of the lead agency. The SMAQMD Board of Directors adopted GHG thresholds on October 23, 2014, via resolution AQMD2014-028, creating a screening-level threshold of 1,100 CO2e per year for land development and construction projects (SMAQMD 2014a). The South Coast Air Quality Management District (SCAQMD) adopted an interim GHG threshold of significance in 2008 for projects where SCAQMD is the lead agency (SCAQMD 2008). These thresholds were determined to be inappropriate for vegetation management projects in the WUI and wildlands that do not impact the underlying vegetative site productivity.

One of the primary challenges in establishing a reasonable threshold and determining impacts relate to the enactment of AB 32 and other GHG-reduction legislation described in the Regulatory Environment section above is the lack of statewide standards. As previously described, much of the legislation requires ARB and others to establish standards that relate to energy efficiency, carbon levels in fuels, stationary-source emissions, and regional transportation planning (i.e., SB 375). These standards are still being developed and have not yet been implemented. No standards have yet been established for hazardous fuel reduction projects that address wildfire risk reduction such as those proposed by the VTP.

While there are no statewide, adopted significance criteria applicable to GHG emissions, CEQA still requires a good faith evaluation of GHGs when determining a project's significant effects on the environment.

THRESHOLDS

Potential climate change and GHG impacts from the VTP come from three kinds of emission producing categories: equipment emissions, herbivore related emissions, and prescribed fire emissions. Construction emissions encompass the emissions from the mechanical and manual equipment necessary to conduct VTP projects as well as the worker trip emissions caused by transportation of work crews and equipment. Emissions from herbivores occur as a result of their digestive and waste processes. Prescribed fire emissions are those expected from combustion of vegetation and comprise the vast majority of the GHG emissions expected to be caused by the VTP.

As discussed above, GHGs have the potential to mix and circulate worldwide making the spatial scale of a meaningful analysis difficult to define. Analyzing the project at the largest possible scale of accumulation, globally, would dilute the impacts of the project considering there was an estimated 35,419 Million Metric Tons (MMT) of CO_2e released to the atmosphere in 2013 (CDIAC, 2013). At the national level, the United States contributed over 15% of the worldwide total GHGs in 2013, approximately 6,673 MMT of CO_2e (EPA, 2013). As discussed above, there are plans and policies to reduce GHGs at the national level, but no thresholds have been established, and this was judged to also be too large of a scale for proper analysis. The State of California has a number of plans and policies in place designed to reduce GHG emissions, most notably the Global Warming Solutions Act of 2006 and the latest overall plan for climate adaptation, Safeguarding California (CNRA, 2014). Natural and working lands are expected to maintain a net sequestration of GHGs within these plans and policies, and reducing the risk of wildfire in these landscapes is consistently listed as a strategy to achieve this objective. No specific project-level threshold for GHG emissions from fuel reduction projects in California's WUI and wildlands has been adopted in these plans and policies. With the state responsible for 458 MMT of CO_2e in 2012 (California EPA, 2012), more than three orders of magnitude greater than emissions from the VTP, this scale may also dilute the program's impacts.

Prescribed fire treatments are the primary driver of GHG emission contributions from VTP projects. Wildland fire emissions are a primary contributor of GHGs from working and natural lands outside of the VTP. Total emissions from wildfires in California accounted for two-thirds of the 69 MMT of CO2e emitted between 2001 and 2010 by forests and wildland in California (Yang 2015), or roughly 4.5 MMT/year. It has been suggested that historic emissions from wildfires in California's forests, shrublands, and grasslands were substantially higher than current emissions (Stephens, et. al., 2007). Periodic disturbance by wildfire or other stochastic events (e.g. insect, disease, or wind) is a natural phenomenon experienced by all vegetation types in California as recognized by fire return intervals (see Section 4.1.3) and condition classes (see Section 4.1.4). McKinley et. al. (2011) describe the forest carbon cycle including periodic disturbance killing some or all of the trees and changing the balance between production and decomposition, but with the average forest carbon stocks being relatively stable over large spatial and temporal scales.

It is unknown whether any individual VTP project will be involved in a wildfire during the effective life of the treatment (see Section 4.1.5.7), but it is reasonable to assume that the collection of projects conducted at the scale of the program will modify wildland fire behavior by reducing the risk of ignition or the potential size and severity of wildland fire in the treated areas and adjacent landscape (see objectives, Section 2.1.4). Landscape level effects from fuel reduction treatment projects were identified in the Rodeo and Chedeski fires in Arizona in 2002 where fires burned less intense on the leeward side of treatment units (Finney et. al., 2005). Other studies have shown that treated forest stands may maintain more carbon in live trees post fire than untreated stands (Carlson et.al, 2012), indicating less intense fire behavior within the treated area. These stands may be more resilient to future fires as well (Stevens et. al., (2014). These studies indicate that VTP treatments can influence fire growth and intensity, and assist suppression efforts at the landscape scale. The threshold chosen for the analysis below is to compare the total VTP emissions to those emissions that would occur had those same treatment acres burned during a wildfire.

The appropriate time scale at which to evaluate the contribution of VTP GHG emissions presents another question in developing a meaningful threshold. When evaluating residual carbon in treated verse untreated stands that had been burned in a wildfire, Kent et. al. (2015) found that time since fire was an important factor influencing the results of their carbon measurements. Emissions will occur the year of project implementation in case of fire, herbivory, and equipment emissions, but benefits will be realized over time in terms of regrowth and reduction of fire risk to the project area and the surrounding landscape. A time period of one year or less will tend to capture immediate project emissions but will not account for the slow decomposition of dead plant material left on site, nor will it capture the benefit of future photosynthetic activity on site as the vegetation community recovers from the project disturbance. If evaluated over the time period of 100 years, an accepted estimate for the residence time of a CO_2 in the atmosphere (IPCC), all treatment emissions and benefits could be accounted for and the impacts from the project may not stand out against the natural carbon cycle fluctuations expected to occur over that time frame at the treatment area. Another potential time frame at which to evaluate GHG contributions from projects would be over the effective life of the treatment. This would tend to capture most of the emissions and benefits expected from the project. According to a recent study by the USFS in conjunction with the Spatial Informatics Group, “net GHG benefits were only realized when the probability of wildfire was high (15 year expected return interval), and only for the thin-from below treatments” (Saah et al 2012). The VTP does not include removal of commercial forest products during projects in tree dominated vegetation types and treatments will closely mimic the “thin from below” treatments in this study. Because the generally accepted time frame for evaluating project emissions is the year of project implementation with emissions generally reported as MT/year, this is also the time frame chosen for this analysis. This will conservatively estimate the VTPs impacts because the benefits of future vegetative growth as the site recovers and the reduction of wildfire risk to the treatment area and surrounding landscape is not taken into account.

VTP projects will occur in wildland urban interfaces and on landscapes recognized as natural and working lands in California’s GHG reduction strategies. Projects will not alter the underlying land use or the productive capacity of treatment areas to support future photosynthetic activity. Additionally, treatments are expected to mimic the effects from fire and bring the project area back into condition class 1 (see Section 4.1.4), which would tend to reduce the potential impacts to site productivity should a future wildland fire occur. Fire disturbance regimes that have departed significantly from ecologically historical conditions can result in large-scale conversions of forests to shrublands and meadows (McKinley, et. al., 2011). In recognition of the important role these landscapes play in the sequestration of GHGs from the atmosphere both presently and in the future, a further threshold has been developed to prevent significant degradation of site productivity from VTP projects.

Thus for this analysis implementation of the vegetation treatment activities under the VTP would result in significant GHG and climate change related impacts if projects were to:

1. Produce emissions that are in excess of that which would periodically be produced from wildfire from those same acres (510,030 MT/year), or significantly degrade the productivity of the site by altering the species composition or degradation of the soil resources.
2. Result in a substantial increase in vulnerability of lands in CAL FIRE's responsibility area due to the effects of climate change.

4.14.2.2 **Impact Analysis Methods**

State CEQA Guidelines state that a lead agency should consider the extent that a project would increase or decrease emissions. This analysis quantifies the GHG emissions associated with each vegetation treatment activity proposed under the VTP.

The five main vegetation treatment activities considered are: prescribed fire, mechanical, manual, prescribed herbivory, and herbicides. The VTP includes a mix of vegetation treatment activities that would be implemented by CAL FIRE Operational Units. (Operational Units are organized to address fire suppression over a geographic area, and are divided by region--North or South. California has 21 Operational Units defined by county lines. Each unit consists of one to three counties. As described in the Chapter 2, Project Description, the Operational Units would annually propose a set of vegetation treatment projects. Individual projects, once implemented, would be complete and would not result in on-going emissions; however, as a program with a planning horizon of 10 years, emissions from VTP activities would occur each year at the rates described in Chapter 2, Project Description (i.e., an estimated 60,000 acres per year for 10 years).

Because of the statewide nature of this Program EIR, the analysis quantifies GHG emissions of an estimated, typical 260-acre project for each of the five treatment activities under the VTP, accounting for any changes to the activity based on vegetation type. Typical project size was derived by information presented in the Project Description (Chapter 2) and Section 4.1. Based on the proposed total acreage, total number of projects by vegetation type, and percentage breakdown by treatment activities, the number of proposed projects and acres by treatment activity and vegetation type were calculated. Emissions in this analysis were derived from the varying types of equipment used and the number of worker trips involved in a typical treatment activity project. In addition to quantifying any equipment related and worker trip information for each treatment activity, the analysis also includes fire emissions associated with broadcast burning for prescribed fire treatment activities. It also considers methane emissions (presented in CO2e) from enteric fermentation of the livestock used in prescribed herbivory treatment activities. Once average project emissions were found for each treatment activity and vegetation type, these emissions were multiplied by the total number of treatment activity projects estimated to occur each year under the VTP to quantify yearly GHG emissions. For more details regarding the specific assumptions used in quantifying the GHG emissions, see Appendix H.

The analysis also qualitatively discusses the potential impacts of global climate change on habitats throughout the state and how that would alter or change the implementation of vegetation treatment projects that could be approved under the VTP. The analysis qualitatively considers the potential long-term benefits of the vegetation treatment projects, but does not attempt to quantify benefits such as carbon sequestration, decreased wildfires as a result of this VTP, etc. Because the potential impacts of global climate change have only recently been realized, extensive data, commonly accepted thresholds of significance, and scientifically supported conclusions are not available. This discussion, therefore, draws from a range of studies that analyze global and regional patterns and trends that could have effects in California and describes the possible effects that could occur as a result of global climate change.

4.14.2.3 Impacts Analysis

The following discussion analyzes the significance of the VTP's potential GHG and climate change-related impacts. See the Impacts Analysis Methods section above for more detail regarding significance criteria used in this analysis.

IMPACT 1 – TREATMENT ACTIVITY GENERATED GHG EMISSIONS: EMISSIONS THAT ARE IN EXCESS OF WHAT WOULD BE PRODUCED BY WILDFIRE

GHG emissions related to vegetation treatment activities implemented under the VTP could be generated by the following five vegetation treatment activities: prescribed fire, mechanical, manual, prescribed herbivory, and herbicide treatments. Appendix H summarizes the GHG emissions per vegetation treatment activity. Emissions are represented in MT of CO2e per year. Emissions were calculated for each treatment activity under each of the three vegetation types. See Appendix H for more detailed calculations and the assumptions used in this analysis. Total emissions for all treatment activities associated with the VTP, would result in GHG emissions of 298,745 MT CO2e per year. The following subsections go into more detail regarding emissions for each of the specific vegetation treatment activities.

Prescribed Fire Treatment Activities

Prescribed fire treatment activities include both pile and broadcast burning. To be conservative, the GHG impacts of prescribed fire projects were analyzed by modelling all acres projected to be treated as broadcast burns. Under the VTP, half of the proposed 60,000 acres per year are expected to be treated using prescribed fire, with the majority of prescribed fire treatments occurring in shrub dominated vegetation. Taking into account that typical prescribed fire treatments would vary among vegetation type in terms of project duration, equipment needed, and crew size, the total GHG emissions for prescribed fire are estimated to be 298,070 MT CO2e per year. Mechanical equipment needed for this activity include tractors, as well as a variety of torches depending on the vegetation type. Helicopters are expected to be used on occasion for aerial burns in shrub-dominated areas. This equipment is estimated to result in GHG emissions of 63.36 MT of CO2e per year. Taking into account the number of workers needed on average per project, assuming that workers would likely carpool to the site, and assuming each car would generate one round trip per day to the project site (25 miles each way), GHG emissions from employee commute trips for all prescribed fire treatment activities would result in the generation of 15.7 MT of CO2e per year.

The GHG emissions resulting from combustion of vegetation during prescribed fire accounts for most of the emissions for this treatment activity with an estimated 298,149 MT of CO2e generated per year. Emissions for fire were estimated for each vegetation type, taking into account the average fuel loads of the vegetation and the quantity of fuel available for consumption by fire under specific conditions. Emission factors established by the EPA for Methane and emission factors from Development of Emissions Inventory Methods for Wildland Fire for CO2 were used in this analysis. Fire emissions for tree dominated and shrub dominated vegetation are generally higher than emissions from grasslands.

Mechanical Treatment Activities

Mechanical treatment activities include using heavy equipment to clear the land of vegetation. It is estimated that approximately 12,000 acres of the proposed 60,000 acres would be treated with mechanical equipment on an annual basis resulting in the generation of approximately 109 MT of CO2e per year. Equipment typically used for these activities include chisel plows, rotary mowers, chipping equipment, and crawler-type tractors. Crew sizes are typically small for mechanical treatment activities, limited to equipment operators and occasional supervisory personnel. Therefore, worker trip emissions are estimated to generate 2.5 MT of CO2e per year. Equipment emissions are higher than the other activities due to the equipment mix and because average projects tend to take longer to implement than prescribed fire treatment activities, generally ranging from two weeks to three months in duration.

Manual Treatment Activities

Manual treatment activities require larger crew sizes and the use of handheld power and non-power tools. It is estimated that approximately 10 percent of the acres treated under the VTP would use these manual methods. In general, GHG emissions of manual treatment activities are lower than mechanical and prescribed fire activities and are estimated to be 4 MT of CO2e per year under the VTP. Equipment emissions from power tools like chainsaws and power brush saws are estimated to be less than 1 MT of CO2e per year. Because crew sizes are larger for this activity and would require more cars to get to and from the project site, worker trip emissions are estimated to be 3.2 MT of CO2e per year.

Prescribed Herbivory Treatment Activities

Prescribed herbivory treatment activities would involve hauling livestock to a project site to browse or graze on vegetation targeted for treatment. The main equipment involved with this activity would be the use of trucks to carry the livestock to and from the site. In general, crew sizes tend to be smaller with this activity, needing on average only three workers onsite for the typical two week project. As a result equipment and worker trip emissions are combined in the estimate method and account for 31 MT of CO2e per year, this number is higher than any other activity because of the long project duration and the large trucks that carry livestock.

Emissions generated by the livestock from the methane released during enteric fermentation account for approximately 449 MT of CO2e per year and would be the largest source of emissions for this activity. Using a typical sheep herd size of 450 animals, methane emissions per head were calculated. Total GHG emissions for this activity would be approximately 480 MT of CO2e per year.

Herbicide Treatment Activities

Herbicide treatment activities do not involve the use of any GHG emitting motorized equipment as all herbicides are applied manually. The herbicides proposed for use by CAL FIRE are also not expected to generate any GHG emissions and are thus not accounted for in this calculation. As a result, only worker trip emissions are calculated. With an average crew size of 15 workers per project, worker trip emissions would account for 1.2 MT of CO2e per year.

Summary of all Treatment Activities

Total GHG emissions for all treatment activities proposed for the VTP total approximately 298,745 MT of CO2e per year. This number takes into account a variety of assumptions for the treatment activities and vegetation types proposed. Total equipment and worker trip emissions for all five treatment activities account for less than 0.01 percent of total program emissions, or an estimated 53.8 MT of CO2e per year. Emissions from off-road heavy duty equipment would be reduced with implementation of SPR CC-4 (and described in AIR-10 and AIR-11), where all equipment greater than 50 hp would be required to not exceed 16 hours of equipment hours a day and be required to be properly maintained. Livestock emissions account for roughly 0.1 percent of total program emissions. Prescribed fire emissions account for an estimated 99 percent of total program emissions with 298,745 MT of CO2e per year. SPRs CC-1 and FBE-1 would further reduce GHG emissions from prescribed fires by requiring burn intensities to be no more than necessary to accomplish the projects objectives. This number conservatively assumes that all acres are treated by broadcast burning and may be further reduced if some of these acres are piled and burned which reduces the amount of fuel on site available for ignition.

The VTP would create approximately 298,745 MT/year of CO2e, less than the 510,030 MT/year CO2e emissions created by a similar size wildfire burning. A number of SPRs are built into the VTP to ensure this standard is met on the project level. CC-1 requires pre-project modelling of the GHG emissions to minimize the project’s emissions. CC-3 requires implementation of AIR-3 and AIR-4, compliance with a smoke management plan and incorporation of project design elements that minimize emissions. FBE-1 requires an analysis of expected fire behavior and requires burn conditions to be such that fire intensity is the minimum necessary to achieve the projects objectives. SPR HYD-3 and HYD-4 are expected to protect residual vegetation left on site by requiring buffer zones be established around watercourses and prevent direct ignition of fire in these zones. As a result, vegetation treatment activities associated with the VTP would not result in a considerable contribution to GHGs and would result in a **less than significant impact**.

Site productivity will be protected by implementation of SPRs designed to prevent the introduction of invasive species and limit soil disturbance from VTP projects. SPRs BIO-8 and BIO-9 would prevent invasive plants from being introduced to the site and degrading its productive capacity. HYD-3 protects vegetation around watercourses, and BIO-7 establishes vegetative buffer zones around plant and animal species of concern.

CC-2 requires implementation of BIO-5 and BIO-6 to protect specific native vegetation potentially at risk of disturbance from VTP projects. BIO-5 requires that projects be designed to prevent type conversion and BIO-6 protects native oaks. GEO-1 limits activities that may occur on unstable soils, and HYD-7, HYD-8 and HYD-13 prevent soil compaction, protect bare soil from erosion, and disallow new road construction in VTP projects. HYD-15 protects the soil from impacts of burn piles by limiting them to no larger than ten feet by ten feet in size. As a result, vegetation treatment activities associated with the VTP would not result in a considerable contribution to GHGs and would result in a **less than significant impact**.

It is important to note that while the VTP would contribute to the level of GHG emissions; it may actually be less than described above. As described in Chapter 2, the purpose of the VTP program is to modify wildland fire behavior to help reduce losses to life, property, and natural resources. The intended outcome is to have less frequent, smaller (i.e., less acres burned), and shorter duration wildfires over time. Therefore, the emissions from the prescribed burning activities would to some degree be replacing and potentially reducing total emissions from wildfires that would occur to a greater degree and duration without fuel modification. While there is not a direct correlation between implementation of a vegetation treatment project and a proportionate reduction in numbers of fires or acres burned, it is reasonable to acknowledge that while the VTP program would result in emissions of GHGs as a result of prescribed fire, it would likely result in some reduction in the numbers of fires and/or burned acres from wildfires and, therefore, would avoid some emissions associated with those fires. The VTPs contribution to cumulative GHG emissions would not result in a considerable contribution to GHGs and would result in a **less than significant impact**.

IMPACT 2 – IMPACTS OF CLIMATE CHANGE ON VTP PROJECTS: INCREASE IN VULNERABILITY OF LANDS IN CAL FIRE’S RESPONSIBILITY AREA

As discussed previously in this section and in Chapter 2, human-induced increases in GHG concentrations in the atmosphere have led to global warming through the intensification of the greenhouse effect, and associated changes in local, regional, and global average climatic conditions. Although there is a strong scientific consensus that global climate change is occurring and is influenced by human activity, there is less certainty as to the timing, severity, and potential consequences of the climate phenomena. Scientists have identified several ways that global climate change could alter the physical environment in California. These include:

- Increased average temperatures

- Modifications to the timing, amount, and form (rain vs. snow) of precipitation
- Changes in the timing and amount of runoff
- Reduced water supply
- Deterioration of water quality
- Elevated sea level

These changes could translate into a variety of issues and concerns that could affect the lands in CAL FIRE's responsibility area. These include, but are not limited to:

- Increased frequency and intensity of wildland fires as a result of altered weather patterns, precipitation patterns and temperatures (Randerson 2006)
- Increase in uncharacteristically severe fires and fire hazards in California forests due to multiple years of drought along with overstocked vegetation conditions (Lenihan 2003)
- Increased flammability of vegetation due to drought conditions, resulting in an active burning period that starts earlier and lasts longer than historical patterns (Westerling 2006)
- A shift from native to invasive species in chaparral shrubland ecosystems due to a too-frequent fire interval, thus increasing fire threat to a greater degree
- Increased air pollution and related effects on human health from severe wildland fires
- Increased exposure of people and homes to wildland fires in WUI areas (Syphard, 2007)

Climate change is an issue of global scale and the impacts described above have the same likelihood of occurring whether or not any VTP projects are implemented. While GHG emissions from vegetation treatment activities under the VTP emit 298,745 MT CO2e per year (See Impact 1 for more information), there is also an emerging view among scientists that fire hazard mitigation through vegetation treatments or prescribed fire may play a beneficial role in long-term forest carbon sequestration, emissions reductions, and climate change mitigation (Hurteau and North 2010). John Battles, a professor at UC Berkeley, has stated, "Previous research [suggests] that a century of fire suppression has contributed to a potentially unsustainable buildup of vegetation" (Yang 2015). While changes to biophysical conditions have increased the threat of wildland fires in many locations, the exposure of people and homes to these threats has increased due to population growth and development in wildlands and WUI areas (Syphard et al., 2007). Where once only natural resources were threatened by wildland fire in these areas, threats now extend to life and property. There is a critical need for widespread restoration of lower fuel amounts across the West to address these issues.

By changing the composition of the landscape, the VTP allows CAL FIRE to better respond to the changing conditions associated with climate change, without conflicting with any applicable GHG reducing plan, policy, or regulation that has been adopted. In fact, as described in the Regulatory Settings section above, CAL FIRE is a member of the Governor's Climate Action Team and is continuing to implement actions to reduce and mitigate GHG emissions. These actions include treatment activities and programs like the VTP. Additionally, through ARB's Cap-and-Trade Program, CAL FIRE has been allocated grants for GHG reduction projects through the GGRF. The projects being implemented by CAL FIRE are helping to further mitigate the impacts of climate change and to reduce risk associated with catastrophic wildfires.

Furthermore, the adaptive nature of the program, with a variety of vegetation treatment activities and projects, also allows CAL FIRE to be more adaptive and responsive to wildland fires and would not make them more vulnerable to devastating losses. Additionally, through various Climate Change SPRs described in this section, CAL FIRE has protocols in place to further adhere to applicable plans, policies, and regulations and for managing these vegetation treatment activities with maximum feasible environmental protection. CC-1 specifically requires that prior to the approval of a VTP project; the project coordinator shall run a GHG-emissions model, such as FOFEM, to confirm that GHG emissions would be the minimum necessary to achieve risk reduction objectives. CC-2 requires that prescribed burning activities adhere to local air district regulations and only burn on authorized burn days (as described in SPR AIR-3). It also requires that a burn plan be prepared that is designed to initiate a low-intensity ground fire that would only consume the fuels needed to achieve risk reduction objectives (as described in FBE-1 and FBE-2).

In summary, implementation of vegetation treatment activities under the VTP would not result in an increase in vulnerability of lands in CAL FIRE's responsibility area to the effects of climate change and would not conflict with any applicable plan, policy, or regulation that has been adopted for the purposes of reducing the emissions of greenhouse gases. Because implementation of vegetation treatment activities would allow CAL FIRE to better avoid, adapt to, or be resilient in the face of climate change-related impacts, this impact would be **less than significant**.

4.14.2.4 Impact Analysis for Alternatives Considered

Four alternatives are considered under this analysis: Alternative A: WUI Only, Alternative B: WUI and Fuel Breaks, Alternative C: Projects Limited to Very High Fire Hazard Severity Zones, and Alternative D: Treatments that Minimize Potential Impacts to Air Quality. Alternative A proposes to limit fuel reduction projects to WUI areas only, while Alternative B would combine Alternative A with the option to create fuel breaks outside of the WUI. Under Alternative C, vegetation treatment activities would be focused in areas with the highest hazard classification of very high fire hazard severity zones (VHFHSZ). Alternative D reduces the numbers of acres treated under the VTP to 36,000, by reducing the numbers of acres treated through prescribed fire activities by 80 percent.

For Alternatives A, B, and C, the scale of the project remains the same as the proposed VTP at 60,000 treated acres per year for ten years, with the same vegetation treatment activities by vegetation type expected to occur. Geographically, the areas expected to be treated are similar to that proposed under the VTP. Because the nature of treatment activities are expected to be the same and the scale of the program is similar to that of the VTP, it is reasonable to assume that emissions and impacts associated with the VTP would be similar under each of these alternatives. As a result, impacts on GHG emissions and global climate change from vegetation treatment activities under Alternatives A, B and C would have a similar impact to the project and would be required to implement the same SPR's. Overall, impacts would be similar to the project for Alternatives A, B, and C.

Under Alternative D, the scale of the project would be reduced compared to the proposed VTP, from 60,000 acres to 36,000 acres treated per year for ten years. The same vegetation treatment activities by vegetation type are expected to occur, but a reduction in acres treated through prescribed fire treatments is proposed to reduce air quality impacts and indirectly greenhouse gas emissions as well. The reduction in acres treated through prescribed fires would be reduced by 80 percent, or 24,000 acres as compared to the proposed VTP. Geographically, the areas expected to be treated are similar to that proposed under the VTP.

Because GHG emissions related to prescribed fire treatment activities are the highest for all treatment activities, it is reasonable to assume that a reduction of 80 percent, or 24,000 acres, under this Alternative would reduce emissions substantially. Emissions related to other treatment activities would be expected to be the same as the proposed VTP because the same number of acres are expected to be treated using mechanical, manual, prescribed herbivory, and herbicides treatment activities. As a result, overall impacts related to GHGs and global climate change would be expected to be substantially reduced. Overall, Alternative D would result in less GHG and climate change impacts compared to the Proposed Program.

4.14.3 MITIGATION AND STANDARD PROJECT REQUIREMENTS

Under this analysis there are no mitigations. However, several Standard Project Requirements have been developed as part of the project design.

CC-1: Prior to approval of a Unit project under the VTP, the project coordinator shall run the FOFEM, and/or other GHG-emissions models, as appropriate to the treatment activity, to confirm that GHG emissions will be the minimum necessary to achieve risk reduction objectives.

CC-2: Carbon sequestration measures shall be implemented per SPRs BIO-5 and BIO-6 to reduce total carbon emissions resulting from the treatment activity.

CC-3: Treatment activity-related air pollutant emission control measures for prescribed burns shall be implemented in accordance with SPRs AIR-3 and AIR-4.

CC-4: Treatment activity-related air pollutant emission control measures for equipment operation hours, practices, and maintenance shall be implemented in accordance with SPRs AIR-11 and AIR-12.

5 CUMULATIVE EFFECTS ANALYSIS

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5.1 INTRODUCTION

Defining the scope of a cumulative impact analysis is challenging, particularly for a program such as the VTP. Because the VTP is statewide, it can be argued that a large range of non-VTP projects, programs, and activities that occur throughout the state should be incorporated into the cumulative analysis of VTP because they affect resource conditions on a statewide basis. As examples, the resources of the state that are affected by the VTP (e.g., air and water quality, fish and wildlife populations, public safety) are all affected by a wide range of non-VTP programs and actions including regulation of pollution control, water quality, and timber harvesting; city and county land use decisions; land management policies, plans, and on-the-ground projects; funding of resource protection and fire suppression activities; human population growth; and a host of other actions. The relevance of these other actions and the magnitude of their effects, relative to potential effects of the VTP, vary widely.

The strategy for defining an appropriate range of actions and conditions for the VTP cumulative analysis requires consideration of baseline conditions and projection of reasonably foreseeable related future actions. Recognizing that a broad range of activities can affect vegetation conditions, the VTP cumulative effects analysis has attempted to focus on those existing conditions and related programs that are similar to, or have similar effects as, the VTP.

The related programs considered for the VTP analysis for cumulative effects analysis include:

- Vegetation and fuels treatment programs undertaken by federal land management agencies and other jurisdictions outside of the VTP
- Regulated timber harvest on state and private lands
- Livestock grazing on state and private lands
- Timber harvest and other land management activities on federal lands

Other programs and actions related to specific resource conditions are included within the cumulative analysis for those resources, including:

- Water Quality: U.S. EPA and Regional Water Quality Control Boards regulatory programs governing water quality
- Air Quality: Regional California Air Resources Board Districts that set standards and programs governing air quality throughout California
- Biological: Federal Endangered Species Act and California Endangered Species Act

The cumulative effects analysis for the VTP Program EIR assesses effects at the program level. The following cumulative effects analysis evaluates the potential for positive and negative cumulative effects from the Proposed Program and Alternatives through direct and indirect effects on the individual resources discussed in Chapter 4. It is possible for cumulative effects to occur locally, but not be detected at broader spatial scales, and some effects at the local and regional levels will need to be addressed at the project level. The programmatic cumulative effects analysis requires a project level environmental analysis, including cumulative analysis, for each VTP project. Analysis at the project level will be conducted through the use of a Project Scale Analysis (Chapter 7) to be used as part of the environmental analysis for each VTP project.

This chapter addresses the cumulative effects by the resource topics presented in Chapter 4. Additional information is included that is relevant specifically to cumulative effects to synthesize and clarify, rather than repeat in detail, information that is found in other parts of this Program EIR. Therefore, the following discussion of cumulative effects relies in part on the more detailed descriptions that are included in other sections of this Program EIR. References are provided to lead the reader to appropriate sections in the Program EIR. For resource areas that were identified as areas of substantial public concern during the scoping process and for areas that were identified of substantial concern during the Program EIR analysis process, greater amounts of assessment and summary of information presented earlier are provided here. For resource areas of lesser concern, the presentation is briefer and refers to earlier sections that address cumulative effects issues.

The resource topic areas for which cumulative effects are specifically considered here include the categories of Biological Resources; Geology, Hydrology, and Soils; Hazardous Materials; Water Quality; Archaeological, Cultural, and Historic Resources; Noise; Recreation; Utilities and Energy; Transportation and Traffic; and Population, Employment, Housing, and Socio-economic Wellbeing. The environmental setting for each resource topic is discussed in Chapter 4 and associated appendices, which provide the context and baseline conditions for evaluating cumulative effects.

5.2 FRAMEWORK

5.2.1 REGULATORY FRAMEWORK IN CALIFORNIA

The CEQA Guidelines require that a Program EIR provide a discussion of cumulative effects, which is a change in the environment that results from adding the effect of the project to those effects of closely-related past, present, and probable future projects. CEQA Guidelines define cumulative effects as two or more individual effects which, when considered together, are considerable or which compound or increase other environmental effects (CEQA Guidelines § 15355). The effects may be changes resulting from a single project or a number of separate projects. The cumulative impact from several projects is the change in the environment that results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative effects can result from individually minor but collectively significant effects (CEQA Guidelines § 15355). In a CEQA evaluation, the proposed action must be considered with the combined effects of the cumulative actions of other closely related projects in a single analysis. The effects from multiple projects may be additive or synergistic.

5.2.2 REGULATORY AND PLANNING FRAMEWORK ON FEDERAL LANDS

Through the implementation of the National Fire Plan and the Healthy Forests Restoration Act of 2003, federal agencies have been instructed to take more aggressive actions to reduce the risks of severe and catastrophic wildfire on public lands. Their goals and objectives are largely consistent with CAL FIRE's Vegetation Treatment Program: to utilize vegetation management programs as a tool to protect life, property, and natural resources from catastrophic wildfire.

Vegetation management under federal agencies such as the Bureau of Land Management, National Parks Service, and Forest Service represents a similar set of actions as those proposed under the VTP. For example, in 2007 the Bureau of Land Management completed a Programmatic Environmental Impact Statement for their Vegetation Treatments Using Herbicides program. The Programmatic EIS covers 17 western states, including the agency's holdings in California. In bioregions with both private and public lands, actions by federal agencies may occur near or in coordination with projects under this Program EIR.

In addition, other forms of vegetation management will also occur in these same watersheds from activities related to commercial timber production and livestock grazing, both on public and private lands. Pre-commercial thinning, selective harvesting, even-age management, and other related actions all result in alterations of the natural vegetation and have bearing on the Program's cumulative effects and the bioregion's overall wildfire hazard, wildlife habitat, and other resources.

5.2.3 FRAMEWORK FOR EVALUATING CUMULATIVE EFFECTS

The main objectives of the California Statewide Vegetation Treatment Program (VTP), as described in Chapter 2, are to:

Vegetation Treatment Program Objectives
1. Modify wildland fire behavior to help reduce losses to life, property and natural resources.
2. Increase the opportunities for altering or influencing the size, intensity, shape, and direction of wildfires within the wildland urban interface.

3.	Reduce the potential size and total associated suppression costs of individual wildland fires by altering the continuity of wildland fuels.
4.	Reduce the potential for high severity fires by restoring and maintaining a range of native, fire-adapted plant communities through periodic low intensity treatments within the appropriate vegetation types.
5.	Provide a consistent, accountable, and transparent process for vegetation treatment monitoring that is responsive to the objectives, priorities, and concerns of landowners, local, state, and federal governments, and other stakeholders.

The focus of the cumulative effects analysis is the collective action of individual projects under the VTP when combined with related projects (for example, timber harvest) on private, state, and federal lands.

Fuel reduction projects are conducted to reduce the threat of catastrophic wildfires. There is substantial evidence that after decades of effective fire suppression, many of California's forests have high accumulations of fuels and a dense forest stand structure that greatly increase the risk of high severity fires (Ryan, 2010). To address this risk, both state and federal agencies are increasing the number of fuel reduction projects with the objective of reducing the frequency of high severity wildfires. There are many different methods for fuel reduction, as described in the Alternatives (Chapters 2 and 3), but the two most common methods are prescribed fire and mechanical removal of vegetation. Fuel reduction projects represent a relatively low intensity of disturbance, but to remain effective in most cases will require repeated treatments into perpetuity (Ryan, 2010).

5.2.4 TEMPORAL AND SPATIAL DOMAIN

The return interval needed for repeating vegetation treatment can vary from several years to several decades, depending on the vegetation type being treated (grassland, shrub, and tree), site conditions, and the pre-1850 mean fire return interval for the region. For example, the fuel load in white fir-mixed conifer stands returns to about 83 percent of pre-burn levels after 10 years (Husari et al., 2006). The analysis period for the cumulative effects analysis covers 10 years of prior management activity. As much as available data on projects outside of CAL FIRE's control allows, the analysis period extends the planning horizon into the future an additional 10 years. This is consistent with the planning horizon that federal agencies are using for developing vegetation treatments on public lands (USDI and USDA Forest Service, 2006a and 2006b).

The spatial domain for the proposed VTP and Alternatives is limited to State Responsibility Area (SRA) and effects from similar projects on federal lands.

5.3 PAST, CURRENT, AND FUTURE PROJECTS

The CEQA Guidelines § 15130 describes the "list" method of addressing cumulative effects wherein the assessment must include a listing of all relevant past, present, and reasonably foreseeable future projects. The project's incremental effect must be viewed in combination with the effects of other relevant past, present, and reasonably foreseeable future projects to determine if the incremental effect of the project is cumulatively considerable. An analysis of those past, current, and future projects whose impacts may combine with the proposed Program are included below.

5.3.1 PAST PROJECTS

The following section considers past vegetation management projects funded by CAL FIRE, federal agencies (US Forest Service and Department of Interior agencies, including the National Park Service, Bureau of Land Management, and US Fish and Wildlife Service), and private parties on both private and public lands in California. The categories of actions considered below include: vegetation management, commercial timber harvesting, and wildfire. Table 5.3-1 provides a summary of these activities by bioregion. CEQA Guidelines do not state a timeframe for listing past projects. Unless otherwise stated, this report documents projects within the last 10 years complete data is available, covering the period from 2004 to 2013.

Other agents such as local governments, water districts, conservancies, as well as private landowners outside of the VTP program are also likely to conduct fuel reduction projects. This information is not available on a statewide basis and likely represents a minor contribution to the overall acreage treated and is not included here. Instead, as part of the Project Scale Analysis (Chapter 7), each project will identify any known vegetation management projects that have occurred in the previous ten years in the immediate planning watershed(s) of the proposed project.

Table 5.3-1 Average Annual Summary of Past Projects and Percentage of Disturbed Acres by Bioregion (2004-2013)

Bioregions	Federal Mechanical & Prescribed Fire Projects	Timber Harvest Plans	CFIP Projects	State VMP Projects	Wildfire	Average Total Disturbed Acres	Treatable Vegetation Acres*	% of Current Acres Disturbed
Bay Area/Delta	37,008	3,028	894	2,002	14,216	57,149	3,200,408	1.79%
Central Coast	33,037	2	0	3,864	96,850	133,753	6,949,833	1.92%
Colorado Desert	39,587	0	0	880	7,629	48,096	4,663,190	1.03%
Klamath/North Coast	27,499	138,261	2,407	4,806	121,594	294,566	13,644,543	2.16%
Modoc	22,137	98,038	490	3,673	59,267	183,605	7,176,933	2.56%
Mojave	30,900	263	0	1,116	30,331	62,610	18,719,988	0.33%
Sacramento Valley	23,130	0	0	3,165	5,398	31,694	1,641,127	1.93%
San Joaquin Valley	17,830	0	0	1,903	5,952	25,685	2,658,732	0.97%
Sierra Nevada	16,516	239,529	3,963	3,990	115,116	379,114	15,588,940	2.43%
South Coast	14,126	24	97	1,698	113,094	129,039	4,392,490	2.94%
Average Totals	261,772	479,144	7,851	27,097	569,447	1,345,310	78,636,184	1.71%

*Treatable Vegetation Acres includes the grass, shrub, and tree vegetative formations in all responsibility areas of California (Local, State, and Federal)

5.3.1.1 Past Projects Undertaken by CAL FIRE

The Vegetation Management Program (VMP) is a cost-sharing program that focuses on the use of prescribed fire, manual, and mechanical means for mitigating wildland fire fuel hazards and other resource management issues on State Responsibility Area (SRA) lands. Implementation of VMP projects is at the discretion of each CAL FIRE administrative unit. Projects undertaken through this program are contained within the Unit's Fire Management Plan and are considered to be of high fire prevention value to the unit. Vegetation management through CAL FIRE's VMP has been limited, averaging approximately 30,000 acres treated annually over the past 10 years, with an average project size of 260 acres. The projects are focused mostly in the Central Coast, Klamath/North Coast, Modoc, and Sierra Nevada bioregions, but have not been locally concentrated within bioregions enough to expect significant effects. Table 5.3-1 provides an average acreage for the past 10 years of VMP projects by bioregion.

CAL FIRE also funds vegetation management projects under the California Forest Improvement Program (CFIP). These projects can involve a range of ground disturbing activities including site preparation, tree planting, release, commercial thinning, fuel reduction and land conservation activities for improving fish and wildlife habitat. Table 5.3-1 provides a summary of the average annual acres of fuel reduction projects funded through CFIP by bioregion for the past 10 years. CFIP projects are most heavily concentrated in the Sierra Nevada and Klamath/North Coast bioregions. CFIP projects tend to be small in size, averaging approximately 40 acres per project over the past 10 years.

Proposition 40, the California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002, provided funding for CAL FIRE to enter into cost-share agreements with private landowners to perform wildfire hazard reduction projects designed to reduce fuel loadings that pose a threat to watershed resources and water quality. Projects were conducted in 15 Sierra Nevada counties: Butte, Plumas, Sierra, Yuba, Nevada, Placer, El Dorado, Amador, Alpine, Calaveras, Tuolumne, Madera, Mariposa, Fresno, and Tulare. The Proposition 40 fuels reduction program ended on March 31, 2014 due to lack of continued funding. Impacts from these projects are included as past CFIP projects in Table 5.3-1.

The history of past VMP projects in combination with other CAL FIRE projects establishes an environmental reference point, or baseline, for the proposed VTP. As a result of a relatively low level of past vegetation management projects, the direct negative effects from past projects are likely to be minor. However, the low level of vegetation management when combined with fire suppression activities has increased the likelihood and risk of more frequent catastrophic wildfires, which may be having a long-term significant indirect negative impact on the environment.

5.3.1.2 Related Past Projects

The following section describes related projects that are not part of the CAL FIRE's proposed VTP, but may produce similar environmental effects and have the potential when combined with activities proposed in this Program EIR to produce a cumulative effect.

Federal agencies conduct vegetation management projects on federal lands that are similar in purpose to the actions described in the proposed VTP. As the Forest Service and other federal natural resource agencies implement the National Fire Plan (USDA and USDI, 2000), the Healthy Forests Restoration Act (GAO, 2003; HFRA, 2003) and the President's Healthy Forest Initiative (Dombeck et al., 2004; Graham et al., 2004; Stephens and Ruth, 2005), a substantial increase in fuel reduction projects and related activities has occurred in recent years and is likely to continue in the foreseeable future. The implementation of these programs has culminated in The National Cohesive Wildland Fire Management Strategy. The Strategy provides a framework for federal land management agencies to work collaboratively among all stakeholders and across all landscapes, using best science, to make meaningful progress towards three goals: resilient landscapes, fire adapted communities, and safe and effective wildfire response. Federal agencies report fuel treatment projects through the National Fire Plan Operations and Reporting System (NFPORS). This information has been summarized to show activities by year in California in Table 5.3-2 below. Note that the acreage treated for fuel reduction, especially by use of prescribed fire, by federal land managers in California has been on the decline throughout the period between 2004 through 2013. See the National Fire Plan web site for additional information on federal projects: www.forestsandrangelands.gov/.

Table 5.3-2 Yearly Fuel Reduction Projects by Treatment Type by Federal Agencies in California for 2004 through 2013

	Mechanical Treatment			Prescribed Fire Treatment			All
Year	**DOI**	**USFS**	**Total**	**DOI**	**USFS**	**Total**	**Grand Total**
2004	26,177	172,968	199,145	90,448	80,487	170,935	**370,080**
2005	31,294	142,201	173,495	80,487	76,391	156,878	**330,373**
2006	103,471	145,782	249,253	76,391	70,224	146,615	**395,868**
2007	31,482	113,232	144,714	70,064	60,215	130,279	**274,993**
2008	30,061	94,886	124,947	60,215	36,210	96,425	**221,372**
2009	71,010	156,358	227,368	36,210	45,426	81,636	**309,004**
2010	20,073	126,886	146,959	45,426	38,918	84,344	**231,303**
2011	11,620	94,876	106,496	38,918	32,890	71,808	**178,304**
2012	13,113	85,913	99,026	32,890	33,241	66,131	**165,157**
2013	9,025	82,226	91,251	29,952	20,060	50,012	**141,263**
Total	**347,326**	**1,215,328**	**1,562,654**	**561,001**	**494,062**	**1,055,063**	**2,617,717**
Annual Average	**34,733**	**121,533**	**156,265**	**56,100**	**49,406**	**105,506**	**261,772**

Both commercial timber harvesting and fuel reduction projects result in the removal of vegetation cover and introduce some degree of site disturbance to the project area. Commercial timber harvesting is considered a more intensive form of vegetation management. Even-aged management systems, such as clearcutting, can result in nearly complete vegetation removal from a site. Timber harvesting that involves thinning or selective harvesting results in partial canopy removal, generally with less site disturbance, less erosion potential, and a lower potential for other immediate water quality effects (Stednick, 2010). Research has shown that observed and predicted erosion rates from timber harvesting or prescribed fire were much lower than erosion rates from wildfires (Elliot and Miller, 2002). Timber harvesting can increase sediment yields from surface erosion of the harvested area, but as vegetation grows back, sediment yields decrease over time at a negative exponential rate (Bunte and MacDonald, 1999). It has been shown that the road network needed to support timber management activities is a more persistent and chronic source of sediment than the harvest area itself (Istanbulluoglu, 2004; Robichaud et al., 2010), suggesting that uneven-aged management requiring roads to be maintained for multiple entries can result in a higher potential for surface erosion compared to even-aged management.

Timber harvesting contributes to the environmental background conditions that projects in the VTP would operate under. Table 5.3-3 provides a summary of the extent of timber harvesting on public and private lands in California. Impacts from commercial timber harvesting mostly occur in the Klamath/North Coast, Modoc, and Sierra Nevada bioregions. No harvesting occurred within the Colorado Desert, Sacramento Valley, San Joaquin Valley, or the South Coast bioregions during this time period.

Table 5.3-3 Average Acres of Commercial Timber Harvesting Activities on Federal and Private Lands, 2003-2014

Bioregions	USFS Even Age	USFS Uneven Age	USFS Yearly Average	Private Even Age	Private Uneven Age	Private Yearly Average	Bioregion Total Yearly Average
Bay Area/Delta	0	0	0	380	2,648	3,028	**3,028**
Central Coast	0	0	0	0	2	2	**2**
Colorado Desert	0	0	0	0	0	0	**0**
Klamath/North Coast	69	44,183	44,253	33,767	60,241	94,008	**138,261**
Modoc	729	32,354	33,083	14,700	50,255	64,955	**98,038**
Mojave	0	0	0	0	263	263	**263**
Sacramento Valley	0	0	0	0	0	0	**0**
San Joaquin Valley	0	0	0	0	0	0	**0**
Sierra Nevada	1,629	180,012	181,641	14,024	43,865	57,889	**239,529**
South Coast	0	0	0	4	20	24	**24**
Grand Totals	**2,427**	**256,549**	**258,976**	**62,875**	**157,293**	**220,168**	**479,144**

High severity wildfires represent one of the greatest forms of disturbance for a watershed. For example, the removal of vegetation, organic material, and changes to soil properties can greatly alter water infiltration rates (Martin, 2001; Neary et al., 2005). Studies have shown that severe wildfires in chaparral areas in southern California can produce water repellent soils (DeBano, 1981). Extensive and severe wildfires, such as those experienced in southern California in 2003, can dramatically alter the timing and distribution of sediment and water from post-fire precipitation events (CAL FIRE, 2003). Generally there is a high degree of variability in burn severity within the footprint of any given wildfire, depending upon weather, fuel, and topographic factors at the time of the burn.

Table 5.3-1 shows the average annual distribution of wildfires by bioregion for the past 10 years. On average, approximately 570,000 acres burn each year across California, but the variability in those numbers is high both spatially and temporally. Those numbers also identify total acres within a fire's perimeter and do not identify the mixture of burn severities within any given wildfire. The contribution of wildfire to cumulative effects is further considered under Section 5.5.4 Cumulative Effects to Water Resources.

HUMAN DEVELOPMENT (PRC 4291 100" DEFENSIBLE SPACE)

Development in California's wildland areas has increased the risk and cost of fighting wildfires. Defensible space ordinances have been developed to reduce the risk of wildfire in the Wildland Urban Interface (WUI). The California State Board of Forestry and Fire Protection (Board) promulgated defensible space regulations necessary to implement Senate Bill (SB) 1369 of 2004. This legislation amended PRC 4291 to, among other things, require persons in the State Responsibility Area (SRA) to maintain fire protection around a structure by removing brush, flammable vegetation, or combustible growth that is located up to 100 feet from the building or to the property line.

The clearance rule represents a type of vegetation management conducted by individual landowners and concentrated in WUI areas across the state. At the time, the Board estimated the total number of structures within the State Responsibility Area (SRA) that are potentially affected by this regulation at 811,158.

GRAZING ON RANGELAND

Prescribed herbivory by livestock is an activity that will be expected to be utilized to meet the objectives of the VTP. The condition and use of rangelands by livestock is analyzed in this section. Grazing of private lands in California is not an activity requiring a permit from a government agency, and there are no consistent measurements taken of California rangeland productivity and utilization. Due to this data constraint, the analysis below uses proxy data to analyze the impacts of grazing on California's rangelands. The analysis utilizes estimates of rangeland size and distribution, the forage capacity of various California rangeland types, and the number of cattle reported in the US Department of Agriculture's census of agriculture. Much of the information relies on data from the 2003 and 2010 Forest and Range Assessments by FRAP, which provide the most recent comprehensive assessment of the state of California's rangeland resources.

An assessment of livestock grazing on California's rangelands is provided here as the closest similar impact to the use of prescribed herbivory in the VTP. The reader should keep in mind that grazing within prescribed herbivory projects in the VTP are expected to be of shorter duration and higher intensity than is the case in traditional grazing for commodity production or ecological values. The goal of VTP projects will be to achieve specific fuel modification in various fuel types, not all of which are considered traditional grazing lands (ex. fuel break maintenance in forested landscapes). The current use of livestock for these purposes is sporadic over space and time in California, and can be considered a minor part of the overall livestock industry analyzed below. No information on the statewide use of livestock for fuel reduction purposes was available for this analysis.

This section describes those areas of California's rangelands where grazing occurs, the amount of rangeland area available for grazing ("available rangeland"), and an estimate of the area actually grazed by livestock ("grazing area"). These metrics help define who owns rangelands, where rangelands are located, how they are managed, and what portion of all rangelands are actually available and used for grazing livestock.

Ownership of rangeland types is not evenly distributed. A majority of Hardwood Woodland, Grassland, and Wetland habitats are privately owned. In contrast, a majority of Conifer Woodland, Shrub, Desert Shrub, and Desert Woodland habitats are publicly owned. The total amount of rangeland across California has been estimated at between 17.4 and 24.4 million acres on private land, and between 16.7 and 32.7 million acres on federal lands (Table 5.3-4). Rangelands are defined by having appropriate vegetation to support grazing, and not based on actual use by livestock (i.e., grazing area).

Table 5.3-4 Various rangeland area estimates by ownership (Million acres)

	Private	Public	Total
Primary rangelands (FRAP)*	24.4	32.7	57.1
Rangeland (NRI)**	18.3	***	18.3
Available rangeland (FRAP)	21.9	19.8	41.7
Grazing area (ERS and RPA****)	17.4	16.7	33.8

ERS – Economic Research Service; FRAP – Fire and Resource Assessment Program; NRI – National Resource Inventory; RPA – The Forest and Rangeland Renewable Resources Planning Act of 1974
*Excludes conifer forest types
**Excludes any hardwood or conifer forest types
***National Resources Inventory (NRI) measure some non-federal public lands but are included in private in this table
****RPA (Mitchell, 2000) estimates used to derive area on public land
Sources: Mitchell, 2000; FRAP, 1999; FRAP, 2002a; NRCS, 2000; ERS, 2001
Table adopted from 2003 FRAP Report

GRAZING AREA

The area of land in California that is actually utilized for livestock grazing is termed “grazing area.” This area represents grazing use for some portion of the year, but does not quantify the intensity or duration of use. Field sampling conducted by the Natural Resources Conservation Service and allotment use records submitted by the Forest Service and BLM are used to determine the amount of grazing area. Table 5.3-5 summarizes the total grazing area in California.

Table 5.3-5 Total grazing area in range and forest categories in all ownerships, 1997 (million acres)

Type of grazing	Acres
Grassland and other pasture and range*	22.3
Forest land grazed**	11.8
Total grazing area	**34.1**

*Grassland and other non-forested pasture and range in farms plus estimates of open or non-forested grazing land not in farms
**Woodland grazed in farms (ERS, 2001)
Table adopted from 2003 FRAP Report

These tables suggest several findings related to potential cumulative effects from grazing:

- When comparing grazing area (34.1 million acres) with primary rangelands (approximately 57 million acres), it appears that primary rangeland area far exceeds the land base actually grazed. This means that there is a substantial area of rangelands where there is inadequate forage or water to support livestock grazing, grazing is not permitted, or the land is managed for ecological values other than forage production for domestic livestock.
- A large proportion of available rangelands (82 percent, or 34.1 million of 41.7 million acres) are already being grazed. On some of this land base the level of grazing is light, with few animals per acre or animals on the landscape for only short periods of time. Overall, however, this means that there are limited opportunities for new grazing activities, especially when considering the on-going decline in the available rangeland base in California due to development and other pressures (Cameron et.al., 2014).
- On public lands, large areas are not available or used at minimum levels for grazing due to exclusion by administrative designations or relatively poor forage production capabilities. Approximately 17 million acres of the nearly 33 million acres of public primary rangelands are grazed (52 percent). Over half of the 17 million acres is in desert land cover types that produce little forage, making them susceptible to environmental damage due to over-grazing (Table 5.3-4).
- In general, private rangeland is used for grazing at a much higher level than public lands. Seventeen million of the 24 million acres of private primary rangeland is grazed (71 percent).
- Private rangeland is more widely used for grazing, in part, because the lands are often more productive and better watered. To some degree this increased use raises the risk of environmental concerns. Lands held by public agencies are more likely managed as wildlife habitat for species not dependent on grazing. Benefits of fire reduction due to grazing are likely better realized on private lands,

and successional changes are more likely on public lands in the absence of grazing or other periodic disturbance events.

FINDINGS ON FORAGE PRODUCTION, GRAZING CAPACITY AND USE

One method to assess the productive capacity of rangelands includes comparing the amount of vegetation available for grazing (forage production) and the extent to which this vegetation is used (use). However, direct estimates of rangeland forage are not comprehensively collected, unlike counterpart measurements for forests (standing board foot volume of forests and harvest levels). This deficiency limits a direct assessment of sustainable forage production and use.

Proxy methods must be used to assess forage production and use. Forage production estimates are made by estimating grazing capacity, or the maximum stocking rate possible without inducing damage to vegetation or related resources, measured in animal unit months (AUMs) per acre by vegetation, ownership, and region. To measure use, FRAP used the number of livestock (specifically beef cattle grazed on rangelands) to evaluate use from a commodity point of view (Mitchell, 2000). Estimates of forage use are derived by approximating the inventory of animals in California forage types.

FORAGE TYPES

Forest and rangelands provide forage (browse and non-woody plants) used for grazing by livestock and game. Forage varies in its quantity by species, time of year, and other factors such as climate, soils, and topography. Cattle consume a varied diet on rangeland that may include grasses, legumes, forbs, and brush (browse). The major land cover types provide varying amounts of forage and include Grassland, Wetland, Hardwood Woodland and Forest, Desert Shrub, Desert Woodland, Shrub, and to a lesser extent Conifer Woodland and Forest. Grasslands are the most important source of forage for California livestock.

GRAZING CAPACITY ESTIMATES

Landowners rely on forage that exists on both publicly and privately owned lands and in a variety of vegetation types. Forage is measured in the form of AUMs, the amount needed to sustain one mature cow and her calf, five sheep, or six deer for a month. An AUM is approximately 800 to 1,100 pounds of dry biomass, and represents the amount of forage that can be removed annually while still maintaining productivity. FRAP has not updated or designed an information system that evaluates forage production or estimates AUM usage since the 1989 Assessment. Because forage production may not be the critical limiting factor affecting rangeland productive capacity, it is unlikely that models supporting this dynamic will be extensively developed. Many other trends, particularly the declining land base and the presence of non-native, invasive species, are likely more important factors affecting long-term sustainability of rangeland productivity.

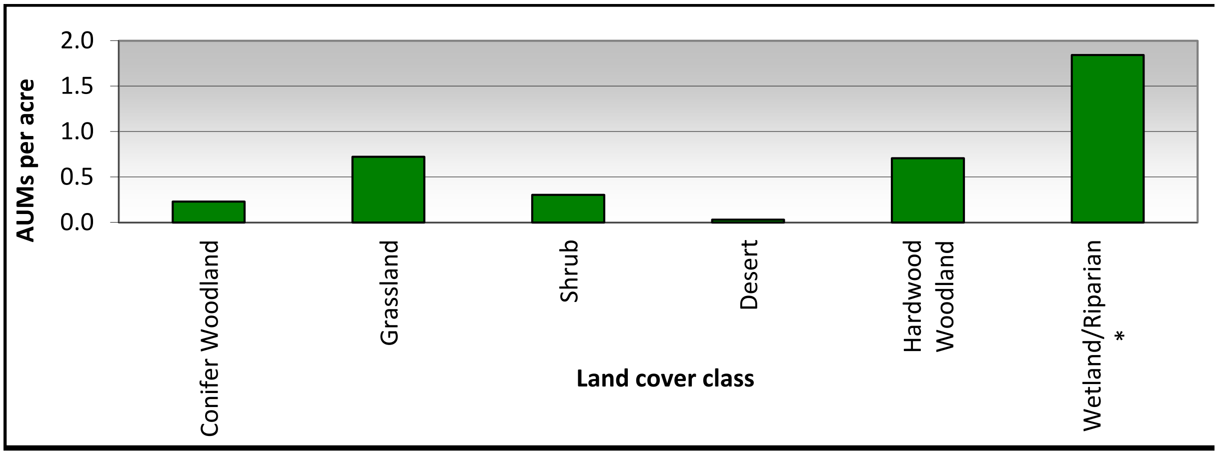

Figure 5.3-1 Average annual grazing capacity (AUM per acre) by primary rangeland cover class

*Includes montane riparian CWHR, valley foothill riparian CWHR, and wet meadow CWHR
Source: FRAP, 2002a; CH2M HILL, 1989
Table adopted from 2003 FRAP Report

Previous assessments (CH2M HILL, 1989) have estimated the forage production for both primary rangelands and secondary lands (conifer forests) producing forage. In this assessment, grazing capacity is used to estimate the sustainable level of grazing which a vegetation type can support, not the actual annual growth of range biomass. Grazing capacity is defined as a stocking rate that is possible without inducing damage to vegetation or other resources. Over 14 million AUMS are produced on California's available primary rangelands (Figure 5.3-1, Tables 5.3-6 and 5.3-7).

Table 5.3-6 Total annual forage production on available primary rangelands by land cover class.

Land cover type	Grazing Capacity in AUMs per acre	Area (millions of acres)	Total AUMs (millions)
Conifer Woodland	0.2	1.6	0.4
Grassland	0.7	9.2	6.6
Shrub	0.3	11.6	3.4
Desert	<0.1	14.3	0.5
Hardwood Woodland	0.7	4.6	3.2
Wetland/Riparian*	1.8	0.4	0.8
Total	**0.4**	**41.7**	**14.8**

AUM – animal unit month
*Includes montane riparian CWHR, valley foothill riparian CWHR, and wet meadow CWHR
Source: FRAP, 2002a; CH2M HILL, 1989; Conner, 2003
Table adopted from 2003 FRAP Report

Table 5.3-7 Total annual forage production on available secondary rangelands by land cover class

Land cover type	Grazing Capacity in AUMs per acre	Area (millions of acres)	Total AUMs (millions)
Conifer Forest and. Montane Hardwood	0.04	19.1	0.8

Source: FRAP, 2002a; CH2M HILL, 1989; Lindstrand, 2003
Table adopted from 2003 FRAP Report

FORAGE USE ON PUBLIC LAND

The use of forage on BLM and USFS lands is reported annually as the number of AUMs permitted in grazing districts or range allotments. As shown in Figures 5.3-2 and 5.3-3, permitted AUMs peaked in the 1980s and have steadily declined. This estimate suggests that less than one million AUMs come from use on federal lands. It also implies that the bulk of the estimated 11.8 million AUMs used in California come from private lands even though the area grazed on public versus private land is nearly equal.

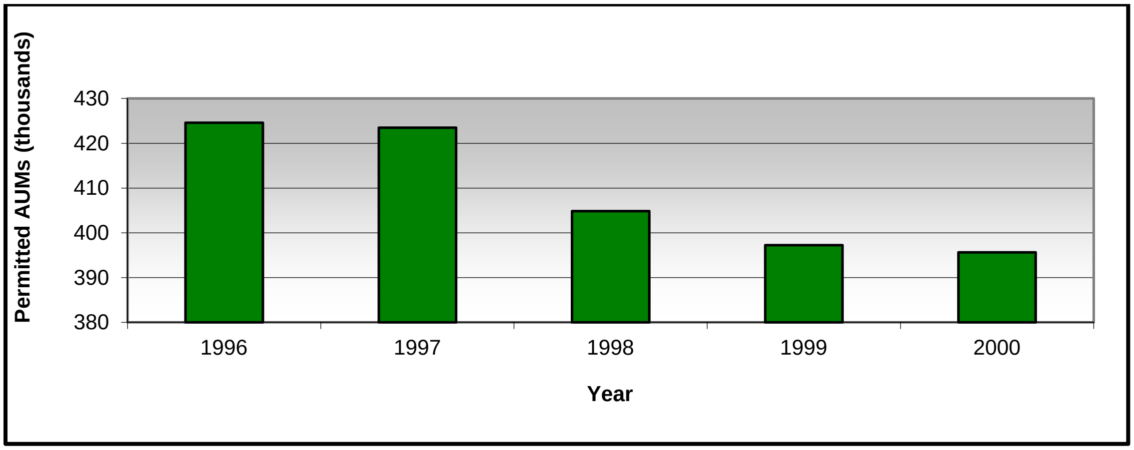

Figure 5.3-2 Number of AUMs on BLM lands with grazing permits and leases, 1996-2000

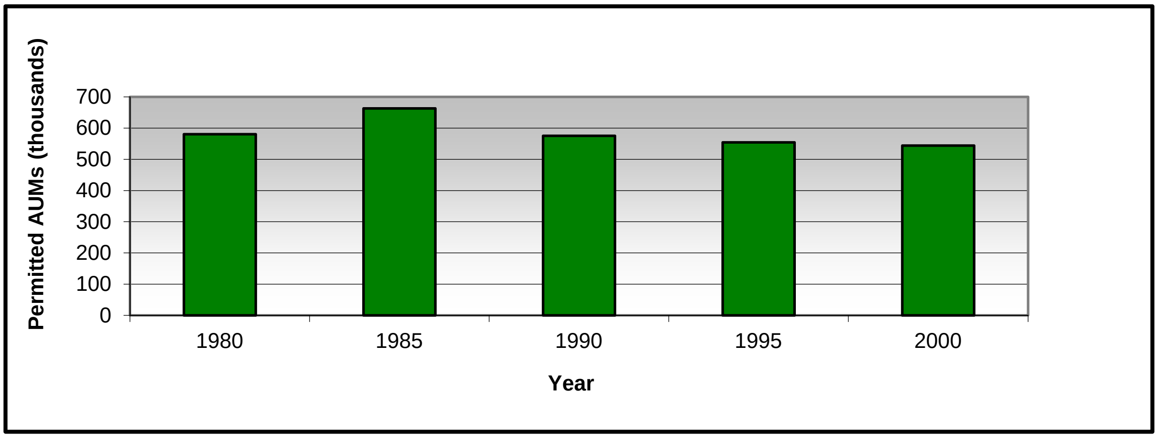

Figure 5.3-3 Number of AUMs on USFS lands with grazing permits, 1980-2000
Source: Compiled by FRAP from USFS, 2002

Tables adopted from 2003 FRAP Report

COMPARISONS OF FORAGE USE AND GRAZING CAPACITY

Grazing capacity on available rangelands in some geographic areas exceeds the amount used for grazing of domestic livestock (Figure 5.3-4). However, excess forage for grazing may not be available because of the seasonal nature of forage availability in relation to the time period that animals are on site to graze. In times of forage shortages or poor nutrition quality, ranchers commonly bring in supplementary feed to meet the animals dietary needs.

This analysis estimates that the grazing capacity on rangelands available for grazing is 14.8 million AUMs. The majority of forage available for grazing exists in the Management Landscape class Working/Private/Sparsely Populated (10.8 million AUMs). Domestic livestock grazing use in all classes is estimated at 11.8 million AUMs based on the approximately two million head of cattle that periodically graze on private rangelands.

This profile suggests that at a broad statewide level, rangeland productivity is being maintained and lands are currently being grazed at a sustainable level. However, specific factors raise questions on the capability of California's rangelands to sustain grazing activities at this level in the future. These concerns include a declining rangeland area, encroachment of invasive non-native species, and grazing use reductions on public lands resulting in potential increased demand for grazing on private lands.

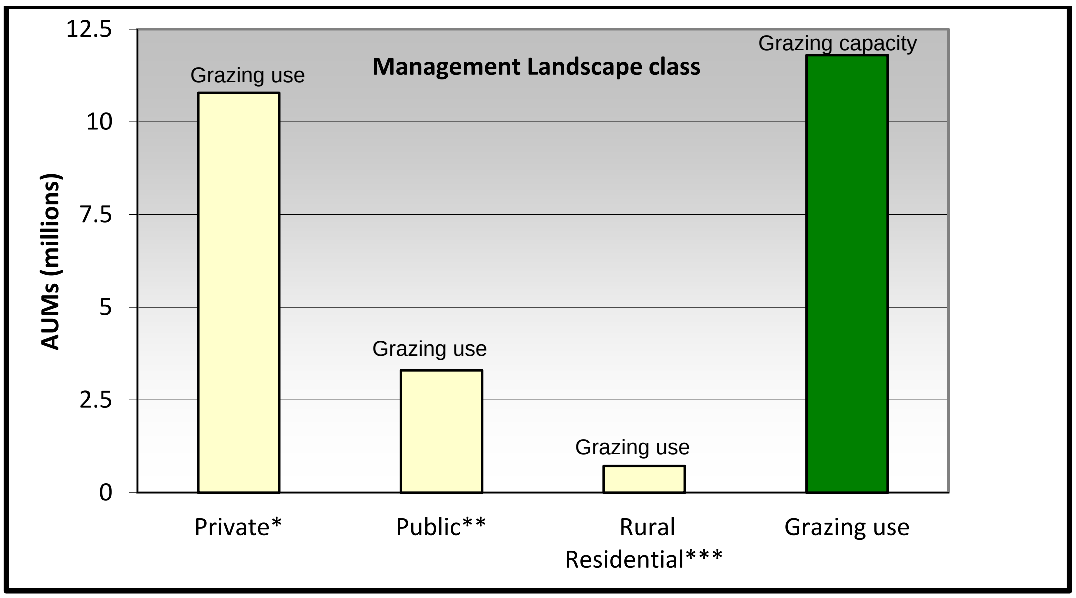

Figure 5.3-4 Grazing capacity by Management Landscape class and total grazing use, available rangelands
Source: FRAP, 2002a; CH2M HILL, 1989; National Agricultural Statistics Service, 2001; Conner, 2003
Table adopted from 2003 FRAP Report

SUMMARY OF PAST PROJECTS

Over the past 10 years (2004 through 2013) CAL FIRE has implemented vegetation management projects on approximately 348,000 acres of land through VMP (270,000 acres) and CFIP (78,000 acres). While there is substantial year to year variation in the amount and geographic distribution of these treatments, the average annual treatment rate is approximately 35,000 acres per year. In general, the projects are broadly distributed across the state, with the greatest concentration in the Central Coast, Klamath/North Coast, Modoc, and the Sierra Nevada bioregions.

Fuel reduction projects on federal lands have been much more extensive over roughly the same time period. Over the past ten years, the USFS has implemented fuel reduction projects on approximately 1.7 million acres. Other federal agencies (BLM, NPS, USFWS, and BIA) have implemented projects on approximately 900,000 acres. The combined total is roughly 2.6 million acres treated from 2004 to 2013. The number of acres treated by federal agencies has been decreasing throughout this time period as indicated by Table 5.3-2. Federal land ownership is heavily concentrated in the Klamath/North Coast, Modoc, Sierra Nevada, and South Coast bioregions. Table 5.3-1 shows federal fuel reduction projects concentrated in these bioregions. The combined average annual rate of fuel reduction projects (CAL FIRE and federal projects) is estimated at approximately 295,000 acres per year over the last 10 years.

Timber harvesting can be considered a related form of vegetation management. Some form of timber harvesting was implemented on over 2.5 million acres of federal lands and on over 2.2 million acres of private lands between 2004 and 2013. A majority of these harvests, approximately 4.1 million acres, were considered uneven aged management. Timber harvest activities on both public and private lands were concentrated in the Klamath/North Coast, Modoc, and Sierra Nevada bioregions (see Table 5.3-3). In addition to the geographic distribution, the amount of timber harvesting also varies from year to year, but the average annual rate of timber harvesting can be estimated at approximately 480,000 acres per year.

When past fuel reduction projects are combined with timber harvesting and other forms of vegetation management, an estimate can be made of the percentage of landscape that is cumulatively disturbed by related activities. In most cases, less than 4 percent of the treatable vegetation in a given bioregion has been disturbed on an annual basis over the past 10 years (see Table 5.3-1). While only a small proportion of a bioregion is treated in a given year, projects that are concentrated in a more localized area (i.e. planning watershed) are much more likely to have cumulative effects that are detectable and potentially significant. Standard Project Requirement (SPR) HYD-16 addresses this issue at the project level by requiring additional analysis prior to project implementation if greater than 20 percent of a planning watershed has been disturbed over a 10 year period (see Section 2.5).

5.3.2 CURRENT PROJECTS

Vegetation management projects funded by CAL FIRE under the VMP and CFIP programs occur on an ongoing basis. CAL FIRE participates in these as funding and staff time is available to do so. The location and extent of these current projects should be roughly proportional to that indicated in Table 5.3-1. The cumulative effects analysis recognizes that similar actions on federal lands are also current and ongoing, but very little information was available on their status. It is assumed that projects continue to be implemented on an annual basis roughly proportional to how they have in the recent past (Table 5.3-1).

Timber harvesting is also an on-going related activity. Timber harvesting on non-federal lands in California are subject to various permitting mechanisms (Timber Harvest Plans, Nonindustrial Timber Management Plans, Emergencies and Exemptions) under the Forest Practice Rules with CAL FIRE as the lead agency. Many permits allow multiple years to complete the harvesting operations, and, in rare cases, expire with no operations occurring. Timber harvesting on federal lands is subject to permitting through NEPA with many projects also occurring over multiple years. All projects that have been permitted, but have not yet expired or otherwise been completed, are considered to be current projects.

FORAGE USE

Forage use is estimated indirectly by evaluating the inventory of beef cattle in a particular year and then calculating the AUMs needed to support that inventory. In 1997, nearly 1.9 million head of cattle were grazed annually for some period on primary and secondary rangelands (National Agricultural Statistics Service, 2001). To estimate the amount of forage used by these animals, the number of months used for range grazing must be estimated. Using this methodology, it is estimated that over 11.8 million AUMs per year are consumed on California rangelands. For more information on the cattle inventory, see the 2003 Fire and Resource Assessment chapter on the Range Livestock Industry (CAL FIRE, 2003).

5.3.3 FUTURE PROJECTS

Future projects in CEQA are defined in the CEQA Guidelines (Section 15130(b)(1)(B)) as projects for which an application has been received at the time the notice of preparation is released. This would include projects that are planned to occur in the near future, but are not currently implemented.

While individual VTP projects may show little signs of disturbance, collectively fuel reduction projects and related vegetation management activities by state and federal agencies could potentially lead to larger scale environmental effects. As described in Chapter 2, the VTP expects to implement projects on approximately 60,000 acres annually over a 10 year period. The average size of individual VTP projects is anticipated to be approximately 260 acres, and their distribution throughout the state is shown in Table 5.3-8 below. In the absence of permitting and funding constraints being modified on federal lands, future fuel reduction projects are expected to occur at roughly the same pace and scale that has been occurring over the last 10 years, approximately 260,000 acres annually (see Table 5.3-2). The implementation of the VTP would cause an average of 60,000 acres treated annually through CAL FIRE. The combined disturbance from future vegetation management projects can be expected to be approximately 320,000 acres annually. These projects can occur in locations across the entire state, but are mainly concentrated in landscapes dominated by grass, shrub, and timber vegetation types (i.e. forest and range settings). California supports approximately 31 million acres of forest land and 57 million acres of primary rangelands (CAL FIRE, 2003; 2010). The combined or cumulative actions of fuel reduction projects on private and federal lands statewide would result in 0.34-3.01 percent of any given bioregion treated per year. Table 5.3-8 shows the expected acres treated if the VTP program treated 60,000 acres on average annually over a ten-year period, and federal programs continued to operate at their current rate over the next 10 years. The actual percentage of the landscape that is considered disturbed at any point in time does not reflect recovery rates and is likely to be less than the amount shown.

Table 5.3-8 Average Annual Acres Expected to be Treated on Private and Federal Lands over a 10 Year Time Frame (2016-2025)

Bioregions	Federal Mechanical & Prescribed Fire Projects	Timber Harvest Plans	CFIP Projects	State VTP Projects	Wildfire	Average Total Disturbed Acres	Treatable Vegetation Acres*	% of Future Acres Disturbed
Bay Area/Delta	37,008	3,028	894	5,855	14,216	61,002	3,200,408	1.91%
Central Coast	33,037	2	0	8,904	96,850	138,793	6,949,833	2.00%
Colorado Desert	39,587	0	0	988	7,629	48,204	4,663,190	1.03%
Klamath/North Coast	27,499	138,261	2,407	11,650	121,594	301,410	13,644,543	2.21%
Modoc	22,137	98,038	490	7,175	59,267	187,107	7,176,933	2.61%
Mojave	30,900	263	0	2,573	30,331	64,066	18,719,988	0.34%
Sacramento Valley	23,130	0	0	2,364	5,398	30,893	1,641,127	1.88%
San Joaquin Valley	17,830	0	0	1,877	5,952	25,659	2,658,732	0.97%
Sierra Nevada	16,516	239,529	3,963	13,411	115,116	388,535	15,588,940	2.49%
South Coast	14,126	24	97	5,204	113,094	132,545	4,392,490	3.02%
Average Totals	261,772	479,144	7,851	60,000	569,447	1,378,213	78,636,184	1.75%

*Treatable Vegetation Acres includes the grass, shrub, and tree vegetative formations in all responsibility areas of California (Local, State, and Federal)

5.4 CUMULATIVE ANALYSIS SUMMARY

For the purposes of this Program EIR, projects implemented under the VTP would have a significant cumulative effect if:

- The cumulative effects of related projects (past, current, and probable future projects) are not significant and the incremental impact of qualifying projects implemented under the proposed VTP is substantial enough, when added to the cumulative effects of related projects, to result in new cumulatively significant impact; or
- The cumulative effects of related projects (past, current, and probable future projects) are already significant and the projects implemented under the

proposed VTP would make a considerable contribution to those effects. In accordance with CEQA Section 21083.3(b)(2),"cumulatively considerable" means that the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects." The California Supreme Court has determined that in certain circumstances, miniscule contributions to a cumulative significant impact can be determined to be less than considerable (Save the Plastic Bag Coalition v. City of Manhattan Beach, 2011).

The potential cumulative effects for each resource area are described in section 5.5 below and outlined in Table 5.4-1 below.

Table 5.4-1 Summary of Potential Significant Cumulative Effects Potential for the Proposed Program*

	Proposed Program		
Resource Area	Yes after mitigation	No after mitigation	No reasonably potential significant impacts
Biological Resources			X
Geology, Hydrology, and Soils			X
Hazardous Materials			X
Water Quality			X
Archeological, Cultural and Historic Resources			X
Noise			
Recreation			X
Utilities and Energy			X
Transportation and Traffic			X
Population, Employment, Housing, & Socio-economic Wellbeing			X
Air Quality		X	
Aesthetics and Visual Resources			X
Climate Change			X

5.5 CUMULATIVE EFFECTS EVALUATION BY RESOURCE TOPIC

The following section discusses the potential for cumulative effects for the following resource topics (see Chapter 4 for additional information on each resource topic):

- Biological Resources
- Geology, Hydrology, and Soils
- Hazardous Materials
- Water Quality
- Archaeological, Cultural and Historic Resources
- Noise

- Recreation
- Utilities and Energy
- Transportation and Traffic
- Population, Employment, Housing, and Socio-economic Wellbeing
- Air Quality
- Aesthetics and Visual Resources
- Climate Change

5.5.1 BIOLOGICAL RESOURCES

This section discusses the types of effects that may occur under the Vegetation Treatment Program (VTP) and related treatments from other vegetation disturbing activities on terrestrial wildlife and plants, aquatic resources, and measures of riparian ecosystem function. These potential impacts are discussed fully in Section 4.2. Included here is additional information that is relevant specifically to cumulative effects and the potential for the proposed VTP or Alternatives to contribute to other land disturbing management practices that may result in a significant cumulative impact to terrestrial wildlife and plants, aquatic resources, and riparian ecosystems.

The environmental setting for biological resources is described in Section 4.2. This cumulative impact analysis specific to biological resources assumes full implementation of the VTP as proposed (i.e. 60,000 acres treated per year distributed as identified in Table 3.3-1). Cumulative effects to biological resources could occur from fire hazard reduction, timber stand improvement and other vegetation treatment efforts included in the VTP when considered in the context of other existing and proposed land uses. The incremental contribution of the VTP to an evaluation of cumulative effects is determined by the number of acres treated annually under that program in combination with the acreage modified or expected to be modified by other land uses.

Plant communities, including the biological resources they support, potentially impacted by VTP activities have for the most part evolved under the influence of periodic fires of varying intensity, frequency, and size, and other agents of change. Changes to these natural disturbance regimes have occurred as a result of changes in settlement patterns, resource extraction, plant species composition, and fire suppression, significantly altering the ecological processes under which these plant and animal communities have evolved. Complicating these relationships is the fact that disturbance effects on biological resources vary depending on species mobility, time of year, and aspects of their natural history.

For several reasons, biological resources and dynamic changes of plant communities present one of the more challenging areas to address with respect to cumulative effects determinations. For example, fire can have two markedly different effects on wildlife habitats. Large fires do not burn evenly and as a result produce a mosaic of vegetation and post-fire plant community succession. Alternatively, at a smaller scale, an intense stand-replacing fire can reduce habitat heterogeneity and foster a uniformity of food and cover value particularly in areas of similar slope, aspect, and soil type. Both outcomes may either be positive, negative, or exhibit no particular effect depending on the degree of habitat patchiness and the wildlife species of concern. Thus, simple generalization of the effects of post fire or other disturbance induced habitat conditions and their implications for biological resources are not informative. While disturbance-caused modification of one habitat type into another may in many cases be “value-neutral,” in other cases, such as the loss or fragmentation of habitat for a threatened or endangered species, resource managers and the public may be very concerned about conversion of habitat type.

Cumulative positive, neutral, or negative effects may also arise temporally. For example, vegetation treatments may be detrimental for some species in the short-term but lead to long-term improvements in habitat quality, or help prevent other long-term detrimental effects such as habitat loss or change in plant community species composition from wildfire. In addition, impacts can be seasonal in nature depending on habitat use.

Overall, it is impossible to precisely specify at the scale of the state or region both the biophysical and economic ramifications of interaction between disturbance and biological resources. In the case of fire as an agent of disturbance, a number of experts have indicated that when one considers qualitatively the effect of fire (prescribed and otherwise) on biological resources, fire regimes, and wildland habitats at the scale of the state, it is likely that fire, at least over the short term, has had a net neutral if not beneficial effect (Sugihara et al., 2006). On the other hand, specific fires in specific places at specific times can have significant adverse effects on particular species and/or their habitat. Given the dynamic nature of vegetation and population response, these effects are of the greatest concern for species near the lower bound of population viability (i.e., state and federally listed species).

Cumulative effects occurring at the scale of the state or the region may not inform project level cumulative effects analysis. The Project Scale Analysis (Chapter 7) developed as part of this Program EIR is designed to provide guidance to project scale cumulative effects analysis. Cumulative effects, either negative or positive, can potentially impact individual species of concern, the distribution and sustainability of special habitat elements, wildlife, vegetation structures, and other biological resources. Cumulative effects attributable to these kinds of impact mechanisms are generally most reliably assessed at the scale of the individual project and lands immediately adjacent. In some cases, information from larger regional studies is needed to supplement information on the local project area.

The VTP Program EIR cumulative impact analysis, conducted at the scale of the watershed or bioregion, identifies and assesses impact mechanisms that may influence landscape scale biological resource issues such as wildlife movement or habitat capability across broad regions, likelihood of genetic interchange, change in plant community composition as a result of non-native species establishment, or change in species distribution. Recognition of the scalar nature of assessment and management is not a new concept to existing resource management institutions. For example, the federal Endangered Species Act envisions the maintenance and recovery of ecosystems upon which threatened, endangered, or candidate species exist as the preferred approach over individual species management. Similarly, recognition of the interaction of human-altered or working landscapes and wildlands is central to the science of landscape ecology and the sustainability of biological diversity.

Riparian function encompasses a wide variety of processes (hydrologic, geomorphic, biotic) across a range of spatial and temporal scales. These processes interact to ultimately determine the character of the riparian zone and aquatic habitat quality. The metering of sediment, water flow, and structural complexity of the stream environment is a function of the underlying geology, topography, and condition of adjacent vegetation both near the stream and in upland environments. Vegetation management practices have the potential to alter these ecological processes directly within the riparian zone or indirectly through management of uplands. Vegetation management activities may result in or contribute to significant adverse effects to aquatic species through 1) changes in stream temperature, 2) increased sediment and other water quality parameters (e.g. dissolved oxygen, nutrients etc.), 3) altered composition and abundance of fish, amphibians and other aquatic species, 4) unstable stream banks, 5) reduction of in-stream structural complexity, 6) reduction in large woody debris recruitment, and 7) altered peak and base flows. Strategies to address these potential adverse effects will vary regionally and protections or management of riparian zones is ultimately dependent on state and federal regulations in effect, site specific variation in vegetation composition, site-tree height, geology, slope, and other baseline conditions.

The potential for cumulative effects arising from vegetation treatment program practices on water quality (e.g., sediment load, water temperature, and water quality) are addressed in Section 5.5.4. This section considers the recruitment potential of large woody debris, riparian canopy condition, and effects of vegetation management along the continuum of stream classification as a determinant of habitat quality for aquatic species, particularly salmonid and amphibian populations.

5.5.1.1 Significance Criteria

Appendix G of the CEQA Guidelines (the CEQA Environmental Checklist) specifies that the Program and Alternatives would have a significant adverse effect to biological resources if any of them would:

A. Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife or US Fish and Wildlife Service.
B. Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or US Fish and Wildlife Service.
C. Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.
D. Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites;
E. Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.
F. Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.

For a variety of ecological questions and conservation issues, a regional scale analysis as done for this document can provide guidance to examine trends and spatially explicit landscape design concepts when data is available. For other questions and conservation issues, more detailed analysis is necessary and must be carried out at the scale of the watershed or other planning unit. The regional or program scale disclosure provided within this document is intended to examine the likelihood of a bioregional or statewide cumulative effect, but also to provide context to the determination of cumulative effects at the project scale. Project scale cumulative effects analyses may make findings specific to project level implementation that support or disagree with those made at the program scale.

Bioregions were used to determine percent ground disturbance attributed to both current and future conditions under the proposed VTP and the relative contribution of the proposed VTP to other similar ground disturbing programs. The analysis assumes that historic ground disturbing activities and acreage affected will continue at a similar rate in the future. Vegetation acreage is limited in extent to those types potentially treated. Additionally, no attempt was made to account for the relative differences in the rate of recovery that is specific to the type of vegetation treated. For example, grass dominated systems frequently attain pre-project conditions in less than five years while other vegetation types may take markedly longer to attain pre-project conditions.

Statewide, annual VTP acres disturbed is about 0.08 percent of the treatable vegetation acres (see Table 5.3-1). At the scale of the bioregion, annual VTP acreage disturbed ranges from 0.01 percent in the Mojave to 0.18 percent in the Bay Area/Delta (Table 5.5-1).

Table 5.5-1 Percent of Total Treatable Vegetation Disturbed by the VTP

Bioregions	VTP Disturbed
Bay Area/Delta	0.18%
Central Coast	0.13%
Colorado Desert	0.02%
Klamath/North Coast	0.09%
Modoc	0.10%
Mojave	0.01%
Sacramento Valley	0.14%
San Joaquin Valley	0.07%
Sierra Nevada	0.09%
South Coast	0.12%
Average Totals	0.08%

Because of the amount of acreage eligible but not receiving treatment under the VTP, the proposed Program would likely result in a less than significant cumulative effect on biological resources at the bioregional scale. Wildfires would continue to occur in California, having both negative and positive effects on biological resources and wildlife habitat condition; the magnitude of effect being dependent on a wide suite of physical, biological, and climatic variables.

It is unlikely that sufficient acreage will be treated under the VTP as proposed to result in a measurable cumulative impact over the no treatment option when assessed at the scale of a bioregion.

There may indeed be the potential for adverse effects on biological resources to occur at a localized scale that will need to be addressed at the project level through the use of the Project Scale Analysis (Chapter 7) and consultation with subject matter experts as needed. In general, VTP-treated acreage will not be extensive enough, or result in significant alteration of treated vegetation types, to result in a negative cumulative effect to biological resources when considered with other land management activities at the bioregion or statewide scale. Implementation of the Standard Project Requirements (Section 2.5) and any Project Specific Requirements identified through the Project Scale Analysis (Chapter 7) will further reduce the likelihood that any project or combination of projects will result in a negative cumulative effect on biological resources either locally or at the bioregional scale. Indirect effects of desired fuel condition and vegetation regeneration diminish over time as treated areas, in the absence of retreatment or wildfire, recover pretreatment vegetation structure. Rate of change is dependent on a large number of environmental variables and short or long term effects on a given species are similarly variable.

VTP projects that result in an extensive, long term, or permanent type conversion are most likely to result in a measurable or significant contribution to negative cumulative effects to the wildlife community. VTP projects implemented in grass and forb dominated plant communities generally return to pretreatment conditions within a few years, although change in species composition is a concern at the scale of the project. Similarly, VTP projects in tree dominated communities typically focus on modification of midstory or understory vegetation structure or alteration of tree overstory canopy closure levels. Long term or permanent type conversion is most likely in shrub dominated plant communities that are not fire adapted and/or are vulnerable to the establishment and expansion of competing non-native species post treatment. Conversion of shrub dominated habitat may, in conjunction with other similar shrub land disturbing land use effects, result in a negative cumulative effect on shrub dwelling fauna. However, the likelihood of multiple projects occurring in the same watershed or otherwise in close proximity temporally and thus contributing to a significant “cumulative effect” is very low given the small number of possible VTP projects in shrub land habitats and implementation of Standard Project Requirements, such as BIO-5 (Chapter 2.5), intended to minimize project level impacts to the bioregion. Cumulative effects identification and development of appropriate mitigation or management measures, including avoidance, is most effectively done at the scale of the project when the spatial and temporal juxtaposition of multiple project effects can be evaluated.

5.5.1.2 Determination of Significance

The following section evaluates potential cumulative effects to biological resources arising from implementation of the Proposed Program or the Alternatives. The potential for a cumulative effect is discussed for each significance criterion listed above.

CRITERION A – CANDIDATE, SENSITIVE, OR SPECIAL STATUS SPECIES

Potential to have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a listed, candidate, sensitive or special status species in local or regional plans, or regulations, or by California Department of Fish and Wildlife or U.S. Fish and Wildlife Service.

The California Department of Fish and Wildlife annually documents the status of rare, threatened and endangered species and identifies threats to these species. California is the most biologically diverse state in the contiguous United States and has the largest state human population. As a result, threats to the continued existence of native species and the natural communities on which they rely are also increasing.

Habitat modification, non-native species, and water withdrawals are frequently mentioned threats to these species (CDFW, 2005). When categories of threat were ranked by CDFW, urbanization of the state's wildlands poses the greatest threat to the continued existence of the endangered flora and fauna (CDFW, 1991). Other significant threats to plants include effects associated with livestock grazing, off-road vehicles, conversion of native habitats to agriculture, competition with non-native plants, and road construction/maintenance. Effects from logging were ranked 17th in the 21-category list of threats to state-listed plants (CDFW, 1991). Other significant threats to animals include effects associated with water projects, introduced predators and competitors, conversion of native habitats to agriculture, livestock grazing, environmental contaminants, and flood control activities. Effects from logging were ranked 11th in the 18-category list of threats to state-listed animal species (CDFW, 1991). It is presumed that effects from fuel reduction treatments are generally less intensive then those from commercial timber operations, but there can be exceptions depending on the project objectives and treatment methods.

Wildfires typically influence markedly greater amounts of acreage than that to be treated under the proposed VTP or any of the alternatives. The likelihood of reduction in number or distribution of plant or animal species of concern is potentially markedly higher under large and uncontrolled land disturbance events like those arising from wildfire. Effects of wildfire are varied and include influence on animal movements, direct mortality, seed dispersal, and enhancement of habitat for non-native invasive species. VTP projects are unlikely to reduce the number or distribution of plant or animal species of concern as assessed at the scale of the bioregion. VTP program contributions to cumulative effects of land disturbing events that reduce the number or range of species of concern is negligible and may result in an overall but immeasurable beneficial effect to the degree that wildfire events are reduced in frequency, extent, or intensity.

TERRESTRIAL WILDLIFE

Terrestrial wildlife and plant populations can be extirpated or fall to levels where formal listing is warranted if habitat conditions are degraded to a point that populations are no longer self-sustainable. However, it is unlikely that VTP treatment acreage in conjunction with other similar programs and vegetation treatment efforts will be sufficiently extensive and concentrated in time and space to threaten population sustainability or eliminate a plant or animal community. Statewide, average annual acreage disturbed by the proposed Program (60,000) would represent approximately 0.25 percent of the acreage available for treatment (Table 3.3-1). Significant cumulative direct and indirect effects on listed, sensitive, and common species are not expected to occur for several reasons.

- The potential for cumulative direct and indirect effects is minimal given the relatively small average size of VTP projects (260 acres) and low likelihood of temporal and spatial adjacency to similar effects from non-VTP management efforts.
- Implementation of SPRs, PSRs, and implementation of the PSA, to eliminate direct effects or reduce indirect effects to a negligible or less than significant impact on special status species at the scale of the project. Similar avoidance measures and mitigations are routinely employed by other agencies as required by statute and through environmental review.
- Species considered common and terrestrial plant and animal communities will not experience sufficient cumulative habitat alteration from the VTP and other similar vegetation treatment programs to threaten plant or wildlife population or community sustainability given the spatial and temporal limits described above.
- Duration of cumulative effects is further ameliorated by recovery and re-occupancy rate of populations and habitat structure. Rate of response will vary by species and pre-treatment vegetation structure, condition of untreated or adjacent habitat, and treatment method. Grasslands would again be candidate for treatment in as little as 3 years after the initial treatment. Shrublands and forestlands (given treatment of the shrub component of the latter) may again be suitable for treatment 10 years after the initial treatment, but is highly variable depending on site conditions.

INVASIVE SPECIES

The introduction of exotic species can be a serious threat to native plant and animal communities. Invasive non-native species alter ecosystem structure, composition, and processes and out-compete and exclude native plants and animals. Those non-native species that have successfully established themselves and expanded their range in California’s diverse environments have had far reaching effects. These effects include direct competition or hybridization with and subsequent exclusion of native species, and also as an agent for the change of ecosystem function. Ecosystem effects include alteration of disturbance regimes, such as frequency and intensity of fire and potential changes in soil erosion rates. VTP objectives and those of other similar programs are to reduce fuel accumulations and potential for large scale disturbance events and conditions suitable for establishment of invasive species. Implementation of SPRs BIO-8 and BIO-9 will additionally limit the introduction or movement of invasive species at the project scale (Chapter 2.5).

SNAGS AND LARGE, DOWNED LOGS

Snags (standing dead trees) and downed logs (portions of or entire trees that have fallen to the ground) have been shown to have significant positive habitat value for many plants and animals and are considered “special habitat elements.” This term refers to specific physical and biological attributes of the landscape without which certain species either are not expected to be present or will exist in greatly reduced numbers (Mayer and Laudenslayer, 1988). Snags, downed logs, and the capability of the land to produce these elements over time are of particular concern because adequate numbers, size, and decay classes of these habitat elements are required for the long-term persistence of dependent wildlife species. Significant reductions in the amounts of coarse woody debris and downed logs below desired levels impair habitat value, forest productivity, and biological diversity (Spies and Cline, 1988). Standard Project Requirements HYD-3, HYD-4, and FBE-1 are designed to mitigate the impacts of VTP projects through the retention of core areas of undisturbed vegetation in watercourse buffer zones, and burn intensities below those expected to consume large, downed logs (Chapter 2).

CRITERION A – DETERMINATION OF SIGNIFICANCE

Pre-project scoping at the scale of the project and, if necessary, implementation of surveys to determine species’ presence will assess the likelihood of project level impact to species of concern (BIO-2, BIO-3, and BIO-4). Implementation of SPRs and the PSA will further provide for the protection of plant and animal species of concern. When considered at a bioregion or program scale, the relatively small amount of acreage treated, recovery potential of plant communities treated, and implementation of the PSA (in combination with other land disturbing activities and mitigation measures at the bioregional scale) results in a **less than significant** VTP contribution to cumulative effects. For example, the proposed Program’s ten year treatment acreage compared to the treatable acres within each of California’s bioregions ranges from 0.04 percent in the Colorado Desert Bioregion to 0.59 percent in the Klamath/North Coast Bioregion (Table 3.3-1).

No terrestrial wildlife or plant populations are expected to drop below self-sustaining levels as a result of VTP implementation. Similarly, no terrestrial community will be eliminated. Analysis of the direct and indirect effects associated with the proposed VTP and Alternatives concluded that for representative species of concern, no alternative would result in a significant effect after application of identified PSRs. In general, conditions for terrestrial and aquatic species are expected to show continued improvement over time as plant communities are incrementally protected from the effects of unnaturally large and intense wildfire and as plant communities adapted to periodic disturbance are reintroduced to this important driver of ecosystem processes.

Land disturbance activities resulting from any of the VTP vegetation treatment options and other cumulative action have the potential to create or enhance land conditions that facilitate the establishment or spread of non-native invasive species. Although treated acreage within the proposed Program and Alternatives is low relative to other land disturbing management activities at the bioregional scale, range expansion of non-native invasive species into new areas could, considering difficulty of plant control and area affected, result in a significant cumulative effect. VTP management actions may also decrease the frequency, extent, or severity of wildfire and as a consequence the extent of disturbed landscape available for establishment of non-native invasive species. Similarly, VTP projects can be developed to specifically target non-native invasive weed infestations as part of larger invasive plant control efforts. Project level mitigation and management practices are designed to reduce the probability of introduction, establishment, and spread of non-native invasive species. These practices include minimization of ground disturbance, treatment timing depending on plant composition at the treatment site, pre-project surveys, and post-project monitoring and follow-up action as appropriate. When assessed at the scale of the bioregion, VTP contributions to the cumulative effect of land disturbing events that create conditions favorable to the establishment or expansion in range of invasive non-native species is **less than significant**. The VTP may result in an overall but immeasurable beneficial effect to the degree that infestations are controlled as a project objective or wildfire events are reduced in frequency, extent, or intensity.

Project alternatives that utilize prescribed fire as a vegetation treatment method have the potential to influence the retention of existing snag or downed log densities. Depending on prescribed burn fire intensity, snag or downed log size, location in treatment units, topography, and other site specific conditions, degree of consumption of these forest features by fire would be variable. Cumulative, direct, and indirect effects to the quality and frequency of occurrence of these forest structural elements are determinations made at the scale of the project. With SPRs in place, at the scale of the bioregion the cumulative effects of VTP treatments and related activities on snag and downed log densities are expected to be **less than significant**. It is possible for cumulative effects to occur locally but not be detected at the broader bioregion scale, but with PSRs put into place as a result of a Project Scale Analysis the cumulative effects of VTP treatments and related activities on snag and downed log densities are expected to be less than significant at the project level.

The cumulative impact of the proposed Program, Alternatives, and other related activities on candidate, sensitive, or special status species is considered **less than significant** with implementation of the Standard Project Requirements (Chapter 2.5) and any Project Specific Requirements identified through the Project Scale Analysis (Chapter 7).

CRITERION B – RIPARIAN HABITAT OR OTHER SENSITIVE NATURAL COMMUNITIES

Substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, and regulations or by the California Department of Fish and Wildlife or US Fish and Wildlife Service.

It is highly unlikely that watersheds supporting listed species or water bodies designated as impaired relative to beneficial uses are the product of a single impact associated with one specific land use at a particular time. These watersheds and status of the resource values they support are therefore, by definition, the product of the cumulative effect of a variety of historic and contemporary land use practice effects and the rate of ecosystem recovery. The objective of the VTP Program EIR cumulative effects analysis is to assess the likelihood that effects remaining after implementation of VTP projects and required management and mitigation measures will result in a less than significant impact when assessed at the scale of the bioregion.

A large number of environmental variables influence the structure and function of aquatic and riparian systems. Working landscapes generally exhibit a wide range of conditions and are the result of historical and contemporary practices. Other lands may exhibit minimal disturbance with little or no evident effects to aquatic and riparian resources values. Within forest and rangelands, major concerns vary by watershed and are typically assessed as “limiting factors,” or inputs to aquatic and riparian systems that limit the ability of the ecosystem to function at a level that produces desired values and products. These factors include: sediment input, large woody debris recruitment and delivery, stream bank stability, temperature, condition of headwater environments, and forest canopy nutrient input to stream ecosystems.

Little comparative baseline data is available to address long-term amphibian population trends in the western United States and California. True frog and toad species have exhibited the most significant declines. Forty percent of the toad species (four of ten) and 88 percent of the native frog taxa (seven of eight) have been removed from at least 45 percent of their historic California distribution (CDFW, 2005). It is likely that a number of different factors are contributing to the documented declines. One possible explanation suggests that the long-term cumulative effects of multiple factors, where natural low points in amphibian population cycles synergize with widespread environmental alterations (e.g., extended drought, chemical pollutants, predation by and competition with non-native species, and disease) will create extinction events. Species occurring in aquatic habitat types such as springs, seeps, marshes, and small headwater streams are at the greatest risk for continued population decline. Degradation and reduction of aquatic habitats has occurred statewide but some regions have experienced greater levels of habitat loss.

The status of salmon populations and their habitat can be taken as one measure of change in aquatic and riparian resource health. Annual estimates of salmon population levels exhibit marked variation due to a large number of interacting environmental conditions. These include specific stream habitat availability to accommodate freshwater life history requirements, water quality and availability, rainfall pattern as an influence on stream flow and juvenile migration rate, oceanic conditions during early residence, level of commercial and recreational harvest, and historic and current land use activities (e.g., agriculture, timber management, and urbanization). These and other environmental conditions have resulted in long-term downward trends in population for specific salmon stocks and for some, formal listing under the California and/or federal Endangered Species Act.

Regional Water Quality Control Boards (RWQCBs) are required to identify water bodies with impairments to beneficial uses using a method termed Total Maximum Daily Load (TMDL). This process identifies miles impaired, pollution types, and pollution sources. The RWQCBs then develop implementation plans to improve water quality. A review of the 2010 TMDL impairment lists reveals that California has over 29,000 miles of impaired streams. This represents about 16 percent of the total miles of streams and rivers in California. Impairment information for RWQCB watersheds provides a description of the cause of pollution that result in impairment. Most watercourses have many different potential causes, but do include Silviculture, rangeland grazing, and/or agriculture as at least one of the causes of impairment. A high percentage of watercourses also include impairments identified as unknown, indicating uncertainty in identifying nonpoint pollution sources (US EPA, 2015).

SEDIMENT

Stream bank erosion is a natural process that occurs sporadically in forested and non-forested watersheds (Richards, 1982). Under natural conditions, this process is part of the normal equilibrium of streams. The forces of erosion (water), resistance (root strength and bank material), and sediment transport maintain an important balance. Human activity can accelerate stream bank erosion.

The roots of riparian vegetation help bind soil together, which makes stream banks less susceptible to erosion. Riparian vegetation can also provide hydraulic roughness elements that dissipate stream energy during high or overbank flows, which further reduces bank erosion. In most cases, vegetation immediately adjacent to the stream channel is most important in maintaining bank integrity (FEMAT, 1993); however, in wide valleys with shifting unconfined stream channels, vegetation throughout the floodplain may be important over longer periods.

Riparian vegetation also can provide hydraulic elements that dissipate stream energy during high or overbank flows, which further reduces bank erosion. Although there is limited data quantifying the effective zone of influence relative to root strength, Forest Ecosystem Management Assessment Team (1993) concluded that most of the stabilizing influence of riparian root structure is probably provided by trees within 0.5 potential tree height of the stream channel. Overall, buffer widths for protecting other riparian functions (e.g., large wood recruitment and shading) are likely adequate to maintain bank stability if they are performing most of those functions (see HYD-3 in Chapter 2.6).

Harvesting of trees adjacent to streams can lead to a loss of root strength, thus making stream banks more susceptible to erosion. Important alterations of the system components that may result from timber harvesting activities include: 1) removing trees from or near the stream bank; 2) changing the hydrology of the watershed; and 3) increasing the sediment load, which fills pools and contributes to lateral scour by forcing erosive stream flow against the stream bank (Pfankuch, 1975; Cederholm et al., 1978; Chamberlin et al., 1991). With respect to the northern California coast, it is noteworthy that redwoods, the dominant conifer along many streams, re-sprout following harvesting. As a result, decreases in redwood root strength are typically lower than in other forest types.

VTP management practices which may influence stream bank stability are not readily assessed at the scale of the bioregion. Stream bank erosion is largely a localized process and determining relative contribution of effects that result in a significant cumulative effect contribution and assessed at the scale of a bioregion is not possible. Implementation of HYD-3 (watercourse buffers) is likely to provide adequate protection from VTP projects contributing to stream bank erosion processes.

Wildfire consumption of upland vegetation and post wildfire increases in stream discharge can result in stream bank instability depending on stream size, wildfire impact on streamside vegetation, and other environmental variables. To the degree that VTP projects reduce the frequency, extent, or intensity of wildfire, stream bank stability is likely benefited.

LARGE WOODY DEBRIS

Large woody debris from coniferous trees is an important determinant of stream structural complexity particularly in areas where geology and topography do not provide for other instream structural elements such as boulders. Numerous studies have shown that large wood is an important component of fish habitat (Swanson et al., 1976; Bisson et al., 1987). Trees entering stream channels are critical for sediment retention (Keller and Swanson, 1979; Sedell et al., 1988), gradient modification (Bilby, 1979), structural diversity (Ralph et al., 1994), nutrient production (Cummins, 1974), and protective cover from predators.

The potential for trees to enter a stream channel from tree mortality, windthrow, and bank undercutting in the riparian zone is mainly a function of slope distance from the stream channel in relationship to tree height. As a result, the zone of influence for large wood recruitment is determined by specific stand characteristics rather than an absolute distance from the stream channel or floodplain. Slope and prevailing wind direction are other factors that can affect the amount of large wood recruited to a stream (Spence et al., 1996).

May and Gresswell (2003a) examined the relative contribution of processes that recruit and redistribute large wood in headwater streams. Stream size and topographic setting strongly influenced processes that delivered wood to the channel network. In small colluvial channels draining steep hillslopes, processes associated with slope instability and windthrow were the dominant means of large wood recruitment.

Reid and Hilton (1998) documented wood recruitment source distances for a steep headwater second growth redwood watershed. They reported that about 90 percent of the instances of large wood input occurred from tree falls within 35 meters (115 feet) of the channel in un-reentered second growth redwood/Douglas-fir forests in the North Fork of Caspar Creek, located in western Mendocino County.

FEMAT (FEMAT, 1993) concluded that the probability of wood entering the active stream channel from greater than one tree height is generally low. Two widely used models of large wood recruitment also assume that large wood from areas outside one tree height seldom reaches the stream channel (Van Sickle and Gregory, 1990; Robison and Beschta, 1990). Additional studies support the contention that most large wood is recruited from within 20 meters (66 feet) to 40 meters (130 feet) of the channel bank. For example, Benda et al (2002) reported that in the absence of landslides, wood recruitment in both old-growth and second-growth forests in Humboldt County study sites originated from within 20 to 40 meters of the stream. The four main input mechanisms for their second-growth forest sites in the Van Duzen River watershed included bank erosion, mortality, landslides, and anthropogenic (or logging related), and averaged 18, 21, 13, and 50 percent, respectively.

The potential size distribution of large wood is also an important factor when considering the appropriate activities in buffer strips relative to large wood potential recruitment. Larger pieces of wood form key structural elements in streams, which serve to retain smaller debris that would otherwise be transported downstream during high flows (Murphy, 1995). The size of these key pieces is approximately 12 inches or more in diameter and 16 feet in length for streams less than 16 feet wide and 24 inches or more in diameter and 39 feet in length for streams greater than 66 feet wide (Bisson et al., 1987). As a result, riparian management zones must ensure not only an appropriate amount or volume of wood, but wood of sufficient size to serve as “key pieces.”

Coniferous large wood significantly outlasts deciduous large wood in the stream system (Harmon et al., 1986; Grette, 1985). Simply setting aside buffers of second-growth hardwoods does not provide optimal large wood input over the short term, because unassisted recovery of these areas to pre-logging coniferous large wood recruitment levels may take 100 to 200 years.

Land management and VTP activities that influence tree growth rate, stand density, and mortality rate will determine recruitment of aquatic large woody debris (greater than 10cm in diameter and greater than 1 meter in length) (Naiman et al., 2002). Ultimately, a sustained balance must be established between forest stand development through phases of stem exclusion (natural tree mortality and adjustment of stand tree density) or periodic pre-commercial/commercial thinning and the rate at which other means of tree mortality, such as windthrow, fire, and lateral bank undercutting (among others) recruits trees of a desired species and size to the aquatic environment. These riparian forest stand composition variables are further influenced by site specific variables such as existing forest stand structure and composition, soil productivity, influence of competing vegetation, stream size and ability to transport large woody debris material, and current large woody debris loads and residence time.

VTP thinning in conjunction with other land management actions conducted in the riparian zone have the potential to either enhance or diminish development and recruitment of large woody debris to the aquatic environment depending on silvicultural prescription applied, degree of impact to existing trees, and the ecological variables previously described. VTP management practices which may influence aquatic large woody debris development and recruitment potential are not readily assessed at the scale of the bioregion. Projects with that potential are expected to be uncommon, small in extent, and distributed over a wide area.

Wildfire consumes debris jams and reduces overall wood volume, and post wildfire increases in stream discharge increases the transport and accumulation of existing large woody debris (Berg et al., 2002). To the degree that VTP projects reduce the frequency, extent, or intensity of wildfire, aquatic large woody debris presence is likely benefited.

HEADWATER ENVIRONMENTS

Headwater streams and drainages (Forest Practice Rule Class II and III) are areas that contribute to stream ecosystem function. These areas can represent 60-80 percent of total channel length in mountainous terrain (May and Gresswell, 2003a). These small streams contribute structural components such as large woody debris, spawning gravels and stream substrate, and invertebrate and detritus inputs. These sites also contribute to water quality and provide for storage of potentially deleterious fine sediment. Similarly, they can have a strong influence on the rates of sediment and wood delivery to larger watercourses, and consequently, habitat value for a variety of aquatic and semi-aquatic vertebrates and other biota (Welsh and Ollivier, 1998). Management approaches aimed at restoration and management of watershed processes, rather than individual habitat characteristics, may be more effective in developing complex stream channel structure (May and Gresswell, 2003b). The underlying assumption is that movement toward restoration of natural processes and levels of sediment production, large woody debris recruitment, and other stream function processes will be positive for stream biota.

The structure and function of stream ecosystems has been extensively studied and reinforces the concept of the “river continuum” (Vannote et al., 1980) – that energy and organic material inputs to stream processes change in a predictable way along the stream course from headwaters to downstream reaches. A variety of land uses, including timber harvest and forest management, can influence background erosion and sedimentation regimes, recruitment of large woody debris and other ecological processes. The delivery, residence time, and transport of these additional sediments and woody debris influence stream channel conditions and associated biota. Change in vegetation in the vicinity of headwater streams can markedly alter the function of these stream types and those larger stream systems supported. Change in the efficiency of the channel to recharge groundwater, meter trapped sediments and water flow, and process organic material and other nutrients for use by aquatic biota downstream can be expected. Past management practices that reduced local sources of wood and rate of wood recruitment increase the relative importance of wood contributed by debris flows in colluvial tributaries where this means of recruitment occurs. Most debris flows in the northern California Coast Ranges originate from zero-order colluvial-filled hollows. The principle influence of vegetation along Class III channels on the mobilization of debris is the presence of in-channel large trees that could slow or stop mobilized sediment and debris under some circumstances or contribute large wood at other times. Because debris flow potential is not universal, watercourse and lake protection zone (WLPZ) boundaries cannot be used as a surrogate to actual site inspection for potential zones of failure.

Type disturbance has markedly different results on the structure and function of stream and associated riparian ecosystem processes. For example, floods, fire, and mass wasting events are generally less frequent and result in large localized changes to stream system processes, whereas timber harvest, land conversion, and agricultural and urban development are more frequent and large scale in effects. Treatment methods associated with the VTP and other similar land management activities can alter headwater stream system function and habitat quality. Significant vegetation removal by any means can release perched sediment deposits, alter habitat quality by filling interstitial spaces in the streambed, and reduce large woody debris and consequently volume of sediment storage capacity. In general, the topographic placement of many headwater stream and seep environments prevent or make impractical vegetation treatment by mechanical means. Similarly, where these environments are accessible to other VTP methods they are effectively avoided or excluded from treatment during project level planning and implementation. Prescribed fire as a vegetation treatment method has the greatest potential to negatively impact these stream environments by removing woody debris, releasing stored sediments and altering vegetation cover, habitat conditions, and microclimate.

Because of the small size of headwaters and close connection with uplands, these areas are readily influenced by adjacent land uses. Species that inhabit headwater environments can be especially vulnerable to habitat alteration. These species, such as amphibians and other taxa, generally achieve higher population densities in headwater habitats. In addition, individual species inhabiting headwater habitats generally exhibit low levels of vagility (mobility) sometimes spending their entire life cycle in a few square meters of habitat (Sheridan and Olson, 2003). Recolonization of suitable vacant habitat may require extensive periods of time or, lacking movement into vacant habitat, result in local population extirpation.

Headwater stream reaches, lacking fish populations, provide areas with little or no fish predation pressure to the benefit of several aquatic and semi-aquatic amphibians. Amphibians that breed primarily in stream habitats represent a large component of stream biomass and in the Pacific Northwest may exceed fish in both numbers and biomass (Hawkins et al., 1983). Welsh and Ollivier (1998) examined the effect of sediments on aquatic amphibian densities in coast redwood. Three species were sampled in numbers sufficient to be informative: tailed frog (*Ascaphus truei*, larvae), Pacific giant salamander (*Dicamptodon tenebrosus*, paedomorphs and larvae), and southern torrent salamander (*Rhyacotriton variegatus*, adults and larvae). Densities of amphibians were significantly lower in the streams impacted by sediment. While sediment effects were species-specific, reflecting differential use of stream microhabitats, the shared vulnerability of these species to infusions of fine sediments was probably the result of their common reliance on interstitial spaces in the streambed matrix for critical life requisites, such as cover and foraging. Studies by Diller and Wallace (1996) and Wilkins and Peterson (2000) indicate persistence of headwater amphibians in managed forests and demonstrate the need to focus on importance of abiotic features such as parent geology, topography and channel characteristics to predict species distribution and responses to disturbance.

FOREST CANOPY NUTRIENT INPUT

Vegetation management practices can lead to changes in leaf litter distribution and dynamics in upland and riparian areas, which in turn affect availability in streams. Harvest intensity (i.e., the proportion of forest canopy removed) and cutting frequency affect the rate of nutrient removal from the system (Beschta et al., 1995).

Detritus enters a stream primarily by direct leaf or debris fall, although organic material may also enter the stream channel by overland flow of water, mass soil movements, or shifting of stream channels. Few studies have been done relating litter contributions to streams as a function of distance from the stream channel; however, it is assumed that most fine organic litter originates within 100 feet or approximately 0.5 tree height from the channel (FEMAT, 1993). In most cases, however, buffers designed to protect most large wood recruitment would likely ensure nearly 100 percent of detrital input. A buffer width of 0.75 of a site-potential tree height is needed to provide full protection for litter inputs (Spence et al., 1996).

Stand age significantly influences detrital input to a stream system. Detrital input from outside the stream channel was estimated to be two times as high in old-growth forests as in either 30- or 60-year-old forests (Richardson, 1992) and could be as much as five times as high in old-growth forests as in recently clearcut forests (Bilby and Bisson, 1992). However, reduced levels of detrital input into streams attributable to streamside timber harvesting is somewhat offset by concomitant increases in detritus production within stream channels (primarily dead algae and other aquatic plant debris). Reduced riparian forest canopy increases light levels and, therefore, the production of algae. The abundance and composition of detritivore (macro-invertebrates that process detritus) assemblages in streams are determined largely by the plant composition of riparian zones (Gregory et al., 1991). Therefore, changing the stand composition may alter the macro-invertebrate composition.

In the North Fork of Caspar Creek within California's redwood region, most macro-invertebrate and algal variables increased significantly after logging. Macro-invertebrates increased because of increased stream algae. Algae increased because of increased light, water temperature, and nutrients. Logging effects on the North Fork of Caspar Creek biota were often not dramatic because forest practices minimized the effects. The three most important practices that ameliorated the effects were the presence of riparian buffer zones, absence of roads near the stream, and use of cable yarding which minimized soil disturbance (Bottroff and Knight, 1996).

CRITERION B – DETERMINATION OF SIGNIFICANCE

The statewide ten-year average acreage proposed for treatment within the VTP is 600,000 acres, which is 2.4 percent of the approximately 25 million acres available for treatment (Table 3.3-1). This means that there will be very few projects spread over many acres, and the probability of numerous projects occurring in a single watershed is very low, even over 10 years.

Landscape constraints, Standard Project Requirements, and Project Specific Requirements developed as a result of the Project Scale Analysis will, in the aggregate, reduce cumulative impacts to aquatic resources and riparian function to a **less than significant** level as assessed at the scale of the bioregion. Reduction in the occurrence of high severity wildfire as a result of vegetation treatment technique application is expected to provide additional benefits to aquatic resources although to a degree not presently determinable.

The cumulative effects of VTP treatments and related activities on aquatic large woody debris recruitment and delivery mechanisms are expected to be negligible or immeasurable. VTP projects with the potential to make a cumulative effect contribution to existing areas of stream bank instability are expected to be uncommon, small in extent, and distributed over a wide area. With project level management and mitigation measures such as HYD-3, HYD-4, and FBE-1 in place, and as assessed at the scale of the bioregion, the cumulative effects of VTP treatments and related activities on watercourse sediment levels are expected to be **less than significant**.

Headwater stream ecosystems vary greatly in terms of how they function both locally and at a basin scale. This variability manifests itself in differences in channel morphology, hydrologic regime, and riparian and biological characteristics. The variability of these small headwater streams therefore challenges the manager’s ability to predict process and management effects at a large scale (Headwaters Research Cooperative, 2001). Several headwater stream protection measures are described in the Project Scale Analysis (Chapter 7) and include equipment limitation and exclusion zones (HYD-3) and stipulations on the use of prescribed fire (HYD-4 and FBE-1). With project level management and mitigation measures in place, and as assessed at the scale of the bioregion the cumulative effects of VTP treatments and related activities on headwater stream and seep environments, ecological processes, and associated biota are considered **less than significant** and no further mitigation additional to that implemented at the scale of the project is required.

Substantial reduction in forest canopy nutrient input to stream systems is not expected to occur during VTP projects with project level management and mitigation measures in place. Assessed at the scale of the bioregion, the cumulative effects of VTP treatments and related activities on forest canopy nutrient input to stream systems is considered **less than significant** and no further mitigations additional to these implemented at the scale of the project are required.

The cumulative impact of VTP with other related actions is considered **less than significant** at the scale of the Bioregion with implementation of the Standard Project Requirements (Chapter 2) and any Project Specific Requirements identified through the Project Scale Analysis (See Chapter 7).

CRITERION C – FEDERALLY PROTECTED WETLANDS

Substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.

Wetlands are part of the foundation of our nation's water resources and are vital to the health of waterways and communities that are downstream. Wetlands feed downstream waters, trap floodwaters, recharge groundwater supplies, remove pollution, and provide fish and wildlife habitat. Wetlands include swamps, marshes and bogs. Wetlands are often found alongside waterways and in flood plains. However, some wetlands have no apparent connection to surface water like rivers, lakes or the ocean, but have critical groundwater connections (US EPA, 2015).

The government achieves the restoration of former or degraded wetlands under the Clean Water Act Section 404 program as well as through watershed protection initiatives. For regulatory purposes under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (40 CFR 230.3(t)).

The US EPA has identified hydrologic alterations, pollution inputs, and vegetation damage as the primary threats affecting the health and functionality of the nation's wetlands (US EPA, 2001). Specific actions proposed by the VTP with the ability to impact wetlands are: water diversions (drafting); runoff including sediment, animal waste, nutrients, or pesticides; and vegetation damage by equipment, prescribed fire, or herbivores.

CRITERION C – DETERMINATION OF SIGNIFICANCE

The VTP proposes a number of Standard Project Requirements to reduce the likelihood of substantial adverse effects on federally protected wetlands as defined by Section 404 of the Clean Water Act. Most are associated with activity setback from waterbodies adjacent to the project area, including FBE-1, BIO-10, BIO-11, HAZ-8, HYD-3, HYD-4, HYD-5, HYD-6, and HYD-17 (see Chapter 2.5). With implementation of the Standard Project Requirements, no impacts from the proposed Program or Alternatives are expected. Land management practices, such as Silviculture, that may combine with the impacts of the VTP to create a significant impact follow similar mitigation measures to those proposed by the VTP. No further mitigations additional to those implemented at the scale of the project are required.

The cumulative impact of the proposed Project or Alternatives with other related actions is considered **less than significant** at the scale of the Bioregion with implementation of the Standard Project Requirements (Chapter 2.5) and any Project Specific Requirements identified through the Project Scale Analysis (Chapter 7).

CRITERION D – NATIVE RESIDENT OR MIGRATORY FISH OR WILDLIFE SPECIES

Interfere substantially with the movement of any native resident or migratory species or with established native resident or migratory species corridors, or impede the use of native species nursery areas.

The ability of wildlife to move across the landscape is essential to long-term sustainability of populations and the maintenance of regional biological diversity. In environments that are heavily impacted by urbanization or agricultural land uses, the pattern of habitat loss, associated habitat fragmentation, and disruption of movement patterns has a marked influence on ecosystem processes (Forman, 1997). Conserving well-connected networks of large wildland areas where ecological and evolutionary processes function over large spatial and temporal scales requires adequate landscape connections. Establishing or maintaining linkages between areas of wildland is a well-recognized tenet of conservation biology and positively influences the ability of wildlife populations to respond to stochastic environmental influences such as fire, flood, or non-native species as well as longer term directional effects such as climate change, and maintains long term population viability above that of otherwise isolated wildlife populations.

Countering the effects associated with habitat loss and fragmentation at the landscape scale requires a systematic approach for identifying, protecting, and restoring functional connections. For example, early regional conservation planning for the Northern Spotted Owl identified landscape scale linkages and hypothesized habitat conditions between population centers necessary for successful movement and subspecies interaction (Thomas et al., 1990). Similarly, the South Coast Missing Linkages Project (Penrod et al., 2003) identified 15 areas where habitat retention was necessary to maintain movement patterns of focal wildlife species across the landscape.

Landscape scale corridor identification or other areas of reproductive importance (nursery areas) are typically an element described in species conservation planning documents such as Habitat Conservation Plans, Recovery Plans and Natural Community Conservation Plans (Criterion F).

CRITERION D – DETERMINATION OF SIGNIFICANCE

Land disturbance activities resulting from any of the vegetation treatment options have the potential to alter the habitat suitability of identified landscape linkages making them unsuitable for movement of certain focal species. Cumulative direct and indirect effects to landscape linkages are a determination made at the scale of the project as described in the Project Scale Analysis (Chapter 7). Alternatively, these same practices have the potential to protect linkages from catastrophic loss or enhance habitat value within those landscape scale features. As assessed at the scale of the bioregion, VTP effects are expected to be negligible or immeasurable. VTP program contributions to cumulative effects of land disturbing activities that interfere substantially with the movement of any native resident or migratory species, or with established native resident or migratory species corridors, or impede the use of native species nursery areas, is **less than significant**. The VTP may result in an overall but immeasurable beneficial effect to the degree that wildfire events are reduced in frequency, extent or intensity. Based on the average size of VTP projects (260 acres), frequency of occurrence, and expected spatial distribution, the cumulative impact of VTP with other related actions is considered **less than significant** at the scale of the Bioregion with implementation of the Standard Project Requirements (Chapter 2.5) and any Project Specific Requirements identified through the Project Scale Analysis (Chapter 7).

CRITERION E – CONFLICT WITH LOCAL POLICIES OR ORDINANCES

Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.

County and local governments may have specific policies or ordinances for resources that are not addressed at the state or federal level. Common examples of these are oak retention during development and the time-of-day restrictions on noise generating activities. VTP projects in the proposed Program and Alternatives including mechanical and manual treatments, especially in the WUI, may include activities that would be subject to these ordinances. Standard Project Requirements BIO-5, BIO-6 and NSE-1 would reduce the likelihood that VTP projects would violate these local policies or ordinances. Additional mitigation measures would be developed through the Project Scale Analysis (Chapter 7) as necessary.

CRITERION E – DETERMINATION OF SIGNIFICANCE

The cumulative impact of the proposed Program or Alternatives with other related actions is considered **less than significant** at the scale of the Bioregion with implementation of the Standard Project Requirements and any Project Specific Requirements identified through the Project Scale Analysis (See Chapter 7).

CRITERION F – LOCAL, REGIONAL, OR STATE HABITAT CONSERVATION PLANS

Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan or other approved local, regional or State habitat conservation plan.

Natural Community Conservation Plans (NCCP), authorized under California's Natural Community Conservation Planning Act and Endangered Species Act, as well as Habitat Conservation Plans and other planning vehicles provided for under the federal Endangered Species Act are increasingly being used in California as a means to conserve species of concern. As additional acreage of wildland and wildland-urban interface lands are enrolled under these planning efforts, the potential for off-site and indirect cumulative effects also increases. As of August 2014, 23 active NCCPs covering more than 11 million acres have been issued by the California Department of Fish and Wildlife (CDFW, 2014). As of February 17, 2015 a total of 156 HCPs had been issued within California and Nevada by the US Fish and Wildlife Service according to the Environmental Conservation Online System (ECOS, 2015). Several other types of conservation agreements are also available to address species listed under the federal ESA. There have been 26 Safe Harbor Agreements, 16 Candidate Species Conservation Agreements, and two Candidate Species Conservation Agreements with Assurances issued by the USFWS in California and Nevada (ECOS, 2015).

The NCCP program of the CDFW is an unprecedented effort by the State of California and numerous private and public partners that takes a broad-based ecosystem approach to planning for the protection and perpetuation of biological diversity. A NCCP identifies and provides for the regional or area wide protection of plants, animals, and their habitats. The primary objective of the NCCP program is to conserve natural communities at the ecosystem scale while accommodating compatible land use. The program seeks to anticipate and prevent the controversies and gridlock caused by species' listings by focusing on the long-term stability of wildlife and plant communities and including key interests in the process.

The NCCP program is a cooperative effort to protect habitats and species. The program, which began in 1991 under the State's Natural Community Conservation Planning Act, is broader in its orientation and objectives than the California and Federal Endangered Species Acts. These laws are designed to identify and protect individual species that have already declined in number significantly.

Habitat Conservation Plans (HCP) are long-term agreements between an applicant and the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service. They are designed to offset any harmful effects that a proposed activity might have on federally-listed threatened and endangered species. The HCP process allows projects to proceed while providing a conservation basis to conserve the species and provide for incidental take. The purpose of the habitat conservation planning process and subsequent issuance of incidental take permits is to authorize the incidental take of threatened or endangered species, not to authorize the underlying activities that result in take. This process ensures that the effects of the authorized incidental take will be adequately minimized and mitigated to the maximum extent practicable.

CRITERION F – DETERMINATION OF SIGNIFICANCE

VTP projects under the proposed Program will, as part of project planning and completion of the Project Scale Analysis, review applicable local and regional habitat conservation plans. Conflicting objectives will be identified at the project level and resolved through coordination with appropriate State or federal fish and wildlife agencies. In addition, opportunities to further the objectives of local and regional conservation plans through vegetation treatments conducted under the VTP will also be identified and implementation coordinated through appropriate State or federal fish and wildlife agencies (BIO-4, Section 2.5). Therefore, the cumulative effect of the proposed Program and Alternatives, with related programs, will not significantly conflict with established conservation programs or plans. The cumulative impact of proposed Program and Alternatives with other related actions is considered **less than significant** at the scale of the Bioregion with implementation of the Standard Project Requirements (Chapter 2.5) and any Project Specific Requirements identified through the Project Scale Analysis (Chapter 7).

CUMULATIVE IMPACT ANALYSIS FOR ALTERNATIVES CONSIDERED

The scale of the No Project alternative is the same as the proposed Program, but due to implementation barriers, it is expected that the treated acres will be fewer. It is likely the

No Project alternative will have similar impacts on biological resources as the proposed Program, due to the overall lower treated acreage and the use of environmental review procedures.

Because the scale of Alternatives A, B, and C would be the same as the proposed VTP at 60,000 acres treated annually for ten years, with the same vegetation treatment activities by vegetation type expected to occur, Alternatives A, B, and C would have similar impacts as the proposed VTP. These alternatives have fewer acres available for treatment which may increase the likelihood that treatment impacts to biological resources would be condensed in a localized area. Through implementation of the PSA (Chapter 7) and SPRs such as HYD-16 (Section 2.5) the likelihood of impacts at the planning watershed level would be minimized. Therefore, the increases in risk to biological resources attributable to Alternatives A, B, and C would not be cumulatively considerable and the cumulative impact would be less than significant.

Alternative D would treat fewer acres with the same landscape constraints on the placement of treatments (i.e. the same treatable area) as the proposed VTP. This would serve to dilute the impacts on biological resources as a lower percentage of the acres available for treatment would receive treatment in any given year relative to the proposed VTP and Alternatives A, B, and C. Alternative D would also use less prescribed fire than the proposed VTP or any of the alternatives. Relative to biological resources, introducing less fire into ecosystems that have significantly deviated from their natural fire regimes may reduce some of the benefits of the program. However, the other treatment alternatives (manual, mechanical, herbivory, and herbicide) can introduce similar ecosystem impacts and can more finely target vegetation to manipulate, potentially offering greater protection to vegetation desired for retention than prescribed fire would. Therefore, the increases in risk to biological resources attributable to Alternative D would not be cumulatively considerable and the cumulative impact would be less than significant.

5.5.1.3 Mitigations

Please see Section 2.5 and Chapter 7 of this document for SPRs and the Project Scale Analysis that avoids significant impacts to biological resources.

5.5.2 GEOLOGY, HYDROLOGY, AND SOILS

This section summarizes the potential cumulative effects to geologic, hydrologic, and soil resources due to implementing vegetation treatment activities under the VTP and alternatives. Geology, hydrology and soils are also analyzed in Chapter 4.3.

5.5.2.1 Significance Criteria

The significance criteria identified in Chapter 4.3 are used here to evaluate potential cumulative effects. Significance criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines and are the following:

a) Be located on unstable geologic units or soils, including expansive soils; or located on geologic units or soils that could become unstable as a result of the project; resulting in ground failures.
b) Exposure of people or structures to the risk of loss, injury, or death involving landslides.
c) Result in substantial soil erosion or loss of topsoil.
d) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge, such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.
e) Substantially alter the existing drainage pattern of the site or area, including through alteration of the course of a stream or river, in a manner that would result in substantial erosion or sedimentation on- or off-site.
f) Create or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff.
g) Place housing within a 100-year flood hazard area, as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map, or other flood hazard delineation map.
h) Place structures within a 100-year flood hazard area that would impede or redirect flood flows.
i) Expose people or structures to a significant risk of loss, injury, or death from flooding, including flooding resulting from the failure of a levee or dam.
j) Inundation by seiche, tsunami, or mudflow.

5.5.2.2 Determination of Significance

5.5.2.2.1 Cumulative Impact Analysis for Program

The following section evaluates potential cumulative effects to geologic, hydrologic, and soil resources arising from implementation of the Proposed Program or the Alternatives. The potential for a cumulative effect is discussed for each significance criterion listed above.

When properly implemented, the majority of SPRs and PSRs result in the implementation of onsite controls that prevent significant cumulative impacts to geologic, hydrologic, and soil resources at the local scale. However, a mechanism in which multiple projects over time and space can potentially lead to significant cumulative impacts to these resources is through the cumulative increase in runoff due to vegetation removal and subsequent decreases in evapotranspiration. Increased runoff from multiple projects over time and space has the potential to trigger several of the significance criteria listed above. Given that the cumulative increase in flow is a concern for many of these criteria, the potential for these significant increases will be evaluated first and used to evaluate significant cumulative impacts for criterion A through K.

SPR HYD-16 was created to help minimize cumulative vegetation removal-induced increases in flow at the planning watershed scale to non-significance. HYD-16 assumes that flow increases will be kept to a non-significant level if no more than 20 percent of a planning watershed is treated through fuel treatments or logging within a 10-year timespan. The 20 percent vegetation removal threshold is established using information from Grant et al. (2008), which shows that flow increases in small watersheds (less than 3.9 mi^2) are not detectable if vegetation removal is below 29 to 15 percent for rain-dominated watersheds and rain-snow mixed watersheds, respectively. Twenty percent is chosen because it is within the range stated by Grant et al. (2008).

Accurate and recent data on cumulative land use activities at the planning watershed scale was not available at the statewide scale. However, bioregion lumped data on past, present, and foreseeable activities is available from Section 5.3. Table 5.3-8 shows the annual average acreage of federal vegetation treatments, private logging and fuel reduction treatments, and wildfire, along with the projected VTP acreage by bioregion. By removing wildfire, the potential for significant impacts can be evaluated for the VTP along with past, present, and foreseeable projects (Table 5.5-2). Multiplying the annual average acreage by 10 and dividing by the total treatable area within each bioregion provides an estimate of bioregion-averaged percent disturbance across a 10-year time span. Table 5.5-2 indicates that the 20 percent disturbance threshold is not exceeded for any bioregion over a 10-year timespan. The bioregions with the highest potential for exceeding the 20 percent threshold over a 10-year timespan are the Modoc, Sierra Nevada, Sacramento Valley, and Klamath/North Coast (Table 5.5-2). Of these bioregions, only the Sierra Nevada and Klamath/North Coast overlap with geomorphic provinces that have a higher potential for hydrogeomorphic impacts (i.e., the Sierra Nevada, northern portion of the Coast Ranges, and the Klamath Mountains).

Table 5.5-2 Cumulative Disturbance Projections

Bioregions	Federal Projects	Projected VTP Projects	Combined Projects	Treatable Vegetation Acres*	% of Area Annually Distrubed	% of Area Annually Distrubed
Bay Area/Delta	37,008	5,855	3,922	3,200,408	1.46%	14.62%
Central Coast	33,037	8,904	2	6,949,833	0.60%	6.04%
Colorado Desert	39,587	988	0	4,663,190	0.87%	8.70%
Klamath/North Coast	27,499	11,650	140,667	13,644,543	1.32%	13.18%
Modoc	22,137	7,175	98,528	7,176,933	1.78%	17.81%
Mojave	30,900	2,573	263	18,719,988	0.18%	1.80%
Sacramento Valley	23,130	2,364	0	1,641,127	1.55%	15.53%
San Joaquin Valley	17,830	1,877	0	2,658,732	0.74%	7.41%
Sierra Nevada	16,516	13,411	243,492	15,588,940	1.75%	17.54%
South Coast	14,126	5,204	121	4,392,490	0.44%	4.43%
Average Totals	**261,772**	**60,000**	**486,994**	**78,636,184**	**1.03%**	**10.28%**

To assess the potential for the Proposed Program to increase the percent of treated area above 20 percent threshold across the range of planning watersheds, generalized information about Calwater planning watersheds is used. There are 7,035 Calwater planning watersheds in California, of which 5,600 Calwater planning watershed contain more than 2 percent of its area in SRA. Calwater planning watersheds range in size from 3,000 to 10,000 acres. The VTP proposes to treat 60,000 acres per year. With an average project size of 260 acres, this comes to approximately 230 projects per year. The small number of projects relative to the number of planning watersheds available for project activities indicates a small percentage of watersheds will be disturbed in any given year by the proposed VTP.

Given the range of acreage for planning watersheds, and assuming an even distribution of all other types of past, present, and foreseeable activities across all 7,035 planning watershed, it would be expected that between zero to three projects could be implemented in a planning watershed over a ten year period before the 20 percent disturbance threshold is reached. The highest likelihood for exceeding the threshold is in the smallest planning watersheds with the highest levels of past, present, and foreseeable activities. Exceeding the 20 percent threshold doesn't automatically trigger a significant cumulative impact; rather it requires additional analysis at a more appropriate scale and with a higher level of rigor than can be accomplished at the Program scale.

CRITERION A – BE LOCATED ON UNSTABLE GEOLOGIC UNITS OR SOILS

Be located on unstable geologic units or soils, including expansive soils; or located on geologic units or soils that could become unstable as a result of the project; resulting in ground failures.

Project scale unstable geologic units or unstable soils are mitigated through the use of SPR GEO-1 (see Section 2.5). GEO-1 reduces significant impacts to unstable geologic units and unstable soils by requiring either a Registered Professional Forester (RPF) or Professional Geologist (PG or CEG) to identify unstable areas or soils during the project planning phase, and avoiding the features during project implementation. Avoidance measures will prevent significant impacts by avoiding ground disturbance within the unstable features, avoiding the removal of vegetation that provides rooting strength to the unstable area, and avoiding hydrologic changes that can increase the susceptibility of failure for the unstable feature.

Under the proposed VTP, unstable geologic units or unstable soils can only be included within the project area if a Certified Engineering Geologist provides a geologic report stating that the proposed activities will not result in an adverse significant impact to unstable features. Additional SPRs that help reduce the significance of project activities to unstable geologic units and unstable soils within a project area include FBE-1, HYD-3, HYD-4, HYD-5, and HYD-7.

A mechanism in which multiple activities over time and space can potentially lead to significant impacts to unstable geologic units and/or soils is through the cumulative increase in runoff due to vegetation removal and subsequent decreases in evapotranspiration. If the increased runoff is delivered to the watercourse network, there is the potential that flow can undercut steep, watercourse-adjacent hillslopes; triggering debris sliding (Reid, 2010). This phenomenon is typically associated with inner-gorges – a landform common in tectonically active areas (Reid, 2010). Under GEO-1, inner gorges within the project area will be avoided or will be assessed and mitigated using PSRs designed by a CEG. Despite this, inner gorges within the project area and downstream of the project areas are potentially susceptible to failure by fluvial undercutting. By implementing SPRs FBE-1, HYD-3, HYD-4, HYD-5, HYD-7, and HYD-16 the cumulative impacts of the Program to Criterion A would be reduced to **less than significant.**

CRITERION B – EXPOSURE OF PEOPLE OR STRUCTURES TO THE RISK OF LANDSLIDING

Exposure of people or structures to the risk of loss, injury, or death involving landslides.

The SPRs mentioned in Criterion A are used to prevent the triggering of landslides on unstable areas or soils. By incorporating the SPRs mentioned for Criterion A, the

Program will prevent significant cumulative impacts of landsliding to people or structures. The cumulative impacts of the Program to Criterion B would be considered **less than significant.**

CRITERION C – SOIL EROSION OR LOSS OF TOPSOIL

Result in substantial soil erosion or loss of topsoil.

Project scale soil erosion or loss of topsoil is mitigated by SPRs that control fire burn severity (FBE-1, HYD-15) and the location of ignitions relative to watercourses (HYD-4), minimize soil compaction and prevent erosion (HYD-5, HYD-7, HYD-9 and HYD-13), and limits equipment use on steep slopes (HYD-14)

While HYD-16 is primarily an SPR that minimizes vegetation removal-induced changes in hydrology, disturbed area also relates to the degree of ground disturbance and potential erosion in a planning watershed (MacDonald et al., 2004). As such, the implementation of HYD-16 will require project proponents to determine if cumulative significant impacts related to erosion are or will occur as a result of project activities. If non-mitigatable cumulative significant impacts are determined through project scale hydrologic analysis, then the project will not fall under the scope of the VTP PEIR. As such**, no significant cumulative impacts** to erosion and/or topsoil erosion are expected as a result of this Program.

CRITERION D – DEPLETE GROUNDWATER OR INTERFERE WITH GROUNDWATER RECHARGE

Substantially deplete groundwater supplies or interfere substantially with groundwater recharge, such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.

Vegetation removal increases annual water yield (Bosch and Hewlett, 1982) through the mechanism of decreased evapotranspiration and subsequent increased water inputs to soils. This increases groundwater levels and increases groundwater recharge. The Program will result in **no significant cumulative impacts** that will result in groundwater depletion or groundwater recharge.

CRITERION E – ALTERING THE DRAINAGE PATTERN OR COURSE OF A STREAM OR RIVER.

Substantially alter the existing drainage pattern of the site or area, including through alteration of the course of a stream or river, in a manner that would result in substantial erosion or sedimentation on- or off-site.

Standard Program Requirements FBE-1, HYD-4, HYD-5, HYD-7, HYD-13, HYD-14, and HYD-15 are used to minimize drainage alteration at the hillslope scale. Several SPRs help to prevent the alteration of the course of a stream or river (i.e., channel migration). Most wildland streams or rivers downstream of VTP projects will generally be confined by narrow valley walls, which will limit the potential for channel migration (Beechie et al., 2005). Channel migration may occur on alluvial fans, when sediment-laden streams emerge from confined valleys. Channel migration may also occur if sufficient flow, sediment, or debris is delivered to channels prone to meandering or avulsing. HYD-16, along with any identified PSRs, will help to minimize flow increases to non-significance in the downstream direction, and onsite controls (see Criterions A and C) will prevent excess downstream accumulations of sediment and/or debris. As a result, the Program will result in **no significant cumulative impacts** to existing drainage patterns or to the course or location of streams and rivers inside or outside the project areas.

CRITERION F – CREATE RUNOFF THAT WILL EXCEED THE CAPACITY OF DRAINAGE SYSTEMS OR PROVIDE POLLUTED RUNOFF

Create or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff.

Sections 4.3 and 5.5.2 provides a process-based rationale for why onsite controls and the implementation of HYD-16 will minimize significant cumulative impacts to flow increases to non-significance. These SPRs will prevent overwhelming the capacity of existing drainage systems. The SPRs discussed for Criterion C will minimize onsite and offsite pollution of runoff. As a result, the Program will result in **no significant cumulative impacts** to the conveyance of drainage systems or to runoff pollution.

CRITERION G – PLACE HOUSING WITHIN A FLOOD HAZARD AREA

Place housing within a 100-year flood hazard area, as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map, or other flood hazard delineation map.

The Program does not propose to place housing within flood hazard areas, and will have **no significant cumulative impact** for this criterion.

CRITERION H – PLACE STRUCTURES WITHIN FLOOD HAZARD AREAS THAT WOULD MODIFY FLOOD FLOWS

Place structures within a 100-year flood hazard area that would impede or redirect flood flows.

The Program does not propose to place structures within flood hazard areas, and will have **no significant cumulative impact** for this criterion.

CRITERION I – EXPOSE PEOPLE OR STRUCTURES TO FLOODING, INCLUDING FAILURE OF A LEVEE OR DAM

Expose people or structures to a significant risk of loss, injury, or death from flooding, including flooding resulting from the failure of a levee or dam.

Sections 4.3 Section 5.5.2 provides a process-based rationale for why onsite controls and the implementation of HYD-16 will minimize significant cumulative impacts to flow increases to non-significance. Properly implementing these SPRs will prevent the downstream flooding. As a result, the Program will result in **no significant cumulative impacts** to downstream flood damage to life or property, or the likelihood of failure of a levee or dam.

CRITERION J – INUNDATION BY SEICHE, TSUNAMI, OR MUDFLOW

Inundation by seiche, tsunami, or mudflow.

The Program does not involve the construction of housing or structures within areas subject to seiche, tsunami, or landslide hazards. Landslide initiation is the only Program-related mechanism that can affect the occurrence of seiches, tsunamis, or mudflows. Landslide initiation by Program activities are minimized by the SPRs discussed for Criterions A and B. As a result, **the Program will not result in significant cumulative impacts** that will affect inundation by seiche, tsunami or mudflows.

5.5.2.2.2 Cumulative Impact Analysis for Alternatives Considered

The scale of the No Project alternative is the same as the proposed Program, but due to implementation barriers, it is expected that the treated acres will be fewer. It is likely the No Project alternative will have similar impacts on hydrology, geology, and soils as the proposed Program, due to the overall lower treated acreage and the use of environmental review procedures.

Because the scale of Alternatives A, B, and C would be the same as the proposed VTP at 60,000 acres treated annually for ten years, with generally the same vegetation treatment activities by vegetation type expected to occur, Alternatives A, B and C would have similar impacts as the proposed VTP. These alternatives have fewer acres available for treatment which may increase the likelihood that treatment impacts to geologic, hydrologic, and soil resources would be concentrated in a localized area. Alternative A would concentrate activities within the WUI, which generally has less inherent risk to geologic, hydrologic, and soil resources (i.e., flatter topography). Alternative B spreads treatments between the WUI and fuel breaks. Many fuel breaks are located on ridge tops which are an area of low inherent risk for runoff production and/or erosion. Alternative C disperses treatments more than the proposed VTP, Alternatives A, or Alternative B. Through implementation of onsite controls that limit runoff production and erosion, and SPRs such as HYD-16 (Section 2.5) the likelihood of concentrating impacts at the planning watershed level would be minimized. Therefore, the increases in risk to geologic, hydrologic, and soil resources attributable to Alternatives A, B, and C would not be cumulatively considerable and the cumulative impact would be less than significant.

Alternative D would treat fewer acres with the same landscape constraints on the placement of treatments (i.e. the same treatable area) as the proposed VTP. This would serve to dilute the impacts on geologic, hydrologic, and soil resources as a lower percentage of the acres available for treatment would receive treatment in any given year relative to the proposed VTP and Alternatives A, B, and C. Alternative D would also use less prescribed fire than the proposed VTP or any of the alternatives, and prescribed fire has a higher likelihood of triggering cumulative impacts than most other types of activities. The other treatment alternatives (manual, mechanical, herbivory, and herbicide) can more finely target vegetation to manipulate, potentially offering greater protection against runoff and/or erosional increases. Therefore, the increases in risk to biological resources attributable to Alternative D would not be cumulatively considerable and the cumulative impact would be less than significant.

5.5.2.3 Mitigations

Please see Section 2.5 and Chapter 7 of this document for SPRs and the Project Scale Analysis that avoids significant impacts to geologic, hydrologic and soil resources.

5.5.3 HAZARDOUS MATERIALS

This section summarizes potential cumulative effects of hazardous materials and public health impacts due to implementing vegetation treatment activities under the VTP and alternatives. Hazardous material impacts and impacts to public health are analyzed in Chapter 4.4.

5.5.3.1 Significance Criteria

The significance criteria identified in Chapter 4.4 are used here to evaluate potential cumulative effects. Significance criteria are based on the checklist presented in

Appendix G of the State CEQA Guidelines. Refer to Chapter 4.4.2 for the significance criteria used in this cumulative impacts analysis.

5.5.3.2 Determination of Significance

As described in Section 4.4 Hazardous Materials, projects approved under the proposed Program would result in less-than-significant impacts related to the creation of hazards through the use, transport, or disposal of hazardous materials. Projects approved under the proposed Program or any of the Alternatives would comply with hazardous materials SPRs, including relevant federal and State regulations. Hazardous material exposure is typically site-specific and does not combine with other projects to result in significant adverse cumulative impacts. Further, herbicides used under the proposed Program or Alternatives would not be persistent compounds (Appendix D) and would degrade within a few hours to few weeks when exposed to sunlight, moisture, and soil. These substances do not accumulate to produce known long-term impacts. Thus, because exposure of the public or environment to hazardous materials would be site-specific, would be limited in duration (would occur once per year at a maximum), there would be no cumulative effect. This would be a **less than significant cumulative impact**.

VTP projects under the proposed Program or Alternatives would be located throughout wildlands in the State and in areas of moderate to very high fire hazard severity. Therefore, cumulative wildfire hazards are considered significant. While VTP projects would result in activities that would require the transport and use of flammable materials (e.g., fuels) and use of equipment that could ignite dry vegetation and cause fire, CAL FIRE implements strict practices for operation of its equipment and would have appropriately trained personnel to properly suppress fires in the event of an inadvertent ignition. Further, VTP projects would be subject to SPRs that would reduce risk of ignition associated with VTP activities (ADM-1, ADM-5, FBE-2, and HAZ-14). Therefore, the proposed Program or any of the Alternatives would result in **less than significant cumulative impacts** to wildland fire risks.

5.5.3.3 Mitigations

Please see Section 2.5 and Chapter 7 of this document for SPRs and the Project Scale Analysis that avoids significant impacts from hazardous materials.

5.5.4 WATER QUALITY

This section summarizes the potential cumulative effects to water quality due to implementing vegetation treatment activities under the VTP and alternatives. Water quality is also analyzed in Chapter 4.5.

5.5.4.1 Significance Criteria

The following significance criteria have been developed based on the "Hydrology and Water Quality" sections of CEQA Appendix G: Environmental Checklist Form of the State CEQA Guidelines. The impact of the Program on water quality would be considered significant if projects that qualify for implementation under the proposed Process would:

a) Violate any water quality standards or waste discharge requirements
b) Would substantially degrade water quality

The significance criteria related to cumulative effects for hydrology, that typically fall under "Hydrology and Water Quality" in CEQA Appendix G, are covered in Section 5.5.2.

5.5.4.2 Determination of Significance

5.5.4.2.1 Cumulative Impact Analysis for Program

This section uses water quality objectives to determine the potential for significant cumulative effects due to Program activities. Section 5.3 addresses significant impacts related to water quality objectives such as sediment, settleable material, and turbidity, as these are primarily sedimentary cumulative effects. Proper implementation of the SPRs and PSRs described in section 4.3 and 4.5, and discussed in section 5.3, will prevent significant cumulative impacts for these water quality objectives and for sediment-bound nutrients. In addition, HYD-17 will minimize sedimentary and nutrient-related impacts from herbivory by the requirement of targeted grazing (i.e., no grazing within stream-adjacent areas) in project areas.

Significant cumulative impacts to water quality from these constituents are also minimized by the implementation of HYD-3, which requires the use of WLPZs and/or ELZs during project activities. Buffer zones will not be subject to VTP activities, except by low intensity backing fires during prescribed fire (i.e., HYD-4). These buffer zones will provide additional infiltration capacity and surface roughness, which will minimize the water quality impacts if there are project-related increases in runoff and erosion. HYD-3 will also minimize temperature impacts in the downstream direction, as it will protect shade adjacent to watercourses. Water Board jurisdictions with an abundance of 303(d) listings for temperature in forested areas (e.g., the North Coast Water Board) will not be subject to cumulative temperature increases due to the low intensity of activities outside the protected buffers (i.e., ladder fuel removal rather than dominant or co-dominant crown removal).

SPRs and PSRs related to pesticides and other hazardous material are addressed in Chapter 4.4. The short residence time of herbicides, the dispersed pattern of treatment, and dilution in the downstream direction means that herbicides will not significantly accumulate over time and space. Impacts associated with other hazardous materials will be mitigated through avoidance or the implementation of onsite controls described in Chapter 4.4.

Ultimately, watersheds that are impaired will go through a consultation process with the appropriate Regional Water Quality Control Board to ensure that cumulative significant impacts are avoided for 303(d) listed watersheds. This consultation, along with the requirements of HYD-16 (i.e., additional analysis for watersheds exceeding disturbance thresholds) and proper implementation of Program SPRs and PSRs will result in **no significant cumulative impacts** to water quality from Program activities.

5.5.4.2.2 Cumulative Impact Analysis for Alternatives Considered

The scale of the No Project alternative is the same as the proposed Program, but due to implementation barriers, it is expected that the treated acres will be fewer. It is likely the No Project alternative will have similar impacts on water quality as the proposed Program, due to the overall lower treated acreage and the use of environmental review procedures.

Because the scale of Alternatives A, B, and C would be the same as the proposed VTP at 60,000 acres treated annually for ten years, with generally the same vegetation treatment activities by vegetation type expected to occur, Alternatives A, B and C would have similar impacts as the proposed VTP. All require the inclusion of WLPZs and ELZs. These alternatives have fewer acres available for treatment which may increase the likelihood that treatment impacts to water quality would be concentrated in a localized area. Alternative A would concentrate activities within the WUI, which generally has less inherent risk to water quality (i.e., flatter topography). Alternative B spreads treatments between the WUI and fuel breaks. Many fuel breaks are located on ridgetops which are an area of low inherent risk for runoff production and/or erosion. Alternative C disperses treatments more than the proposed VTP, Alternative A, or Alternative B. Through implementation of onsite controls that limit runoff production and erosion, and SPRs such as HYD-16 (Section 2.5) the likelihood of concentrating impacts at the planning watershed level would be minimized. Therefore, the increases in risk to water quality attributable to Alternatives A, B, and C would not be cumulatively considerable and the cumulative impact would be less than significant.

Alternative D would treat fewer acres with the same landscape constraints on the placement of treatments (i.e. the same treatable area) as the proposed VTP. This would serve to dilute the impacts on water quality as a lower percentage of the acres available for treatment would receive treatment in any given year relative to the proposed VTP and Alternatives A, B, and C. Alternative D would use less prescribed fire than the proposed VTP or any of the alternatives, but this might trigger more use of other activity types with different types of water quality impacts (e.g., herbivory for pathogens; mechanical for oil or grease; herbicides for hazardous materials) . However, the other treatment alternatives (manual, mechanical, herbivory, and herbicide) can more finely target vegetation to manipulate, potentially offering greater protection against runoff and/or erosional increases. Therefore, the increases in risk to water quality attributable to Alternative D would not be cumulatively considerable and the cumulative impact would be less than significant.

5.5.4.3 Mitigations

Please see Section 2.5 and Chapter 7 of this document for SPRs and the Project Scale Analysis that avoids significant impacts to water quality.

5.5.5 ARCHAEOLOGICAL, CULTURAL, AND HISTORIC RESOURCES

This section evaluates potential cumulative effects to archeological and cultural resources that may result from implementing the Proposed Program or any of the Alternatives.

5.5.5.1 Significance Criteria

The significance criteria and thresholds used for evaluating archeological and cultural resources in Section 4.6 are appropriate for addressing cumulative effects as well.

Appendix G of the CEQA Guidelines, the CEQA Environmental Checklist, specifies that the Program and Alternatives would have a significant adverse effect to prehistoric, historic, and paleontological resources if any of them would:

a) Cause a substantial adverse change in the significance of a historical resource, as defined in Section 15064.5 of the CEQA Guidelines
b) Cause a substantial adverse change in the significance of an archaeological resource, pursuant to Section 15064.5 of the CEQA Guidelines
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature
d) Disturb any human remains; including those interred outside of formal cemeteries

In addition to prehistoric and historic archaeological sites, cultural resources also include those used for traditional cultural practices, or “ethnographic” resources. The Program and Alternatives would have a significant adverse impact on ethnographic resources if any of them would:

e) Cause a substantial adverse change to locations associated with the traditional beliefs of Native Americans, including areas used or assumed to be used for ceremonial activities

f) Cause a substantial adverse change to locations and or resources used by Native Americans to carry out or support economic, artistic, or other cultural practices.

5.5.5.2 Determination Threshold

The thresholds used are the same as those presented in Section 4.6.2.

ARCHAEOLOGICAL RESOURCE

Any change in the classification or potential classification of an archaeological resource that reduces it from significant or potentially significant to less than significant is considered a significant adverse impact from the proposed Program or Alternatives.

HISTORICAL RESOURCE

The material impairment of a historical resource or its immediate surroundings that alters, in an adverse manner, the physical characteristics of a historical resource so that it would no longer be included in the California Register of Historic Places or a local register of historical resources is considered a significant adverse impact from the program. The criteria for listing are included in Section 4.6.2 of this document.

ETHNOGRAPHIC RESOURCE

An adverse change to an ethnographic resource is one that would lessen the ability of Native Americans to access traditional sites, as defined above, or to utilize such sites, or the resources therein, for their traditional purposes.

5.5.5.3 Determination of Significance

Section 4.6 addresses potential effects to cultural resources that include prehistoric, historic, ethnographic, and paleontological. Given the abundance of cultural resources across the state, the increase in vegetation treatments that would result from the proposed Program and Alternatives has the potential to contribute to a cumulative effect. The potential impact from different treatment methods and appropriate management methods to prevent significant adverse effects are addressed in Section 4.6. The review procedures as described in *Archaeological Review Procedures for CAL FIRE Projects* (Foster and Pollack, 2010), and included under the Standard Project Requirements (SPRs) for cultural resources, include an evaluation of the potential for cumulative effects. With the increased number of prescribed burns and other vegetation management projects on private and federal lands, the potential exists that archaeological, historical, and ethnographic resources could be disturbed with a greater frequency and hence the impact could be cumulative. The CAL FIRE project protocol, which includes review by professional archaeologists as needed, and the SPRs for cultural resources (CUL-1 through CUL-5) should reduce the impact to less than significant. See Section 4.6 for additional information on the CAL FIRE protocol for archaeological review.

No significant cumulative impacts to archaeological or cultural resources are expected from the implementation of the proposed Program or any of the Alternatives.

5.5.5.4 Mitigations

Please see Section 2.5 and Chapter 7 of this document for SPRs and the Project Scale Analysis that avoids significant impacts to archaeological, historic, and cultural resources.

5.5.6 NOISE

This section evaluates potential cumulative effects to noise due to implementing either the Proposed Program or any of the alternatives. Program effects to noise are analyzed in Chapter 4.7. Evaluation of cumulative effects to noise is based on the same criteria and thresholds presented in Chapter 4.7.

5.5.6.1 Significance Criteria

The significance criteria and thresholds used for evaluating noise in Chapter 4.7.2 are appropriate for addressing cumulative effects as well.

Noise effects would be considered significant if the Program or the Alternatives would cause:

a) Exposure of persons to or the generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies
b) Exposure of persons to, or the generation of, excessive ground-borne vibration or ground-borne noise levels
c) Substantial permanent increase in ambient noise levels in the project vicinity (above levels existing without the project)
d) Substantial temporary increase in ambient noise levels in the project vicinity (above levels existing without the project)

5.5.6.2 Determination Threshold

The Program and Alternatives are evaluated using thresholds established in Chapter 4.7.2.2 and are considered to create a significant effect when a treatment or treatments creates:

a) Noise in excess of 90 dBA at 50 feet, or in excess of 65 dBA at 1,600 feet at sensitive receptor locations (schools, residential units, churches, libraries, commercial lodging facilities, and hospitals or care facilities)
b) Noise levels in excess of 70 dBA L_{dn}
c) The Program and Alternatives are considered to create moderately adverse effects when noise levels are between 60 and 70 dBA L_{dn} (State Office of Noise Control, 1976)

Potential effects related to noise from proposed Program activities, or any of the Alternatives, are described in Chapter 4.7.2, with background information and data in Appendix F. Chapter 4.7.2 discusses the potential for noise effects from management activities that include: mowing, operating heavy machinery (dozers, excavators, etc.), chain saws, trucks, helicopters, and hand equipment. Noise effects occur only if the noise is heard or felt by a receptor. Sensitive human receptor concerns given particular consideration in Chapter 4.7.2 are recreation areas and residential areas. Wildlife also can be a sensitive noise receptor, particularly during the reproduction season.

Disturbances associated with mechanical treatments could be substantial, though short in duration. Equipment associated with mechanical treatments can generate noise levels ranging from approximately 75 to 90 dBA at 50 feet, depending upon the equipment being used, although mobile chippers can reach sound levels of 115 dBA (Appendix F, Table F.3-2). Typical operating cycles may involve two minutes of full-power operation, followed by three or four minutes of operation at lower levels. With most projects occurring in rural areas, it is unlikely that project noise will combine with other sources of noise to create a chronic or persistent impact. VTP projects particularly within the WUI could have a cumulative impact to noise. However, the effects are short lived and implementing management measures should reduce the impact to less than significant.

For a cumulative noise related effect, VTP projects would need to add to existing ambient noise levels to cause a significant adverse impact, or that noise from two or more individual projects combines to create such an impact. Standards for what constitutes a significant cumulative noise impact in rural forest and range settings, where most projects occur, are not well defined. For effects to occur, cumulative noise must be heard or felt.

5.5.6.3 Determination of Significance

Implementation of the proposed Program will not result in a measurable bioregional cumulative effect contribution to noise after SPRs and PSRs are applied at the project scale. The majority of projects will occur in remote areas and VTP projects occurring concurrently with other noise producing land management activities are expected to be few in number and are generally undeterminable at the scale of the bioregion.

Substantial permanent or temporary increases in ambient noise levels or exposure of persons to noise or vibration levels above applicable local general plan, noise ordinance or other agency standards are not expected with the application of PSRs and are similarly not cumulatively measurable when assessed at the scale of the bioregion. When examined at the scale of a bioregion, VTP projects typically occur in a wildland or wildland-urban interface setting. The vast majority of the noise generated from the proposed Program is located significant distances away from sensitive receptors. Noise effects arising from the proposed Program or any of the alternatives are of short duration (less than 10 weeks per project on average) and limited to typical workday hours (7AM to 7PM) that may also be seasonally limited. Of the approximately 230 projects that might be implemented per year, 135 (57 percent) of the projects will take place in rural bioregions such as the Klamath/North Coast, Modoc, Sacramento Valley, San Joaquin, Mojave and Colorado Desert.

Some projects will occur in the WUI where operations could occur adjacent to residences and other sensitive receptors. Noise in these situations is generally recognized as a necessary element toward achievement of other desirable land condition objectives. Few VTP projects are expected to occur immediately subsequent to other noise generating land management activities and thus the cumulative duration of noise generation is negligible. It is highly unlikely that a single residential or commercial area will be affected by the noise from more than one watershed treated annually and concurrent with or subsequent to other noise generating land management activities.

The cumulative contribution to duration of unwanted noise levels to sensitive receptors is **less than significant** at the scale of the bioregion. Adoption of proposed Program Standard Project Requirements and any PSRs as a result of a Project Scale Analysis (Chapter 7) reduces individual project level effects to a level that are unlikely to create a cumulative impact to baseline noise levels. Mitigation measures are presented in Chapter 4.7.3.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause cumulatively significant impacts to human health and community well-being or sensitive receptors due to noise.

Alternative A would treat a smaller landscape as the proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A is more likely to result in simultaneous projects occurring in or near a particular community, and therefore more likely to cause significant cumulative noise impacts to human health and community well-being or sensitive receptors.

Similarly, Alternative B would treat a smaller landscape but the same number of acres as the Proposed Program, but only allow WUI and fuel break projects. Due to the limited types of projects that could be implemented, it is more likely that, under Alternative B, a community would have more than one simultaneous fuel reduction project occur, and therefor cumulative noise impacts to human health and community well-being or sensitive receptors would be significant.

Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program. This Alternative would limit projects to Very High Fire Hazard Severity Zone (VHFHSZ), which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because this Alternative would exclusively focus projects in areas of high hazard and not human development (as in Alternatives A and B), with the mitigation measures proposed below Alternative C would not result in significant cumulative noise impacts to human health and community well-being or sensitive receptors.

Alternative D would treat the same landscape as the proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. Although the maximum potential dBA of prescribed fire projects is the highest of all treatment methods, prescribed fire using helicopter has the shortest duration of all treatment methods. Since noise affects individuals differently, different people will be bothered by loud noise over a short period or moderate noise over a longer period. However, the reduction in prescribed fire is not replaced entirely by increases in other treatment methods, and so the overall noise impacts are less. Because of the overall smaller treatment area proposed, and with the mitigation measures proposed below, Alternative D would not result in significant noise impacts to human health and community well-being or sensitive receptors.

5.5.6.4 Mitigations

Please see Section 2.5 of this document for Standard Project Requirements to avoid significant impacts to noise. If the Project Scale Analysis (Chapter 7) uncovers cumulative effects that may occur locally but be undetected at the scale of the bioregion, Project Specific Requirements will mitigate those effects to a less than significant level.

5.5.7 RECREATION

This section summarizes the potential for cumulative effects to Recreation due to implementing either the proposed Program or any of the alternatives. Program effects to Recreation are analyzed in Chapter 4.8. The same significance criteria and thresholds that were identified in Chapter 4.8 are used here to evaluate potential cumulative effects.

5.5.7.1 Significance Criteria

Appendix G of the CEQA Guidelines, the CEQA Environmental Checklist, poses the following to be considered in determining whether the Program or Alternatives would cause significant impacts to recreation. The Program and Alternatives would create significant effects if they would:

a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?
b) Include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?

5.5.7.2 Determination Threshold

An effect is considered significant if it would:

a) Close a significant portion of public recreational areas because of VTP treatments during the peak visitor season over a calendar year.
b) Severely reduce visual quality (more than 80 percent burned and black, cleared of vegetation, or comprised of dead plants) on more than 10 percent of the area of any one state park, private recreation area or other publicly accessible recreational area, during the peak visitor season over a calendar year.

The estimation of effects (Chapter 4.8) is based on the temporal and spatial extent of VTP treatments that are likely to occur on state parks or other public lands where the VTP operates. Evaluating cumulative effects includes considering potential effects from multiple VTP projects, as well as similar projects on other public lands that could result in a substantial reduction in access to recreational areas.

Implementation of the proposed Program or any of the Alternatives will not result in a measurable cumulative effect to recreation. No substantial increase in recreational areas with severely reduced visual quality or access during the peak visitor season is detectable. VTP projects are expected to be relatively few in number and occurrence. For the proposed Program, on an annual basis, except in the Colorado Desert, treatable recreation areas are 10 percent or less of the total treatable acreage in each bioregion. Not all projects under this Program EIR in each bioregion will take place on recreational lands, nor would they take place within the same calendar year or take place substantially during peak visitor season.

Public recreational pursuits generally take place on State Parks, National Parks and Recreation Areas, National Forests, Bureau of Land Management lands, and other public lands. A cumulative effect could potentially occur where VTP project acres are adjacent to or within the same bioregion as other land management activities in similar stages of implementation and vegetation recovery that impact the recreational experience or opportunity. Given the expected geographic distribution of VTP projects and number of projects conducted within a bioregion, it is highly unlikely that VTP projects would combine with other land management activities to contribute to a cumulative impact to recreational closures or visual quality of recreational experiences.

No severe reduction in visual quality is expected on state park or other public recreational area during peak visitor periods. Implementation of VTP and similar land management projects is likely to be spread over the entire year, with many projects occurring in non-peak visitation months. Peak visitor use tends to occur during the summer months for many recreational areas. Prescribed fire is most commonly implemented in fall, winter and spring, which are off-peak months for recreational use. From a cumulative effects perspective, at the scale of the bioregion, it is unlikely that short or long term changes in vegetation condition and recreational access associated with VTP projects would combine with other past, current, or planned land disturbing management activities to produce a significant cumulative impact on recreational experience or access.

There is a low likelihood that more than 10 percent of a given recreational area (state park, conservancy, etc.) would be treated in a single year, unless the recreational area was very small. Many recreational areas (state parks, conservancies, etc.) are a part of a larger bioregion and it is unlikely that all recreation areas in a bioregion would be intensively treated (greater than 10 percent area) in a single year, and it is unlikely that 10 percent of most recreational areas would be simultaneously treated. Similarly, when considering the likelihood of cumulative effects, many high use recreational areas on lands potentially subject to VTP projects (state parks, conservancies, wildlife management areas, ecological reserves, etc.) are not subject to significant land disturbing management activities related to resource extraction (timber harvest, mining etc.). These lands of limited or constrained use further reduce the likelihood of a cumulative effect arising from implementation of a VTP project in concert with another land disturbing management activity that negatively affects recreational values or access.

Tables 5.3-1 and 5.3-2 provide a summary of vegetation management projects for CAL FIRE and federal agencies (National Park Service, US Forest Service, Bureau of Land Management, US Fish and Wildlife Service). Other agencies, local government, water districts, conservancies, and private landowners outside of the VTP program are also likely to conduct fuel reduction projects. However, this information is not available on a statewide basis and likely represents a minor contribution to the overall acreage treated and is not included here.

In areas of mixed ownership (public and private), VTP projects could occur simultaneously with or sequential to other land disturbing activities. This scenario could result in a short-term cumulative effect to recreational value or access. Data is not available to evaluate the likelihood of the spatial and temporal relationship of VTP projects and those on public recreational land at the bioregional scale. Although speculative, it appears unlikely that cumulative bioregional scale negative project impacts on recreational values or access would arise because of the needed intersection of variables such as occurrence of tree and shrub vegetation type, CAL FIRE jurisdiction within a project area of mixed ownership and of high recreational use, and of sufficient VTP and other land disturbance activity acreage of sufficient treatment intensity.

Prescribed fire can also provide maintenance and improvements to the visual aesthetics of recreation areas. Prescribed fire tends to open up forest stands and can increase the number and visibility of flowering plants (Wade and Lunsford, 1998; DeBano et al., 1998).

5.5.7.3 Determination of Significance

Because of the overall low percentage of recreational acres treated as part of the Proposed Program and under similar projects on public lands, as well as the limited resource extraction that occurs on recreational lands, there is a low likelihood of significant cumulative effects to public recreational areas. It is unlikely that VTP projects under the proposed Program will result in closure of a significant portion of public recreational areas because of VTP or related projects during peak visitor season over a calendar year. Similarly, it is unlikely that enough related vegetation management projects – either through the VTP or other programs, would occur geographically close enough to one another to cumulatively severely reduce visual quality during peak visitor season over a calendar year. In addition, VTP treatments can have longer term beneficial effects that may be cumulative if projects are in or near the same recreational area.

As part of the Project Scale Analysis (Chapter 7) each project will identify any known vegetation management projects that have recently occurred in the immediate planning watershed(s) for the proposed project. **No significant cumulative impacts** to recreational resources are expected from the implementation of the project or any of the alternatives.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant cumulative impacts to recreational closures or viewsheds.

Alternative A would treat a smaller landscape as the proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A would drastically reduce the number of projects on recreational land, since any treated recreational land would have to exist in the WUI area. This Alternative would result in less than significant cumulative impacts to recreational closures or viewsheds.

Similarly, Alternative B would treat a smaller landscape but the same number of acres as the proposed Program, but only allow WUI and fuel break projects. Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program, but would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because these Alternatives continue to focus the VTP on areas that do not necessarily overlap with recreational areas (human development and very fire hazard, respectively), there is an overall less than significant cumulative impact to recreational closures or viewsheds due to Alternatives B and C.

Alternative D would treat the same landscape as the proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. Because of the overall smaller treatment area proposed and the reduction in the use of prescribed fire, Alternative D would not result in significant cumulative impacts to recreational area closures or viewsheds.

5.5.7.4 Mitigations

There are no Standard Project Requirements required to avoid significant impacts to recreation effects. If the Project Scale Analysis (Chapter 7) uncovers cumulative effects that may occur locally but be undetected at the scale of the bioregion, Project Specific Requirements will mitigate those effects to a less than significant level.

5.5.8 UTILITIES AND ENERGY

This section evaluates potential cumulative effects to utilities and energy due to implementing either the proposed Program or any of the alternatives. Program effects to utilities and energy are analyzed in Chapter 4.9. Evaluation of cumulative effects to utilities and energy is based on the same criteria and thresholds presented in Chapter 4.9.

5.5.8.1 Significance Criteria

The significance criteria and thresholds used for evaluating impacts to utilities and energy in Chapter 4.9.2 are appropriate for addressing cumulative effects as well.

An impact to utilities and energy is considered to be significant if the proposed program or Alternatives would:

a) Cause substantial alterations to water, wastewater, or power systems.
b) Cause substantial disruption in utility service or access to public facilities.
c) Cause substantial damage to utilities, utility service or public facilities within the project area.

5.5.8.2 Determination Threshold

Any direct damage to or disruption of water or energy facilities from a project would be considered a significant impact.

Potential effects related to utilities and energy facilities from proposed Program activities, or any of the Alternatives, are described in Chapter 4.9.2. That section discusses the potential for damage to or disruption of water and energy facilities from vegetation management activities. Mechanical, hand, herbicide, and herbivory treatments are all confined to a specific project area and the likelihood of a prescribed fire escaping to damage such facilities is low. None of the projects approved under this Program EIR include the permanent construction of facilities requiring power or water. No significant adverse impacts that would damage water or energy facilities from a project are expected from implementing the proposed Program or any of the Alternatives.

Implementation of the proposed Program or any of the Alternatives will not result in measurable cumulative damage to or disruption of water or energy facilities. Even if a prescribed fire escaped, the distribution of projects under this Program EIR (Table 3.3-1) demonstrates it is unlikely that additional prescribed fires will be utilized in the same *local* area for a fuels management project. None of the Alternatives suggest an increase in projects or acres treated versus the proposed Program.

The effects on water and energy facilities due to the implementation of vegetation management projects outside of this Program EIR are expected to be similar to those used for VTP projects. The only similar programs that use prescribed fire are treatments by the Department of the Interior and US Forest Service. On average, the Department of the Interior and the USFS treat about four times as many acres as the VTP program with prescribed fire, but many of their treatments are in unpopulated forested areas that do not have the utility infrastructure a more developed landscape requires.

5.5.8.3 Determination of Significance

The cumulative effect of individual VTP projects conducted under the proposed Program and similar vegetation management projects undertaken under a different program will not have significant effects on utilities and energy facilities. The cumulative impacts of these projects on utilities are considered **less than significant**.

No water or energy facilities would be directly damaged by any of the Alternatives; there are no significant cumulative impacts from implementing the No Project Alternative or Alternatives A-D.

5.5.8.4 Mitigation(s)

There are no Standard Project Requirements required to avoid significant impacts to utilities and energy. If the Project Scale Analysis (Chapter 7) uncovers cumulative effects that may occur locally but be undetected at the scale of the bioregion, Project Specific Requirements will mitigate those effects to a less than significant level.

5.5.9 TRANSPORTATION AND TRAFFIC

This section evaluates potential cumulative effects to transportation due to implementing either the proposed Program or any of the Alternatives. Program effects to transportation are analyzed in Chapter 4.10. Evaluation of cumulative effects to transportation is based on the same criteria and thresholds presented in Chapter 4.10.2.

5.5.9.1 Significance Criteria

A cumulative effect will be considered significant if results of the analysis indicate that any of the following criteria will be met due to implementation of the proposed Program or Alternatives:

a) An increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)

b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways

5.5.9.2 Determination Threshold

The following threshold is used to determine whether there is a substantial adverse effect to local residential or commercial development due to traffic generated by the Program or any of the Alternatives:

a) Traffic increases in excess of 10 percent Average Daily Trips (ADT) of the capacity of roads that serve residential and/or commercial areas near project areas.

Potential effects related to transportation from proposed Program activities, or any of the Alternatives, are described in Chapter 4.10 Transportation and Traffic. That section discusses the potential for transportation effects associated with increases in traffic volume associated with trips to and from the project site. The findings suggest that most projects are likely to have 5-10 vehicles traveling to and from the work site each day, which result in 10-20 average daily trips (ADT) per project.

Implementation of the proposed Program or any of the Alternatives will not result in a measurable cumulative effect contribution to traffic volume. None of the Alternatives proposed treating more acres or implementing more projects than the proposed Program. No substantial increase in vehicle trips, volume to capacity ratio, or increase in intersection congestion is detectable at the scale of the bioregion due to VTP projects and other concurrent or future projects. Similarly, no cumulative effect contribution to level of service standards established by county congestion management agency for roads or highways is detectable at the scale of the bioregion. The majority of projects will occur in remote areas and background traffic and transportation levels on those road systems are generally well below road capacity.

The types and number of vehicles used to implement vegetation management projects under programs outside of this Program EIR are expected to be similar to those used for VTP projects. The number of vehicles required for each treatment type is expected to vary from one to two light trucks every few days for a prescribed herbivory treatment and up to ten vehicles per day for a large prescribed burn or hand thinning treatment. Most of the vehicles used on VTP projects will be used for transporting people or fire equipment, with a small number of heavy trucks required at the beginning and end of some projects to transport heavy machinery (dozers, masticators, etc.). Heavy truck traffic to transport logs, in the event of nearby timber harvesting, will be on roads designed to support such loads. No logs will be removed from VTP projects, so VTP projects will not add to the cumulative number of logging trucks on the road.

The cumulative effect of individual VTP projects conducted under any alternative and similar vegetation management projects undertaken under a different program may have local short-term effects on transportation and traffic. These effects may be detectable at the scale of the project and are mitigated to less than significant levels as part of project planning and implementation at that scale of analysis. It is unlikely that a single residential or commercial area will be affected by the traffic from more than one VTP treatment annually. Furthermore, in an area where multiple VTP or other treatments could occur within one year, the likelihood of all treatments occurring simultaneously is low. At most, the nearest residential or commercial area to a VTP treated area would be affected by two simultaneous projects.

Additionally, the number of ADT generated per project is expected to be well below the capacity of typical low volume roads. It is highly unlikely that vehicle traffic associated with VTP project implementation will occur concurrently with other land management activities in a remote wildland setting and utilizing the same or redundant portions of an established road system.

5.5.9.3 Determination of Significance

No significant cumulative effects to transportation or traffic are expected from implementing the proposed Program with the application of SPRs and any identified PSRs.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant cumulative impacts to transportation and traffic.

Alternative A would treat a smaller landscape as the proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A is more likely to result in simultaneous projects occurring in or near a particular community, and therefor likely to cause significant cumulative transportation and traffic impacts.

Similarly, Alternative B would treat a smaller landscape but the same number of acres as the proposed Program, but only allow WUI and fuel break projects. Due to the limited types of projects that could be implemented, it is more likely that, under Alternative B, a community would have more than one simultaneous fuel reduction project occur, and therefor cumulative impacts to transportation and traffic would be significant.

Alternative C would also treat a smaller landscape but the same number of acres as the proposed Program. This Alternative would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because this Alternative would exclusively focus projects in areas of high hazard and not human development (as in Alternatives A and B), with the mitigation measures proposed below Alternative C would not result in significant cumulative transportation and traffic impacts.

Alternative D would treat the same landscape as the proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. However, the reduction in prescribed fire is not replaced entirely by increases in other treatment methods, and so the overall transportation and traffic impacts are less. Because of the overall smaller treatment area proposed, and with the mitigation measures proposed below, Alternative D would not result in significant cumulative transportation and traffic impacts.

5.5.9.4 Mitigation(s)

Please see Section 2.5 of this document for Standard Project Requirements to avoid significant impacts to transportation and traffic. If the Project Scale Analysis (Chapter 7) uncovers cumulative effects that may occur locally but be undetected at the scale of the bioregion, Project Specific Requirements will mitigate those effects to a less than significant level.

5.5.10 POPULATION, EMPLOYMENT, HOUSING, AND SOCIO-ECONOMIC WELLBEING

This section summarizes the potential for cumulative effects to Population, Employment, Housing, and Socio-economic Wellbeing due to implementing either the proposed Program or any of the alternatives. Program effects to Population and Housing are analyzed in Chapter 4.11 Population, Employment, Housing, and Socio-economic Wellbeing. The following significance criteria and threshold were identified and are used here to evaluate potential cumulative effects.

5.5.10.1 Significance Criteria

Appendix G of the CEQA Guidelines, the CEQA Environmental Checklist, contains only one question which is relevant to the VTP program. The proposed Program and Alternatives would be considered to create a significant effect if treatments would:

a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).

5.5.10.2 Determination Threshold

As stated in Chapter 4.11.2, there is no accepted threshold for evaluating a significant change in population. Population increases less than 0.5 percent were considered less than significant.

5.5.10.3 Determination of Significance

There are no growth-inducing effects associated with VTP projects under the proposed Program or any of the Alternatives and no changes to the population in project areas, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).

No significant cumulative effects are expected from implementing the Program or any of the Alternatives.

5.5.10.4 Mitigation(s)

There are no Standard Project Requirements or mitigation measures required to avoid significant impacts to population, employment, housing, and socio-economic wellbeing. If the Project Scale Analysis (Chapter 7) uncovers cumulative effects that may occur locally but be undetected at the scale of the bioregion, Project Specific Requirements will mitigate those effects to a less than significant level.

5.5.11 AIR QUALITY

This section summarizes potential cumulative effects to air quality due to implementing vegetation treatment activities under the VTP and Alternatives. Impacts to air quality and the potential for vegetation treatment activities to generate emissions identified by the State of California as pollutants of concern are analyzed in Chapter 4.12.

5.5.10.5 Significance Criteria

The significance criteria identified in Chapter 4.12.2 are used here to evaluate potential cumulative effects. Significance criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines as well as by mass emission thresholds set by the various air districts in California. Refer to Chapter 4.12.2 for the significance criteria used in this cumulative impacts analysis.

5.5.10.6 Determination of Significance

Implementation of the VTP would result in emissions of criteria air pollutants (CAPs) (e.g., particulate matter [PM_{10} and $PM_{2.5}$]) and precursors (e.g., oxides of nitrogen [NO_X] and reactive organic gases [ROG]) throughout the State. While the specific locations of where VTP projects would occur are not currently known, many counties throughout the state are currently in nonattainment for CAPs subject to the California Ambient Air Quality Standards (CAAQS) and National Ambient Air Quality Standards (NAAQS). Air districts in California develop air quality attainment plans designed to reduce emissions of criteria air pollutants. Air quality attainment plans include a multitude of air pollution control strategies. When developing air quality attainment plans, air districts account for the emissions from all present and future development in the region by relying on city and county general plans.

As described in Chapter 4.12, air quality impacts from VTP projects fall into two categories: construction emissions and prescribed fire emissions. Emissions from the combustion of vegetation during prescribed fire treatments constitute the largest source of emissions from VTP projects. The location and timing of prescribed fires are controlled by local air district having authority through their burn authorization program and adherence to the conditions and requirements in the approved smoke management plan. Through this process, the local air district limits the amount of material burned on any given day to that which would not cause or contribute to exceedances of air quality standards or result in smoke impacts to smoke sensitive areas. Implementation of AIR-3, AIR-4, and AIR-12 require all projects conducted under this VTP to adhere to these protocols prior to igniting any prescribed burn project.

It is important to note that while the VTP's contribution from prescribed burning to pollutant emissions would be considerable, it may actually be less than what is reported in this Program EIR. As described in Chapter 2, the purpose of the VTP program is to modify wildland fire behavior to help reduce losses to life, property, and natural resources. The intended outcome is to have less frequent, smaller (i.e., less acres burned), and shorter duration wildfires over time. Therefore, the emissions from the prescribed burning activities would to some degree be replacing and potentially reducing total emissions from wildfires that would occur to a greater degree and duration without fuel modification. While there is not a direct correlation between implementation of a vegetation treatment project and a proportionate reduction in numbers of fires or acres burned, it is reasonable to acknowledge that while the VTP program would result in substantial emissions of CAPs as a result of prescribed fire, it would likely result in some reduction in the numbers of fires and/or burned acres from wildfires and, therefore, would avoid the emissions associated with those fires. Prescribed burning in the VTP program would also shift those emissions to the fall, winter and spring months not normally associated with wildland fires, and only on days authorized by the local regulating authority (AIR-3) when emissions are less likely to impact population centers. The VTPs contribution to air quality impacts from prescribed fire emissions would not be cumulatively considerable; the **cumulative impact would be less than significant**.

Emissions from construction like activities as described in Chapter 4.12 constitute the remainder of the emissions from VTP projects that may impact air quality. SPR AIR-2 requires all projects to identify the project's CAP emissions and compare these against the thresholds identified by the local air district. When project level emissions exceed the air district's thresholds, AIR-2 requires the implementation of AIR-3 through AIR-11 to further constrain the projects emissions. MM AIR-1 would further limit the number of projects that could occur simultaneously in the San Joaquin Valley Unified Air Quality Control District, the most sensitive air district to the TAC class of pollutants, to those that would keep the cumulative project level daily emissions of CAPs and precursors below that set by the air district for construction like activities. Through limitations in the number of projects that could occur simultaneously and other emission reducing constraints, the VTPs air quality emissions for construction like activities would not be cumulatively considerable; the **cumulative impact would be less than significant**.

As discussed under Impacts 3 through 5 in Section 4.12.2.3, the vegetation treatment activities under the VTP would not generate significant health risks associated with toxic air contaminants, expose sensitive receptors to odors, or expose sensitive receptors to NOA-containing fugitive dust because projects implemented under the VTP would be required to implement several SPRs. SPRs AIR-9, AIR-10, AIR-11, NSE-4 and NSE-5, would limit or minimize exposure of sensitive receptors to TAC emissions that would exceed air district thresholds, fugitive dust emissions containing natural occurring asbestos, and/or excessive odors. Therefore, the increases in health risk attributable to the project would not be cumulatively considerable; the **cumulative impact would be less than significant**.

CUMULATIVE IMPACT ANALYSIS FOR ALTERNATIVES CONSIDERED

Because the scale of Alternatives A, B, and C would be the same as the proposed VTP at 60,000 treated acres for ten years, with the same vegetation treatment activities by vegetation type expected to occur, Alternatives A, B and C would have similar CAP emissions, TAC emissions, NOA-containing fugitive dust emissions, and objectionable odors from vegetation treatment activities. Emissions from prescribed fires and construction related activities would be similar to the proposed program. Alternatives A, B, and C would implement similar constraints on prescribed burning and construction like activities as the proposed program to reduce the air quality impacts from these activities. Therefore, implementation of Alternatives A, B, or C would not result in a considerable contribution to significant cumulative air quality impacts; **the cumulative impact would be less than significant.** Similar to the proposed VTP, Alternatives A, B and C would not generate significant health risks associated with toxic air contaminants, NOA-containing fugitive dust emissions, and/or excessive odors. Therefore, the increases in health risk attributable to Alternatives A, B, and C would not be cumulatively considerable; **the cumulative impact would be less than significant.**

Alternative D would reduce the total number of acres treated and significantly reduce the number of acres treated through use of prescribed fire. This alternative would also disallow variances to burn on no burn days in non-attainment air basins. This alternative would reduce the expected CAP emissions, TAC emissions, NOA-containing fugitive dust emissions, objectionable odors, toxic air contaminants, and NOA-containing fugitive dust emissions from vegetation treatment activities. Therefore, the increases in health risk attributable to Alternative D would not be cumulatively considerable; **the cumulative impact would be less than significant.**

5.5.10.7 Mitigations

Please see Section 2.5 and Chapter 7 of this document for SPRs and the Project Scale Analysis that avoids or minimizes significant impacts to air quality. One additional mitigation measure was identified in this analysis to reduce air quality impacts in the San Joaquin Valley Unified Air Quality Management District. This is identified as MM AIR-1 below.

Mitigation Measure AIR-1

To achieve compliance with local air district emission thresholds in the San Joaquin Valley Unified Air Quality Management District, simultaneously projects within that air district will be constrained to appropriate number as not to exceed air quality standards. As a result, the Program shall implement the following:

- CAL FIRE shall not allow more than 7 simultaneous treatment activities to occur in the San Joaquin Valley Unified Air Quality Management District.

5.5.11 AESTHETICS AND VISUAL RESOURCES

This section summarizes the effects to aesthetic and visual resources due to implementing either the Proposed Program or any of the alternatives. Program effects to aesthetic and visual resources are analyzed in Chapter 4.13. The following significance criteria and thresholds were identified and are used here to evaluate potential cumulative effects.

5.5.11.1 Significance Criteria

The significance criteria and thresholds used for evaluating aesthetics and visual resources in Chapter 4.13 are appropriate for addressing cumulative effects as well. According to Appendix G of the CEQA Guidelines: the CEQA Environmental Checklist, an aesthetic impact would be considered significant if the Program and Alternatives would:

a) Have a substantial adverse effect on a scenic vista
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway
c) Substantially degrade the existing visual character or quality of the site and its surroundings
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area

5.5.11.2 Determination Threshold

Visual effects from the program would be considered significant if the acreage of treatments causing adverse and long term effects, as determined through the analysis process, exceeds more than 10 percent of the scenic byways viewshed acreage within that bioregion in any 10-year period.

5.5.11.3 Determination of Significance

Visual effects from vegetation treatments tend to have very localized and project specific effects. Treatment effects that may impair visual or aesthetic conditions in one location don't combine to degrade conditions at another location. When treatments occur in the same area they may cumulatively add to the total amount of viewshed acreage that is temporarily impaired. The perceived impact to visual quality varies substantially with the treatment method. Scorched ground and tree trunks from a prescribed fire are likely to be viewed negatively, especially if the fire kills overstory trees. However, this is not a permanent impact. Studies have shown that the perception of visual quality of a forested area can improve within one to two years following a low intensity prescribed fire (Jakes, 2006a). Mechanical treatments also can affect visual quality. The public tends to perceive clearcuts negatively, while thinning that reduces stand density has been shown to improve visual quality (Jakes, 2006b). Treatment of slash is another factor that affects visual quality. Studies have shown that increasing amounts of slash and downed woody material decrease the perception of visual quality.

The threshold of 10 percent or more of the viewshed acreage in a bioregion in a 10 year time period is a measure of the potential cumulative effects of the program. At a program level there is unlikely to be a noticeable impact at the bioregion or state level from a project implemented under the proposed Program. Any project level effects are likely to be short-term effects to visual resources that results from vegetation treatments. In addition, many projects occur on private lands where public access is limited and the opportunity for visual impairments is less likely. As such, there is a **less**

than significant cumulative impact to scenic vistas and viewsheds from implementing the proposed Program.

Prescribed burn projects generate smoke which has the potential to contribute to short term effects to visibility and longer term effects to regional haze. These issues are addressed in Chapter 4.12 Air Quality and Chapter 4.13 Aesthetics and Visual Resources, and under Chapter 5.5.11 Cumulative Effects to Air Quality. For all prescribed burns, however, a burn plan will be required that includes a smoke management plan (SMP). The SMP will minimize public exposure to smoke generated by prescribed burns. Because only a small amount of smoke would remain in the treatment area for a short period during and after the prescribed burn, the cumulative effects to visual resources are considered **less than significant**.

As described in Section 4.6 Archaeological, Cultural, and Historic Resources, protections are in place to reduce damage to scenic resources such as historic buildings via the use of CAL FIRE Archaeologists and the *Archaeological Review Procedures for CAL FIRE Projects* (Foster and Pollack, 2010). The cumulative impacts to scenic resources of this type are considered **less than significant.**

Due to the activities described as part of the Proposed Program and Alternatives under this Program EIR, there would not be any new sources of substantial light or glare which would adversely affect day or nighttime views in the area. The land management activities described in this Program EIR would not involve the construction involving materials that may produce light or glare. This impact is considered **less than significant**.

The No Project alternative would apply to a landscape that is larger than the proposed Program, but due to costs, time constraints, and other limitations, it is anticipated that a smaller amount of acreage would actually be treated each year. Because of this, it is not likely to cause significant cumulative impacts to aesthetic and visual resources.

Alternative A would treat a smaller landscape as the Proposed Program, but treat the same number of acres. Because projects would only be allowed in the WUI, Alternative A would drastically reduce the number of prescribed fire and mechanical projects in grass or shrub, since any treated land would have to exist in the WUI area. Similarly, Alternative B would treat the same number of acres as the proposed Program across a smaller landscape, but only allow WUI and fuel break projects. The overlap of those project types, grass or shrub vegetation, a scenic viewshed and WUI area or fuel break need is unlikely to occur often, and Alternatives A and B would cause a less than significant cumulative impact to aesthetic and visual resources.

Alternative C would also treat a smaller landscape but the same number of acres as the Proposed Program. This Alternative would limit projects to VHFHSZ, which are determined by the existing fuels, topography, weather/climate, crown fire potential, and ember production and movement. Because this Alternative would exclusively focus projects in areas of high hazard, the required overlap of prescribed fire or mechanical treatment, grass or shrub vegetation, a scenic viewshed, and VHFHSZ is unlikely to occur often. Alternative C will have a less than significant cumulative impact to aesthetic and visual resources.

Alternative D would treat the same landscape as the Proposed Program but treat a smaller amount of acres due to the reduction of the use of prescribed fire. However, the reduction in prescribed fire is not replaced entirely by increases in other treatment methods, and so the overall visual impacts are less. Because of the overall smaller treatment area proposed, and with the mitigation measures proposed below, Alternative D would not result in significant cumulative aesthetic and visual resources impacts.

5.5.11.4 Mitigation(s)

There is a Standard Project Requirement for shrublands in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, and San Bernardino counties to mitigate potential aesthetic and visual impacts to those areas:

AES-1: See **BIO-5** for shrublands in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, and San Bernardino counties.

BIO-5: Vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties shall:

- Be designed to prevent vegetation type conversion.
- Not take place in vegetation that has not reached the age of median fire return intervals.
- Not re-enter treatment areas for maintenance in an interval shorter than the median fire return interval outside of the wildland urban interface and excluding fuel break maintenance.
- Not take place in old-growth chaparral without consultation regarding the potential for significant impacts with the Department of Fish and Wildlife and the California Native Plant Society.
- Take into account the local aesthetics, wildlife, and recreation of the Shrub-dominated Subtype during the planning and implementation of the project.
- During the project planning phase provide a public workshop, or public notice in a newspaper that is circulated locally describing the proposed project during the project planning phase for projects outside of the WUI. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

For areas located outside of the counties specified in AES-1, the Project Scale Analysis (Chapter 7) will uncover any cumulative effects that may occur locally but be undetected at the scale of the bioregion. Project Specific Requirements will mitigate those effects to a less than significant level.

5.5.12 CLIMATE CHANGE

This section summarizes potential cumulative effects to Greenhouse Gas (GHG) emissions and global climate change due to implementing vegetation treatment activities under the VTP and Alternatives. Impacts from and the potential of vegetation treatment activities to generate GHG emissions and their contribution to global climate change are analyzed in Chapter 4.14.

5.5.12.1 Significance Criteria

The significance criteria identified in Chapter 4.14.2 are used here to evaluate potential cumulative effects. Significance criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines. Refer to Chapter 4.14.2 for the significance criteria used in this cumulative analysis.

5.5.12.2 Determination of Significance

Section 4.14 addresses climate change and GHGs, which, because no single project can meaningfully effect global climate change, by their very nature are cumulative impacts. As described, a number of SPRs are included in the VTP to reduce the impact on climate change and GHGs, including: BIO-8, BIO-9, CC-1, FBE-1, GEO-1, HYD-7, HYD-8, HYD-13, and HYD-15. The VTP would not exceed the screening threshold of significance for GHG used in this Program EIR and no additional mitigation is necessary to reduce this impact. Thus, the projects contribution to cumulative GHGs is considered to be **less than significant**.

CUMULATIVE IMPACT ANALYSIS FOR ALTERNATIVES CONSIDERED

Because the scale of the Alternatives A, B, and C would be the same as the proposed VTP at 60,000 treated acres for ten years, with the same vegetation treatment activities by vegetation type expected to occur, Alternatives A, B and C would have similar GHG emission impacts. Emissions from prescribed fires would still likely constitute the largest source of emissions, with yearly GHG emissions less than the screening threshold of significance used in this Program EIR. Therefore, Alternatives A, B, and C would not result in a considerable contribution to the cumulative GHG impact. Similar to the project, c**umulative GHG impacts for Alternatives A, B, and C would be less than significant.**

Alternative D would reduce the total number of acres treated and significantly reduce the number of acres treated through use of prescribed fire. This alternative would also disallow variances to burn on no burn days in non-attainment air basins. This alternative would reduce the expected GHG emissions from vegetation treatment activities on the program scale, but emissions from any individual project would be similar to those under the proposed VTP and all other alternatives. Therefore, Alternative D would not result in a considerable contribution to the cumulative GHG impact. Similar to the proposed VTP, **cumulative GHG impacts for Alternative D would be less than significant.**

5.5.12.3 Mitigations

Please see Section 2.5 and Chapter 7 of this document for SPRs and the Project Scale Analysis that minimize significant impacts to climate change.

6 SIGNIFICANT EFFECTS AND GROWTH INDUCING IMPACTS

6.1 SIGNIFICANT AND UNAVOIDABLE ENVIRONMENTAL EFFECTS OF THE PROPOSED PROJECT

Section 21100(b)(2)(A) of the Public Resource Code (PRC) provides that an EIR shall include a detailed statement setting forth "in a separate section: any significant effect on the environment that cannot be avoided if the project is implemented." Accordingly, this section provides a summary of significant environmental impacts of the project that cannot be mitigated to a less-than-significant level.

Chapter 4, "Affected Environment, Effects and Mitigations," provides a description of the potential environmental impacts of the project and recommends various mitigation measures to reduce impacts, to the extent feasible. Chapter 5, "Cumulative Effects Analysis," determines whether the incremental effects of this project are significant when viewed in connection with the effects of past projects, other current projects, and probable future projects. After implementation of the recommended mitigation measures, the impacts associated with implementation the proposed program would be reduced to a less-than-significant level.

SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES

No reasonably foreseeable significant irreversible environmental changes have been identified that would result from implementation of the proposed program or the alternatives to the proposed program. While the proposed program will provide access to firefighting personnel to previously inaccessible areas, this is only to allow for initial fuels modification, periodic maintenance of treatments, and access for fire suppression equipment and personnel, all of which occur infrequently. This infrequency of entry would make irreversible damage from environmental accidents unlikely. The proposed program does not commit future generations to similar uses.

6.2 GROWTH-INDUCING IMPACTS

CEQA specifies that growth-inducing impacts of a project must be addressed in an EIR (PRC § 21100[b][5]). Specifically, Section 15126.2(d) of the CEQA Guidelines states that the EIR shall:

Discuss the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects which would remove obstacles to population growth (a major expansion of a wastewater treatment plant might, for example, allow for more construction in service areas). Increases in the population may tax existing community service facilities, requiring construction of new facilities that could cause significant environmental effects. Also, discuss the characteristics of some projects which may encourage and facilitate other activities that could significantly affect the environment, either individually or cumulatively. It must not be assumed that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment.

Direct growth inducement would result if a project involved construction of new housing, which would facilitate new population to an area. Indirect growth inducement would result, for instance, if implementing a project resulted in any of the following:

- Substantial new permanent employment opportunities (e.g., commercial, industrial, or governmental enterprises)
- Substantial short-term employment opportunities (e.g., construction employment) that indirectly stimulates the need for additional housing and services to support the new temporary employment demand)
- Removal of an obstacle to additional growth and development, such as removing a constraint on a required public utility or service (e.g., construction of a major sewer line with excess capacity through an undeveloped area)

The State CEQA Guidelines do not distinguish between planned and unplanned growth for purposes of considering whether a project would foster additional growth. Therefore, for purposes of this EIR, to reach the conclusion that a project is growth inducing as defined by CEQA, the EIR must find that it would foster (i.e., promote, encourage, allow) additional growth in economic activity, population, or housing, regardless of whether the growth is already approved by and consistent with local plans. The conclusion does not determine that induced growth is beneficial or detrimental, consistent with Section 15126.2(d) of the State CEQA Guidelines.

The proposed program will not have any growth-inducing impacts because it will not foster growth or result in new housing or construction of facilities. The project is a vegetation management project intended to better manage the State's resources and protect people and sensitive natural communities from the effects of catastrophic wildfires. No reasonably foreseeable growth-inducing impacts have been identified that would result from implementation of the proposed program or the alternatives to the proposed program.

7 PROJECT SCALE ANALYSIS

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7.1 INTRODUCTION

The CEQA Guidelines, Section 15168, describe Program Environmental Impact Reports (EIR). more specifically, Section 15168(c)(4) suggests that the adopting agency "use a written checklist or similar evaluation" to document the evaluation of the site and the activities proposed to determine whether the environmental effects of the operation are covered in the Program EIR. The Project Scale Analysis (PSA) in this PEIR functions as the environmental checklist that shall be completed by the project applicant and evaluated by the lead agency for all VTP projects. The completed checklist will indicate whether a proposed project is within the scope and analysis of the Program EIR.

A completed PSA documents whether a particular proposed project's site-specific effects are less than significant with the use of the applicable Standard Project Requirements (SPR) in the EIR. Project Specific Requirements (PSRs) may be used to address site specific impacts in addition to the SPRs. Monitoring procedures in Appendix I may be used evaluate the performance of SPRs and PSRs. An Implementation Checklist (Appendix I) will be used to evaluate the implementation of the SPRs and PSRs for each project.

In CEQA terms, the VTP PSA also functions as an "Initial Study." If the PSA reveals no significant adverse impacts resulting from the VTP project, then the project is in compliance with CEQA.

If the project could create environmental impacts that have not been addressed or that cannot be avoided using measures from the PSA/environmental checklist, the project falls outside the scope of this Program EIR and CEQA requires the Department to do a supplemental environmental analysis and public review through the State Clearinghouse or make a finding of overriding considerations.

The following analysis requests basic information about the size, location, and type of project being proposed. The PSA addresses the various resource areas that include SPRs in Chapters 4 & 5, and requires project submitters to describe how their project will conform to the conditions and procedures stipulated in the Program EIR.

When prescribed burning is proposed, a burn plan, smoke management plan, and Go-No Go checklist are also required in order to verify that the proposed burn is within the scope of the VTP. The Go-No Go Checklist will be required prior to the actual burning operation. Examples of a VTP Prescribed Fire Burn Plan, Smoke Management Plan and VTP Prescribed Fire Go-No Go Checklist are included in Appendix J. Additional permits required for prescribed burning include an Air Quality Burn Permit (which is incorporated into the smoke management plan) and a CAL FIRE Burn permit as specified in PRC 4423 and applied as directed under PRC 4423.1, 4492, and 14 CCR § 1253.

Upon project completion, the Implementation Checklist will be used to validate that all the SPRs and PSRs were incorporated. This completion inspection will be conducted by CAL FIRE personnel.

7.2 PROJECT SCALE ANALYSIS

The following pages include the Project Scale Analysis for the CAL FIRE Vegetation Treatment Program.

PROJECT SCALE ANALYSIS
CAL FIRE Vegetation Treatment Program

SUMMARY OF PROJECT	
Project Name:	
CAL FIRE Unit & Contact:	**Location (legal description & nearest landmark or community):**
Project Coordinator and Contact Information:	
Treatment Type: ☐ *WUI* ☐ *Fuel Break* ☐ *Ecological Restoration*	
Project Objectives and Rationale: (*Provide a set of objectives that are consistent with the Program EIR, including the proposed treatment effects on fire behavior. See PSA Attachment C.)*	
Project Description: *(Provide a summary of the project and its intended objective(s). Briefly describe the environmental setting, including the types of habitat to be treated and unique features within the habitat. Indicate if work will be conducted in conjunction with other related or similar projects in the Operational Unit. The description should also describe any coordination with private, local, federal or other State agencies.)*	
Size of project (acres):	
Duration/Timing of project activities:	
Types of treatment activities proposed (include acres for each):	
Manual:	**Mechanical:**
Prescribed Fire:	**Herbicide:**
Prescribed Herbivory:	
Project Priority Ranking: *(Follow the flow chart in PSA Attachment B to find the priority ranking. Describe any additional considerations or arguments for increasing the priority.)*	
Mapped in a geospatial database supported by CAL FIRE? ☐ *Yes* ☐ *No*	
Types and numbers of equipment proposed to be used:	

Are there any proposed project requirements, in addition to the items listed in the PSA Attachment A, that will require the project to undergo supplemental environmental review such as a negative declaration or mitigated negative declaration?
Are there local or county ordinances that need to be considered when implementing the proposed project?
Was a public forum/workshop conducted? *(Public forum is required for projects outside the WUI and as specified in BIO-5. Please ID type and date of the meeting advertisement(s), attendance, concerns raised, and any resolutions or changes incorporated into the project.)*

Review of the project's consistency with VTP EIR

ADMINISTRATIVE PROCEEDURES:

1. Will the project implement SPRs ADM 1-8 (PSA Attachment A)? ☐ *Yes* ☐ *No* ☐ *Other*

If NO or OTHER, explanation required:

REGULATORY REQUIREMENTS:

2. Are any of the following applications, permits, or consultations required? ☐ *Yes* ☐ *No* ☐ *Other*

DFW Stream Alteration Permit: ______

State & Federal Endangered Species Consultation: ______

Corps of Engineers 404 Permit: ______

RWQCB or NPDES Permit: ______

DPR Right to Enter or Temporary Use Permit: ______

PRC 5024 Review: ______

Stormwater Management Plan: ______

Encroachment Permit (Specify Agency): ______

Other (Specify): ______

COMMENTS:

PRESCRIBED FIRE REQUIREMENTS:

3. Does the project include prescribed fire? (If NO, please proceed to Aesthetics) ☐ *Yes* ☐ *No*

4. Explain how the prescribed fire has been designed to initiate a surface fire of sufficient intensity that will only consume surface and ladder fuels consistent with the requirements of SPR FBE-1:

5. Has a burn plan been prepared consistent with the requirements of SPR FBE-2?

☐ *Yes* ☐ *No* If NO, explanation required:

6. Has a *First Order Fire Effects Model* (FOFEM) or similarly accepted model been run consistent with SPR FBE-3?

☐ *Yes* ☐ *No* If NO, explanation required:

7. Are there any additional Fire Behavior-Related PSR measures incorporated into the project or are there any requested exemptions from the notification requirements in FBE-4?

☐ *Yes* ☐ *No* If YES, explanation required:

AESTHETICS:

8. Would the project result in any unique aesthetic impacts that were not addressed in the VTP Program EIR?

☐ *Yes* ☐ *No* If YES, explanation required (How is this project within the scope of this PEIR?):

9. For a project with prescribed burning: if any part of the proposed project would be located upon highly visible slopes, is this project of such a size and design as to cause significant visual distraction and/or loss of aesthetic value? Include visual impact of pre-treatment effects, such as creation of mechanical or hand-constructed fire lines.

☐ *Yes* ☐ *No*

If YES, will any of the following measures be incorporated to minimize impacts?

☐ Straight line boundaries and other strong linear configurations will be avoided as much as possible.

☐ Area will not be 100% cleared through burning operations; unburned areas will be left to add textural variety.

☐ Natural or existing features will be followed, such as stream courses, vegetation type lines, ridge tops, etc.

☐ Fire line edges on the outside-of-the-burn side will be feathered into the natural landscape, with brush cuttings used to disguise the lines and provide soil cover after the burn.

☐ Project will not be burned upon highly visible slopes and/or visual impact expected to be minimal.

Provide additional explanation if necessary:

10. Are there additional PSR measures to protect aesthetic resources incorporated into the project?

☐ *Yes* ☐ *No* If YES, explanation required:

AGRICULTURE:

11. Would the project result in the permanent conversion of agricultural land to non-agricultural uses or conflict with existing zoning or Williamson Act contracts for agricultural uses?

☐ *Yes* ☐ *No* If YES, **STOP.** Proposed project is incompatible with this PEIR.

FOREST RESOURCES:

12. Would the project result in the permanent loss or conversion of forest land to non-forest uses or result in conflicts with areas designated for forest lands (as defined by PRC 12220(g)), timberlands (as defined by PRC 4526), or timberland zoned as Timberland Production (as defined by GC 51104(g))?

☐ *Yes* ☐ *No* If YES, explanation required (How is this project within the scope of this PEIR?):

AIR QUALITY:

13. Would the project create emissions that are not discussed in the VTP Program EIR?

☐ *Yes* ☐ *No* If YES, **STOP.** Proposed project is incompatible with this PEIR.

14. Have all air quality SPRs been incorporated into the project (AIR-1 through AIR-12)?

☐ *Yes* ☐ *No* If NO, explanation required:

15. List any PSRs that would be required for the project:

BIOLOGICAL RESOURCES:

16. Have all biological resources SPRs been incorporated into the project (BIO-1 through BIO-13)?

☐ *Yes* ☐ *No* If NO, explanation required:

17. List any PSRs that would be required for the project, including any CDFW recommendations:

18. If burning large areas of mature chaparral vegetation would occur during winter or spring, would this project cause low regeneration and/or depletion of available wildlife forage?

☐ *Yes* ☐ *No* If YES, discuss project conditions or mitigation measures that would be implemented:

19. If burning dense stands of chaparral would occur in winter or spring, would this project cause significant adverse effects on plant regeneration and/or loss of wildlife habitat and oak woodlands?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

20. If burning dense stands of chaparral would occur in summer or fall, would this project cause a significant loss of wildlife habitat and/or damage to oak woodlands?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

21. If burning in areas with oak or conifer overstory would occur, would this project result in undesired adverse effects on conifer and/or oak tree survival?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

---

22. Would the project result in a reduction in oak trees that could adversely affect wildlife habitat, species diversity, or a cumulative lack of oak regeneration in the area?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

---

23. Would this project result in significant detrimental effects on wildlife habitat by creating a large homogeneous ecotone with no mosaic or strips of unburned vegetation?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

---

24. Would any special status species be adversely affected by this project? Include the results from 9-quad CNDDB run.

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

---

25. If burning, would this project cause significant negative impacts to known and occupied habitats of special status species?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

26. Will the proposed project disrupt critical deer migration corridors or critical habitats of any game species?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

27. If burning in or adjacent to areas classified as wetlands or riparian zones, would this project result in undesired changes in vegetation character or other adverse impacts to riparian plants, fish, or wildlife habitat?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

28. Will the proposed project result in a detrimental impact to a biological resource in order to provide protection of human life and property?

☐ *Yes* ☐ *No* If YES, list project conditions, discussion of the lost value and the reasoning. Including any mitigation measures that would be implemented:

CULTURAL RESOURCES: (Answers to 30 - 33 shall be included in a Confidential Addendum).

29. Have all cultural resources SPR been incorporated into the project (CUL-1 through CUL-5)?

☐ *Yes* ☐ *No* If NO, explanation required:

30. Has a Confidential Archaeological Addendum been prepared and signed by a CAL FIRE archaeologist and is the signature page confirming such review attached?

☐ *Yes* ☐ *No* If NO, please explain why one is not required:

31. Would archaeological, cultural, or historical resources be adversely affected by this project? Include Archaeological reviews and/or surveys in confidential addendum.

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

32. Will the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

33. Will the project disturb any human remains, including those interred outside of formal cemeteries?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

GEOLOGY AND SOILS:

34. Have all geology and soils SPR been incorporated into the project (GEO-1 through GEO-2)?

☐ *Yes* ☐ *No* If NO, explanation required:

35. List any Project Specific Requirements (PSRs) that would be required for the project:

36. If using *heavy equipment* on unstable areas/soils, will this project cause landslides or significant erosion?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

37. Would the project disturb any geologically unstable areas/soils within or adjacent to the project?

☐ *Yes* ☐ *No* If YES, list project conditions or mitigation measures that would be implemented:

GREENHOUSE GAS EMISSIONS:

38. Have all GHG SPRs been incorporated into the project (CC-1 through CC-4)?

☐ *Yes* ☐ *No* If NO, explanation required:

39. List any PSR GHG mitigation measures that would be required for the project.

HAZARDS AND HAZARDOUS MATERIALS:

40. Have all hazard and hazardous materials SPRs been incorporated into the project (HAZ-1 through HAZ-14)?

☐ *Yes* ☐ *No* If NO, explanation required:

41. List any Project Specific Requirements (PSRs) that would be required for the project:

42. Would the project use any chemicals/herbicides that were not evaluated in the VTP Program EIR?

☐ *Yes* ☐ *No* If YES, explanation required (how is this project within the scope of this PEIR?):

HYDROLOGY AND WATER QUALITY:

43a. Have all hydrology and water quality SPRs been incorporated into the project (HYD-1 through HYD-17)?

☐ *Yes* ☐ *No* If NO, explanation required:

43b. Is the Project area with a waterbody listed on the 303(d) list?

☐ *Yes* ☐ *No* If YES, please identify the waterbody, reason for listing, and project impact:

---

44. List any Project Specific Requirements (PSR) that would be required for the project:

---

45. Will the removal of vegetative cover result in increased water runoff on slopes and subsequent adverse effects on water quality or other resources?

☐ *Yes* ☐ *No* If YES, list any Project Specific Requirements (PSRs) that would be implemented:

---

46. If burning in a watercourse, lake, or reservoir, will the removal of vegetative cover or other phases of the proposed project significantly increase turbidity or deposition of sediment?

☐ *Yes* ☐ *No* If YES, list any Project Specific Requirements (PSRs) that would be implemented:

---

47. If burning is planned within a WLPZ/ELZ, will this project cause a significant increase in water temperature that is detrimental to beneficial uses?

☐ *Yes* ☐ *No* If YES, list any Project Specific Requirements (PSRs) that would be implemented:

48. Will this project cause slash or woody debris to be deposited in a watercourse, lake or reservoir?

☐ *Yes* ☐ *No* If YES, list any Project Specific Requirements (PSRs) that would be implemented:

49. Are there any other circumstances or site conditions present in this project as designed that have not been mitigated to avoid adverse impacts on water quality?

☐ *Yes* ☐ *No* If YES, list any Project Specific Requirements (PSRs) that would be implemented.

NOISE:

50. Have all noise SPRs been incorporated into the project (NSE-1 through NSE-5)?

☐ *Yes* ☐ *No* If NO, explanation required:

51. List any Project Specific Requirements (PSRs) that would be required for the project:

RECREATION:

52. Will the proposed project result in a significant portion of the recreational area being closed during peak visitor season over a calendar year, or more than 10 percent of the recreational area in a condition of decreased visual quality during peak visitor season?

☐ *Yes* ☐ *No* If YES, explanation required:

53. List any Project Specific Requirements (PSRs) that would be required for the project:

TRANSPORTATION:

54. Have all transportation SPRs been incorporated into the project (TRA-1 through TRA-2)?

☐ *Yes* ☐ *No* If NO, explanation required:

55. List any Project Specific Requirements (PSRs) that would be required for the project:

UTILITIES AND ENERGY:

56. Are there any transmission lines or other electrical, telecommunications, or water supply facilities in or near the project area? If so, protective measures will need to be taken and may include installation of firebreaks using hand treatments around sensitive equipment.

☐ *Yes* ☐ *No* If YES, explanation required:

57. Will treatment activity include digging below the surface of the ground to a depth of greater than 2 feet? If so, the project manager shall contact local utilities to determine location of buried underground utilities.

☐ *Yes* ☐ *No* If YES, explanation required:

58. List any Project Specific Requirements (PSRs) that would be required for the project:

CUMULATIVE IMPACTS:

Yes	Maybe	No	
☐	☐	☐	1. Will the project be conducted in conjunction with or at the same time as other projects in the CAL FIRE Unit?
☐	☐	☐	2. Will the project be part of a series of inter-related projects?
☐	☐	☐	3. Are there any other projects that must be completed for any part of this project to be implemented?
☐	☐	☐	4. Will the combined acreage of this project and any past, current, and reasonably foreseeable future projects exceed 20% of a CalWater Planning Watershed over a 10-year timespan?
☐	☐	☐	5. Will the combined acreage of this project and any other proposed or completed VTP project exceed 110% of any bioregion as identified in Table 2.5-6 over an annual or 10 year period?

If YES or MAYBE, please explain:

Attachments:

PSA Attachment A – VTP Standard Project Requirements

- ☐ Project Mitigation Monitoring and Reporting Program
- ☐ Archaeological reviews/surveys (Confidential addendum)
- ☐ Air Quality and GHG Emissions Estimates
- ☐ Wildlife reviews/CNDDB Records Search/Biologist Recommendation
- ☐ Prescribed Fire Burn Plan
- ☐ Smoke Management Plan
- ☐ Air photo of project area
- ☐ Vicinity map on a USGS quad map
- ☐ Parcel map with APN's covering all ownerships within project area
- ☐ Soil survey map of project area
- ☐ Model run of FOFEM, BEHAVE, or other appropriate fire behavior modeling simulation
- ☐ Other ____

RECOMMENDATION:

☐ Project is consistent with activities evaluated under the VTP Program EIR and all appropriate SPRs and mitigation measures have been incorporated into the project.

☐ Certain proposed activities may not be consistent with activities evaluated in the VTP EIR and additional environmental review is required.

☐ Project is consistent with activities evaluated under the VTP Program EIR; however, some SPRs and mitigation measures applicable to the project have not been incorporated and as a result additional environmental review may be warranted.

Applicant's Signature: ______________________________ RPF# ______ **Date:** __________

Unit Forester's Signature: ______________________________ RPF# ______ **Date:** __________

Unit Chief's Signature: ______________________________ **Date:** __________

PSA ATTACHMENT A- VTP STANDARD PROJECT REQUIREMENTS

7.2.1.1 Administrative Standard Project Requirements

ADM-1: Prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using standard project requirements (SPRs). If burning operations are done with CAL FIRE personnel, the Battalion Chief and/or their Company Officer designee shall meet with the project coordinator onsite prior to operations to discuss resource protection measures. Additionally, the project coordinator shall specify the resource protection measures and details of the burn plan in the incident action plan (IAP) and shall attend the pre-operation briefing to provide further information.

ADM-2: All protected resources shall be flagged, painted or otherwise marked prior to the start of operations by someone knowledgeable of the resources at risk, their location, and the applicable protection measures to be applied. This work shall be performed by a Registered Professional Forester (RPF), or his/her supervised designee, for any project in a forested landscape as defined in PRC § 754.

ADM-3: The project coordinator or designee shall monitor SPR implementation (and effectiveness in some cases) as an adaptive management tool. If a SPR does not perform adequately to protect the specified resource, the project coordinator will determine adaptation strategies, in coordination with the contractor and/or CAL FIRE personnel, and require their implementation.

ADM-4: If monitoring is necessary (e.g., effectiveness monitoring), the project coordinator or designee shall notify the party responsible for monitoring a minimum of three weeks in advance of operations. More advanced notification is encouraged from project coordinators to parties responsible for more rigorous monitoring activities.

ADM-5: All ground disturbing treatment activities, including land clearing and bull dozer line construction, shall be suspended when a red flag warning is issued by the local National Weather Service office.

ADM-6: The project coordinator or designee shall consult with the USFS, CAL FIRE, or other public agencies as appropriate to develop a list of past, current, and reasonably foreseeable probable future projects within the planning watershed of the proposed project. If the total combined acreage disturbed in the planning watershed exceeds 20% in a 10-year period, compliance with HYD-16 must be met prior to any ground disturbing operations. Projects that may combine with VTP projects to create the potential for significant effects include, but are not limited to, controlled burning, fuel reduction, and commercial timber harvesting.

ADM-7: The Sacramento Program manager shall track the annual and 10-year average annual acreage treated by the VTP, by bioregion. If the acreage treated within any bioregion exceeds 110 percent of the yearly amounts as identified in **Error! Reference source not found.**, the Program manager will notify the affected CAL FIRE Units that any additional projects submitted within that bioregion fall outside of the scope of analysis by this PEIR and additional CEQA analysis will be required. Additional CEQA analysis, such as a mitigated negative declaration, shall assess the cumulative impacts of the proposed project and identify any additional project constraints that may be necessary to mitigate these to less than significant. Additional CEQA analysis may be tiered off this PEIR when the proposed project is otherwise consistent with the VTP.

ADM-8: During the project planning phase, the project proponent will provide a public workshop for projects outside of the WUI. A public notice will be advertised in a local newspaper. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

7.2.1.2 Aesthetics-Related Standard Project Requirements

AES-1: See **BIO-5** for shrublands in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, and San Bernardino counties.

7.2.1.3 Air Quality-Related Standard Project Requirements

AIR-1: The project shall comply with all local, state, and federal air quality regulations and ordinances. The local Air Pollution Control District (APCD) or Air Quality Management District (AQMD) will be contacted to determine local requirements.

AIR-2: Prior to approval of an CAL FIRE Unit project under the VTP, the project coordinator shall model the project's Criteria Air Pollutant (CAP) emissions and compare the projected emissions levels to the thresholds identified by the local air district. If emissions levels exceed air district thresholds, consultation of the air district will occur.

AIR-3: In accordance with CCR Section 80160(b), all burn prescriptions shall require the submittal of a smoke management plan for all projects greater than 10 acres or are estimated to produce more than 1 ton of particulate matter. Burning shall only be done in compliance with the burn authorization program of the local air district having jurisdiction over the project area. Example of a smoke management plan is in Appendix J.

AIR-4: Fire emissions and fire behavior shall be planned, predicted, and monitored in accordance with SPRs FBE-1, FBE-2, and FBE-3 with the goal of minimizing air pollutant emissions.

AIR-5: Dust control measures shall be implemented in accordance with SPRs Hyd-9 with the goal of minimizing fugitive dust emissions.

AIR-6: The speed of activity-related trucks, vehicles, and equipment traveling on dirt areas shall be limited to 15 miles per hour (mph) to reduce fugitive dust emissions.

AIR-7: In areas where sufficient water supplies and access to water is available, all visible dust, silt, or mud tracked-out on to public paved roadways as a result of project treatment activities shall be removed at the conclusion of each work day, or at a minimum of every 24 hours for continuous fire treatment activities.

AIR-8: Ground-disturbing treatment activities, including land clearing and bull dozer lines, shall be suspended when there is a visible dust transport outside the project boundary.

AIR-9: Ground-disturbing treatment activities shall not be performed in areas identified as “moderately likely to contain naturally occurring asbestos (NOA)” according to maps and guidance published by the California Geological Survey (CGS), unless an Asbestos Dust Control Plan is prepared by the Operational Unit and approved by the air district(s) with jurisdiction over the project site. This determination would be based on a CGS publication titled *A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos* (Churchill and Hill 2000), or whatever more current guidance from CGS exists at the time the VTP project is evaluated. Any NOA-related guidance provided by the applicable local air district shall also be followed. If it is determined that NOA could be present at the project site, then an Asbestos Dust Control Plan shall be prepared and implemented in accordance with Title 17 of the Public Health CA Code of Regulations of Section 93105.

AIR-10: Operation of each large diesel- or gasoline-powered activity equipment (i.e., greater than 50 horsepower [hp]) shall not exceed 16 equipment-hours per day, where an equipment-hour is defined as one piece of equipment operating for one hour (daily CAPs, TACs, GHGs).

AIR-11: All diesel- and gasoline-powered equipment shall be properly maintained according to manufacturer's specifications, and in compliance with all state and federal emissions requirements. Maintenance records shall be available for verification.

AIR-12: A CAL FIRE Unit shall not conduct more than five simultaneous VTP activities on any day within an air district when multiple units reside within the same air district boundary. When a single CAL FIRE Unit resides within an air district boundary, one day total activity emission estimates will not exceed the current air district’s Threshold of Significance. No more than one of these projects shall be a prescribed burn, unless additional prescribed burns have been approved by the local air district having authority over the project area.

Mitigation Measure AIR-1

To achieve compliance with local air district emission thresholds in the San Joaquin Valley Unified Air Quality Management District, simultaneous projects within that air district will be constrained to an appropriate number as not to exceed air quality standards. As a result, the Program shall implement the following:

- CAL FIRE shall not allow more than seven simultaneous treatment activities to occur in the San Joaquin Valley Unified Air Quality Management District, regardless of the number of CAL FIRE units in the district.

7.2.1.4 Biological Standard Project Requirements

BIO-1: Projects shall be designed to avoid significant effects and avoid take of special status species as defined in the glossary as a plant or animal species that is listed as rare, threatened, or endangered under Federal law; or rare, threatened, endangered, candidate, or fully protected under State law; or as a sensitive species by the California Board of Forestry and Fire Protection.

BIO-2: The project coordinator shall run a nine-quad search or larger search area (may be required if a project is on the boundary of two USGS quad maps) of the area surrounding the proposed project for special status species, using at a minimum, the California Natural Diversity Database (CNDDB) or its successor (e.g., DFW's Vegetation Classification and Mapping Program, VegCAMP).

BIO-3: The project coordinator shall write a summary of all special status species identified in the biological scoping including the CNDDB search with a preliminary analysis, identifying which species would be affected by the proposed project. A field review will then be conducted by the project coordinator to identify the presence or absence of any special status species, or appropriate habitat for special status species, within the project area.

BIO-4: The project coordinator shall ensure that a CAL FIRE Environmental Coordinator analyze impacts to any species identified in a CNDDB or BIOS search and shall submit the summary and preliminary analysis to the CDFW, USFWS, and [if applicable] NOAA Fisheries for consultation. The preliminary analysis shall be accompanied with a standard letter containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.

- A description of the types of activities used in the project (e.g., prescribed burning; mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- The output from the CNDDB run, including a map of any special status species located during the field review, and the SPRs that will be implemented to minimize impacts on the identified special status species.
- A request for information regarding the presence and absence of special status species, including any applicable HCPs, in the project vicinity, and potential take avoidance measures to be implemented as PSRs.
- An offer to schedule a day to visit the project area with the project coordinator.

BIO-5: Vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties shall:

- Be designed to prevent vegetation type conversion.
- Not take place in vegetation that has not reached the age of median fire return intervals.
- Not re-enter treatment areas for maintenance in an interval shorter than the median fire return interval outside of the wildland urban interface and excluding fuel break maintenance.
- Not take place in old-growth chaparral without consultation regarding the potential for significant impacts with the CDFW and the CNPS.
- Take into account the local aesthetics, wildlife, and recreation of the shrub-dominated subtype during the planning and implementation of the project.
- During the project planning phase provide a public workshop or public notice in a newspaper that is circulated locally describing the proposed project during the project planning phase for projects outside of the WUI. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

BIO-6: In shrublands containing native oaks, treatments may incorporate retention of older, acorn producing oaks to create deer forage. CAL FIRE or applicants may plant other vegetation to promote species diversity and improve wildlife habitat when such practices are not in conflict with program goals.

BIO-7: Unless otherwise directed by CDFW, a minimum 50 foot avoidance buffer shall be established around any special status animal, nest site, or den location and a minimum 15 foot avoidance buffer shall be established around any special status plant within the project area. Additional buffer distances may be required through consultation with the appropriate State or Federal agencies, or a qualified biologist to avoid significant effects to special status species (see BIO-4).

BIO-8: In order to reduce the spread of new invasive plants, only certified weed-free straw and mulch shall be used.

BIO-9: During the planning phase, if the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures shall be developed using principles outlined in the document "Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition)" or other relevant documents. Coordination of mitigation measures will also include consultation with CDFW.

BIO-10: If water drafting becomes a necessary component of the proposed project, drafting sites shall be planned to avoid adverse effects to special status aquatic species and associated habitat, in-stream flows, and depletion of pool habitat. Screening devices shall be used for water drafting pumps, and pumps with low entry velocity shall be used to minimize removal of aquatic species, including juvenile fish, amphibian egg masses, and tadpoles, from aquatic habitats.

BIO-11: Aquatic habitats and species shall be protected through the use of watercourse and lake protection zones (WLPZ), as described in California Forest Practice Rules (14 CCR Chapters 4, 4.5, and 10). Other operational restrictions may be identified through consultation with CDFW and RWQCB (see BIO-4). See HYD-3 for these standard protection measures.

BIO-12: For projects that require a non-construction-related CDFW Streambed Alteration Agreement, any BMPs identified in the agreement shall be developed and implemented.

BIO-13: If any special status species are identified within the project area, an onsite meeting shall occur between the project coordinator and operating contractor. At this meeting the project manager shall conduct a brief review of life history, field identification, and habitat requirements for each special status species, their known or probable locations in the vicinity of the treatment site, project specific requirements or avoidance measures, and necessary actions if special status species or sensitive natural communities are encountered.

7.2.1.5 Climate Change-Related Standard Project Requirements

CC-1: Prior to approval of a Unit project under the VTP, the project coordinator shall run the FOFEM, and/or other GHG-emissions models, as appropriate to the treatment activity, to confirm that GHG emissions will be the minimum necessary to achieve risk reduction objectives.

CC-2: Carbon sequestration measures shall be implemented per SPRs BIO-5 and BIO-6 to reduce total carbon emissions resulting from the treatment activity.

CC-3: Treatment activity-related air pollutant emission control measures for prescribed burns shall be implemented in accordance with SPRs AIR-3 and AIR-4.

CC-4: Treatment activity-related air pollutant emission control measures for equipment operation hours, practices, and maintenance shall be implemented in accordance with SPRs AIR-11 and AIR-12.

7.2.1.6 Archaeology and Cultural Resources-Related Standard Project Requirements

CUL-1: The project coordinator or designee shall order a current records check as per the most current edition of “Archaeological Review Procedures for CAL FIRE Projects” (CAL FIRE, 2010, see Appendix H). The project coordinator may contact landowners within the project area who might have already conducted a records check for a Timber Harvest Plan or other project on their land to limit costly redundant records searches. Records checks must be less than five years old at the time of project submission.

CUL-2: Using the latest Native Americans Contact List from the CAL FIRE website, the project coordinator or designee shall send all Native American groups in the counties where the project is located a standard letter notifying them of the project. The letter shall contain the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- A request for information regarding potential cultural impacts from the proposed project.

CUL-3: The project coordinator or designee shall contact a CAL FIRE Archaeologist or CAL FIRE Certified Archaeological Surveyor to arrange for a survey of the project area if necessary. The specific requirements need to comply with the most current edition of “Archaeological Review Procedures for CAL FIRE Projects” (CAL FIRE, 2010).

CUL-4: Protection measures for archaeological and cultural resources shall be developed through consultation with a CAL FIRE archeologist. If new archaeological sites are discovered, the project coordinator or designee shall notify Native American groups of the resource and the protection measure with the standard second letter (see Appendix H). Locations of archaeological resources should not be disclosed on a map to the members of the public, including Native American groups.

CUL-5: If an unknown site is discovered during project operations, operations within 100 feet of the identified boundaries of the new site shall immediately halt, and the project will avoid any more disturbances. A CAL FIRE Archaeologist shall be contacted for an evaluation of the significance of the site. In accordance with the California Health and Safety Code, if human remains are discovered during ground disturbing activities, CAL FIRE and/or the project contractor(s) shall immediately halt potentially damaging activities in the area of the burial and notify the County Coroner and a qualified professional archaeologist to determine the nature and significance of the remains.

7.2.1.7 Fire Behavior-Related Standard Project Requirements

FBE-1: The prescribed fire burn prescription shall be designed to initiate a surface fire of sufficient intensity that will only consume surface and ladder fuels. The prescribed fire burn prescription shall be designed and implemented to protect soil resources from direct soil heating impacts. Soil damage will not occur as a result of this project.

FBE-2: A burn plan shall be created using the burn plan template. The burn plan shall include a fire behavior model output of BEHAVE or other fire behavior modeling simulation and performed by a fire behavior technical specialist (S-490 qualified). The burn plan shall be created with input from the vegetation project's Battalion Chief and a fire behavior technical specialist (S-490 qualified).

FBE-3: The project coordinator shall run a First Order Fire Effects Model (FOFEM) to analyze fire effects. The results of the analysis shall be included with the Burn Plan. FOFEM calculates consumption of fuels, tree mortality, predicted emissions, GHG emissions, and soil heating.

FBE-4: Approximately two weeks prior to commencement of prescribed burning operations the project coordinator shall 1) post signs along the closest major road way to the project area describing the project, timing, and requesting for smoke sensitive persons in the area to contact the project coordinator; 2) publish a public interest notification in a local newspapers describing the project, timing, and requesting for smoke sensitive persons in the area to contact the CAL FIRE project coordinator; 3) send the local county supervisor a notification letter describing the project, its necessity, timing, and summarize the measures being taken to protect the environment and prevent escape; and 4) develop a list of smoke sensitive persons in the area and contact them prior to burning.

7.2.1.8 Geologic Standard Project Requirements

GEO-1: An RPF or licensed geologist shall assess the project area for unstable areas and unstable soils as per 14 CCR 895.1 of the California Forest Practice Rules. Guidance on identifying unstable areas is contained in the California Licensed Foresters Association *Guide to Determining the Need for Input From a Licensed Geologist During THP Preparation* and California Geological Survey (CGS) Note 50 (see Appendix C). Priority will be placed on assessing watercourse-adjacent slopes greater than 50%. If unstable areas or soils are identified within the project area, are unavoidable, and are potentially directly or indirectly affected by the project operations, a licensed geologist (P.G. or C.E.G.) shall conduct a geologic assessment to determine the potential for project-induced impacts and mitigation strategies. Project shall incorporate all of the recommended mitigations. Geologic reports should cover the topics outlined in CGS Note 45 (see Appendix C).

GEO-2: The potential impacts of prescribed fire on geologic processes shall be reduced by following the Fire Behavior-related SPRs FBE-1, FBE-2, and FBE-3.

7.2.1.9 Hazards and Hazardous Material-Related Standard Project Requirements

HAZ-1: Prior to the start of vegetation treatment activities, the project coordinator shall conduct an Envirofacts web search to identify any known contamination sites within the project area. If a proposed vegetation treatment project occurs in areas located on the DTSC Cortese List, no activities shall occur within 100 feet of the site boundaries.

HAZ-2: Prior to the start of vegetation treatment activities, the project coordinator or contractor shall inspect all equipment for leaks and regularly inspect thereafter until equipment is removed from the site.

HAZ-3: Prior to the selection of treatment activities, CAL FIRE shall determine if there are viable, cost-effective, non-herbicide treatment activities that could be implemented prior to the selection of herbicide treatments.

HAZ-4: Prior to the start of herbicide treatment activities, the project coordinator shall prepare a Spill Prevention and Response Plan (SPRP) to provide protection to onsite workers, the public, and the environment from accidental leaks or spills of herbicides, adjuvants, or other potential contaminants. This plan shall include (but not be limited to):

- A map that delineates VTP staging areas, where storage, loading, and mixing of herbicides will occur
- A list of items required in a spill kit onsite that will be maintained throughout the life of the project

- Procedures for the proper storage, use, and disposal of any herbicides, adjuvants, or other chemicals used in vegetation treatment

HAZ-5: If remediation of hazardous contamination is needed, the project coordinator shall hire a licensed contractor with expertise in performing such work. The contractor shall comply with all laws and regulations governing worker safety and the removal and disposal of any contaminated material.

HAZ-6: All pesticide use shall be implemented consistent with Pest Control recommendations prepared annually by a licensed Pest Control Advisor.

HAZ-7: All appropriate laws and regulations pertaining to the use of pesticides and safety standards for employees and the public, as governed by the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, and local jurisdictions shall be followed. All applications shall adhere to label directions for application rates and methods, storage, transportation, mixing, and container disposal. All contracted applicators shall be appropriately licensed by the state. The project coordinator shall coordinate with the County Agricultural Commissioners, and all required licenses and permits shall be obtained prior to pesticide application.

HAZ-8: Projects shall avoid herbicide treatment in areas adjacent to water bodies and riparian areas. Application of herbicides shall be outside the WLPZ and ELZ as specified in HYD-3, or at the distances set forth in the herbicide label requirements, whichever is greater. No aerial spraying of herbicides shall occur under this Program EIR.

HAZ-9: The following general application parameters shall be employed during herbicide application:

- Application shall cease when weather parameters exceed label specifications, when sustained winds at the site of application exceeds seven miles per hour (MPH), or when precipitation (rain) occurs or is forecasted with greater than a 40 percent probability in the next 24-hour period to prevent sediment and herbicides from entering the water via surface runoff
- Spray nozzles shall be configured to produce a relatively large droplet size
- Low nozzle pressures (30-70 pounds per square inch [PSI]) shall be observed
- Spray nozzles shall be kept within 24 inches of vegetation during spraying

Drift avoidance measures shall be used to prevent drift in locations where target weeds and pests are in proximity to special status species or their habitat. Such measures can consist of, but would not be limited to, the use of plastic shields around target weeds and pests and adjusting the spray nozzles of application equipment to limit the spray area.

HAZ-10: All herbicide and adjuvant containers shall be triple rinsed with clean water at an approved site, and the rinsate shall be disposed of by placing it in the batch tank for application per 3 CCR § 6684. Used containers shall be punctured on the top and bottom to render them unusable, unless said containers are part of a manufacturer's container recycling program, in which case the manufacturer's instructions shall be followed. Disposal of non-recyclable containers will be at legal dumpsites. Equipment would not be cleaned and personnel would not bathe in a manner that allows contaminated water to directly enter any body of water within the treatment areas or adjacent watersheds. Disposal of all pesticides shall follow label requirements and local waste disposal regulations.

HAZ-11: Storage, loading and mixing of herbicides shall be set back at least 150 feet from any aquatic feature or special status species or their habitat or sensitive natural communities.

HAZ-12: Appropriate non-toxic colorants or dyes shall be added to the herbicide mixture where needed to determine treated areas and prevent over-spraying.

HAZ-13: For treatment activities located within or adjacent to public recreation areas, signs shall be posted at each end of herbicide treatment areas and any intersecting trails notifying the public of the use of herbicides. The signs shall consist of the following information: signal word, product name, and manufacturer; active ingredient; EPA registration number; target pest; treatment location; date and time of application; date which notification sign may be removed; and contact person with telephone number. Signs shall be posted at the start of treatment and notification will remain in place for 72 hours after treatment ceases.

HAZ-14: All heavy equipment shall be required to include spark arrestors or turbo chargers that eliminate sparks in exhaust and have fire extinguishers onsite.

7.2.1.10 Hydrologic and Water Quality-Related Standard Project Requirements

HYD-1: The project shall comply with all applicable water quality requirements adopted by the appropriate Regional Water Quality Control Board and approved by the State Water Board (i.e., Basin Plan).

HYD-2: During the planning phase the project coordinator shall submit a standard letter to the appropriate RWQCB containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.

- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- Notification of whether the project drains directly into an impaired water body, and the type of water quality constituent(s) that is impairing the water body.
- A request for information and recommendations regarding the potential for significant water quality impacts from the proposed project and an offer to schedule a day to visit the project area with the project coordinator. The project shall incorporate the recommendations that prevent significant impacts to water quality as PSRs.

HYD-3: A WLPZ shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current California Forest Practice Rules (**Error! Reference source not found.**). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation within the WLPZ or ELZ will not be disturbed by project activities, with the exception of backing prescribed fire. Class IV watercourse protections shall be PSRs specified in the PSA, and designed in conjunction with any recommendations from RWQCB staff.

Watercourse and lake protection zone buffer widths by watercourse classification and hill slope gradient (See HYD -3)

Note: ELZ-Equipment Limitation Zone, PSR-Project Specific Requirement

Water Class Characteristics or Key Indicator / Beneficial Use	1)Domestic supplies, including springs, on site and/or within 100 feet downstream of the project area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning	1) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for non-fish aquatic species. 3) Excludes Class III water that are tributary to Class I waters	No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II water under normal high water flow conditions of timber operations	Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use
Water Class	Class I	Class II	Class III	Class IV
Slope Class (%)	Width (ft.)	Width (ft.)	Width (ft.)	Width
<30	75	50	50 (ELZ)	PSR
30-50	100	75	50 (ELZ)	PSR
>50	150	100	50 (ELZ)	PSR

HYD-4: No direct ignition shall be allowed within the WLPZ or ELZs. However, it is acceptable for a fire to enter or back into a WLPZ's or ELZ's.

HYD-5: Compacted and/or bare linear treatment areas (e.g., fire breaks, roads, or trails) capable of generating storm runoff shall be drained via water breaks using the spacing guidelines contained in Sections 914.6, 934.6, and 954.6(c) of the California Forest Practice Rules.

HYD-6: Compacted and/or bare treatment areas shall be drained such that they are hydrologically disconnected from watercourses or lakes. Measures to hydrologically disconnect these areas shall be guided by consulting with Technical Rule Addendum #5 of the California Forest Practice Rules – Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings

HYD-7: No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or damage to soil structure. Saturated soil means that soil and/or surface material pore spaces are filled with water to such an extent that runoff is likely to occur. Indicators of saturated soil conditions may include, but are not limited to: (1) areas of ponded water, (2) pumping of fines from the soil or road surfacing material during timber operations, (3) loss of bearing strength resulting in the deflection of soil or road surfaces under a load, such as the creation of wheel ruts, (4) spinning or churning of wheels or tracks that produces a wet slurry, or (5) inadequate traction without blading wet soil or surfacing materials.

HYD-8: For remaining hydrologically connected areas of compacted or bare linear treatment areas, disturbed areas will be mulched with onsite native vegetative material (e.g., cut material).

HYD-9: During dry, dusty conditions, unpaved roads shall be wetted using water trucks or treated with a non-toxic chemical dust suppressant (e.g., emulsion polymers, organic material). Any dust suppressant product used shall be environmentally benign (i.e., non-toxic to plants and shall not negatively impact water quality) and its use shall not be prohibited by the ARB, U.S. Environmental Protection Agency (EPA), or the State Water Resources Control Board. Exposed areas shall not be over-watered such that water results in runoff. The type of dust suppression method shall be selected by the contractor based on soil, traffic, site-specific conditions, and local air quality regulations.

HYD-10: Prior to the start of onsite activities, all equipment will be inspected for leaks and regularly inspected thereafter until equipment is removed from the project area. All contaminated water, sludge, spill residue, or other hazardous compounds will be contained and disposed of outside the boundaries of the site, at a lawfully permitted or authorized destination.

HYD-11: Staging areas shall be designated and located to prevent leakage of oil, hydraulic fluids, or other chemicals into watercourses or lakes.

HYD-12: All heavy equipment parking, refueling, and service shall be conducted within designated areas outside of the WLPZ or ELZ.

HYD-13: No new roads (including temporary roads) shall be constructed or reconstructed (reconstruction is defined as cutting or filling involving less than 50 cubic yards/0.25 linear road miles). Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice Rules.

HYD-14: Heavy equipment is prohibited on slopes exceeding 65 percent or on slopes greater than 50 percent where the erosion hazard rating is high or extreme. Heavy equipment is prohibited on slopes greater than 50 percent that lead without flattening to watercourses.

HYD-15: Burn piles shall not exceed 20 feet in length, width, or diameter, except when on landings, road surfaces, or on contour.

HYD-16: At the CalWater Planning Watershed scale, if the combined, appropriately-weighted acreage subjected to fuels treatments and logging exceed 20% of the watershed area within a 10-year timespan (see Appendix K for calculation procedures); an analysis will be performed to determine the potential for hydrologically-induced significant impacts of the proposed activity.

HYD-17: If herbivory is proposed to treat vegetation in a project area containing watercourses, then the following items must be addressed as PSRs:

- The project will require water on site in the form of an on-site stock pond outside the WLPZ or ELZ, or a portable water source located outside the WLPZ or ELZ.
- The project will specify animal containment measures in the PSA to prevent animals from entering the WLPZ and/or ELZs. These might include the use of fencing (i.e., fixed or portable), the use of guard or herd dogs, or the use of an on-site herder.

7.2.1.11 Noise-Related Standard Project Requirements

NSE-1: All powered equipment shall be used and maintained according to manufacturer’s specifications.

NSE-2: Equipment engine shrouds shall be closed during equipment operation.

NSE-3: All heavy equipment and equipment staging areas shall be located as far as possible from nearby noise-sensitive land use (e.g., residential land uses, schools, hospitals, places of worship).

NSE-4: All motorized equipment shall be shut down when not in use. Idling of equipment or trucks shall be limited to 5 minutes.

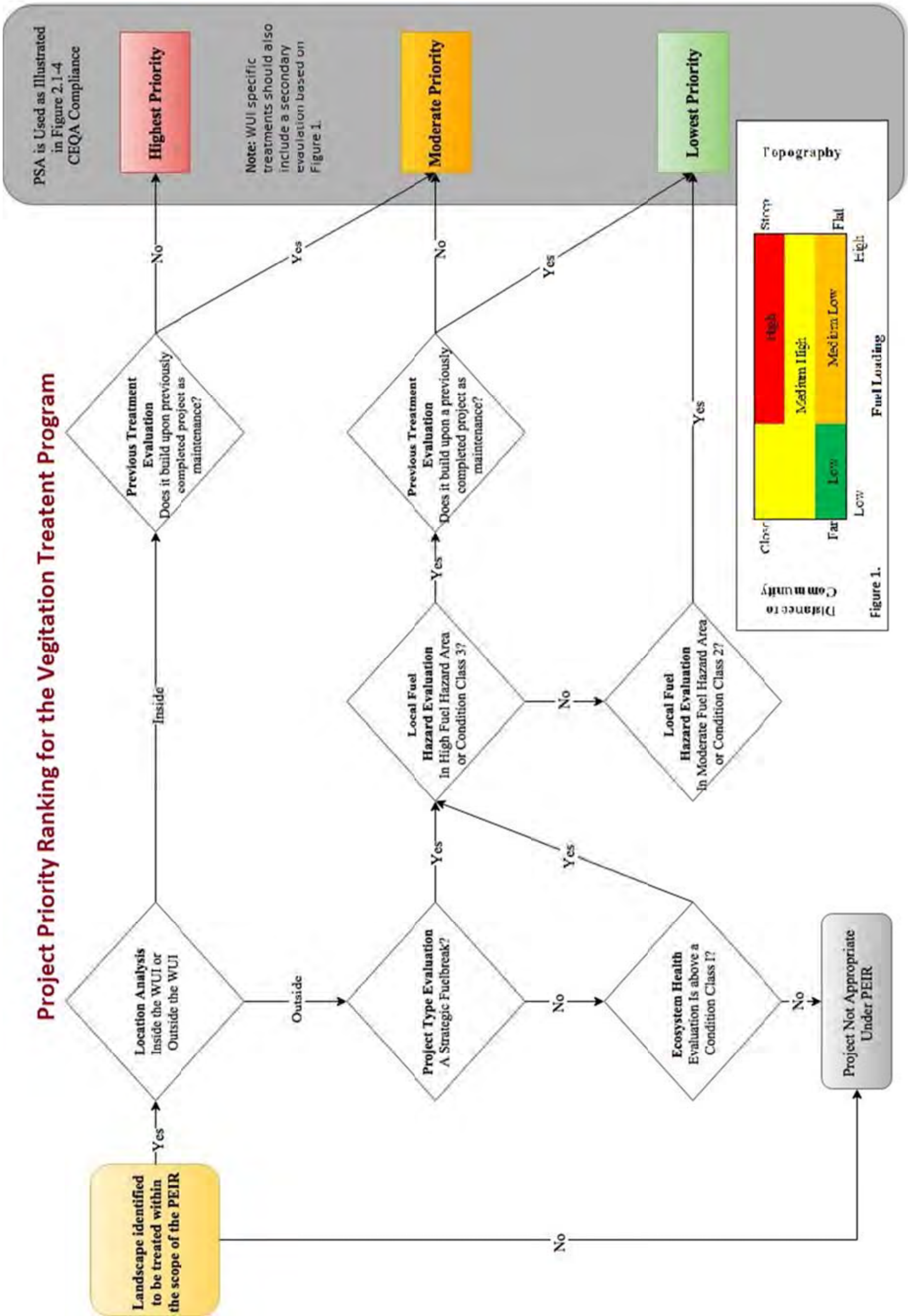
NSE-5: Public notice of the proposed project shall be given to notify noise-sensitive receptors of potential noise-generating activities.

7.2.1.12 Traffic-Related Standard Project Requirements

TRA-1: Public road ways leading into project area shall be signed to warn traffic of the project activities that are taking place. Road signage shall be posted the morning prior to the commencement of burning operations and shall remain until all operations are completed.

TRA-2: Direct smoke and dust impacts to roadway visibility and the indirect distraction of operations shall be considered during burning operations. Traffic control operations shall be implemented if weather conditions inhibiting smoke and dust dispersion have the potential to impact roadway visibility to motorists.

7.2.2 PSA ATTACHMENT B- PROJECT PRIORITY RANKING


Project Priority Ranking for the Vegitation Treatent Program
PSA is Used as Illustrated in Figure 2.1-4 CEQA Compliance
Highest Priority
Note: WUI specific treatments should also include a secondary evaluation based on Figure 1.
Moderate Priority
Lowest Priority
Landscape identified to be treated within the scope of the PEIR
Yes
No
Location Analysis
Inside the WUI or Outside the WUI
Inside
Outside
Previous Treatment Evaluation
Does it build upon previously completed project as maintenance?
Project Type Evaluation
A Strategic Fuelbreak?
Local Fuel Hazard Evaluation
In High Fuel Hazard Area or Condition Class 3?
Does it build upon a previously completed project as maintenance?
Ecosystem Health
Evaluation Is above a Condition Class 1?
Local Fuel Hazard Evaluation
In Moderate Fuel Hazard Area or Condition Class 2?
Project Not Appropriate Under PEIR
Topography
Steep
Flat
High
Medium High
Medium Low
Low
Close
Far
Distance to Community
Fuel Loading
Figure 1.

7.2.3 PSA ATTACHMENT C- VTP OBJECTIVES & PROJECT OBJECTIVE EXAMPLES

Vegetation Treatment Program Objectives
1. Modify wildland fire behavior to help reduce losses to life, property and natural resources.
2. Increase the opportunities for altering or influencing the size, intensity, shape, and direction of wildfires within the wildland-urban interface (WUI).
3. Reduce the potential size and total associated suppression costs of individual wildland fires by altering the continuity of wildland fuels.
4. Reduce the potential for high severity fires by restoring and maintaining a range of native, fire-adapted plant communities through periodic low intensity treatments within the appropriate vegetation types.
5. Provide a consistent, accountable, and transparent process for vegetation treatment monitoring that is responsive to the objectives, priorities, and concerns of landowners, local, state, and federal governments, and other stakeholders.

WUI treatment sample objectives –

- Reduce the vertical and horizontal continuity of fuels adjacent to structures.
- Provide vegetation clearance along ingress and egress for public safety.

Ecological Restoration treatment sample objectives –

- Recreate pre-settlement fire regimes, stand structures and species compositions
- Increase the quality of habitat for early seral stage wildlife species.
- Increase range forage conditions for domestic livestock

Fuel Break treatment sample objectives –

- Provide a shaded fuel break between #### and #### to help slow the progress of wildfire impacting the #### community and/or allow for the safe deployment of firefighting personnel.

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Portions of two earlier Program Environmental Impact Reports for Vegetation Management Program, April 2000 and October 2012 were incorporated into this PEIR. They were prepared by Jones and Stokes Associates, Baldwin, Blomstrom & Wilkerson & Associates, Trinity County Resource Conservation District, and CAL FIRE. The overall content of this EIR reflects the work of the Department of Forestry and Fire Protection, acting in its capacity as a contractor to the Board of Forestry and Fire Protection.

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A. ANALYSIS ASSUMPTIONS AND METHODS

Spatial Modeling and Bioregion Review

A.1 SPATIAL MODELING FOR THE VEGETATION TREATMENT PROGRAM (VTP) – EXECUTIVE SUMMARY

A.1.1 ABSTRACT

The proposed Vegetation Treatment Program (VTP) of the California Department of Forestry and Fire Protection (Cal Fire) will operate on a base of approximately 31 million acres of wildland vegetation throughout California, with approximately 25 million acres of those acres being within treatable vegetation types. Over 90% of the base area is on private, non-federal jurisdictions lands, where land use ranges from wildland-urban interface (WUI) areas, to commercial timber production, to sparsely populated ranches or non-commercial private lands.

Not all eligible wildland acres are in equal need of, or would equally benefit from, vegetation treatment under the program. Under this PEIR three treatable vegetation types (Tree, Shrub, Grass) were identified, along with three treatments (WUI, Fuel Breaks, and Ecological Restoration).

In support of the PEIR, three separate Geographic Information System (GIS) based analyses were preformed to map areas of eligible acres for VTP projects under the three treatments and within the three treatable vegetation types. The first analysis provided possible project areas that fell within the State Responsibility Area (SRA) and identified wildland urban interface (WUI) areas. The second analysis provided possible project areas that created fuel breaks along ridgelines and identified potential fuel breaks along roadways in the State Responsibility Areas and Local Responsibility Areas (LRA). The third analysis provided possible project areas within Ecological Areas, which were identified by selecting all State Responsibility, excluding any area identified as wildland urban interface (WUI), and identifying area where the condition class identified by FRAP was a two or a three. All three analyses where overlaid with the three treatable vegetation types to produce the approximate treatable acres under the VTP, approximately 24.9 million acres.

Two additional Geographic Information System (GIS) based analyses were also preformed to map the alternative VTP projects. The first analysis consisted of including all wildland urban interface (WUI) areas within the SRA and joining it with Fuel Breaks exclusively within the WUI in both the State Responsibility Areas (SRA) and Local Responsibility Areas (LRA). The second analysis identified areas that were Very High Fire Danger Severity Zones (VHFDSZ) with in the State Responsibility Area (SRA). These two analyses where also overlaid with the three treatable vegetation types to

produce the approximate treatable acres under the VTP. The produced maps, tables, charts, and graphs depict all available treatable acreages at a statewide level within the VTP.

A.1.2 STATE OF CALIFORNIA RESPONSIBILITY AREAS

The State of California is divided into three different types of responsibility areas: Federal Responsibility Areas (FRA), State Responsibility Areas (SRA), and Local Responsibility Areas (LRA). The definition of State Responsibility Area (SRA) is defined by Public Resources Code (PRC) 4126, while lands that shall not be included in the SRA are defined is PRC 4127. The methodology for determining FRA, SRA, and LRA within California is described in Cal Fire's State Responsibility Area Classification System[1], which more clearly describes the process for excluding and including lands in the SRA. SRA reviews occur every five years; this EIR used the most recent review information that was completed in 2015. This EIR primarily focuses on SRA lands and only includes LRA lands when discussing Fuel Break, Alternative B, and Alternative C treatment areas. FRA lands are excluded in their entirety.

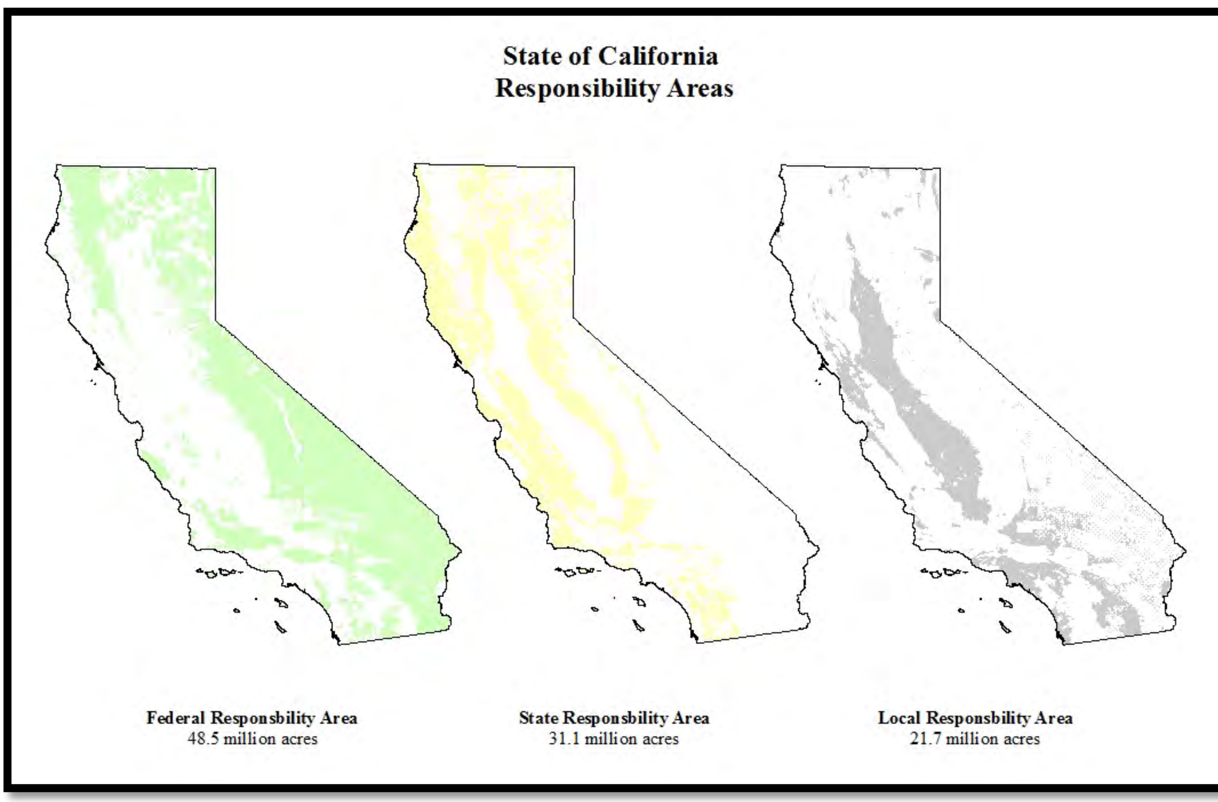


Figure A.1-1 Responsibility areas within the State of California.

[1] Available at http://frap.fire.ca.gov/projects/sra_review/downloads/SRA%20Review/2013%20SRA%20Review/SRA_Classification_System_Update.pdf

A.1.3 VEGETATION FORMATIONS

Within the State and Local Responsibility Areas the VTP identified Treatable Vegetation Formations. These are identified and grouped throughout the document by tree, shrub, and grass. These groups are assembled by their respective WHR name and extracted out of the FVEG15_1[2] database to create the VTP vegetation layer (Figure A.1-2). These formations were then intersected with the Treatments and Alternative Treatments to create *Treatable Acres within the Treatments*.

FVEG15_1 was initially created by CAL FIRE FRAP to compile the “best available” land cover data into a single data layer to support the legislatively mandated Forest and Rangeland Assessment. CAL FIRE in cooperation with California Department of Fish and Wildlife VegCamp program and extensive use of the USDA Forest Region 5 Remote Sensing Laboratory (RSL) Data compiled the “best available” land cover data available for California into single comprehensive statewide data set. The data spans a period from approximately 1990 to 2014. Typically the most current, detailed and consistent data were collected for various regions of the state. Decision rules were developed that controlled which layers were given priority in areas of overlap. Cross-walks were used to compile the various sources into the common classification scheme, the California Wildlife Habitat Relationships (CWHR) system. Approximately 57% of the state was mapped from USDA USFS CALVEG data, and 29% was mapped from VegCamp Manual of California Vegetation Classification system (MCV) data using crosswalks supplied by VegCamp staff. The remaining 14% comes from mostly federal sources that were used to identify urban areas (NLCD), Agriculture (NASS) and LANDFIRE to fill in desert lands that had not been mapped by any California efforts. Both the CALVEG and MCV are more detailed classifications then the CWHR data, so specific CALVEG or MCV types often get lumped into CWHR types. For example CALVEG types Coastal Live Oak (QA), California Bay (QB), madrone (QH), Engleman Oak (QN), California Walnut (QV), and Interior Live Oak (QW) calveg types all crosswalk into the CWHR type Coastal Oak Woodland (COW). Crosswalks would be similar for the MCV to CWHR also.

[2] Available at http://frap.fire.ca.gov/data/frapgisdata-sw-fveg_download.php.

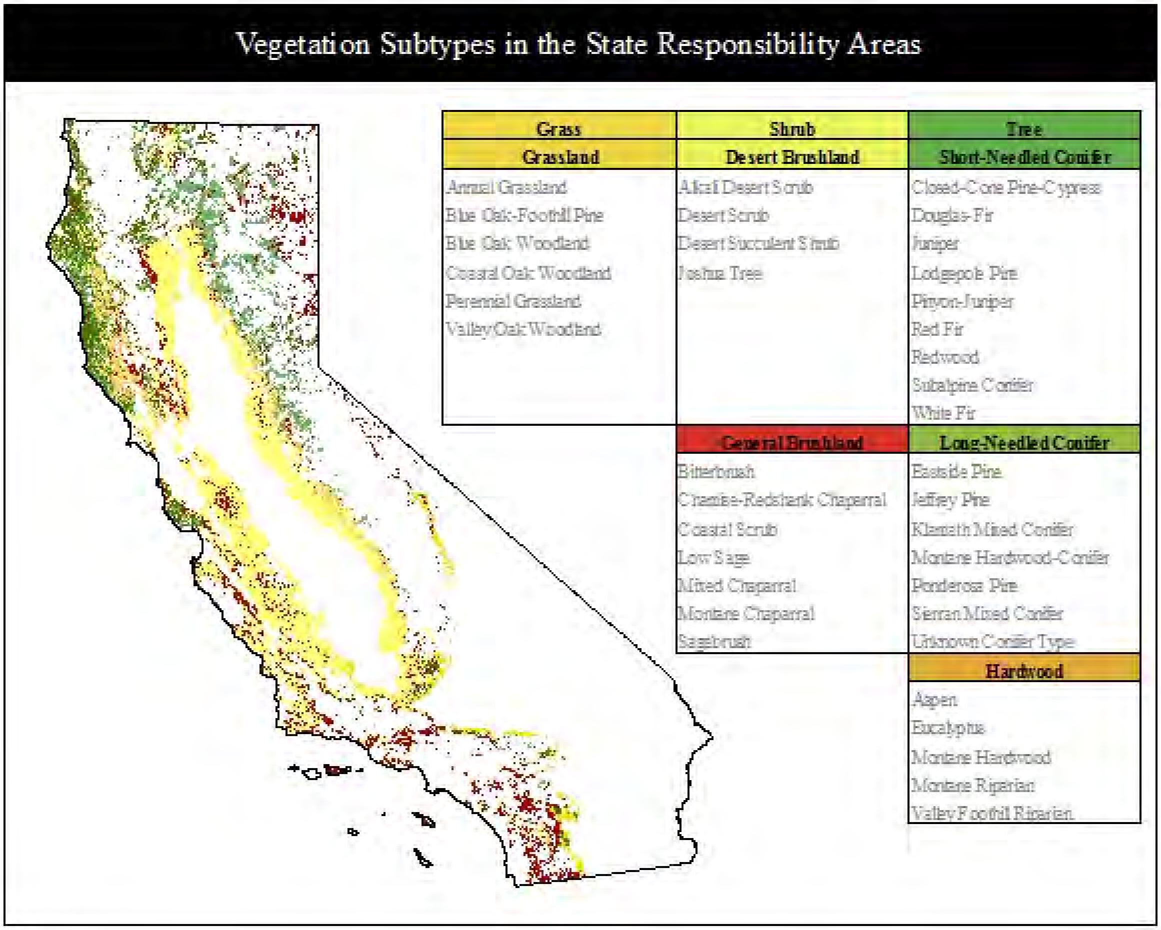


Figure A.1-2 Vegetation Subtypes in the State Responsibility Areas.

A.1.4 TREATMENTS

Three treatments types were identified within the VTP: Wildland Urban Interface (WUI), Fuel Breaks, and Ecological Restoration. Each requiring a different level and type of analysis to derive total acreage within a treatment area, see table A.1-1.

Table A.1-1 VTP Treatment Analysis Table

VTP Treatment Areas				
	WUI	Fuel Breaks		Ecological Restoration
Base Layer	WUI Zones	Ridgelines	Roads	SRA
Overlays	SRA	SRA & LRA	SRA & LRA Condition Class 2 & 3 WUI	Condition Class 2 & 3
Exclusions	Non-WUI			WUI
Proximity		150ft Buffer	150ft Buffer	

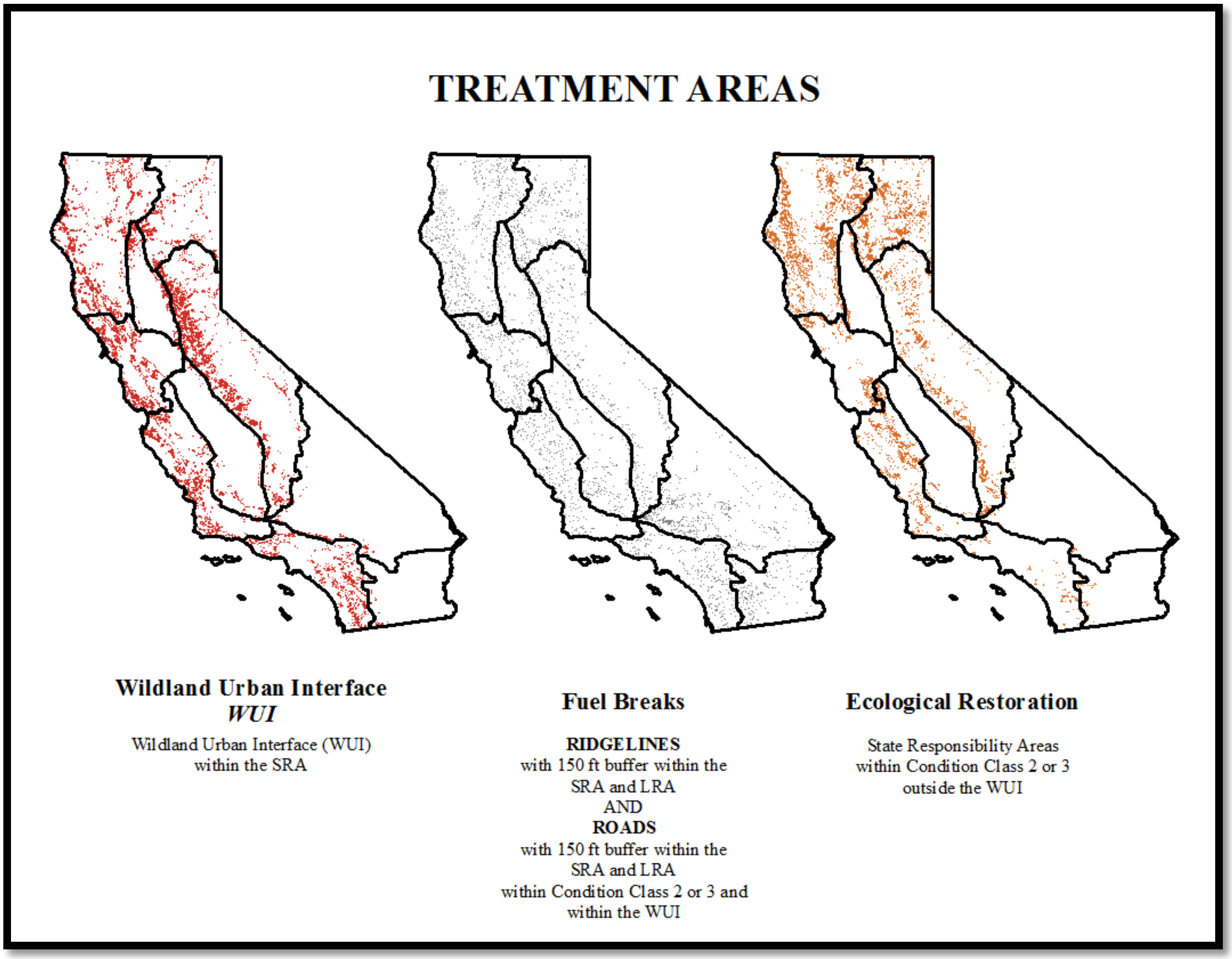


Figure A.1-3 Treatment Areas identified within the VTP.

A.1.4.1 Treatment: Wildland Urban Interface (WUI)

The Wildland Urban Interface (WUI) Treatment Area was derived from WUI03_1[3] and SRA15_1[4]. WUI was identified and extracted from WUI03_1. State Responsibility Areas were identified and extracted from SRA15_1. WUI and SRA were then overlaid and overlapping areas were identified to create the WUI Treatment Area for analysis within the VTP. The methodology for creating WUI03_1 is found in the Characterizing the Fire Threat to Wildland-Urban Interface Areas in California, attached to end of this appendix. There is also a summary discussion of Characterizing the Fire Threat to Wildland-Urban Interface Areas in California in Chapter 4.1.

A.1.4.2 Treatment: Fuel Breaks

The Fuel Break Treatment Area was derived through analysis of ridgelines and roadways. There is no standard dataset for California which identifies ridgelines within

[3] Available at http://frap.cdf.ca.gov/data/frapgisdata-sw-wui.php
[4] Available at http://frap.cdf.ca.gov/projects/sra_mapping/sra_2015php

the state; therefore a ridgeline model was created from the USGS Digital Elevation Model of California reversing the hydrological toolset within ESRI's ArcMap to acquire ridgelines instead of steams. More information about that process can be found at ESRI's website.[5] While the ridgelines created an accurate model for a large majority of the state, we do acknowledge that the modeling had trouble with mesa areas in southern California and Modoc, therefore some areas within the southern California bioregions and the Modoc bioregions may have slightly higher available treated acres than what is truly available within the Fuel Break Treatment Areas. The identified ridgelines were given a 150ft rounded buffer and then overlaid with State Responsibility (SRA) and Local Responsibility (LRA) lands. Areas where extracted where the two layers intersected to create the ridgeline features of the Fuel Break Treatment Area. Cal Fire does not maintain a statewide roads layer; therefore the ESRI Streets layer was utilized as a standard road layer for this analysis. Roads were given the same 150ft rounded buffer that the ridgelines received, but were instead overlaid with not only with State Responsibility (SRA) and Local Responsibility (LRA) lands, but also WUI and Conditional Class 2 or 3 from CAFRCC03_2[6]. Roads and Ridgelines were then merged together, to create the Fuel Break Treatment Area for analysis within the VTP.

A.1.4.3 Treatment: Ecological Restoration

The Ecological Restoration Treatment Area was derived from SRA15_1, CAFRCC03_2, and WUI03_1. State Responsibility Areas, Condition Class 2 or 3, and Non-WUI were overlaid and overlapping areas were identified to create the Ecological Restoration Treatment Area for analysis within the VTP.

A.1.5 ALTERNATIVES

Four Alternatives were identified within the VTP, alternative A, B, C, D. Similar to the treatments, each required a different level and type of analysis to derive total acreage within an alternative treatment area with the exception of Alternative D which utilized the previous VTP footprint, see table A.1-2.

[5] Available at http://support.esri.com/cn/knowledgebase/techarticles/detail/39093
[6] Available at http://frap.fire.ca.gov/data/frapgisdata-ffrcc-statewide.php

Table A.1-2. Alternative Analysis Table

Alternatives				
	Alternative A	Alternative B		Alternative C
Base Layer	WUI*	WUI*	Fuel Breaks*	Fire Hazard Severity Zones (LRA &SRA)
Overlays				VHFDSZ
Exclusions				
Proximity				

* Derived from the VTP Analysis.

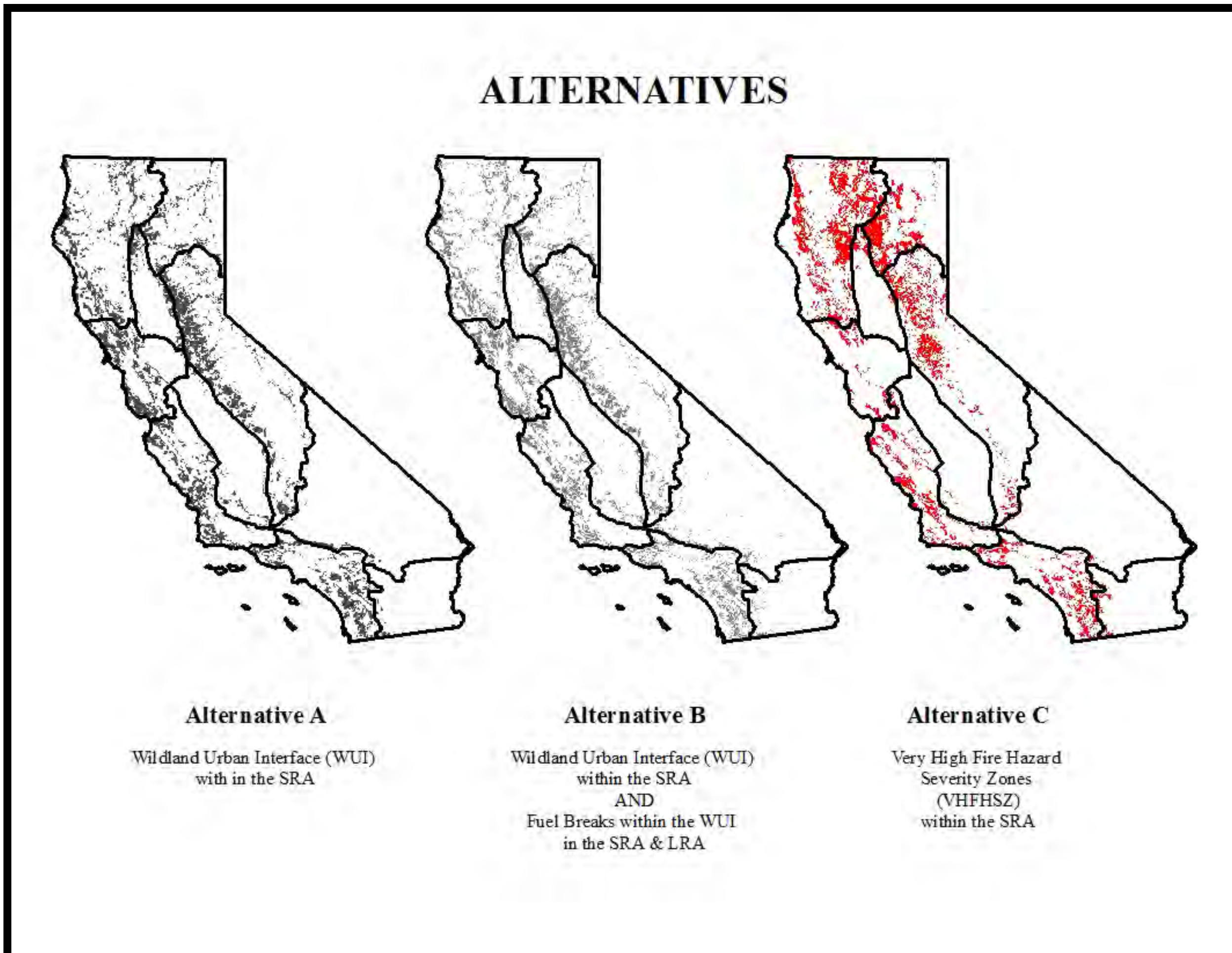


Figure A.1-4 Alternative Treatment Areas identified within the VTP.

A.1.5.1 Alternative A: Wildland Urban Interface (WUI)

Alternative A utilized the previously described WUI treatment area with no alterations.

A.1.5.2 Alternative B: Wildland Urban Interface & Fuel Breaks

Alternative B also utilized the previously described WUI treatment areas with no alterations. The previously described Fuel Breaks were overlaid with WUI areas in both the SRA and LRA. Overlapping areas between Fuel Breaks and WUI were identified to create an Alternative B Fuel Break. The WUI treatment areas were then combined with Alternative B Fuel Breaks to create the Alternative B Treatment Area for the alternative analysis within the VTP.

A.1.5.3 Alternative C: Very High Fire Danger Severity Zones (VHFDSZ)

Alternative C Treatment Areas were derived from FHSZS06_3[7]. Areas identified within the data set as Very High Fire Danger Severity Zones (VHFDSZ) were extracted to create the Alternative C Treatment for alternative analysis within the VTP.

A.1.5.4 Alternative D: Air Quality

Alternative D Treatment Areas were placed in the same footprint as the VTP treatment area with only a reduction in acres treated applied. No additional spatial analysis was conducted.

[7] http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_zones_maps.php

A.2 BIOREGION OVERVIEW

A.2.1 KLAMATH/ NORTH COAST BIOREGION

Description: Bounded on the west by the Pacific coastline and on the north by the Oregon border. The bioregion extends eastwards to include all of Klamath National Forest and Shasta-Trinity National Forest and the entire North Coast Range (down to the Sacramento Valley floor) The southern boundary reaches the southern limits of Lake and Mendocino counties.

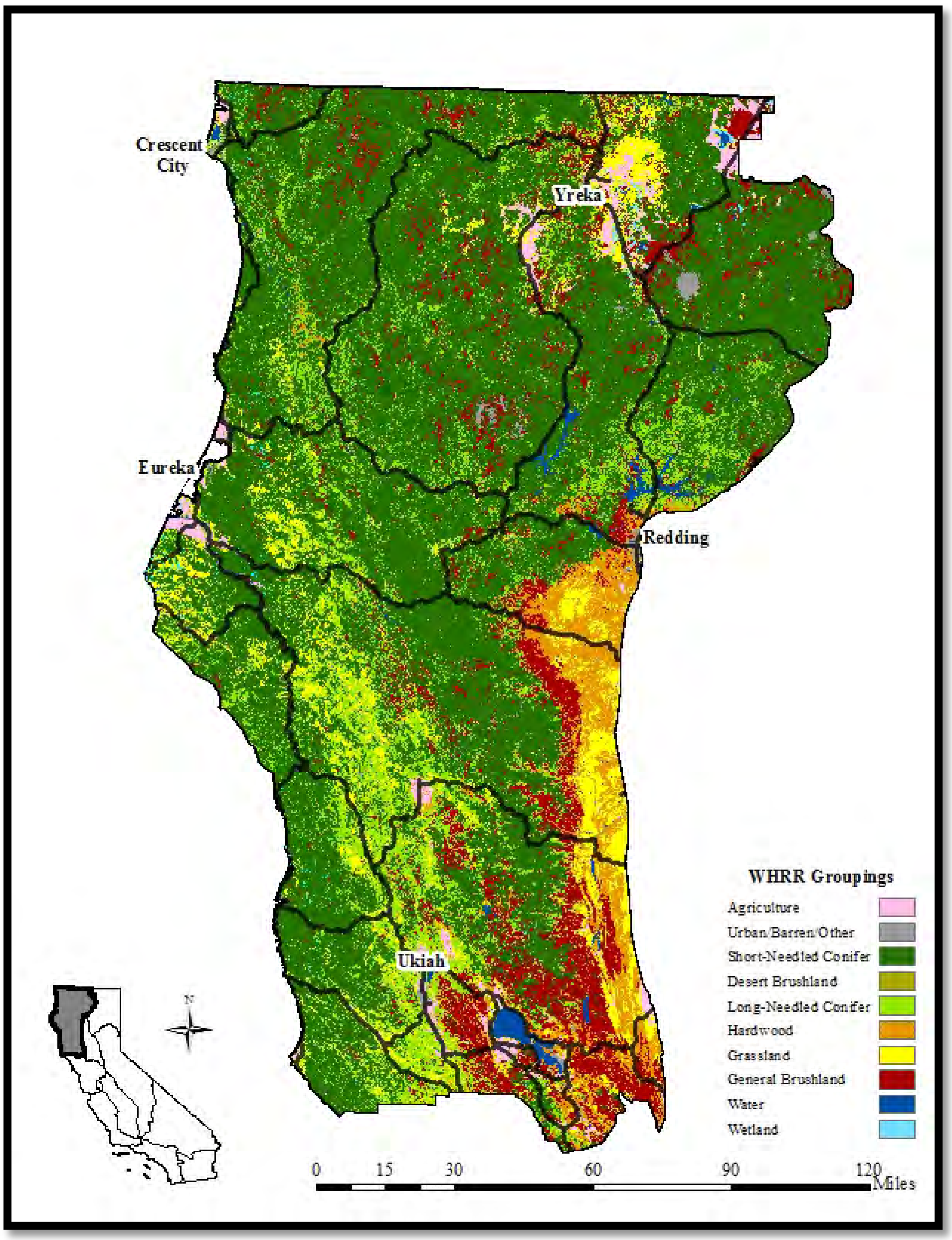


Figure A.2-1Klamath/ North Coast Bioregion

A.2.2 MODOC BIOREGION

Description: Bounded on north by the Oregon border and on the east by the Nevada border. The bioregion extends west to include all of Modoc National Forest and Lassen National Forest, plus additional lands extending down to the Sacramento Valley floor. The southern boundary reaches the southern limits of Lassen National Forest and Lassen County.

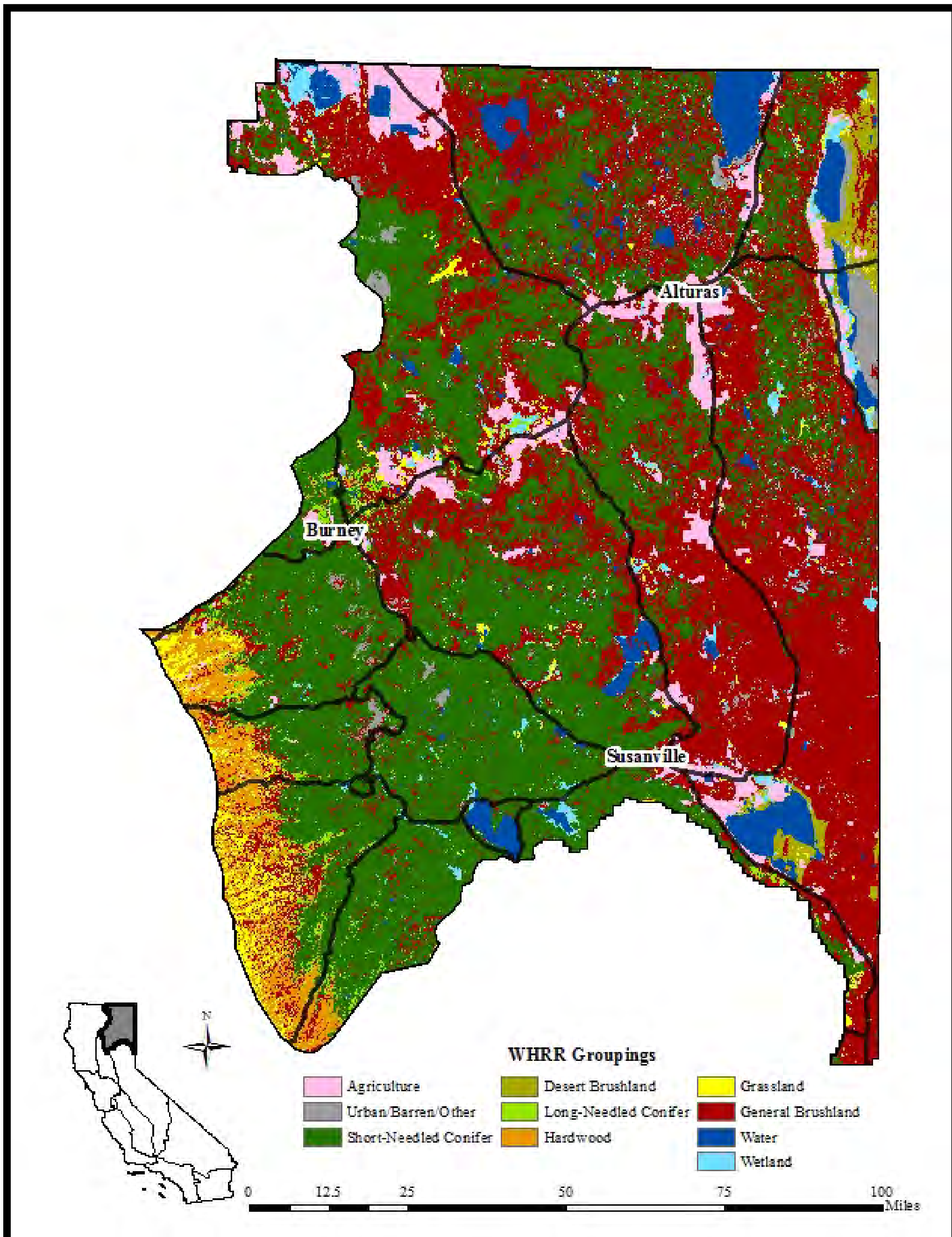


Figure A.2-2 Modoc Bioregion

A.2.3 SACRAMENTO VALLEY BIOREGION

Description: The western, northern and eastern limits are the edges of the valley floor (essentially where the blue oak woodland starts). The southern limit is the northern edge of the Sacramento-San Joaquin Delta.

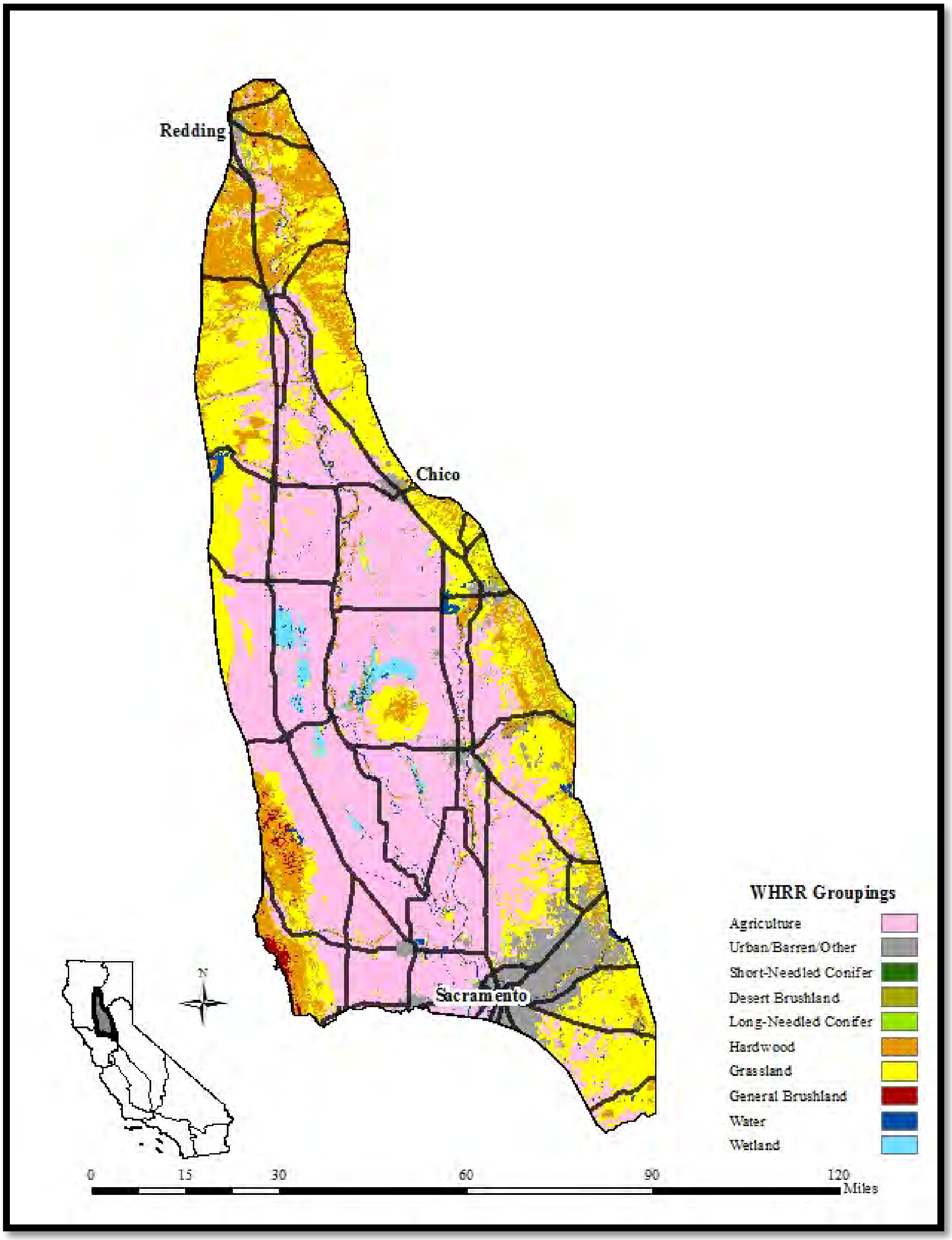


Figure A.2-3 Sacramento Valley Bioregion

A.2.4 BAY AREA/ DELTA BIOREGION

Description: The boundary is essentially the immediate watershed of the Bay Area and the Delta, not including the major rivers that flow into the Delta. Bounded on the north by northern edge of Sonoma and Napa counties and the Delta and extending east to the edge of the Sacramento valley floor. The bioregion is bounded on the south by the southern edge of San Joaquin County, the eastern edge of the Diablo Range, the southern edge of Santa Clara and San Mateo counties.

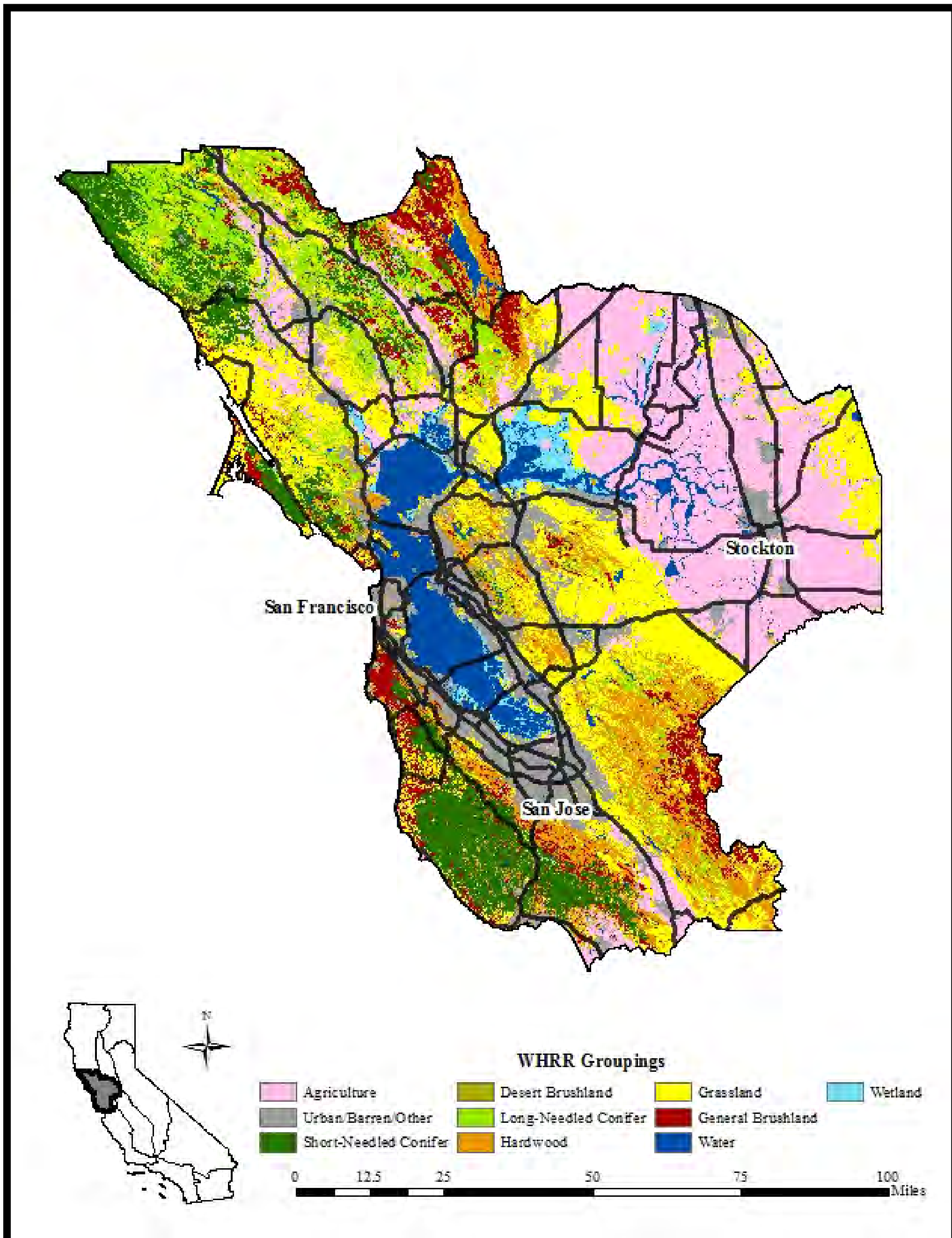


Figure A.2-4 Bay Area/ Delta Bioregion

A.2.5 SIERRA BIOREGION

Description: Bounded on the north by the northern edge of Plumas National Forest. The western edge is the Sacramento Valley floor. Bounded on the east by the Nevada state line and the western edge of BLM's California Desert Conservation Area and bounded on the west by the Sacramento and San Joaquin Valley floors, and south to the Tejon Pass in the Tehachapi Mountains.

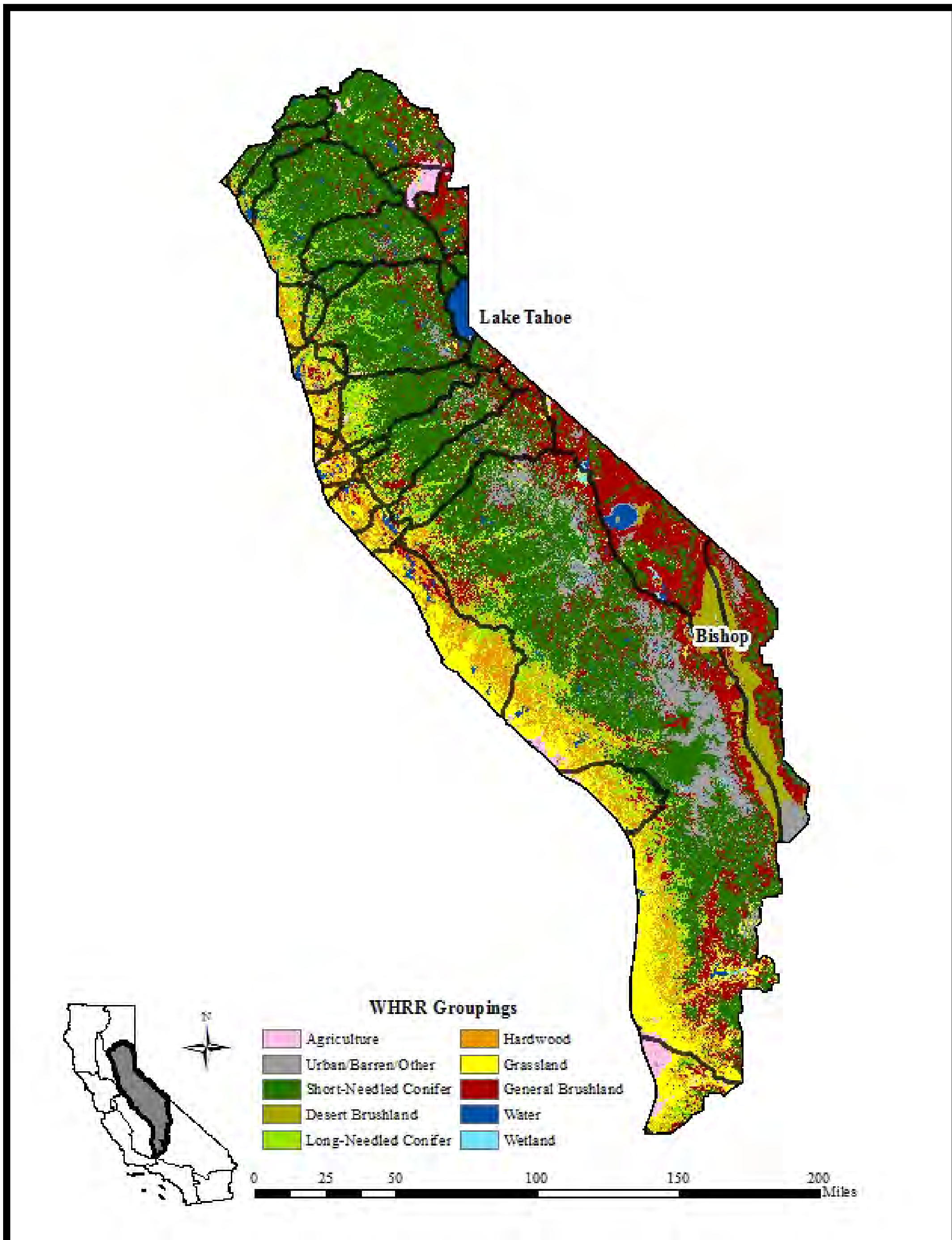


Figure A.2-5 Sierra Bioregion

A.2.6 SAN JOAQUIN BIOREGION

Description: Bounded on north by the southern edge of the Delta, and on all other sides (west, south, east) by the San Joaquin Valley floor. The one major exception to this is the southwestern extension to include the Carrizo Plain and BLM-managed lands in the Caliente Resource Area (eastern San Luis Obispo County).

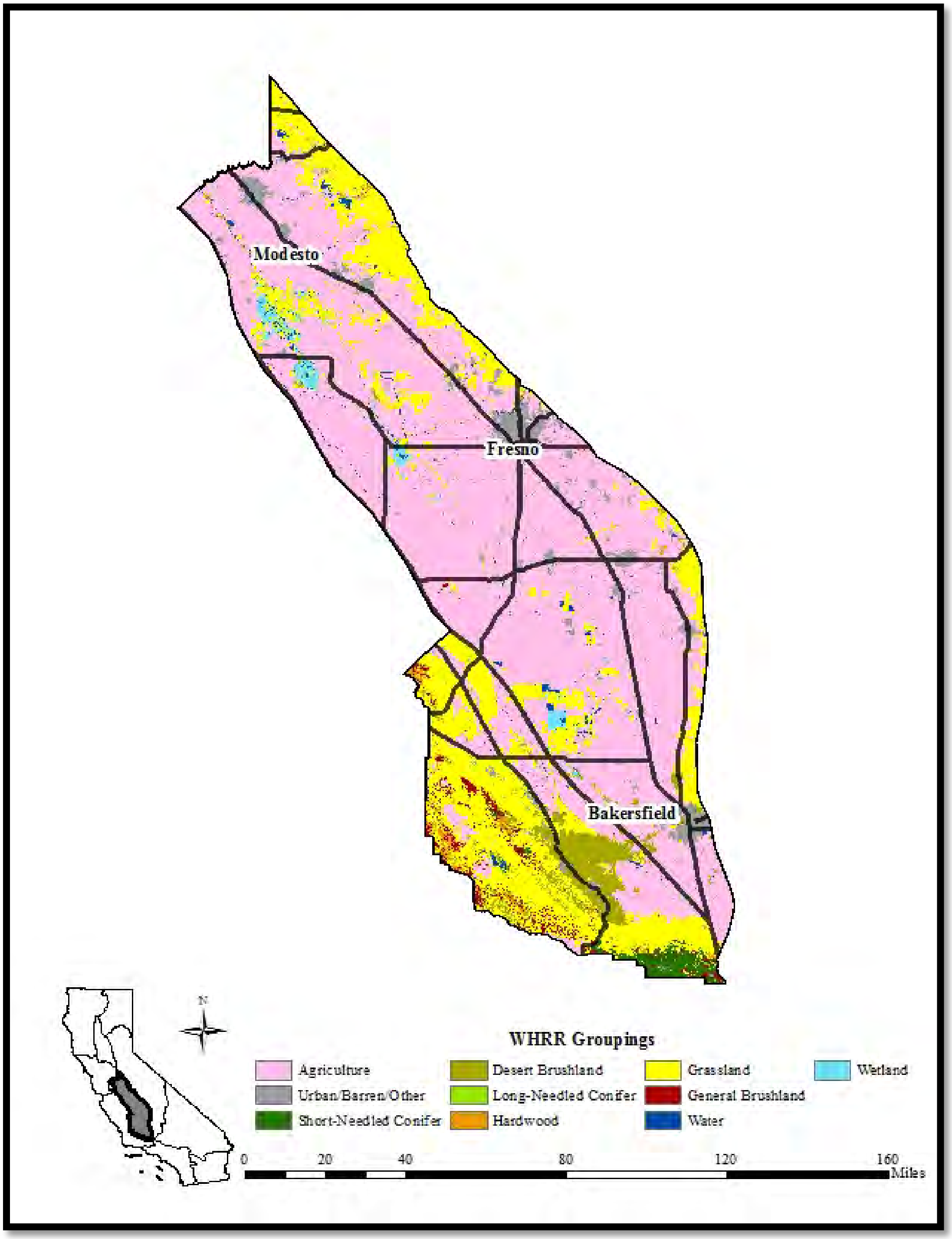


Figure A.2-6 San Joaquin Bioregion

A.2.7 CENTRAL COAST BIOREGION

Description: Bounded on north by the northern limits of Santa Cruz and San Benito counties, and on the east by the San Joaquin Valley floor and the Carrizo Plain. The southeastern limit is the eastern and southern edges of the Los Padres National Forest. The western edge is the coastline.

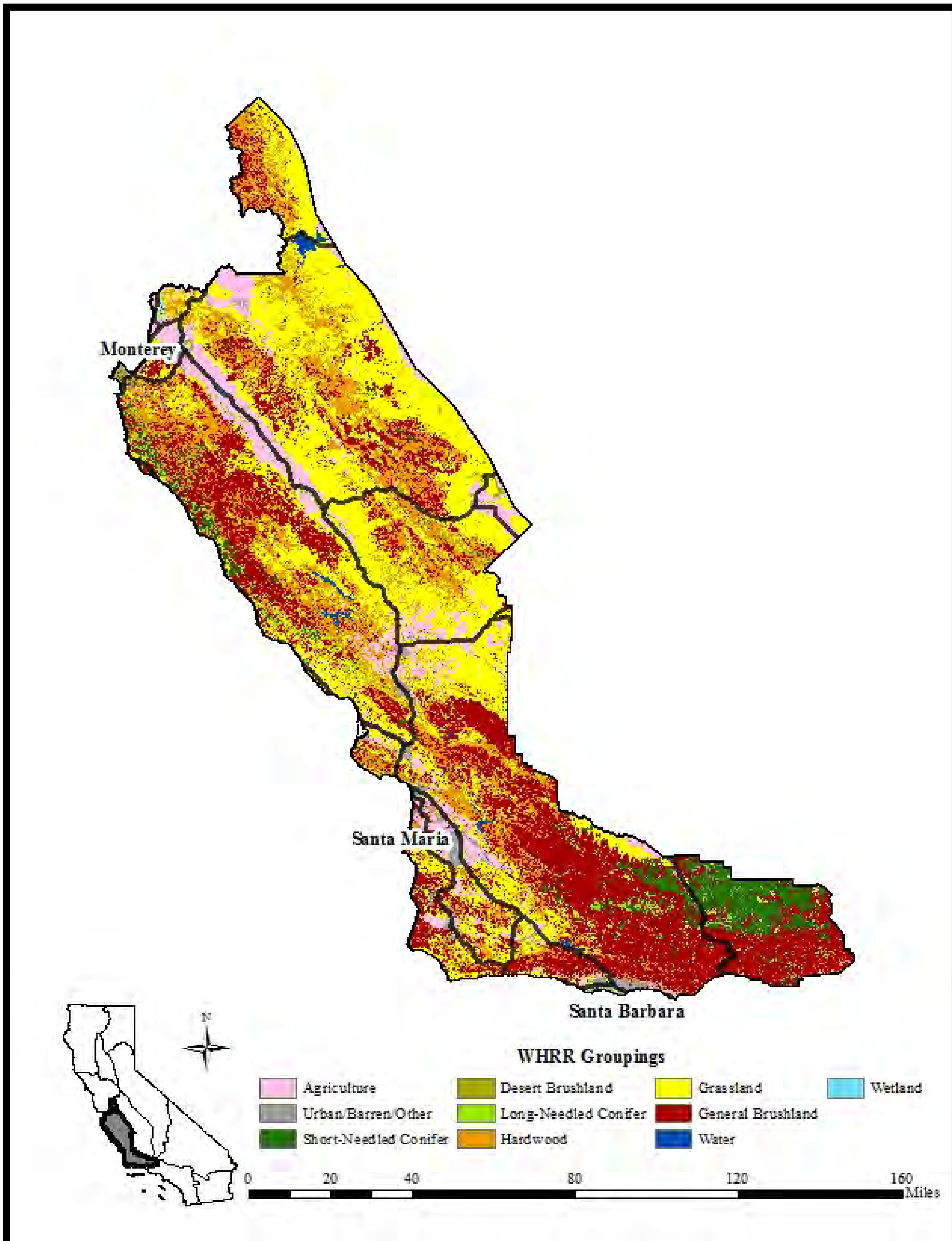


Figure A.2-7 Central Coast Bioregion

A.2.8 MOJAVE BIOREGION

Description: Bounded on west by western edge of BLM California Desert Conservation Area and on east by Nevada state line. Bounded on south by the northern base of the San Gabriel and San Bernardino Mountains, the southern edge of Joshua Tree National Monument, and the southern edge of San Bernardino County (between Joshua Tree and Nevada state line).

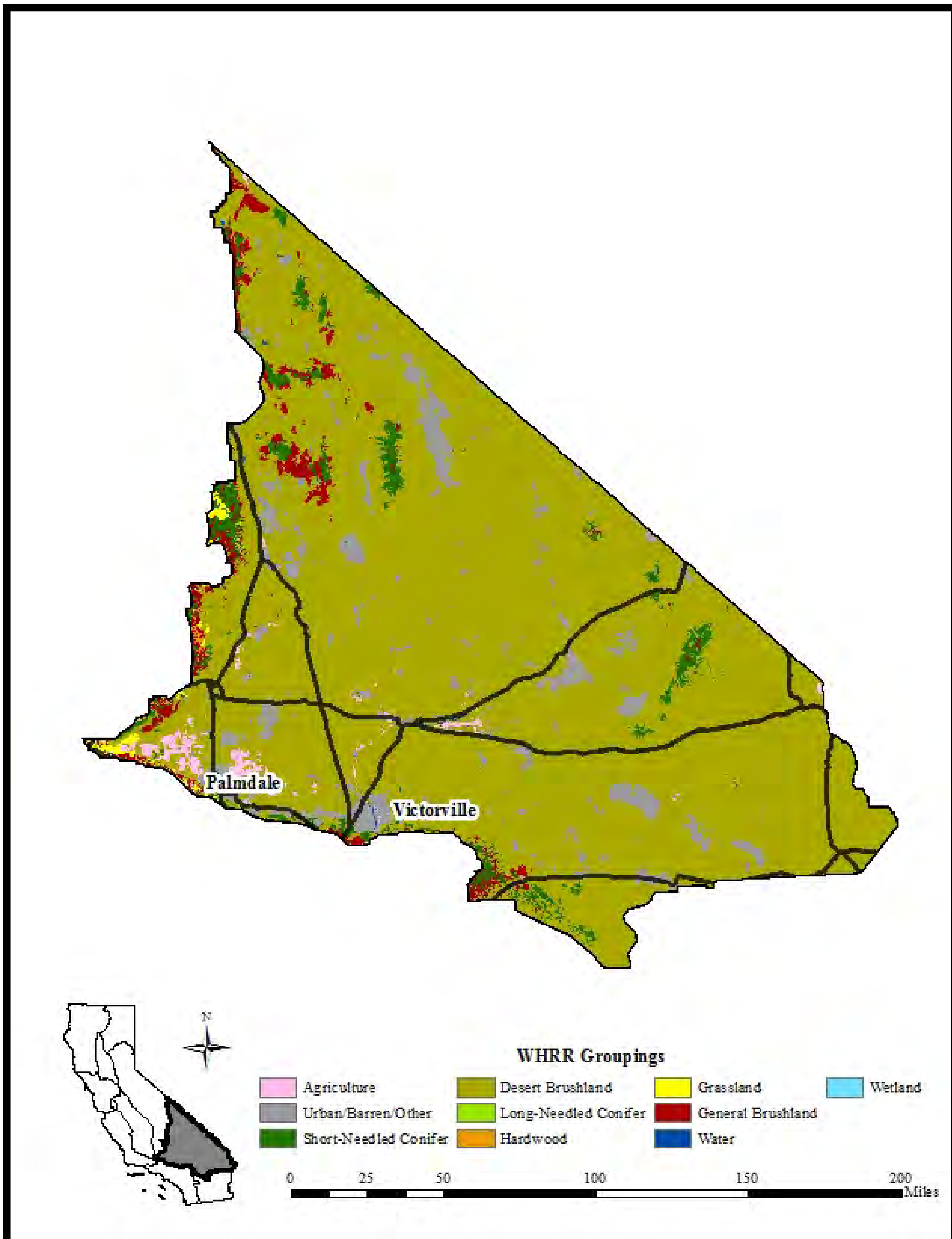


Figure A.2-8 Mojave Bioregion

A.2.9 SOUTH COAST BIOREGION

Description: Bounded on the north by the southern edge of Los Padres National Forest and the northern base of the San Gabriel and San Bernardino Mountains and bounded on the east by the western edge of the BLM California Desert Conservation Area and on south by Mexican border.

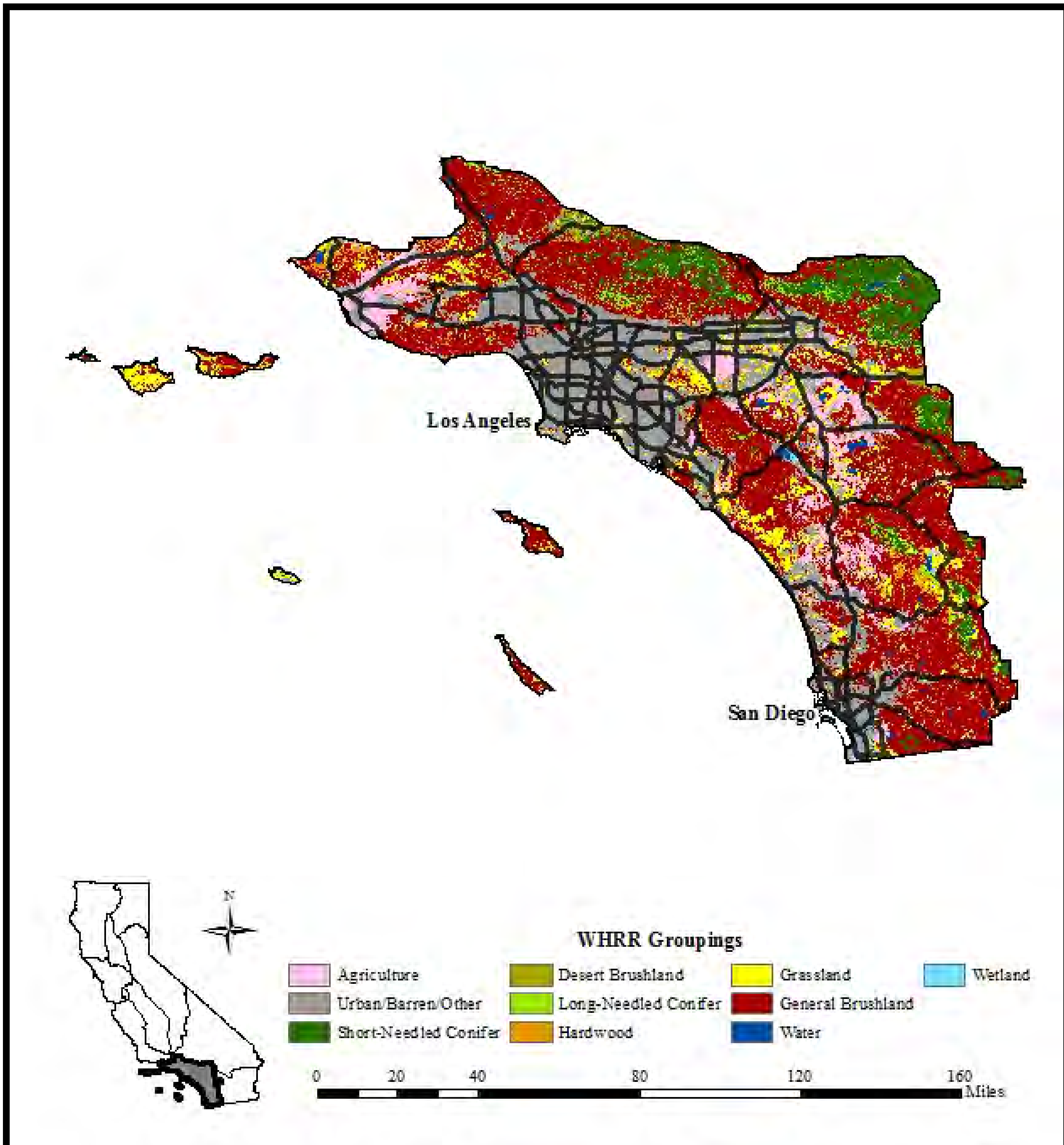


Figure A.2-9 South Coast Bioregion

A.2.10 COLORADO DESERT BIOREGION

Description: Bounded on the west by the western edge of the BLM Desert Conservation Area and on the north by the southern edge of Joshua Tree National Monument and the southern edge of San Bernardino County and the east by Arizona state line and on south by Mexican border.

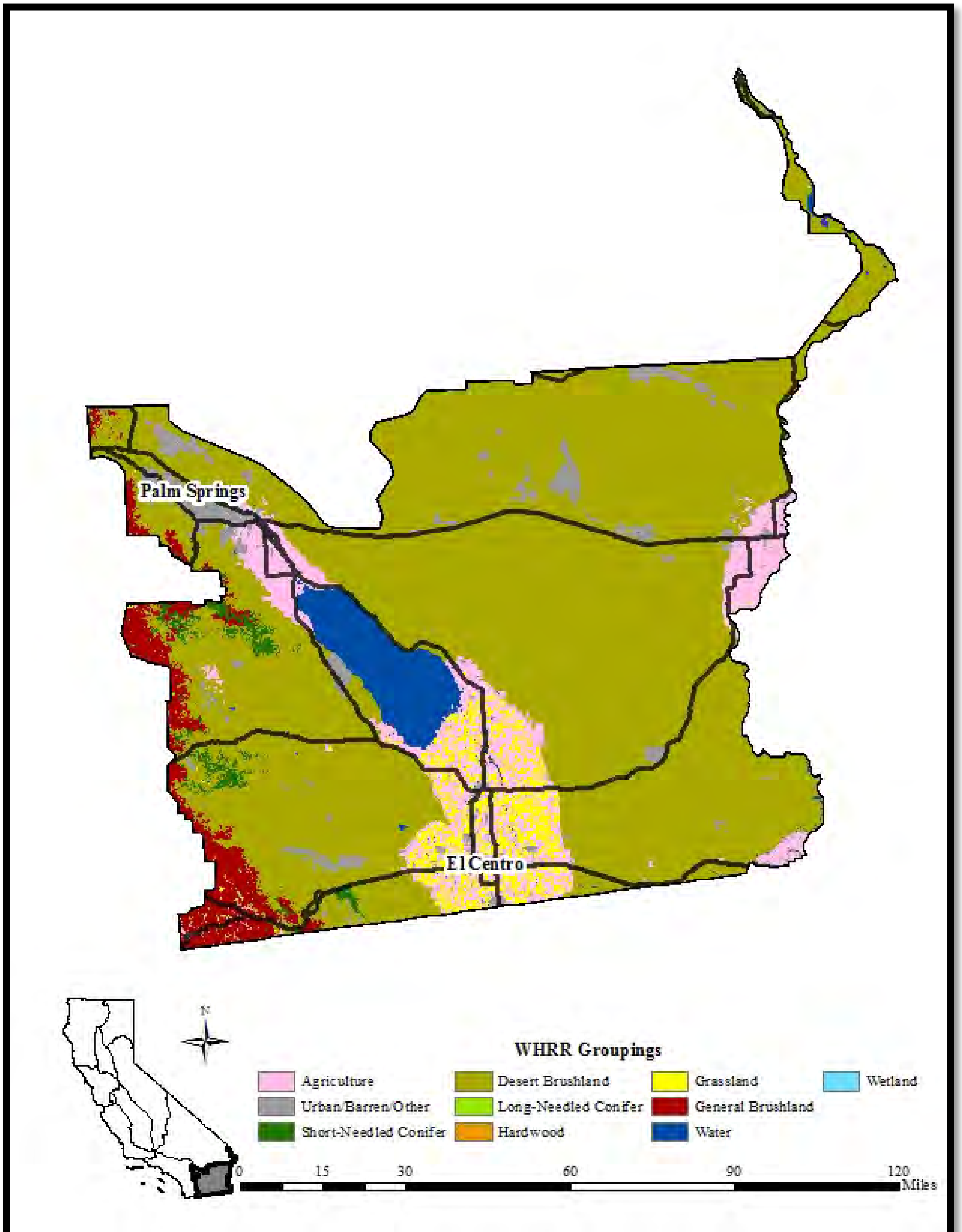


Figure A.2-10 Colorado Desert Bioregion

Characterizing the Fire Threat to Wildland–Urban Interface Areas in California

Introduction

This document outlines the procedures used to identify areas in California that pose significant threats from wildfire to the people of California. It was prepared under the auspices of the California Fire Alliance -- a coalition of representatives from State and Federal Fire Agencies, originally formed in 1996, who have collaborated on integrating fire management and planning across jurisdictional boundaries. While much of the basic premise and data for the development of this analysis has a beginning in the California Department of Forestry and Fire Protection's California Fire Plan, this work represents new and original work that is sanctioned by the USDA Forest Service, the USDI Bureau of Land Management and National Park Service, in addition to CDF. The Fire Alliance views the issue of the wildland interface as a natural area for collaboration, and is optimistic that the following analysis can be a model for other areas. The analysis was prepared in response to a mandate from Congress in the 2000-2001 Interior Appropriations bill establishing the National Fire Plan.

Utilizing a Geographic Information System (GIS) approach that is at the heart of the California Fire Plan, the three main components in the assessment of threat from wildland fire to Wildland-Urban Interface areas of California are:

- Ranking fuel hazard
- Assessing the probability of wildland fire
- Defining areas of suitable housing density that lead to Wildland-Urban Interface fire protection strategy situations

These three independent components were then combined using GIS capabilities to identify wildland interface areas threatened by wildfire. In addition to mapping these areas, a list of communities was developed that summarized a non-spatial assessment of key areas within the vicinity of significant threat from wildland fire. A subset of that list was made that includes those communities that have a significant fire threat from nearby Federal lands. A buffer distance of 1.5 miles was used in the analysis to define "nearby" federal lands.

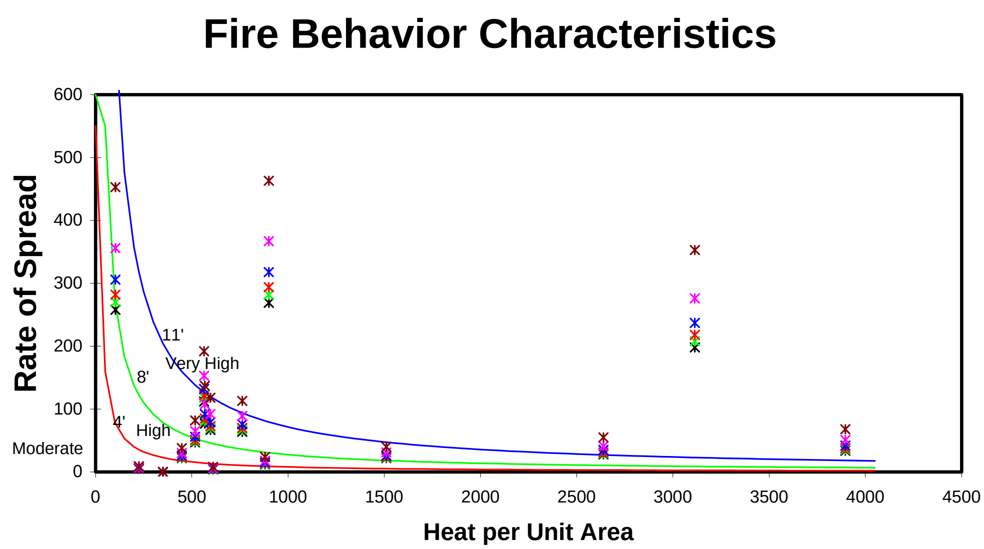
Methods

1. Defining Fuel Hazard

The California Department of Forestry and Fire Protection's Fire and Resource Assessment Program staff built a methodology of assigning fire hazard across diverse landscapes of California as part of California's Fire Plan. The first step in the hazard assessment process is development of a vegetation map based on the best available, most recent and detailed vegetation composition and structure information. These vegetation maps were then translated (using a crosswalk process similar to that used in the Sierra Nevada Ecosystem Project but specific to each local area) to Fire Behavior Prediction System (FBPS) fuel models. Recent large fires are mapped and used to change the base map to better reflect current wildland fuel conditions. A forest growth model is included to account for new vegetation growth since the last wildfire. The California Interagency Fuel Mapping Group guided this assessment and resolved mapping differences at jurisdictional boundaries, producing a seamless map of fuel characteristics across all ownerships and protection jurisdictions. That is, local representatives of Federal, State and local fire agencies have contributed to the development of the statewide fuels data.

The next step in this assessment is to convert the fuels map to a fire hazard map. Potential fire behavior drives the hazard ranking with fire hazard defined as the fire behavior potential of the wildland fuel, given average bad fire weather conditions. Fire behavior is calculated using the Fire Behavior Prediction System equations and then summarized into moderate, high, or very high classes. The method first calculates the expected fire behavior for unique combinations of slope and fuels under average bad fire weather conditions. Figure 1 portrays the rate of spread and heat flux of the fuel-by-slope-class combinations on top of three fireline intensity iso-curves that divide the space into hazard rank subspaces. Thus, each fuel-by-slope-class combination receives a surface hazard rank according to its location within Figure 1.

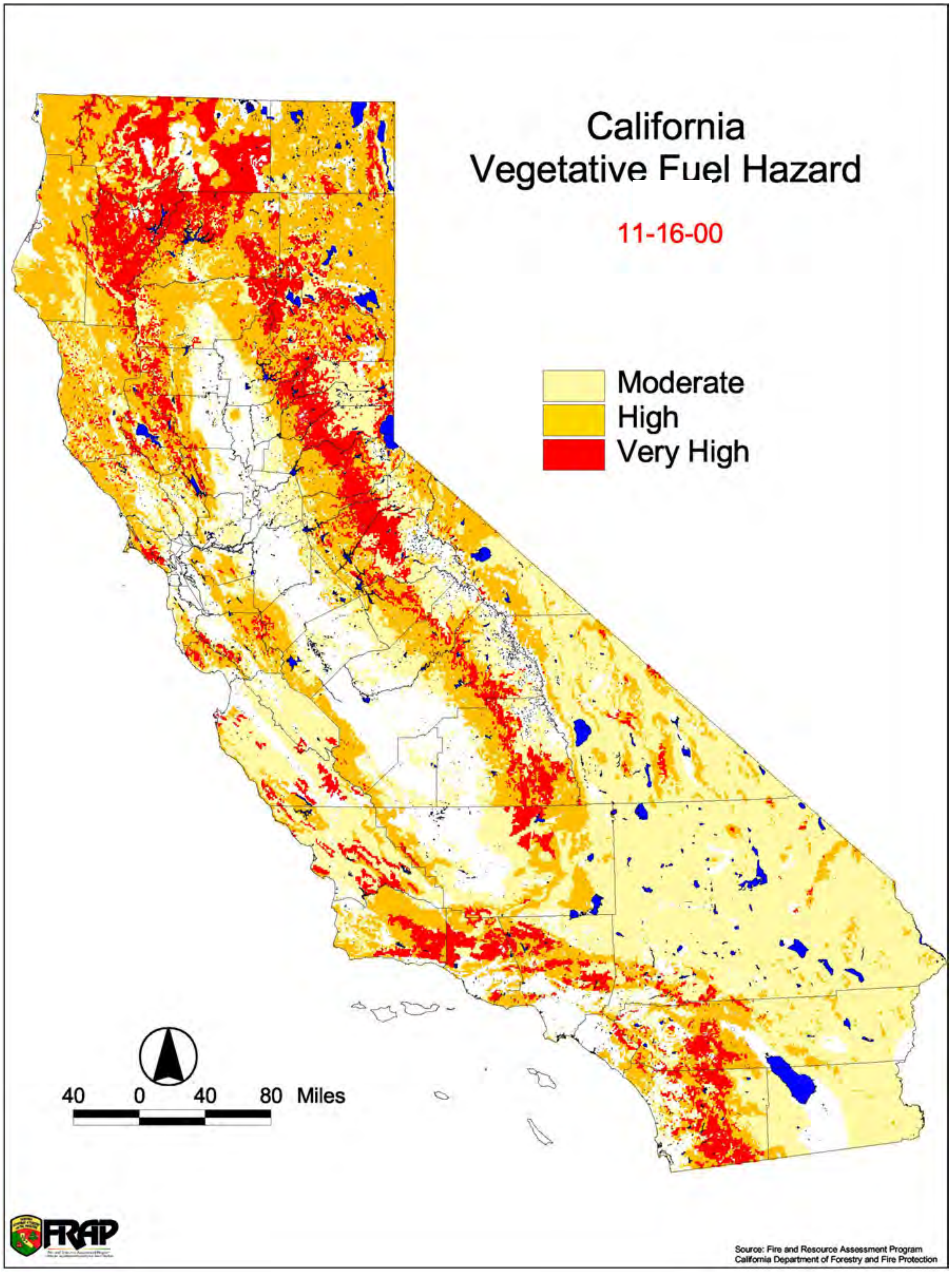
Figure 1. Fire behavior characteristics chart of fuel models by NFDRS slope classes.



In this graph, each column of "x" s represents the fire behavior characteristics of a fuel type burning on increasingly steep slopes. The area above and to the right of the blue line indicates fire behavior with flame lengths greater than 11 feet in the surface fuels. The area between the green line and the blue line indicates fire behavior with flame length potential between 8 feet and 11 feet. The red line is the 4-foot flame length line. Surface hazard is moderate for fuel types in the 0 – 4 foot flame length area, high for the 4 – 8 foot flame length area and very high for fuels with greater than 8 foot flame length potential.

The Fire Plan process uses a grid system for data analysis. Staff formed the grid by partitioning each 7.5" USGS quadrangle sheet into 81 (9-by-9) mini-quads. Each grid cell is approximately 450 acres. This method allows more complex data to be summarized and presented in a consistent mapping process. A surface fire hazard map is made by assigning a hazard ranking to each grid cell based on its slope class and fuel model. The final fire hazard includes an assessment of 2 additional factors that lead to severe fire behavior (ladder and crown fuels). Figure 2 shows the spatial allocation of fuel hazards across California as developed through this methodology.

Figure 2 shows the spatial allocation of fuel hazards across California



2. Probability of Burning

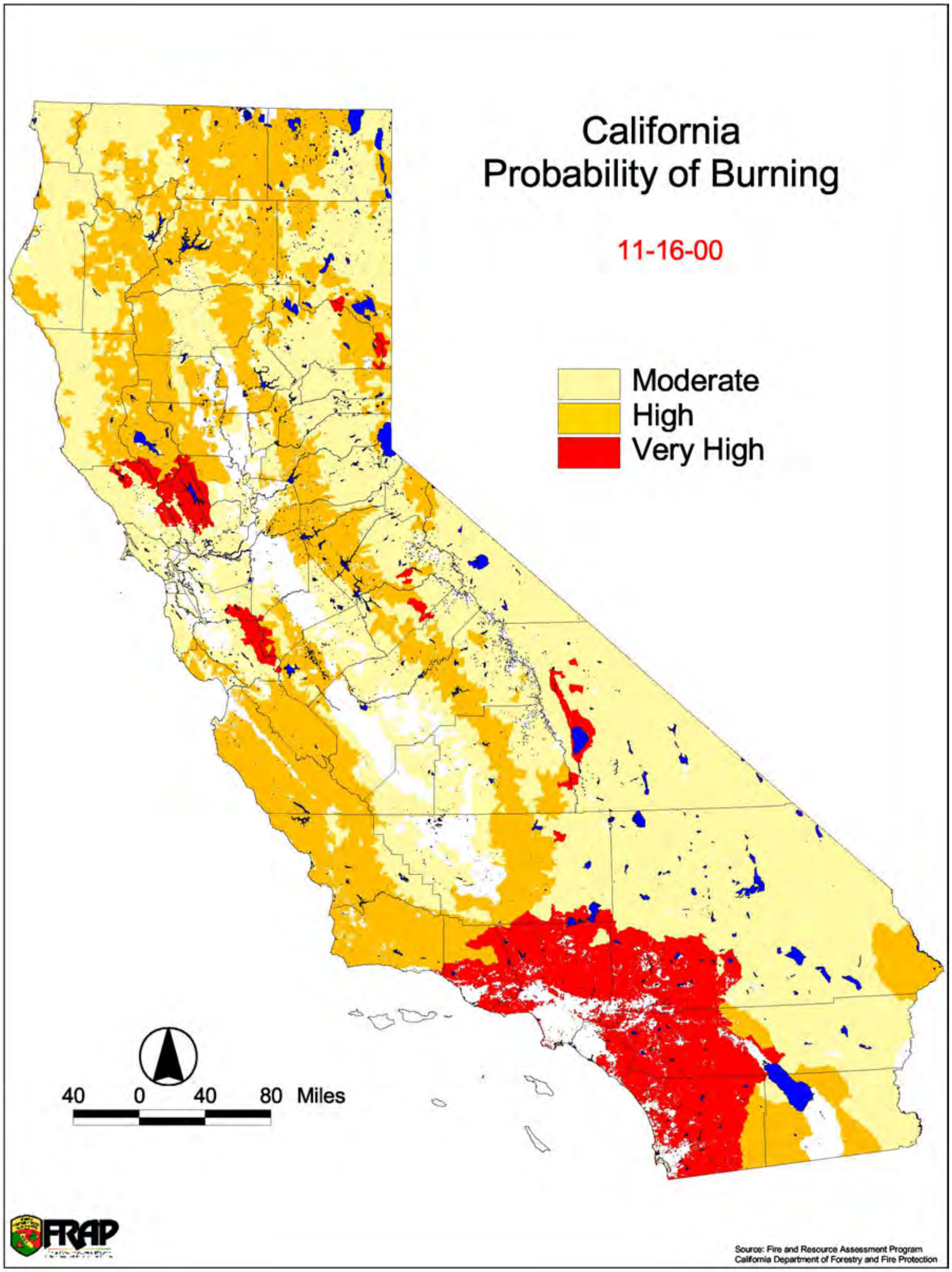
The probability of a fire burning in a given location is based on a milieu of factors including vegetative fuel condition, weather, ignition source, fire suppression response, and more. The Fire and Resource Assessment Program staff has analyzed 47 years of fire history from 1950 – 1997 with respect to vegetation type, bio-region, and owner class to produce a 3 class ranking of the probability of a costly damaging fire (PFIRE). The method used to determine PFIRE was similar to the calculation of fire rotation used in analyzing fire regimes. Fire perimeter data (from all of the wildland fire protection agencies) was overlaid on the vegetation type map to determine how many acres burned in each vegetation type during the entire period of record. These values were then divided by the total area in that particular vegetation type multiplied by the number of years of fire perimeter data in the record. The calculated probability values are then grouped into the following three classes:

- Very High (probability of a fire is 1% per year or greater)
- High (probability of a fire is 0.33% - 1% per year)
- Moderate (probability of a fire is less than 0.33% per year)

These values are equivalent to fire frequencies of less than 100 years, 100-300 years, and greater than 300 years, respectively.

The resultant figure represents the annual likelihood that a large damaging wildfire would occur in that particular vegetation type. The analysis is summarized by watershed and ranked based on the highest PFIRE identified through this analysis. Figure 3 shows the distribution of PFIRE within California.

Figure 3 identifies the probability of a given piece of ground burning



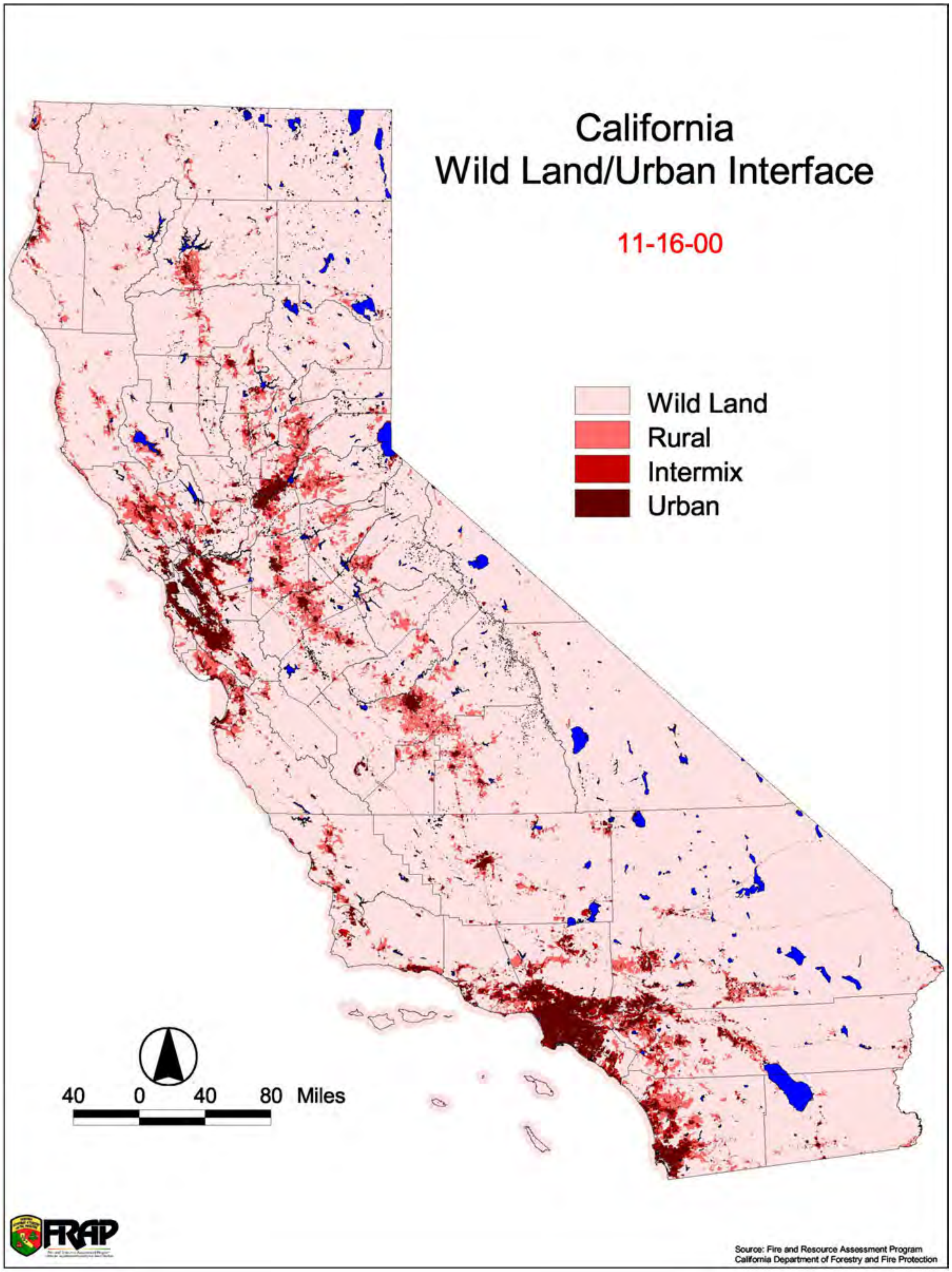
3. Defining the Urban-Interface

Areas of concern regarding housing and public safety were defined as those areas that have a structure density of 1 house per 40 acres, or denser, as calculated from the 1990 census block data. The census data is resolved into polygons called “blocks”, designed to hold roughly 400 people, and consequently vary widely in size and shape depending on the nature of development in a given area. Often, census blocks include many areas that are not typically developed, so the density of housing is not accurately represented by dividing the number of houses by the acres in the census block. To resolve this problem, staff “migrated” the density from areas of restricted development to areas of non-restricted development. Federal land is considered restricted development land in this analysis (houses in the wildland are on private ownership rather than federal ownership, generally). The migrated census data is categorized based on density and grouped into the following classes:

- Urban (more than one house per 0.5 acres)
- Intermix (from one house per 0.5 acres to one house per 5 acres)
- Rural (from one house per 5 acres to one house per 40 acres)
- Wildland (less than one house per 40 acres).

Figure 4 shows the breakdown of these areas for the entire State.

Figure 4 characterizes the extent and density of the Wildland-Urban Interface.



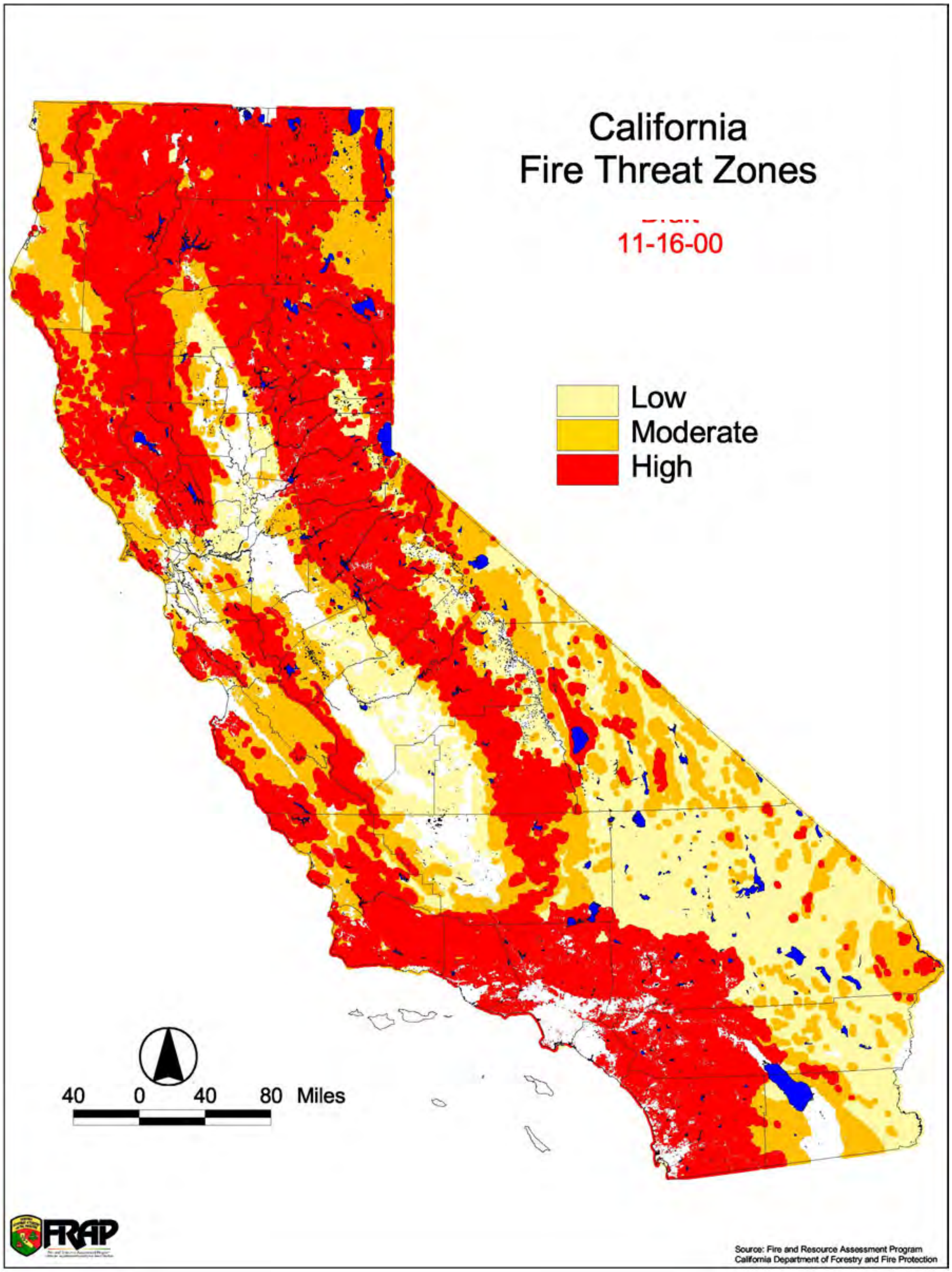
4. Assessing Fire Threat

Staff calculated a numerical index of fire threat based on the combination of hazard rank and fire probability. A 1 – 3 ranking from PFIRE (probability of a damaging fire occurring) was summed with the 1 – 3 ranking from the fuel hazard component to develop a threat index ranging from 2 to 6. This threat index is then grouped into three threat classes. Scores from four to six received a high threat rank; a score of three received a moderate threat rank; and a score of two received a low threat rank (Table 1). Areas that did not support wildland fuels (e.g., open water, agriculture lands, etc.,) were omitted from the calculation of fire threat (Figure 5). Additionally, areas of very large urban centers (i.e., “concrete jungles”) were also removed from the final analysis by combining the fire threat coverage with the urban-interface coverage.

Table 1. Fire threat matrix based on hazard rank and fire probability.

	Hazard Rank		
PFIRE	**1 (Moderate)**	**2 (High)**	**3 (Very High)**
1 (Moderate)	2 (Low)	3 (Moderate)	4 (High)
2 (High)	3 (Moderate)	4 (High)	5 (High)
3 (Very High)	4 (High)	5 (High)	6 (High)

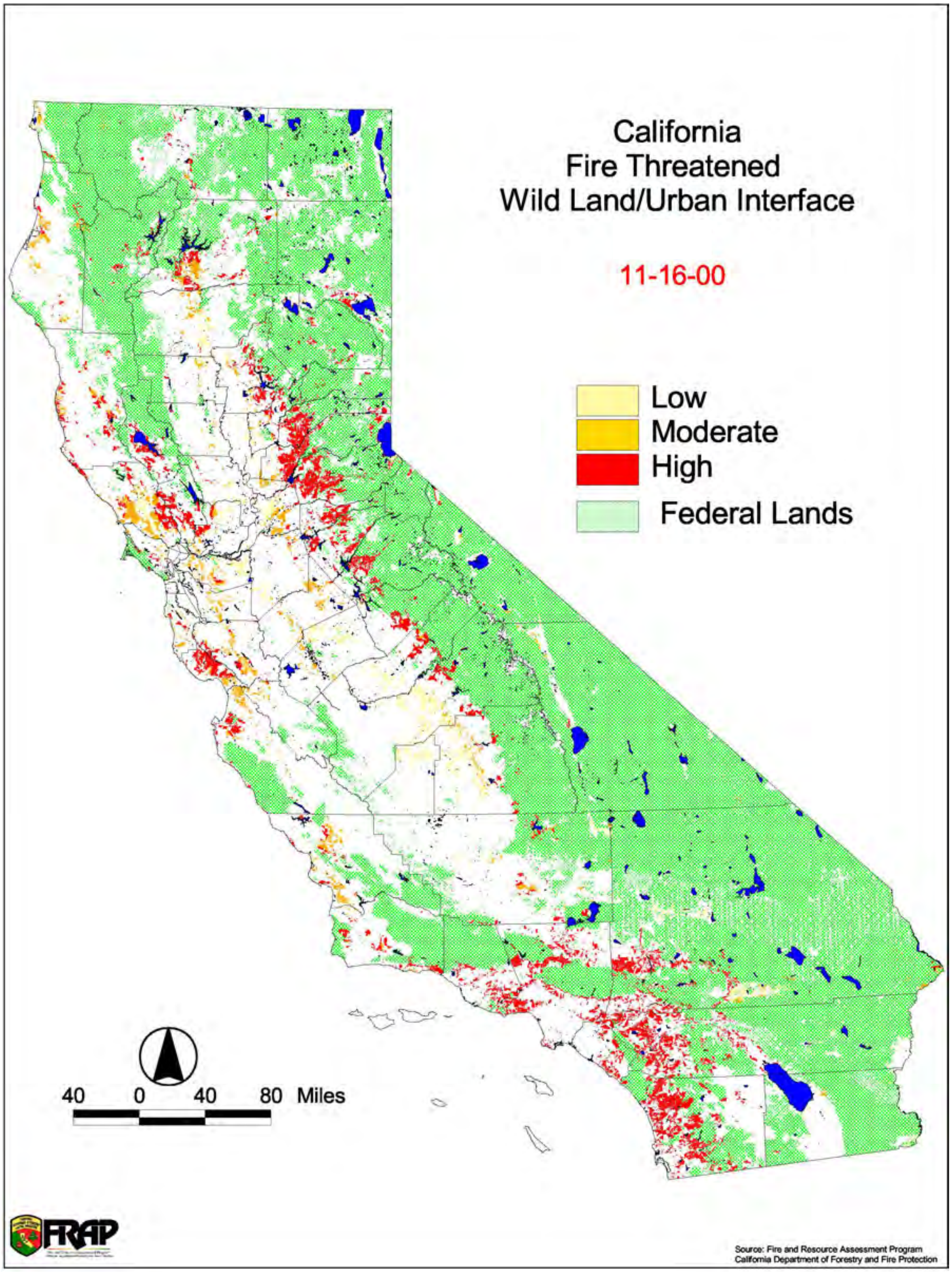
1) Figure 5 shows California's Fire Threat Zones



5. Identifying Fire Threatened Wildland-Interface Areas

The final step in the analysis was to search for all areas identified in the urban- interface layer that were in the vicinity of fire threats. Staff defined vicinity as all areas within 1.5 miles of a fire threat. Consequently, all areas with WUI values from 1 to 3 (i.e., densities greater than one house per 40 acres except those not supporting wildland fuels or in large urban centers) were labeled with the highest threat rank within a 1.5 mile radius. A 0.25 mile high density buffer for the urbanized density class (i.e., greater than 1 house per 0.5 acre) was included to account for the peripheral areas of urban centers abutting wildlands. Hence, high density areas lying immediately adjacent to wildlands would be included, but not those urbanized areas in the central parts of cities. The resultant map of threatened Wildland- Interface areas shows not only the aerial extent of affected areas, but also the relative fire threat to those areas (Figure 6).

Figure 6 shows fire threatened areas in the Wildland-Urban interface



6. Threatened communities

As a final product, the data in Figure 6 was overlaid on a map of place names to derive a list of communities threatened by wildfire. Place names (from the U.S. Census Bureau) can be selected based on the level of threat posed to them. A similar subset list can be made to find those threatened communities that are within the vicinity of federal ownership. For mapping purposes, a 1.5 mile buffer distance or other appropriate buffer distance can be used to define "vicinity". To accomplish this, a mask of the fire threat data can be created to highlight only those areas on Federal lands, and then run the same calculations performed statewide. The list of these place names, and corresponding fire threat level is given in Appendix A, " List of Fire Threatened Communities in California". The list separates those communities having some or all of their fire threat coming from federal lands from those where none of their fire threat comes from federal lands.

Discussion

While we believe the analysis presented accurately defines WUI areas potentially under threat from wildland fire, a number of caveats to the analysis are warranted. First, we have based our assessment based on the proximity of houses and fire threat as defined by hazard and fire probability. Additional data, such as fire weather frequency, may improve the development of the "fire threat" construct. However, in as much as solutions to the WUI issue largely focus on mitigating hazard and improving structure and surroundings characteristics to avoid house ignition, we feel that this scheme of density of housing and assessments of wildland fire threats should form the key components of an effective analytical framework for addressing the problem.

One key element that has emerged in other assessments directed at this and similar land management issues, is the use of other resource data that might be combined into the framework. As an example, if watersheds providing municipal water supplies were viewed as important in selecting wildland areas for mitigation of fire threats, where both watershed and community protection objectives might be realized, GIS-based data on watersheds could be brought into the analysis. In fact, this is the very foundation of the California Fire Plan. Managing for wildfire is a complex business, and there is no reason to believe that we should arbitrarily limit the complexity of our planning tools.

However, we are also obliged to note that constraints and caveats to the underlying data classifications, resolution, and accuracy could call into question the derived assessment when looked at under a microscope. If additional data is included, it simply also brings to bear these same issues as they relate to these new data. For the purposed of broadly defining these areas at the Statewide scale, we are confident that the data used here are sufficient to the task. We further believe that errors in our assessment would be selected out during the project level planning process where refinement of project planning required to mitigate fire threats to people is undertaken. As the Fire Alliance has supported refinement of existing data, and the development of new data, we think that this assessment approach can easily incorporate new information as it becomes available. We also believe it is sufficiently flexible such that the framework can change to take advantage of new ideas in characterizing and classifying the Wildland-Urban Interface issue.

Disclaimers

This mapping analysis will need field review to validate the basic assessments and conclusions. The California Fire Plan process calls for using the best available data for analysis and having field fire managers and community stakeholders validate the underlying data. Tactical project decisions are then made on the best combination of strategic assessments and local knowledge. Most of the data sets used in this analysis have gone through this field validation process. However, several data sets are taken "as is" and may not reflect actual current conditions.

The urban-wildland interface assessment and the community names list are based on 1990 Census Bureau information. There is a good likelihood that communities have been omitted that should be included and there are probably communities included that should be omitted. California is experiencing rapid growth, especially in rural areas removed from the urban centers. Validating and updating the basic 1990 census data is beyond the capability of field managers and stakeholders so existing data is used 'as is" with the intent of updating the analysis when the 2000 census data is available.

One basic assumption in the Wildland-Urban Interface housing density mapping is that the houses in a census block are on the private land portion of the block and not on the federal land. There may be local exceptions to this assumption, for example: concentrations of summer cabins on national forest leases. Also, we assumed housing is evenly distributed over the private land portion of the census block. Field validation may find concentrations of housing that could alter the housing density mapping.

The hazard assessment is based on the best available vegetation maps. In some parts of California this data is very good. However, in other areas the vegetation mapping is old and otherwise less than desirable. Field validation has corrected many mapping errors but probably not all.

The fire probability assessment includes fire perimeter maps for all agencies dating back to 1950. Older fire perimeters were digitized from paper map archives. The maps have been field validated to the extent that this history is available. It is possible that some fires are not in the database. This mapping is a cooperative effort between local and state wildland fire agencies and federal land management agencies with wildland fire protection responsibilities. The possibility exists that some fires from other land managers have not yet been included. For example, fires on military bases and prescribed fires on private ownerships may be missing from this analysis.

Field validation efforts are focused on areas of greatest concern, areas where their efforts will have the greatest impact. In other words, community stakeholders and fire managers are not spending a lot of time fine-tuning data in areas where they know fires are not a problem. The benefit to this approach is that projects are being proposed and developed in the most important areas. The caution is for those making decisions removed from this local knowledge base; the base data may not be perfect.

B. BIOLOGICAL RESOURCES

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	Prescribed Fire	Mechanical	Mechanical Thinning	Manual	Manual Thinning	Herbivory	No Treatment
Invertebrates	Many invertebrates, including some subterranean species, have small distribution areas and are therefore particularly susceptible to habitat changes that result in direct mortality or habitat loss. However, a review of the scientific literature by Swengel (2001) found that fire has little direct impact on most subterranean invertebrates. Overall mortality of invertebrates depends on the proportion of organic soil consumed by the fire and the depth of heating of the soil. Invertebrates that occupy deeper soil horizons are less vulnerable than those in the litter layers as are species with thick cuticles (Wikars and Schimmel 2001).	Soil invertebrates play an essential role in decomposition and nutrient cycling and include detritivores such as earthworms and arthropods and species active in decomposition of dead wood on the forest floor such as termites, beetles, and ants. Although not well studied, researchers believe that thinning is likely to have significant short-term negative effects on invertebrates of the soil and organic layers as a result of treatments that will cause soil compaction and disruption or loss of organic layers (Niwa et al. 2001). Direct impacts mortality and loss of food and cover. Hanula and Wade have shown that in some ecosystems these species can have long recovery periods post-treatment (Hanula and Wade 2003). Soil invertebrates may be more protected from such effects than those in the litter layers (ODF 2008).	Soil compaction from mechanical thinning can make soil uninhabitable by detritivores (earthworms, mites, springtails, etc.; Battigelli and others 2004), at least in the short-term. However, there is some evidence that these organisms may be buffered from longer-term effects of thinning more than those in litter. Peck and Niwa (2004) found no difference in densities of soil detritivores between thinned and unthinned stands in the upper five cm 16-41 years after thinning. However, these organisms have relatively limited dispersal ability and will be slow to recover from negative effects (Pilliod and others 2006).	Direct effects of mechanical treatments on subterranean mammals are primarily negative and include mortality, injury, or habitat destruction as a result of soil compaction and/or collapsed burrows. However, long-term indirect effects to this guild are mostly positive	Soil compaction from mechanical thinning can make soil uninhabitable by detritivores (earthworms, mites, springtails, etc.; Battigelli and others 2004), at least in the short-term. However, there is some evidence that these organisms may be buffered from longer-term effects of thinning more than those in litter. Peck and Niwa (2004) found no difference in densities of soil detritivores between thinned and unthinned stands in the upper five cm 16-41 years after thinning. However, these organisms have relatively limited dispersal ability and will be slow to recover from negative effects (Pilliod and others 2006).	Subterranean invertebrates could suffer injury or mortality as a direct result of herbivory treatments due to soil compaction and burrow collapse. The significance of these impacts are relative to the herd size and how much of the landscape will be treated as well as the density and distribution of the affected taxa.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Amphibians / Reptiles	Direct mortality or disturbance to amphibians and reptiles that burrow under cover objects are addressed in the "Amphibians/Reptiles" section under the "Ground-dwelling Fauna" discussion as such species are more appropriately described by that guild. No exclusively subterranean amphibians or reptiles occur in project area.	Direct effects to amphibians and reptiles that burrow under cover objects are addressed in the "Amphibians/Reptiles" section under the "Ground-dwelling Fauna" discussion as such species are more appropriately described by that guild. No truly subterranean amphibians or reptiles occur in project area.	Direct effects to amphibians and reptiles that burrowunder cover objects are addressed in the "Amphibians/Reptiles" section under the "Ground-dwelling Fauna" discussion as such species are more appropriately described by that guild	Direct effects of manual treatments on amphibians and reptiles that burrow under cover objects are addressed in the "Amphibians/Reptiles" section under the "Ground-dwelling Fauna" discussion as such species are more appropriately described by that guild. No exclusively subterranean amphibians or reptiles occur in project area.		Impacts to subterranean herpetofauna are similar to those on subterranean invertebrates, injury and/or mortality related to soil compaction and burrow collapse.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Birds	Prescribed fire is unlikely to result in direct mortality to birds like burrowing owl that nest underground or some species of swallow that nest in burrows excavated in substrates such as sand banks, primarily in cliff faces and cut banks. Fire severity and the depth of the nest are factors affecting potential mortality for burrowing birds.	The potential direct effects of mechanical treatments on burrowing owl, a special status species that utilizes the burrows of other species, are addressed in the "Shrub-dwelling Fauna" section. No truly subterranean birds exist.	Direct effects of mechanical treatments are primarily disturbance, injury, and/or mortality of eggs and nestlings of ground-nesting birds (Smith 2000). Such treatments are also likely to result in loss of nesting habitat in the short-term. (Pilliod et al. 2006).	No truly subterranean bird species occur in California.		The only species of bird occurring in the project area that is appropriate for consideration in this section is burrowing owl since it nests in underground burrows. Herbivory is not expected to have any direct effects on burrowing owl as the species has evolved in grazed habitats, having evolved alongside bison herds. In fact, the indirect effects of grazing on burrowing owl are positive as grazing pressure has been shown to enhance the suitability of burrowing owl habitat by maintaining low vegetation height at nest burrows (Murray 2005). Ground nesting birds are vulnerable to trampling of eggs and nests by livestock trampling where herbivory treatments are applied.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

	Prescribed Fire	Mechanical	Mechanical Thinning	Manual	Manual Thinning	Herbivory	No Treatment
Mammals	Direct mortality of small mammals as a result of fire are primarily from heat effects and asphyxiation. Using cooler prescriptions may reduce heat effects.	Direct effects of mechanical treatments on subterranean mammals are primarily negative and include mortality, injury, or habitat destruction as a result of soil compaction and/or collapsed burrows. However, long-term indirect effects to this guild are mostly positive	Direct effects of mechanical treatments on subterranian mammals are primarily negative and include mortality, injury, or habitat destruction as a result of soil compaction and / or collapsed burrows. However, long term indirect effects to this guild are mostly positive.	Direct effects to mammals from manual treatments primarily include disturbance to subterranean mammals while workers are on site. However, possible injury or mortality could also occur as a result of burrow collapse and soil compaction but, as mentioned above, hand crews are more likely to avoid destruction of burrows than equipment used for mechanical treatments.		As is the case with other subterranean fauna, subterranean mammals are vulnerable to injury and/or mortality as a direct effect of soil compaction and/or burrow collapse likely to occur as a result of herbivory treatments	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Ground Dwelling Invertebrtes	The direct effects of prescribed fire on ground-dwelling insects and other invertebrates depend largely on their location at the time of the fire and fire intensity, which depends, in part, on duff consumption. Most adult forms can burrow or fly to escape injury or mortality (Lyon et al. 2008). Meanwhile, many invertebrates have immobile life stages that occur in surface litter or aboveground where they are much more susceptible to the effects of fire.	Invertebrates are generally short-lived and have a small dispersal range or are sedentary during one or more life stages. Therefore, mechanical treatments can potentially affect local populations through direct injury and/or mortality depending on the season, type, and size of the treatment. Species with life stages associated with the litter or duff layer are particularly susceptible to injury or mortality from mechanical treatments (ODF 2008).	Invertebrates of the forest soil play an important role in decomposition and nutrient cycling. These include detritivores such as snails, slugs, and arthropods. Niwa et al (2001) suggest that thinning likely has substantial negative short-term effects on invertebrates associated with organic layers due to soil compaction and disruption or loss of organic layers, dependent upon soil type and thinning treatment.	While some direct effects could occur to ground-dwelling invertebrates as a result of manual treatments from trampling by hand crews or disturbance from tools, such direct mortality is much less likely to occur with manual treatments than with prescribed fire or mechanical treatments.		Invertebrates may be killed or injured as a result of trampling.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Ground Dwelling Amphibians / Reptiles	The herpetofaunal species most vulnerable to fire are those that require leaf litter, duff, and other cool, moist substrates that are usually consumed by fire. Direct mortality and/or injury of terrestrial amphibians and reptiles as a result of prescribed fire is believed to be rare and of negligible concern at the population level (Lyon et al. 1978, Means and Campbell, 1981, Russel et al. 1999, and Smith 2000). This is based on the continued presence of live amphibians post-fire. Survival is likely a result of the ability of some life stages of terrestrial herpetofauna to seek shelter in underground burrows or under moist refugia (Bamford 1992, Friend 1993, Main 1981, and Vogl 1973). A study in Australia found that one species of anuran (Hyperolius nitidulus) can detect the sound of fire and respond by moving toward cover (Grafe et al. 2002).	Little is known about the direct effects of mechanical treatments on reptiles but injury and mortality are likely to be slightly less substantial than to amphibians given that reptiles generally have a bit greater mobility. However, all terrestrial herpetofauna are at risk or direct injury and/or mortality from mechanical treatments.		Direct injury and mortality to terrestrial herpetofauna are also less likely to occur with manual than other treatments as a result of trampling, disturbance from tools, and removal of cover objects.		If applied in habitat suitable for less mobile species or life stages of herpetofauna, herbivory treatments could result in injury or death due to trampling, especially when herds are flushed.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

	Prescribed Fire	Mechanical	Mechanical Thinning	Manual	Manual Thinning	Herbivory	No Treatment
Ground Dwelling Birds	Direct mortality and/or injury to ground-dwelling birds as a result of prescribed fire are highly dependent upon the season, uniformity and severity of the burn (Lyon and Telfer 2008). Adult mortality is considered low. However, burns occurring during the breeding season substantial increase the risk of mortality to ground-nesting species, especially eggs, nestlings and fledglings.Nest destruction and mortality of young have been reported for a number of ground-nesters including ruffed, spruce, and sharp-tailed grouse (Grange 1948), northern harrier (Kruse and Piehl 1986), and greater prairie chicken (Svedarsky et al.1986). A study conducted on prescribed fires in the Blue Mountains in Oregon used artificial nests to assess mortality of ground-nesting birds as a result of spring burning. It found that direct mortality of ground nests could result. The same study showed that the level of mortality caused by spring burns could be correlated with the method of administering the burn. Spring burns administered by helicopter appeared to be more patchy than those administered by drip-torch thus resulting in lower mortality of artificial nests (22%) compared with spring burns administered by drip-torch (44%) (Fosdick 2005). Reproductive success may also be reduced the first year following a fire due to decreased availability of food from spring fires (Finch et al. 1997). As mentioned above, ground-nesting birds that re-nest following a nest failure are affected less than those that do not.	Direct effects of mechanical treatments are primarily disturbance, injury, and/or mortality of eggs and nestlings of ground-nesting birds (Smith 2000). Such treatments are also likely to result in loss of nesting habitat in the short-term. (Pilliod et al. 2006).		Injury and/or mortality to ground-nesting birds can occur as a result of trampling or ground disturbing activities associated manual treatments. As mentioned above, nest failure could also result as a response to disturbance.		Ground nesting birds are vulnerable to trampling of eggs and nests by livestock trampling where herbivory treatments are applied.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Ground Dwelling Mammals	Direct mortality or injury to ground-dwelling mammals as a result of prescribed fire is largely dependent on the mobility of the species and intensity and uniformity of the burn. In general, larger, more mobile species such as ungulates, top carnivores, mesocarnivores, etc. are better able to flee from a fire with the possible exception of newborn, old, and sick individuals.Smaller ground-dwelling mammals with less mobility such as rodents and lagomorphs are at greater risk of direct impacts from prescribed fire. Those that lack the ability to burrow or cannot escape to cover or flee from a fire quickly enough are particularly susceptible.	Direct effects of mechanical treatments on large, mobile mammals are not expected to occur with the exception of disturbance during the breeding season which would likely be at a negligible level due to the large home ranges of larger mammals. Although there is a slightly greater chance that smaller, less mobile mammals may suffer direct injury and/or mortality, it is unlikely to occur at a significant level. The exception is nest destruction or mortality of the young of small, ground-nesting mammals.		Direct effects on terrestrial mammals potentially resulting from manual treatments are most likely to occur during the breeding season to small mammals that rear their young on the ground.		As with ground-nesting birds, small mammals that rear their young on the ground are susceptible to trampling by livestock in areas treated with herbivory.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

	Prescribed Fire	Mechanical	Mechanical Thinning	Manual	Manual Thinning	Herbivory	No Treatment
Shrub Dwelling Invertebrates	Direct effects of prescribed fire on shrub-dwelling invertebrates are highly dependent on their mobility. Adult and flighted forms are likely to escape fire whereas less mobile or sedentary forms that reside on aboveground plant tissue are more susceptible to injury and mortality from fire. Therefore seasonality of the burn is important and invertebrate phenology should be considered when planning the timing of the burn.	Many shrub-dwelling invertebrates are at particular risk of suffering immediate adverse impacts, primarily displacement, from manual treatments owing to the fact that shrubs are often the targets of mechanical treatments (ODF 2008). Similar to terrestrial invertebrates, immobile or sedentary life stages are at the greatest risk of direct injury and mortality from mechanical treatments.	Many shrub-dwelling invertebrates are at particular risk of suffering immediate adverse impacts, primarily displacement, from mechanical treatments owing to the fact that shrubs are often the targets of mechanical treatments (ODF 2008). Similar to terrestrial invertebrates, immobile or sedentary life stages are at the greatest risk of direct injury and mortality from mechanical treatments.	Please see the section on mechanical treatments and shrub-dwelling invertebrates, as the effects of manual treatments that remove shrubby vegetation are the same. However, effects from manual treatments are likely to occur on a smaller scale since smaller tracts are expected to receive manual treatments compared to mechanical treatments.	Invertebrates of the forest soil play an important role in decomposition and nutrient cycling. These include detritivores such as snails, slugs, and arthropods. Niwa et al (2001) suggest that thinning likely has substantial negative short-term effects on invertebrates associated with organic layers due to soil compaction and disruption or loss of organic layers, dependent upon soil type and thinning treatment.	Because herbivory may be used as a method of shrub removal, the effects of this treatment are the same as for mechanical and manual (above). The extent of such impacts is highly dependent upon the seasonality of the treatment application, as it applies to the phenology of shrub-dwelling invertebrates, and the extent of the landscape treated	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Shrub Dwelling Amphibians/Reptiles	No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.	No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.	No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.	No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.		No exclusively shrub-dwelling amphibians or reptiles occur in California. See the Arboreal Fauna section for a discussion of the effects of prescribed fire on taxa with arboreal habits.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Shrub Dwelling Birds	As with ground-nesting birds, direct injury or mortality can occur to shrub-nesting birds during the breeding season, although perhaps to a lesser degree. However, potential short-terms impacts to shrub-nesting taxa should be assessed when considering spring burns.	Shrub-nesting birds are the most vulnerable to mechanical treatments that remove shrubs during the breeding season when displacement, nest failure, and injury or mortality to nestlings are likely to result. Therefore the breeding biology of shrub-nesting birds should be taken into account when applying mechanical treatments.Once again, seasonality of the treatment application is key in determining the direct effects to shrub-dwelling fauna. Mechanical treatments that remove shrubs will have the greatest impact on small mammals such as rodents that nest therein. As with prescribed fire, breeding biology of shrub-nesting mammals should be considered when scheduling mechanical treatments.		Please see the section on mechanical treatments and shrub-dwelling birds, as the effects of manual treatments that remove shrubby vegetation are the same. However, effects from manual treatments are likely to occur on a smaller scale since smaller tracts are expected to receive manual treatments compared to mechanical treatments. Also, hand crews may be better able than machine operators to identify and avoid bird nests.		Because herbivory may be used as a method of shrub removal, the effects of this treatment are the same as for mechanical and manual (above). The extent of such impacts is highly dependent upon the seasonality of the treatment application, as it applies to the breeding biology of shrub-nesting birds, and the extent of the landscape treated.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

	Prescribed Fire	Mechanical	Mechanical Thinning	Manual	Manual Thinning	Herbivory	No Treatment
Shrub Dwelling Mammals	As with terrestrial mammals, immediate impacts of prescribed fire on shrub-nesting mammals such as some rodents have the greatest potential for occurrence during the breeding season. Therefore breeding biology of shrub-nesting mammals should be considered when scheduling burns.			Please see the section on mechanical treatments and shrub-dwelling mammals, as the effects of manual treatments that remove shrubby vegetation are the same. However, effects from manual treatments are likely to occur on a smaller scale since smaller tracts are expected to receive manual treatments compared to mechanical treatments. Also, hand crews may be better able than machine operators to identify and avoid mammal nests.		Because herbivory may be used as a method of shrub removal, the effects of this treatment are the same as for mechanical and manual (above). The extent of such impacts is highly dependent upon the seasonality of the treatment application, as it applies to the breeding biology of shrub-nesting mammals, and the extent of the landscape treated.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Arboreal Invertebrates	Prescribed fire treatments to be applied under the proposed program are not expected to burn large tree species in the canopy and therefore are unlikely to result in direct harm to arboreal invertebrates.	Removal of trees or snags via mechanical treatments may result in disturbance, injury, or mortality of invertebrates with relatively immobile or sedentary arboreal life stages. However, treatments that remove these habitat elements are not expected to occur on a large scale under the proposed program.		Manual treatments that destroy trees will have effects on arboreal fauna similar to those of mechanical treatments. Although arboreal animals can be disturbed by chainsaws, etc. on the ground, they are less likely to be disturbed by manual treatments aimed at herbaceous and shrubby vegetation than by equivalent mechanical treatments.		Herbivory treatments are not expected to have any direct effects on arboreal wildlife.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Arboreal Amphibians / Reptiles	Many species of amphibians and reptiles exhibit arboreal habits and often forage on invertebrates that breed in foliage or seek shelter in trees. Some such taxa include tree frogs, snakes, lizards, and salamanders. These species are not expected to suffer direct effects as a result of prescribed fire as such treatments, under the proposed program, are likely to be cool prescriptions that would not burn into the canopy. Mortality could occur as a result of asphyxiation but even that is not likely as most "arboreal" herpetofauna, even frogs, are highly mobile and can escape the effects of fire in most situations.	Again, because mechanical treatment applications under the proposed program are not expected to remove many mature trees, arboreal herpetofauna are unlikely to suffer adverse direct impacts from this treatment type. However disturbance, injury, or mortality could occur on a small scale if trees that support herpetofauna with arboreal habits are removed.		Manual treatments that destroy trees will have effects on arboreal fauna similar to those of mechanical treatments. Although arboreal animals can be disturbed by chainsaws, etc. on the ground, they are less likely to be disturbed by manual treatments aimed at herbaceous and shrubby vegetation than by equivalent mechanical treatments.		Herbivory treatments are not expected to have any direct effects on arboreal wildlife.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

	Prescribed Fire	Mechanical	Mechanical Thinning	Manual	Manual Thinning	Herbivory	No Treatment
Arboreal Birds	Because treatments applied under the proposed program are expected to be cooler prescriptions that will not burn large canopy trees, arboreal bird species are largely expected to escape direct impacts resulting from prescribed fire. However, consideration should be given to cavity nesting birds when applying prescribed burn treatments such that defect trees/snags are avoided as well.	Birds are unlikely to suffer direct effects from mechanical treatments, as canopy tree removal under the proposed program will be minimal. However, some disturbance, injury, or mortality to arboreal or cavity nests or immobile nestlings could occur where mature trees or snags are removed.		Manual treatments that destroy trees will have effects on arboreal fauna similar to those of mechanical treatments. Although arboreal animals can be disturbed by chainsaws, etc. on the ground, they are less likely to be disturbed by manual treatments aimed at herbaceous and shrubby vegetation than by equivalent mechanical treatments.		Herbivory treatments are not expected to have any direct effects on arboreal wildlife.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Arboreal Mammals	As with other arboreal species, arboreal mammals are expected to largely escape direct impacts resulting from prescribed fire treatments under the proposed program as long as such treatments do not result in combustion in the canopy. Maternal roost colonies of some bat species occurring in buildings and caves can be adversely affected by smoke inhalation as a result of prescribed burning, especially in the spring.	Similar to arboreal nesting birds, mammals that breed in the forest canopy are unlikely to suffer direct effects from mechanical treatments as canopy tree removal under the proposed program will be minimal. However, some disturbance, injury, or mortality to arboreal or cavity nests or immobile young could occur where mature trees or snags are removed.		Manual treatments that destroy trees will have effects on arboreal fauna similar to those of mechanical treatments. Although arboreal animals can be disturbed by chainsaws, etc. on the ground, they are less likely to be disturbed by manual treatments aimed at herbaceous and shrubby vegetation than by equivalent mechanical treatments.		Herbivory treatments are not expected to have any direct effects on arboreal wildlife.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Subterranian Invertebrstes	The direct impact that prescribed fire has on subterranean animals is dependent upon how deeply the fire heats the ground and whether smoke enters underground tunnels (Shaffer and Laudenslayer 2006). Fires will have little impact upon this guild if they burn lightly over the surface or stay mostly in woody vegetation. Additionally, wildlife in soils with high moisture content should be better protected from fire than wildlife in dry soils. However, high-temperature surface fires have the potential to harm fossorial animals and wildlife that seek shelter underground.Meanwhile, Kalisz and Powell reported on the changes in the soil invertebrate community on ridges of the Cumberland Plateau of Kentucky, USA one year after a prescribed fire (Kalisz and Powell 2000). They quantified a significant reduction (36%) in the total dry mass of soil invertebrates as a result of the fire. Burning was also shown to result in declines in the frequency and occurrence of mesofaunal ants and of macrofaunal beetle larvae and adults. They suggested that managers should consider the possibility that prescribed fire, especially if applied repeatedly and at short intervals, may result in substantial and possibly long-lasting reductions in beetle populations. This may be prevented if managers strive for spatial and temporal heterogeneity on multiple scales, resulting in increased complexity in the post-fire ecosystem (Kalisz and Powell 2000).	Soil invertebrates play an essential role in decomposition and nutrient cycling and include detritivores such as earthworms and arthropods and species active in decomposition of dead wood on the forest floor such as termites, beetles, and ants. Although not well studied, researchers believe that thinning is likely to have significant short-term negative effects on invertebrates of the soil and organic layers as a result of treatments that will cause soil compaction and disruption or loss of organic layers (Niwa et al. 2001). Direct impacts mortality and loss of food and cover. Hanula and Wade have shown that in some ecosystems these species can have long recovery periods post-treatment (Hanula and Wade 2003). Soil invertebrates may be more protected from such effects than those in the litter layers (ODF 2008).	No exclusively subterranean amphibians or reptiles occur in California		No exclusively subterranean amphibians or reptiles occur in California	The use of herbivorous treatment methods is not expected to have substantial adverse effects on subterranean fauna therefore discussion at the level of the sub-guild is unnecessary.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

	Prescribed Fire	Mechanical	Mechanical Thinning	Manual	Manual Thinning	Herbivory	No Treatment
Subterranian Amphibians / Reptiles	No exclusively subterranean amphibians or reptiles occur in California.	The herpetofaunal species most vulnerable to fire are those that require leaf litter, duff, and other cool, moist substrates that are usually consumed by fire. Direct mortality and/or injury of terrestrial amphibians and reptiles as a result of prescribed fire is believed to be rare and of negligible concern at the population level (Lyon et al., 1978, Means and Campbell, 1981, Russel et al., 1999, and Smith 2000). This is based on the continued presence of live amphibians post-fire. Survival is likely a result of the ability of some life stages of terrestrial herpetofauna to seek shelter in underground burrows or under moist refugia (Bamford 1992, Friend 1993, Main 1981, and Vogl 1973). A study in Australia found that one species of anuran (Hyperolius nitidulus) can detect the sound of fire and respond by moving toward cover (Grafe et al., 2002).	No exclusively subterranean amphibians or reptiles occur in California			The use of herbivorous treatment methods is not expected to have substantial adverse effects on subterranean fauna therefore discussion at the level of the sub-guild is unnecessary.	
Subterranian Birds	No exclusively subterranean birds occur in California. However, a discussion of burrowing owl is appropriate here because it nests in the underground burrows of other taxa. Little information exists on the indirect effects of prescribed fire on burrowing owl. However, in northcentral Oregon, burrowing owls were observed nesting in previously unused areas that had recently been burned, suggesting that fire may create suitable habitat by reducing vegetation around potential nest sites and foraging habitat (Green and Anthony 1989). Additionally, in northwestern North Dakota, post-settlement fire suppression may be responsible for the development of a taller, denser, and woodier plant community than previously existed. Such shifts in vegetation composition may have been responsible for the local extirpation of burrowing owls there (Murray 2005).	However, fast-moving fires may not allow enough time for amphibians and reptiles to seek refuge. Therefore, immediate impacts of fire to herpetofauna may be minimized by using slow-burning prescriptions to reduce direct mortality. Mortality of aquatic life stages such as eggs and larval herpetofauna are rarely reported and possibly inconsequential (Driscoll and Roberts 1997 and Lyon et al., 1978). Although aquatic forms are typically much more protected from fire than terrestrial forms, mortality could result from thermal stress or rapid changes in water chemistry in streams, ponds and other aquatic habitats (Spencer and Hauer, 1991).	No exclusively subterranean birds occur in California. However, burrowing owl, a species that nests in the underground burrows of other taxa, is likely to benefit from thinning treatments that reduce vegetation and improve foraging and nesting habitat for the species.			The use of herbivorous treatment methods is not expected to have substantial adverse effects on subterranean fauna therefore discussion at the level of the sub-guild is unnecessary.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.
Subterranian Mammals	Little information exists on the effects of fire on subterranean mammals. Because most mammals that utilize subterranean habitat also inhabit the terrestrial landscape, the indirect effects are addressed in the ground-dwelling fauna section.	Direct mortality of small mammals as a result of fire are primarily from heat effects and asphyxiation. Using cooler prescriptions may reduce heat effects. Studies suggest that mortality of burrowing mammals as a result of fire is low as a result of the insulation provided by the soil (Kramp et al., 1983) for species that are underground or able to escape there when a fire burns through. Other causes of death resulting from fire include physiological stress as animals overexert themselves to escape, trampling as large animals stampede while fleeing, and predation while attempting to escape (Kaufman et al., 1990).	Because most mammals that utilize subterranean habitat also inhabit the terrestrial landscape, the indirect effects are addressed in the ground-dwelling fauna section.			The use of herbivorous treatment methods is not expected to have substantial adverse effects on subterranean fauna therefore discussion at the level of the sub-guild is unnecessary.	Lack of fuel reduction treatment in areas of moderate or high risk of wildfire is likely to have indirect effects on wildlife in two ways. First, by allowing fuel loads to continue to increase, the risk of stand-replacement wildfire also would increase. Such fires affect the wildlife already present indirectly by making the habitat uninhabitable to them, though they create or improve habitat for different species; they also affect some wildlife directly through mortality and disturbance that disrupts essential behaviors such as breeding, foraging, or roosting. Second, lack of fire in fire-evolved ecosystems results in habitat structure and vegetation composition that may be unsuitable to the wildlife of those ecosystems, making them just as uninhabitable as do stand-replacement fires.

Preventing the Spread of Invasive Plants:

Best Management Practices for Land Managers

3rd Edition

California Invasive Plant Council

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Introduction

Purpose Statement

The goal of this manual is to present voluntary guidelines that help those managing wildlands in California to prevent the accidental spread of terrestrial invasive plants.

Invasive Plants

Federal Executive Order 13112 defines an invasive species as an alien (non-native) species whose introduction does or is likely to cause economic or environmental harm, or harm to human health. While the majority of non-native plants do not pose a threat to natural or human systems, the Cal-IPC Invasive Plant Inventory identifies 200 species, approximately 3% of the plant species growing in the wild in California, as invasive (Cal-IPC 2006). These plants have the capacity to alter native ecosystems, with potential detrimental implications for wildlife communities, fire regimes, water flow, and nutrient cycling.

Background

Invasive plants can degrade the ecological integrity of wildlands, and land managers employ a range of tactics to reduce this damage. Controlling already established invasive plant infestations is important. However, stopping the introduction and spread of new invasive plant infestations is the most cost-effective approach to reducing this damage. Prevention is a key aspect of invasive plant management that deserves more attention.

Revegetate or mulch disturbed areas to prevent invasive plants from establishing. Photo: David Chang, Santa Barbara County Agricultural Commissioner

Land managers must have a good understanding of ways to avoid accidentally spreading invasive plants through their work. Such work often involves travel from one worksite to another. Tools, equipment, vehicles, animals, clothing, boots, and project materials moved between worksites can become potential vectors for the spread of invasive plants. Generally speaking, soil and vegetation disturbance, including construction and maintenance activities, can also create suitable conditions for the establishment of invasive plants.

This manual was developed by a technical advisory team made up of land management experts in the state, organized by the nonprofit California Invasive Plant Council (Cal-IPC) and funded by the USDA Forest Service, State & Private Forestry. The team reviewed existing resources to develop an accessible overview of key prevention measures that can be used by all land managers. References to source documents, some of which include extensive detail, can be found in the References section at the end of this manual.

Terminology

In this manual, we occasionally use the term “weed” to mean “invasive plant”, such as when referring to “weed-free straw” for erosion control. We also use the general term invasive plant “spread” to mean introduction of invasive plants to a new area, establishment of new invasive plant populations, or spread of existing invasive plant populations. The Glossary at the end of the manual lists terms used in this text.

Best Management Practices (BMPs)

Best Management Practices are methods or techniques found to be the most effective and practical in achieving an objective, such as preventing or reducing invasive plant spread, while making optimal use of resources.

Prevention BMPs that reduce invasive plant spread can help:

- Reduce future maintenance needs and cost
- Reduce fire hazards
- Reduce herbicide use
- Enhance access and safety
- Limit liability for the governing agency or lessee
- Maintain good public relations
- Protect existing wildlife habitat, native plant populations, beneficial insects, as well as threatened and endangered species.

Target Audience

This manual was developed for those managing wildlands, and includes guidelines for those involved in wildland fire management. The manual can be used in a number of ways. For instance, land managers can use the material in the manual to conduct trainings for work crews. The manual can help land managers by providing language for contractor specifications for work on their land. Managers can also use the manual to develop educational materials for the public.

Scope

The primary focus of this manual is preventing the spread of terrestrial invasive plants. Therefore this manual does not focus on invasive plant control methods; however, control measures are discussed insofar as they relate to prevention. For example, mowing as a control method is not discussed, but because timing of mowing relates directly to potential for invasive plant spread, this aspect is included. Invasive aquatic plants are outside the scope of this manual.

Implementation of BMPs

Effective implementation of prevention BMPs requires a process of continuous learning. These voluntary BMPs were developed with the understanding that each situation and entity has different needs, constraints and resources. The applicability and effectiveness of BMPs will vary with existing land uses, degree of human disturbance, the objectives of the land owners, and the resources available for management activities. For example, programmatic planning BMPs may be less applicable to smaller restoration groups, as these BMPs are more suited for large agencies. A discussion of Prioritizing BMP Implementation appears later in this section on page 5 of this draft to help determine which BMPs to emphasize depending on situational factors. Some BMPs may be able to be implemented with existing resources, while others may only be possible pending allocation of additional resources.

Conducting a thorough pre-activity assessment will help to identify which tasks can spread invasive plants (See Pre-Activity Assessment Outline on page 6 of this draft). Many of these BMPs may overlap with existing practices or standard mitigations, such as those for Storm Water Pollution Prevention, clean air regulations, pest quarantines, or rare species protections.

Using This Manual

This manual provides BMPs to aid in preventing the introduction and spread of invasive plants. Its recommendations are voluntary; each organization can choose how to best incorporate and phase this information into their operations.

Section I includes overview information on what BMPs are, why they are important, and how to best implement them. This section also provides recommendations for BMP prioritization.

Section II provides detail on a wide range of topic-specific BMPs for preventing the spread of invasive plants. Each BMP is appropriate for particular situations; users can select those that are suitable for their use.

The BMPs described in Section II are structured as follows:

> **BMP Statement: Prevention BMP statements, in bold font, describe practices that can prevent the introduction and spread of invasive plants.**
>
> **Considerations:**
>
> a. BMP Considerations are listed below the BMP Statement\
> b. BMP Considerations give more information about why the BMP is important, and may include details, suggestions, examples, and issues to consider when applying the BMP.

Section III presents ready-to-use checklists which contain only the BMP statements to provide a quick and portable reference for field activities. The checklists are divided into five categories:

- Site Assessment, Field Mapping and Monitoring
- Routine Vegetation Management
- New Project – Planning
- New Project – Implementation
- Inspection and Cleaning

These checklists can be used as templates and be modified based on your needs.

Section IV has additional resources and information, a glossary, and other references.

Definition and Categorization of Activities

Definition and categorization of activities may vary among agencies and organizations. For this reason, the definition and scope of each activity and how it may spread invasive plants is described in the introduction of each chapter. When using this manual, consider your activity's scope and potential impact as it relates to the potential to introduce or spread invasive plants. Refer to BMPs in related chapters to customize your prevention practices.

Overall Prevention Principles

Take time to plan. Proper planning can reduce future maintenance costs by reducing the potential for invasive plant introduction and spread. A good first step is to conduct a pre-activity assessment of the work area to determine which activities could spread weeds and which BMPs are applicable.

Stop movement of invasive plant materials and seeds. The movement of workers, materials and equipment can carry weeds between sites. This manual identifies potential vectors of spread and how to eliminate them or reduce their effects.

Reduce soil and vegetation disturbance. Disturbance can allow invasive plants to colonize a new area. When disturbance is unavoidable, managers should conduct follow-up monitoring to ensure early detection of any invasive plants that may have been introduced.

Maintain desired plant communities. A healthy plant community with native and desirable species provides resistance to invasive plant establishment.

Practice early detection and rapid response (EDRR). Early detection and eradication of small populations helps prevent the spread of invasive plants and significantly reduces weed management costs. Regular monitoring increases the chances of success.

Prioritizing BMP Implementation

The prevention BMPs in this manual are developed with the understanding that each situation and entity has different needs and resources. This outline can help you select which areas and species to prioritize when integrating BMPs into management activities.

1. **Management costs. Prioritize:**
    - Areas where future control costs will be high if invasive plants become established
    - Areas where fire risk is high
    - BMPs with approaches that are measurable in cost and effectiveness

2. **Ecological value of habitats. Prioritize:**
    - Areas with threatened or endangered species and habitat
    - Areas of high ecological or conservation value
    - Areas where invasive plants have not invaded

3. **Context of the area being managed. Prioritize:**
    - Wildland and natural areas
    - Areas with new construction or disturbance
    - Areas containing water bodies
    - Areas with important scenic or recreational resources
    - Areas where adjacent land owners are cooperative
    - Areas where wildland interfaces with urban areas
    - Wildland areas frequented by vehicles, equipment and foot traffic

4. **Treatment of invasive species. Prioritize:**
    - Species known or suspected to be invasive but still in small numbers
    - Species that can alter ecosystem processes
    - Species with the potential to alter fire regimes
    - Species that occur in areas of high conservation value
    - Species with the potential to require high management costs
    - Species that are likely to be controlled successfully
    - Species determined to be of regional concern as identified through regional partnerships

Pre-Activity Assessment Outline

This assessment outline can help you proactively address activities that have the potential to spread invasive plants. A site assessment and a description of planned activities will need to be completed as part of this pre-activity assessment.

1. **Conduct a site assessment to ascertain:**
    - A list of invasive plant species found in route to and within worksites. Include exact locations and densities, and the species' dispersal mechanisms.
    - A list of priority areas for implementing prevention BMPs. Refer to Prioritizing BMP Implementation on the previous page for guidance on prioritization.

2. **Describe each activity (e.g. roadside mowing, facility inspection, access road grading and maintenance, and pole/tower repair) to ascertain:**
    - Location(s) of the activity
    - Location(s) of access routes
    - Timing for the activity
    - Tools and equipment to used
    - Materials to be moved, imported or exported
    - Expected alteration of existing vegetation and soil

3. **List the sequence of tasks that are included in the activity. Identify which tasks can be altered to reduce the likelihood of invasive plant spread based on:**

    Task location

    a. Is there a location for this task with less potential to spread invasive plants?

    b. Can access routes be changed to avoid traveling through invasive plant populations?

    c. If materials are being moved, is there a better location for materials to be stored?

    Task timing

    a. Can the task be performed in a different time (earlier/later in the season) or in a different sequence (e.g. spraying after mowing)?

    b. Can invasive plant populations be treated before project tasks commence to reduce the spread of invasive plant parts and seeds?

    Task method

    a. Is there a different method of performing the task that can reduce the risk of spread?

    b. Could using different tools/equipment/materials reduce the risk of spread?

    c. Are weed-free materials available?

4. **Select BMPs from the following chapters to address the potential introduction and spread of invasive plants.**

List of Best Management Practices

Chapter 1: Planning BMPs

Programmatic Planning

PL1: Adopt official policy to prevent invasive plant introduction and spread.

PL2: Include invasive plant risk evaluation as a component of initial project planning.

PL3: Integrate invasive plant prevention BMPs into design, construction, vegetation management and maintenance planning activities.

PL4: Coordinate invasive plant prevention efforts with adjacent property owners and local agencies.

PL5: Develop monitoring plans for BMP implementation and effectiveness.

Activity Planning

PL6: Provide prevention training to staff, contractors and volunteers prior to starting work.

PL7: Conduct a site assessment for invasive plant infestations before carrying out field activities.

PL8: Schedule activities to minimize potential for introduction and spread of invasive plants.

PL9: Integrate cleaning BMPs into planning for land management activities.

PL10: Prepare worksite to limit the introduction and spread of invasive plants.

PL11: Monitor the site for invasive plants after land management activities.

Chapter 2: Project Material BMPs

PM1: Use a weed-free source for project materials.

PM2: Prevent invasive plant contamination of project materials when stockpiling and during transport.

Chapter 3: Travel BMPs

TR1: Plan travel to reduce the risk of invasive plant spread.

TR2: Integrate cleaning activities into travel planning.

Chapter 4: Tool, Equipment and Vehicle Cleaning BMPs

TE1: Designate cleaning areas for tools, equipment, and vehicles.

TE2: Inspect tools, equipment, and vehicles before entering and leaving the worksite.

TE3: Clean soils and plant materials from tools, equipment, and vehicles before entering and leaving the worksite.

TE4: Clean pack, grazing and support animals.

Chapter 5: Clothing, Boots and Gear Cleaning BMPs

CB1: Wear clothing, boots and gear that do not retain soil and plant material.

CB2: Designate cleaning areas for clothing, boots and gear.

CB3: Clean clothing, footwear and gear before leaving the worksite.

Chapter 6: Waste Disposal BMPs

WD1: Designate waste disposal areas for invasive plant materials.

WD2: Render invasive plant material nonviable when keeping it on-site.

WD3: When disposing of invasive plant material off-site, contain it during transport.

(continued)

List of Best Management Practices *(continued)*

Chapter 7: Soil Disturbance BMPs

SD1: Minimize soil disturbance.

SD2: Implement erosion control practices.

SD3: Manage existing topsoil and duff material to reduce contamination by invasive plants.

Chapter 8: Vegetation Management BMPs

VM1: Schedule vegetation management activities to maximize the effectiveness of control efforts and minimize introduction and spread of invasive plants.

VM2: Manage vegetation with methods favorable to desirable vegetation.

VM3: Retain existing desirable vegetation and canopy.

Chapter 9: Revegetation and Landscaping BMPs

RL1: Develop revegetation and landscaping plans that optimize resistance to invasive plant establishment.

RL2: Acquire plant materials locally. Verify that species used are not invasive.

RL3: Revegetate and/or mulch disturbed soils as soon as possible to reduce likelihood of invasive plant establishment.

Chapter 10: Fire and Fuel Management BMPs

Fire Management Planning BMPs

FP1: Consider wildfire implications when setting overall priorities for invasive plant management programs.

FP2: Integrate invasive plant prevention into fire management plans.

FP3: Provide training in preventing the spread of invasive plants.

FP4: Plan to utilize weed-free materials for post-fire activities.

Fuel Management BMPs

FM1: Incorporate invasive plant considerations when developing fuel management programs.

FM2: Maintain active management of invasive plants on fuel management sites.

FM3: Reduce disturbance when implementing fuel management activities.

FM4: Incorporate invasive plant considerations when using prescribed fire.

Fire Suppression BMPs

FS1: Develop operational procedures related to fire suppression to reduce the spread of invasive plants.

FS2: Locate indirect fire lines to reduce additional disturbance and invasive plant spread where feasible.

FS3: Locate fire activity areas in locations free of invasive plants where feasible.

FS4: Clean vehicles, equipment, clothing and gear before arriving and leaving fire activity areas.

FS5: Use water sources free of invasive plants for fire suppression when feasible.

Post-Fire Activities BMPs

PF1: Manage access to burned areas.

PF2: Use weed-free materials for post-fire activities.

PF3: Cover and rehabilitate soil disturbed by suppression activity.

PF4: Develop and implement post-fire integrated invasive plant management prescriptions.

PF5: Revegetate burned areas to reduce the spread of invasive plants.

Chapter 1: Planning BMPs

Integrating prevention BMPs into land management can significantly minimize the introduction and spread of invasive plants. Effective planning reduces costs and enhances project success. This chapter addresses how and when to integrate prevention BMPs into planning and management, and highlights the importance of communication among staff, adjacent property owners and local agencies.

Identifying invasive plant risks early in the planning process helps organizations develop strategies to prioritize prevention measures, allocate resources, and incorporate prevention costs into budgets throughout the project life cycle. Additionally, tracking the costs and results of implementing prevention BMPs will provide references for future projects.

Planning includes developing schedules, budgets, and strategies as well as identifying critical control points for carrying out preventation BMPs. Identifying and mapping invasive plants at worksites is critical for evaluating threats. This helps determine high-risk spots for potential establishment and spread, and helps land managers select appropriate prevention practices.

Map invasive plants before starting work to designate work routes and detect invasive plant infestations early. Photo: Arpita Sinha, Cal-IPC

This chapter includes two sections on planning: programatic planning and activity planning. **Programmatic Planning BMPs** are critical because they lay the framework for prevention BMPs to be integrated into all activity planning and land management. **Activity Planning BMPs** focus on limiting the introduction and spread of invasive plants during each stage of land management. These BMPs start on page 11.

PROGRAMMATIC PLANNING BMPs:

PL1: Adopt official policy to prevent invasive plant introduction and spread.

a. Adopt an environmental stewardship policy that encourages preventing the introduction and spread of invasive plants.

b. Increase organization/agency-wide awareness of invasive plant impacts.

c. Consider using multi-disciplinary teams to address site-specific invasive plant prevention and control challenges.

d. Identify funding, priorities, and personnel assignments for invasive plant prevention. Consider having a dedicated invasive plant contact person.

PL2: Include invasive plant risk evaluation as a component of initial project planning.

a. Integrate invasive plant identification and risk analysis as a part of NEPA/CEQA processes.

b. Evaluate invasive plant spread risks and the long-term maintenance consequences with natural resource managers. Determine project alternatives and management needs based on a pre-activity assessment. See Pre-Activity Assessment Outline on page 6.

c. Incorporate invasive plant prevention measures into project layout, design, and project decisions.

d. Develop mitigation plans for areas where avoidance of invasive plants is not possible.

e. Designate known invasive plant occurrences in maintenance plans and any associated contracts.

PL3: Integrate invasive plant prevention BMPs into design, construction, vegetation management and maintenance planning activities.

a. Include BMP costs in all budgets, estimates and bid packages. Include costs for prevention training for staff and contractors, cleaning routines for clothing, tools, equipment and vehicles, and site preparation and monitoring.

b. Track cost and results of implementing BMPs as a reference for future project planning and cost estimates.

c. Integrate cleaning routines into all land management activities. For detailed cleaning protocol see Checklist E on page 49.

d. Develop incentive programs among staff and volunteers to encourage invasive plant detection and reporting.

e. Include invasive plant prevention measures as part of contract notes and specifications.

f. Develop plant lists and design guidelines for revegetation and landscaping that will optimize resistance to invasive plant establishment. For details see RL1 on page 31.

g. Plan to minimize soil and vegetation disturbance during activities. For details see SD1 on page 27 and VM3 on page 30.

h. When designing vegetation management projects, consider the life cycle and dispersal mechanisms of the invasive plant species within and/or adjacent to the worksite.

i. Acquire documentation of invasive plants along roadways and address treatment strategies in the course of road maintenance activities.

PL4: Coordinate invasive plant prevention efforts with adjacent property owners and local agencies.

a. Coordinate prevention efforts with adjacent property owners to ensure their activities will minimize the introduction or spread of invasive plants into the worksite or neighboring properties.

b. Coordinate with local and state agencies to streamline record keeping systems of invasive plant infestations. Incorporate updates into appropriate databases such as CalWeedMapper (www.calweedmapper.calflora.org) and share with local and state agencies.

c. Coordinate new research on invasive plant prevention and technology with Cal-IPC, agencies, and universities. Share findings with public and private partners.

PL5: Develop monitoring plans for BMP implementation and effectiveness.

a. Establish a periodic monitoring program based on knowledge of high priority invasive plant life cycles (ideally three times a year and during growth periods).

b. Identify and monitor sites that are susceptible to invasion, such as post construction areas and roadsides (from the edge of pavement extending a minimum of fifteen feet), pull outs, trailheads, campgrounds and parking lots.

c. Define "zero tolerance" zones in critical habitats. Commit to keeping these areas free of invasive plants through frequent monitoring and control efforts.

d. Track results of implementing BMPs as a reference for future project planning and cost estimates.

e. Develop follow-up treatments as needed based on monitoring results.

f. Consider modifying BMP implementation based on the following questions:
   - Were invasive plant populations reduced or adequately suppressed thus preventing spread?
   - Was the planned procedure used? If not, why did it vary from the original plan?
   - Were invasive plant prevention costs equal to, less than, or more than projected prevention costs?
   - What was the effect on the targeted invasive plant species?
   - Were there any side-effects on non-target organisms from implementing prevention measures?
   - Was available funding and manpower adequate?
   - Was personnel training adequate?

ACTIVITY PLANNING BMPs:

In addition to the following BMPs, also refer to related BMPS in:

- Chapter 2: Project Materials for procuring and managing erosion and project materials.

PL6: Provide prevention training to staff, contractors and volunteers prior to starting work.

a. Provide pre-work training on invasive plants and prevention BMPs to staff, contractors and volunteers. Training should include:
   - Field identification of invasive plants in the work area
   - Reproductive biology of invasive plants
   - Ecological and economic impacts of invasive plants
   - Invasive plant prevention BMPs
     - Inspection and cleaning protocols for vehicles, tools, equipment, clothes and personal gear
     - When and how to record and report occurrences for invasive plants
     - How to use prevention resources (reporting websites, checklists, etc.)
     - How to treat materials infested with invasive plant propagules.

Photo: John Luker, California State Parks, Angeles District

Train staff and contractors in prevention measures.

b. Provide additional training to staff and contractors managing project materials. Training should include:
   - How to acquire weed-free materials
   - Project material inspection protocols
c. Ensure staff and contractors understand provisions for invasive plant prevention throughout the project. Invasive plant considerations should be routinely addressed during pre-bid, pre-work and meetings, as appropriate.
d. Identify and train personnel responsible for inspection of cleaned tools, equipment and vehicles at facilities and worksites. Require an inspection form or checklist be used to document tools, equipment and vehicles are cleaned before leaving an infested worksite and are clean upon arrival at a clean/uninfested worksite.
e. Provide invasive plant identification guides, prevention BMPs, activity, and cleaning and inspection checklists (see Checklists on page 53) to staff, contractors, and volunteers. Provide these resources in other languages when appropriate. Also have these resources available at highly visible locations such as:
   - Access points
   - Field stations and work trailers
f. Educate all site users about preventing invasive plant spread.
   - Post invasive plant prevention messages using signs and posters at prominent locations such as visitor centers, campgrounds, trailheads. Provide informational materials to site users at visitor centers and events.
   - Install prevention equipment such as boot brushes and washing stations at trailheads.

PL7: Conduct a site assessment for invasive plant infestations before carrying out field activities.

a. A site assessment for invasive plant infestations includes scouting for invasive plants found within the worksite (including the exact locations and densities), and determining priority areas for implementing prevention BMPs.
b. Scout for invasive plants at likely introduction sites such as roadsides, trailheads, campgrounds, staging areas, and other disturbed areas. Wet areas may also be especially susceptible.
c. Scout not only within the worksite but nearby as well.
d. Gauge the extent and intensity of scouting based on:
   - Threat of invasive plants to critical habitats
   - Size of the worksite
   - Type of activity (whether the activity disturbs ground or vegetation, and the degree of the disturbance)
   - Adjacent environment
e. Be especially aware of invasive plant species that are not widespread in the work area and can be controlled using early detection and rapid response. Flag areas infested with invasive plants that are not widespread in the work area. Either avoid disturbance in those areas, or identify and

Photo: Martin Hutten, Yosemite National Park

Evaluate invasive plant risk as a part of project planning and environmental analysis.

isolate contaminated soils during construction or other disturbance. Isolated contaminated soils should be either placed back in the original location or disposed of appropriately to avoid spreading isolated populations of invasive plants throughout the worksite.

f. Review internal documentation and consult local groups and online resources for information on existing and potential invasive plant infestations on and near worksites.
   - Weed Management Areas (WMAs), County Agricultural Commissioner offices, and Resource Conservation Districts are key local groups that have broad awareness of infestations in a given area. Cal-IPC currently maintains an online list of WMAs (www.cal-ipc.org/WMAs).
   - Cal-IPC works with a range of partners to map invasive plants across the state. Occurrence data for invasive plants can be found online at CalWeedMapper (www.calweedmapper.calflora.org), Calflora (calflora.org) and on the California Department of Fish & Game's BIOS viewer (www.bios.dfg.ca.gov).
   - Specimen data can also be found at the California Consortium of California Herbaria (http://ucjeps.berkeley.edu/consortium/), which houses data for over 20 California herbaria including the California Department of Food and Agriculture Weed Laboratory.

g. Document invasive plant findings and communicate them to resource or facility managers.

h. Incorporate findings into a database (e.g. www.calweedmapper.calflora.org) and project drawings or maps.

i. Evaluate invasive plant risks. Determine invasive prevention and management needs at the onset of activity planning. Prioritize treatment of invasive plants based on guidelines in Prioritizing BMP Implementation on page 4.

PL8: Schedule activities to minimize potential for introduction and spread of invasive plants.

a. Prioritize reducing invasive plant seed production along roadsides (edge to fifteen feet along roadway edge) to reduce seed movement by vehicles.

b. Conduct work under conditions that minimize the risk of spread (e.g. frozen ground, snow cover, seed absence).

c. Avoid working during rain events and high winds. Wet conditions make it easier for seeds to be picked up by a vehicle and spread miles down the road.

d. Develop site-specific plans for controlling existing invasive plants before ground-disturbing activities begin.
   - Control invasive plants along access roads before moving equipment into the worksite.
   - Manage invasive plants three to five years prior to the planned disturbance to minimize invasive plant seeds in the soil, when feasible.

e. For details on scheduling vegetation management see VM1 on page 29.

PL9: Integrate cleaning BMPs into planning for land management activities.

a. Determine cleaning needs for tools, vehicles, equipment, clothing, boots and gear in conjunction with each activity and worksite. Include these cleaning needs in project plans, and make prior arrangements for any special needs identified. For details on cleaning see Chapters 4 and 5 on pages 21 and 23.

b. Include cleaning costs in project budgets.

c. Acquire necessary cleaning tools.

d. Designate sites for cleaning vehicles, equipment, pack animals, clothing and gear.

e. Identify cleaning facilities (such as car washes) near the worksite, in the event that cleaning on-site is not an option.

f. Use inspection checklists to ensure comprehensive cleaning. See Checklist E on page 59.

PL10: Prepare worksite to limit the introduction and spread of invasive plants.

a. Protect likely introduction sites such as pull-outs, trailheads, campgrounds, and parking lots from invasive plant introductions by paving, deep mulching, or planting a dominant non-invasive groundcover.

b. Periodically inspect areas of concentrated use, such as staging areas, parking areas, trailheads, or campgrounds, and keep them free of invasive plants.

c. Treat invasive plants at access roads and staging areas before using them.

d. Control invasive plants in areas adjacent to worksites. This prevents seeds or other reproductive structures from moving into the worksite. If removing plants is not feasible, stopping seed set can be an effective way to reduce the potential for spreading the plant.

e. Position activity boundaries to exclude areas infested with invasive plants. Activity boundaries include staging areas, timber harvest landings, skid trails, access roads and other temporary facilities. If this is not possible, control invasive plants in infested areas prior to their use.

PL11: After land management activities, monitor worksites for invasive plants.

a. Carry out the established monitoring plan. Partner with local WMAs (www.cal-ipc.org/WMAs), agencies and organizations to help with monitoring when possible.

b. Train staff to recognize and report invasive plants as part of ongoing monitoring.

c. Monitor areas including:
- On-site cleaning area
- Waste disposal area
- Areas where project materials are stored
- Access routes, roads and other areas of concentrated use
- Areas near salt licks, watering sites, loading/unloading areas and corrals for animals

d. Monitor and maintain revegetation and landscaping to ensure long-term establishment of desired plant species.

e. Monitor during multiple growing seasons, especially at times of germination and flowering, for a minimum of three years after project completion to ensure that any invasive plants are promptly detected and controlled. If three years is not sufficient to control invasive plants, monitoring and treatment should be continued until confident that invasion has been controlled.

f. For on-going projects, continue to monitor until reasonably certain that invasive plants will not reappear. Plan for follow-up treatments based on presence of invasive plants.

Photo: Martin Hutten, Yosemite National Park

Monitor worksite for invasive plant infestations after activities.

Chapter 2: Project Materials BMPs

Project materials are common vectors of invasive plant introduction into new areas. Infested project materials that are imported to worksites can introduce invasive plant propagules and lead to new infestations. This chapter includes practices for minimizing the spread of invasive plants from project materials.

Effective project material management can prevent invasive plant spread at the source and minimize contamination during transport and stockpiling. Because project materials are often managed by different entities or departments during different project phases, developing a procedure for procuring, storing, and inspecting materials at critical control points will streamline materials management and minimize contamination. Additionally, developing relationships with suppliers and requesting that they supply weed-free materials can help to increase demand and availability of these materials.

Project materials include:

- Erosion control materials (silt fences, fiber roll barriers, straw wattles, mulch and straw)
- Soil and aggregate (topsoil, fill, sand, and gravel)
- Landscape materials (plants, seed, sod, mulch, and soil amendments)
- Animal/livestock feed
- Water (for cleaning or irrigation)
- Construction/building materials

Project materials contaminated with invasive plant seeds and parts and spread invasive plants. Use weed-free materials to prevent spreading invasive plants. Photo: Martin Hutten, Yosemite National Park

PM1: Use a weed-free source for project materials.

a. Develop a procedure for procuring and storing weed-free materials and inspecting material sources. Cultivate relationships with suppliers to streamline sourcing of weed-free materials.

b. Select materials based on the environmental needs of the worksite. Understand how weed-free materials are produced, whether the screening criteria is based on noxious weeds or wildland invasive plants. Weed-free materials may not be 100% weed-free, but using weed-free materials can reduce the probability of exposure to invasive plant parts and seeds.
   - Noxious weeds are agricultural weeds listed by the California Department of Food and Agriculture. www.cdfa.ca.gov/plant/ipc/weedinfo/winfo_list-pestrating.htm
   - California Invasive Plant Council's inventory lists wildland invasive plants. www.cal-ipc.org/ip/inventory/

c. Determine the degree to which weed-free project materials are needed for each worksite. Materials from an infested site may be suitable for a worksite that is already infested with the same species. Excavated material from areas containing invasive plants may be reused within the limits of the infestation.
   - For example, materials from a yellow starthistle infested site could be reused in areas already infested by yellow starthistle, but not in areas free of yellow starthistle.
   - Unused excavated material contaminated with invasive plants should be stockpiled on an impervious surface and managed until all invasive plant material is non-viable. For details on managing stockpiled materials see PM2 on page 18.

d. Use weed-free materials for erosion control and soil stabilization.
   - When available, use weed-free straw certified by a county agriculture department, coconut fiber, rice straw and/or native grass straw. These types of erosion control material have limited quantities of invasive plants or contain wetland species that may not survive in dry upland conditions. See Cal-IPC (www.cal-ipc.org/ip/prevention) for a Weed-Free Forage & Straw Supplier List.

Photo: Marla Knight, USDA Forest Service

Contaminated project materials, like this gravel pile, can spread invasive plants to worksites.

   - Perform follow-up inspections at sites where erosion control materials have been used to ensure that any invasive plant introductions are caught early and treated.

e. Use weed-free sand and gravel.
   - Any fill material brought on-site should be clean, debris-free, and devoid of invasive plant parts or seeds. Do not borrow fill from weed-infested stockpiles, road shoulders or ditch lines.
   - Inspect aggregate material sources (including but not limited to surrounding ditches, topsoil piles, gravel/sand piles or pits). See Cal-IPC (www.cal-ipc.org/ip/prevention) for information about procuring weed-free sand and gravel.

f. Use weed-free seed. Verify seed mix to ensure it does not contain invasive plants.
   - Use local seeding guidelines for your county to determine procedures and appropriate seed mixes.
   - A certified seed laboratory should test each lot according to Association of Seed Technologists and Analysts (AOSTA) standards (which include a statewide invasive plant list) and provide documentation of the seed inspection test. Check state, federal, and California Invasive Plant Council lists to see if any local weeds need to be added prior to testing. For more information on locating lists of invasive plants, see PM1d on page 16.

- Seed purchased commercially should have a label that states the following:
    - Species
    - Purity: Most seed should be no less than 75% pure and preferably over 85% pure. The rest is inert matter, weed seed, or other seed.
    - Weed seed content: The tag should state NO invasive plants are present. Only certified weed-free seed should be used. Note that seed is usually certified to be "noxious weed free", referring to the California Department of Food and Agriculture noxious weed list, and may still contain seeds of wildland invasive plant species not included on the noxious weed list.
    - Germination of desired seed: Germination generally should not be less than 50% for most species, although some shrubs and forbs will have lower percentages.

g. Keep and reuse on-site weed-free materials rather than importing new materials to limit contamination.
    - Stockpile topsoil along perimeter of project for later use rather than importing topsoil. For details on topsoil management, see SD3 on page 28.
    - Consider using mulch from non-invasive plant species chipped on site when feasible.

h. Find local sources when off-site weed-free project materials are needed. Inspect project material suppliers as appropriate to determine if the source is weed-free. Weed-free materials may not be 100% weed-free, but using these materials can reduce the probability of exposure to invasive plant contamination.

i. Designate and use weed-free water sources for each project.
    - Inspect water sources to prevent introduction of invasive plants or animals.
    - Designate weed free pathways to water sources.

j. Provide weed-free feed for livestock and pack animals before and after project use to limit invasive plant seed transport via manure.

k. If unable to obtain materials from a weed-free source:
    - Work with a local weed specialist to sterilize or treat materials and provide results of post-treatment inspection. Monitor application areas. For monitoring protocol see PL11 on page 14.
    - If soil sources are infested, treat the invasive plants, then strip the infested topsoil and stockpile the contaminated material for several years to further deplete the soil seed bank. Check regularly for re-emergence of invasive plants and treat as needed.
    - Inspect the area where material from weed-infested sources were used annually for at least three years after project completion to ensure that any invasive plants transported to the site are promptly detected and controlled. For monitoring protocol see PL11 on page 14.

l. Inspect project materials, sources, and storage areas for invasive plants annually and prior to each use to ensure that no invasive plants have invaded since the last inspection. Record inspection results. Continue to monitor worksites for three year after project completion.

m. When feasible, include penalties, performance standards, or withholding provisions in contract specifications by which a contractor is assessed monetary damages for importing invasive plants as a result of non-compliance with contract specifications.

Photo: Mona Robison, California State Parks

These certified weed-free rice straw wattles are contained in plastic packaging to protect them from invasive plant establishment.

PM2: Prevent invasive plant contamination of project materials when stockpiling and during transport.

a. Move only weed-free materials into uninfested areas. Moving materials from one infested location to another within a particular zone may not cause contamination, but moving materials from infested to uninfested areas could lead to the introduction and spread of invasive plants.

b. Clean transport vehicles before and after loading project materials.

c. Encourage log yard and biomass plant operators to maintain weed-free yards, equipment parking areas, off-loading areas, and staging areas. This will reduce the likelihood of invasive plant spread from yard to worksite.

d. During transport, cover exposed piles of materials with geotextile fabric or impermeable material to prevent contamination of weed-free materials or spread of infested materials.

e. Cover exposed piles of project materials with impermeable material to protect materials from wind and rain, and reduce germination of invasive plants.

f. Cover active and inactive soil stockpiles with soil stabilization material or a temporary cover:
  - Soil stabilization used on bare slopes can be used for stockpiled soils. Temporary soil stabilization materials include:
    - Hydroseed (tackifier, fiber or seed)
    - Erosion control blanket (jute mesh or netting)
    - Mulch
    - Soil binder
    - Geosynthetic fabric
  - Surrounded with a linear sediment barrier (e.g. fiber roll).

g. For managing existing topsoil and duff materials see SD3 on page 28.

h. Frequently monitor stockpiles, materials storage areas and borrow pits. Quickly treat new invasive plant populations prior to seed production.

Photo: Ramona Robison, California State Parks

Cover soil stockpiles to prevent invasive plant establishment. Monitor worksites for invasive plants following activities.

Chapter 3: Travel BMPs

Land managers traveling between worksites can become vectors for the spread of invasive plants. For instance, driving a truck along an infested road can pick up seeds and carry them to a worksite. This chapter includes practices for minimizing the introduction of invasive plants by equipment, vehicles, animals and people.

It is important to be aware of travel routes. While cleaning vehicles, equipment, pack animals, clothing and gear is essential; land managers' travel practices can reduce the amount of plant reproductive material that gets transported in the first place.

Vehicles traveling through areas infested with invasive plants can spread viable plant material. Photo: Peter Schuyler, ecological consultant

TR1: Plan travel to reduce the risk of invasive plant spread.

a. Consider the scale of infestation at worksites and travel routes. Typically not all areas are infested to the same degree with the same plants; this may affect the type and degree of prevention measures implemented.

b. Avoid driving off-road whenever possible.

c. When driving off-road, avoid patches of invasive plants.

d. Exclude areas infested with invasive plants from equipment travel corridors and staging areas.

e. Avoid parking on the side of the road in areas infested with invasive plants.

f. Prevent animals (pack and grazing) from entering areas infested with invasive plants.

g. When traveling through infested areas cannot be avoided:

- Consider the sequence of operations. Arrange travel routes from uninfested areas to infested areas. Work first in uninfested areas when vehicles and equipment are free from invasive plant material.
- Control invasive plants at access roads and staging areas before using them.
- Clean your vehicle before leaving the infested area.
- Travel under dry conditions when feasible. Traveling under wet conditions, particularly along unpaved roads, greatly elevates the risk of picking up invasive plant seeds and transporting them.
- Restrict travel to those periods when spread of seed is least likely, such as just prior to flowering or late in the season when seeds have already dropped.

h. Limit the number of roads traveled to minimize soil disturbance and the risk of unintentionally transporting invasive plant parts and seeds on equipment into uninfested areas.

i. Close or reroute public roads or trails in areas infested with invasive plants. Where appropriate, ask user groups to become actively involved to help control an infestation so the trail can be reopened.

j. Perform road maintenance such as road grading, brush clearing, and ditch cleaning from uninfested to infested areas. If possible, schedule such activities when seeds or propagules are least likely to be viable.

Photo: Noa Rishe, California State Parks, Angeles District

Clean seeds and plant parts from vehicles before leaving worksites infested with invasive plants.

TR2: Integrate cleaning activities into travel planning.

a. Include cleaning when planning travel time.

b. Set up cleaning operations to be efficient and effective to have minimal impact on travel time.

c. Remove soil and plant materials from tools, vehicles, equipment, clothing, boots and gear before entering and leaving a worksite.

d. Refer to an inspection checklist to ensure comprehensive cleaning of vehicles, equipment, pack animals, clothing and gear. See Checklist E on page 59.

e. Avoid traveling through areas infested with invasive plants when collecting water for dust abatement or cleaning.

Chapter 4: Tool, Equipment and Vehicle Cleaning BMPs

Tools, equipment and vehicles used for land management activities are potential vectors for invasive plant spread. For example, a mower used at a site infested with yellow starthistle can trap seeds in the mower deck and deposit them at the next worksite. This chapter presents ways to prevent the spread of invasive plants by cleaning hand tools, power tools, construction equipment, vehicles, and pack and grazing animals. For a detailed cleaning protocol see Checklist E in the checklists section of this manual on page 59.

TE1: Designate cleaning areas for tools, equipment, and vehicles.

a. Tools, equipment, and vehicles should be cleaned in areas that are:
   - Easily accessible for monitoring and control
   - Located away from waterways
   - Located away from areas of sensitive habitats or species
   - Near areas already infested with invasive plants
   - Contained with silt fences or soil berms
   - Paved or have sealed surfaces to avoid re-accumulation of soil and plant material on cleaned vehicles and equipment

TE2: Inspect tools, equipment, and vehicles before entering and leaving the worksite.

a. Consider the extent of infestation at worksites. Typically not all areas are infested to the same degree with the same plants, and this may affect the type and degree of inspection needed.

b. Prior to entering an uninfested area, inspect vehicle and equipment undercarriages and tires for seeds or plant parts.

c. Refer to an inspection checklist to ensure comprehensive inspection. See Checklist E on page 59.

Clean tools, equipment, and vehicles to reduce the spread of invasive plants. Photo: Martin Hutten, Yosemite National Park

d. Train staff, contractors and volunteers to inspect for seeds, seed heads, plant material, soil and mud.

e. Procure appropriate equipment for inspections, such as flashlights, portable lighting if night-time inspections are necessary, and under-vehicle mirrors.

f. Inspect areas where tools, equipment and vehicles are stored for invasive plants. Maintain these facilities as weed-free.

g. Ensure that rental equipment is free of invasive plant material before accepting it.

TE3: Clean soils and plant materials from tools, equipment, and vehicles before entering and leaving the worksite.

a. Clean tools, equipment, and vehicles if soil and plant materials are found during inspections.

b. Remove soil, seeds and plant parts from tools, the undercarriage, tires, sideboards, tailgates, and grills of all vehicles and equipment. Wash tires and under carriage if the travel route is muddy. For detailed cleaning protocol see Checklist E on page 59. Cleaning methods are divided into two categories:

- Cleaning without water:
  - Bristle brushes, brooms, scraper and other hand tools (to remove heavy accumulation of soil and debris prior to washing with other tools)
  - High pressure air devices
  - Vacuum cleaner
  - Hand removal
- Cleaning with water:

Wash on a paved surface to avoid creating mud. Contain waste water and splash to prevent invasive plant parts and seed from spreading through runoff. Berms or silt fences installed along perimeters of work areas can aid in preventing the spread of contaminated materials outside the cleaning area.

  - High pressure washers (preferably with 2,000-psi): wash once for six minutes or two to three times for three minutes for best results.
  - Portable cleaning station with undercarriage washers and pressure hoses (useful during maintenance of multiple sites).

c. Dispose of propagule-containing water from equipment washing at a waste management facility or incinerator; not a wastewater treatment plant.

d. Clean carpet, rubber, nylon or plastic materials using:

- A vacuum cleaner
- A variety of brushes with bristles of varying length and texture.

e. Frequently wash vehicles, especially after driving off-road or along roads bordered by a high density of invasive plants, and after traveling under wet conditions.

f. Include cleaning as part of routine maintenance activities for tools, equipment and vehicles. This is in addition to regular cleaning on site.

TE4: Clean pack, grazing and support animals.

a. Brush and clean animals — especially their hooves and legs — before leaving areas infested with invasive plants. For detailed cleaning protocol see Checklist E on page 59.

b. Provide weed-free forage or pelletized feed for livestock (preferably for three days or more) before and after project use to limit invasive plant seed transport via manure.

c. Consider using transitional pastures when moving livestock from invasive plant infested areas.

- Allow animals to graze invasive plants only before they flower or set seed. If this is impossible, contain animals in a weed-free holding area (preferably for three days or more) before moving them into uninfested areas.

Photo: Marla Knight, USDA Forest Service

Contain waste water when washing vehicles to prevent spreading invasive plant parts.

Chapter 5: Clothing, Boots and Gear Cleaning BMPs

Land managers have the potential to be a vector of seed dispersal through what they wear and what they carry into the field. The tendency for a fabric to attract and hold seeds and other plant material varies significantly depending on its texture. This chapter presents prevention practices that can minimize the spread of invasive plant material via clothing, boots, and gear. For a detailed cleaning protocol see Checklist E on page 59.

Wear fabric that does not retain plant material to reduce the spread of invasive plants. Photo: Martin Hutten, Yosemite National Park

CB1: Wear clothing, boots and gear that do not retain soil and plant material.

a. Wear fabrics that do not retain invasive plant propagules:
   - Cotton duck (canvas),
   - Nylon
   - Leather
   - Fabrics such as Para-aramid Kevlar®[1] and Meta-aramid Ripstop Nomex®[2]

b. Avoid brushed cotton, netting, Velcro, and bulky knits like wool and fleece

c. Use special gear as appropriate:
   - Nylon gaiters to cover socks and laces
   - Leather laces on leather boots
   - Rubber boots

d. Consider dedicating a pair of shoes or boots for use only in infested sites.

1. DuPont™ and Kevlar® are registered trademarks of DuPont
2. DuPont™ and Nomex® are registered trademarks of DuPont

CB2: Designate cleaning areas for clothing, boots and gear.

a. Select cleaning areas that are:
   - Easily accessible for monitoring and control
   - Located away from waterways
   - Located away from sensitive habitats or species
   - Near areas already infested with invasive plants

CB3: Clean clothing, boots and gear before leaving worksite.

a. Carry appropriate equipment to help remove soil, seed, and plant parts. This may include wire brushes, small screwdrivers, boot brushes, extra water free of invasive species, and bags for plant material.

b. Remove soil, mud, seeds, and any plant material from clothing, boots and gear before leaving a worksite infested with invasive plants.

c. Clean clothing, boots and gear at the designated cleaning area or at location of exposure to invasive plant seeds or material. In some cases it may be appropriate to bag seeds and plant parts for off-site disposal.

d. Inform coworkers about possible seeds or other propagules carried on their clothing, footwear and gear.

e. For a detailed cleaning protocol see Checklist E on page 59.

Photo: Jen Stern, Cal-IPC

Clean clothing, boots and gear to reduce the spread of invasive plants.

Chapter 6: Waste Disposal BMPs

After removing invasive plants, land managers need to decide what to do with the resulting plant biomass. Our definition of waste includes invasive plant biomass, seeds and contaminated materials such as soil and mulch. These materials may spread invasive plants if they are left viable and uncovered or are transported without containment. This chapter presents guidelines for proper waste disposal to prevent the spread of viable plant material and seeds.

Prevent invasive plant materials from contacting soil when disposing of materials on-site. Photo: Cindy Roessler, Midpeninsula Regional Open Space District

WD1: Designate waste disposal areas for invasive plant materials.

a. Select disposal areas where viable invasive plant materials will be contained, buried or destroyed.

b. Locate debris burn piles in areas that minimize the possibility of invasive plant establishment.

c. Do not dispose of viable invasive plant material that has the ability to resprout or spread at a facility that produces mulch or chipped products.

d. Do not dispose of soil, seeds, or plant material down a storm drain. This action may promote the spread of invasive plants downstream.

e. Develop a monitoring plan for waste disposal areas, including burn piles, to prevent the introduction and spread of invasive plants.

WD2: Render invasive plant material nonviable when keeping on-site.

a. When composting invasive plants on site, consider the reproductive biology of the invasive plants:
   - Composting will render invasive plant material nonviable only if compost piles reach very high temperatures. Finished compost should be monitored for invasive plant emergence.
   - For large amounts of invasive plant material or for invasive plants with rigid stems, contain plant materials by placing them on asphalt or black plastic (4-mm-thickness minimum), covering with black plastic (4-mm-thinkness minimum), and securing the edges with landscaping staples, large rocks or sand bags. Effectiveness of this method varies by plant species.
   - For smaller amounts of plant material or for plants with pliable stems, bag the material in heavy-duty (3-mm or thicker) garbage bags. Keep plant material bagged for at least one month. Effectiveness of this method varies by plant species.
   - Keep covered or bagged materials in the sun, preferably on a dark surface such as asphalt, to accelerate the decomposition process. Material is nonviable when partially decomposed, very slimy or brittle. Once material is nonviable, it can be disposed of in a landfill or brush pile.
   - Monitor the bagged or covered material to ensure the plants do not escape through rips, tears or seams in the plastic.

b. When drying out invasive plants in piles:
   - Prevent cut surfaces of invasive plant stems from contacting soil, to avoid root growth and reestablishment.
   - Invasive plants with viable seeds or fruit attached should not be left on-site to dry out in an exposed manner.

c. When burying invasive plants on-site:
   - Contain all invasive plant material in an excavated pit, cover with woven geotextile, and cover with a minimum of 3 feet of uncontaminated fill material. Effectiveness of this method varies by plant species.
   - This method is best used on a worksite that already has disturbed soil.

d. Burn plant material after obtaining necessary permits.

e. Monitor all disposal sites for emergence of new invasive plants. Locate disposal sites so that they are easy to monitor.

WD3: When disposing of invasive plant material off-site, contain it during transport.

a. Contain invasive plant material in heavy-duty (3-mm or thicker, contractor quality plastic) garbage bags. Securely tie the bags and transport under tarps or in an enclosed truck to an appropriate disposal area.

b. Clean vehicles after transporting invasive plant material. For detailed cleaning protocol see Checklist E on page 59.

c. If invasive plant material has the ability to re-sprout or spread by seed, do not dispose of it at a facility that produces mulch or chip products. Contact your local solid waste authority for additional details.

Photo: Courtesy of Mario Abreu, California Native Plant Society

Contain invasive plant material in heavy-duty garbage bags when disposing of materials off-site.

Chapter 7: Soil Disturbance BMPs

Soil disturbance includes contouring, grubbing, logging, moving, removing, excavating and cutting. Soil disturbance destabilizes and exposes soil, which can impact water and air movement, biological activity, root growth and seedling emergence. Disturbed soil provides an opportunity for invasive plants to establish and spread, to compete with native species, and to colonize new areas.

Soil disturbance often occurs during:

- Road maintenance
- Timber harvesting
- Soil excavation
- Vegetation clearing
- Movement of vehicles and heavy equipment

Minimize soil disturbance by selecting low impact equipment. Photo: Martin Hutten, Yosemite National Park

Soil disturbance should be minimized to the extent practical. Disturbed soil should be stabilized and covered as soon as possible to prevent the germination and growth of invasive plants. If a worksite is infested with invasive plants, schedule treatment of these plants prior to ground disturbance to minimize spread of invasive plants into other uninfested areas. Project materials such as fill, aggregate and erosion control materials can also carry invasive plant seeds, which further increase the risk for infestation after soil disturbance.

In addition to the following BMPs, also refer to related BMPS in:

- Chapter 2: Project Materials for procuring and managing erosion and project materials.

SD1: Minimize soil disturbance.

a. Retain soil and desirable vegetation in and around the activity area as much as possible to prevent the introduction and spread of invasive plants.

b. Minimize ground disturbance, as increased bare ground creates suitable habitat for invasive plant germination.

c. Consider the impacts of different types of equipment. Choose equipment that minimizes soil disturbance.

d. Minimize the frequency of soil disturbance. If a site has to be cleared of vegetation regularly (such as brush clearing), consider paving or otherwise protecting the site with weed-free materials (gravel, mulch, decomposed granite), deep mulching or planting non-invasive groundcover, or sealing bare surface with soil stabilizer. For more information on soil stabilizers see PM2f on page 18.

e. Limit the number of roads and access points used to help minimize soil disturbance, and to limit the risk of unintentionally transporting invasive plants into uninfested areas.

SD2: Implement erosion control practices.

a. Promptly revegetate and/or mulch disturbed soil after ground disturbing activities. This will stabilize soils and reduce the likelihood of invasive plant establishment. For more details on revegetation and erosion control see RL3 on page 33.

b. Use weed-free mulch, logging slash, native plant seed or a native or non-persistent cover crop as temporary cover during the delay between soil disturbance and revegetation.

c. Contain and manage water runoff, which may carry soil, seeds and plant material. Silt fences installed along perimeters of worksites can aid in preventing the spread of infested materials.

SD3: Manage existing topsoil and duff material to reduce contamination by invasive plants.

a. Save local existing topsoil for reuse. Plan topsoil management prior to soil disturbance.
   - Develop topsoil management plans on all projects that include grading or earthwork unless the topsoil and duff material are determined to be contaminated with invasive plants.
   - Identify on the plans where local topsoil and duff material, within the worksite, should be:
     - Removed or excavated
     - Stockpiled
     - Reapplied

b. When excavating local topsoil and removing duff material, minimize handling of the material to reduce detrimental impacts to soil microorganisms.

c. Stockpile local topsoil and duff material in windrows no taller than ten feet for local topsoil and five feet for duff. Implement temporary erosion control measures to reduce the likelihood of invasive plant establishment and loss of material. For erosion considerations see PM2 on page 18.

d. Seed local topsoil stockpiles that will remain in place for over six months with a fast-growing non-invasive native plant species to maintain soil microorganisms. Covering topsoil stockpiles with impermeable barriers such as plastic sheeting may destroy living soil microorganisms. For information on temporary cover materials see PM2f on page 18.

e. Monitor stockpiles of topsoil and duff material regularly as they are highly susceptible to invasion by invasive plants. Determine management needs based on presence of invasive plants.

Photo: Cindy Roessler, Midpeninsula Open Space District

Install wattles or erosion control mats to reduce soil erosion.

Chapter 8: Vegetation Management BMPs

Integrating prevention BMPs into vegetation management can greatly minimize the introduction and spread of invasive plants. For example, scheduling vegetation management activities prior to seed production can reduce the spread of invasive plants. Life cycles of both invasive and desirable plants should be considered when scheduling activities. Mowing invasive plants after seed production will promote seed dispersal and increase the size of infestations.

Vegetation management activities may include but are not limited to: mowing, manual clearing, trimming, mechanized clearing and trimming, herbicide application, prescribed grazing and burning.

Schedule mowing of invasive plants to minimize impact on desirable plants.
Photo: Noa Rishe, California State Parks, Angeles District

VM1: Schedule vegetation management activities to maximize the effectiveness of control efforts and minimize introduction and spread of invasive plants.

a. Consider the timing of invasive plant control efforts based on the plant's life cycle.
   - Schedule land-disturbing activities to occur prior to seed set to minimize spreading seeds. Keep in mind that seeds may be present in the soil.
   - Consider invasive plant reproductive biology and response to fire when planning prescribed burns.
   - Coordinate the timing of maintenance activities and invasive plant control activities. For example, delay mowing until two weeks after herbicide application and delay spraying after mowing until vegetative regrowth has occurred.

- Before excavating invasive plants from drainage ditches, treat the entire infestation to ensure that the plant parts will not spread to adjacent and downstream areas. Avoid side casting (piling excavated soil on either side of a trench when digging a drainage ditch) of accumulated road materials infested with invasive plants. Stockpile in one area that can be monitored.

b. For more details on scheduling see PL8 on page 13.

VM2: Manage vegetation with methods favorable to desirable vegetation.

a. Coordinate management of invasive plants and desirable plants.
   - Schedule mowing, clearing, trimming or grazing of desirable plants for after seed maturation, ensuring desirable plants grow unrestricted and produce seed.
   - Schedule management of invasive plants at early flowering stage (or well before seed development) to avoid spreading viable invasive plant seeds.

b. Limit mowing and other mechanical control to the minimum needed to control invasive plants.
   - To reduce plant shock and root dieback of desirable plant species, mowing height should not be less than six inches. Mowing too low during the growing season will increase soil exposure to sun, soil temperatures and erosion risks, and encourage invasive plant growth.

c. Identify conditions under which invasive plants should not be mowed to avoid spreading them. Some invasive plants have the ability to sprout from stem and root fragments. Mowing these plants should be avoided.

VM3: Retain existing desirable vegetation and canopy.

a. Identify and protect desirable vegetation on site to increase competition with invasive plants. Desirable vegetation should be non-invasive and suitable for the conditions.

b. Train personnel to identify invasive and non-invasive plants on-site. Provide identification guides to field staff.

c. Minimize clearing large amounts of vegetation and creating canopy openings. Increased sunlight and bare ground creates suitable habitats for invasive plant germination.

d. Consider the impacts of different types of equipment. Choose equipment that minimizes vegetation disturbance.

Photo: Noa Rishe, California State Parks, Angeles District

Flag native plants for avoidance before treating invasive plants.

Chapter 9: Revegetation and Landscaping BMPs

Revegetation and landscaping work is often derived from different needs and carried out by different staff or contractors. Revegetation is the process of replanting and rebuilding the vegetated community on disturbed land. Landscaping modifies land to meet functional, aesthetic and regulatory requirements. Despite the differences, revegetation and landscaping share the fundamental goal of creating weed-resistant plant communities.

Creating weed-resistant plant communities requires planning and a thorough understanding of site ecology including: existing soil condition, hydrology, exposure, existing plant community and habitat, invasive plant risk assessment, human impact, and the surrounding environment.

Plant native or desirable non-invasive plants to optimize resistance to invasive plant establishment. Photo: Jack Broadbent, California Department of Transportation

Plant selection is critical to successful revegetation projects. Revegetation and landscaping with desirable non-invasive plants suitable for local conditions can create weed-resistant communities that prevent or slow the establishment, growth, and reproduction of invasive plants. The following prevention BMPs are for revegetation and landscaping projects.
In addition to the following BMPs, also refer to related BMPS in:

- Chapter 2: Project Materials for procuring and managing erosion and project materials.

RL1: Develop revegetation and landscaping plans that optimize resistance to invasive plant establishment.

a. Identify areas where revegetation or landscaping is needed to improve invasive plant resistance of plant communities. Determine the goal of vegetation coverage. Evaluate annually for three years to determine if vegetation establishment is successful.

- Develop weed-resistant plant communities in disturbed areas such as roadsides. Consider using plants that have low growth forms, require no mowing, establish well, and are well adapted to disturbance.
- Revegetate or landscape with local native plants or appropriate non-invasive plants to prevent invasive plant introduction. Native species grown outside of the region may not establish well.

b. Evaluate existing soil type, texture and health to determine vegetation selection, fertilization and maintenance needs.

- Improve unhealthy soil by adding healthy topsoil, compost, fertilizer and/or using aeration to incorporate oxygen into the soil.
- Fertilization, if done improperly, can encourage weed growth and reduce the ability to establish native plants. Organic fertilizers are better suited for native plants because they release nitrogen at a very slow and stable rate.
- Do not fertilize areas treated with compost as the compost will provide the plants with the necessary micro-nutrients to support healthy growth. Compost should be supplied by participants in the US Compost Council's Seal of Testing Assurance Program. A list of current STA program participants is available at: http://compostingcouncil.org.
- If improving soil health is not possible, choose vegetation with low soil-nutrient requirements.

c. Develop a plant palette that will occupy various planting zones/ecological niches in order to create a weed-resistant landscape.

- Select plants, with the aid of a revegetation/landscaping specialist, based on existing soil conditions, drainage patterns, amount of rainfall or irrigation available, exposure and adjacent environment.
- Use native material to the greatest extent possible.

d. Encourage passive regeneration of native plant cover where site conditions permit and where the risk of introducing invasive plants is low.

e. Design irrigation systems with attention to irrigation timing, coverage and quantity to encourage the growth of desirable plants and discourage the growth of invasive plants. Too much water can stunt the growth of drought-tolerant plants and encourage undesirable invasive plants.

RL2: Acquire plant materials locally. Verify that species used are not invasive.

a. Identify sources of native and appropriate nonnative plant materials. Specify and use weed-free locally appropriate seed mixes that will occupy various niches in order to create weed-resistant plant communities.

b. Check seed label for purity, composition, source and germination. Confirm consistency with specifications. For seed label details see PM1 on page 16.

c. Use local native ecotypes when feasible. Native species grown outside of the region may not establish well. Consider contract growing of local native plants.

d. When using local native species is not feasible and the risk of invasive plant infestation is high, use locally grown, non-invasive species proven to grow well locally.

e. Do not plant invasive plants. Verify plant lists do not contain invasive plant species by checking Cal-IPC's invasive plant inventory (www.cal-ipc.org/ip/inventory/weedlist) and the local Agricultural Commissioner's Office.

f. Confirm that only selected plant species are used in the planting, especially when naming inconsistencies are possible.

g. Have extra plant materials on hand. Plan for mortality of 20-30% percentage of container plants.

RL3: Revegetate and/or mulch disturbed soils as soon as possible to reduce likelihood of invasive plant establishment.

a. Promptly revegetate and/or mulch disturbed areas, including new forest openings, with local native or non-invasive plants. For details on acquiring plant materials see RL2 on page 32.

b. Use proper horticultural practices to promote healthy root and foliage growth that will aid in the vegetation's ability to withstand adverse conditions and to compete with invasive plant growth.
   - Avoid use of fertilizer in areas with high infestations of invasive plants where fertilizer may favor growth and spread of invasive plants over desirable species.
   - Consider using compost or organic slow release fertilizer when planting native species. Excessive nitrogen availability promotes the growth of weedy annual grasses, which can dry out the site and crowd out slow-growing perennials.
   - Consider soil inoculation to improve establishment success for planted species. Inoculation refers to the adding of "inoculants" which are mycorrhizal fungi that help with moisture retention and soil/root relationships in the first year of establishment.

c. When revegetation is impossible, consider limited and judicious use of paving/hardscape or otherwise protecting the site using weed-free materials (gravel, logging slash, long-fiber mulch, decomposed granite), deep mulching or using a soil stabilizer. For more information on soil stabilizers see PM2f on page 18.

d. When using mulch:
   - Use weed-free mulch. For information on weed-free mulch see PM1 on page 16.
   - Consider fire risk at the application site. Some long-fiber mulches such as shredded redwood bark (gorilla hair) are highly flammable.
   - Apply mulch at the recommended thickness to suppress the establishment and growth of invasive plants. Ensure mulch remains on-site. Lighter mulches will blow away in areas prone to heavy wind; mulches can move if watering results in surface flow. Consider the use of tackifiers or biodegradable netting.
   - Supplement with additional mulch to retain thickness and effectiveness after it begins to decompose.

Photo: Jim Dempsey, California State Parks

Select plant materials from local sources. Verify that all plants selected are not invasive.

Chapter 10: Fire and Fuel Management BMPs

Wildfire is a natural part of California ecosystems, and the structure and composition of most of California's plant communities are dependent on the periodic occurrence of fire. However, it also has significant potential for creating conditions that aid the establishment or spread of invasive plants which can damage the state's ecosystems. Disturbance created by wildfire suppression activities and pre-fire fuel treatments can also inadvertently contribute to the spread of invasive plants. This chapter addresses the many steps that can be taken to limit invasive plant establishment or spread. However, it must first be stated that **in wildfire suppression, protection of life is the foremost goal. Implementation of the prevention measures described in this manual should not interfere with this goal.** As stated in federal policy, "the safety of firefighters and the public is the first objective on all fire management activities, followed by the protection of property and minimizing impacts to natural and cultural resources."

In addition to the prevention measures summarized in previous chapters, this chapter provides measures specific to wildfire management activities, with sections on: **1) fire management planning, 2) fuel management, 3) fire suppression,** and **4) post-fire activities**. These prevention measures should be considered even for prescribed burns, since they can also inadvertently contribute to the spread of invasive plants.

Fires can result in reduced competition for light, water and nutrients; invasive plants are poised to take advantage of such conditions. In the worst cases, fire and invasive plants form a positive feedback loop where wildfire increases invasive plants, which then alter the fire regime in ways that favor further invasive plant spread (e.g. increasing fire frequency or intensity). An example is the shift seen in some locations in Southern California, where invasive annual grasses are replacing native chaparral. Such major changes in vegetation can also greatly impact

Invasive plants can spread following the disturbance of fire. Photo: Garrett Dickman, Yosemite National Park hydrology, erosion, nutrient levels, and wildlife habitat. There is a strong tie between disturbance and invasive plant establishment and spread. Activities associated with fire and fuel management (for instance, cutting fuel breaks) can be a cause of disturbance, potentially facilitating the spread of invasive plants. Vehicles, personnel and materials (such as hay used for erosion control), can act as vectors for spreading invasive plant seeds. Fire managers working for land management organizations and agencies share the responsibility of managing public and private lands with other resource professionals and can play a key role in reducing the spread of invasive plants associated with fire management.

Preventing the spread of invasive plants by fire and fire-related management activities requires an assessment of land management goals and an understanding of how resident plant communities and species (both native and non-native) will respond to fire and the post-fire environment. Tools such as the Fire Effects Information System website (www.fs.fed.us/database/feis/) and the *A Manual of California Vegetation* and *Fire in California's Ecosystems* can help land managers learn the specific invasive plants of their region and how they are likely to interact with fire in California ecosystems. Additional resources are listed in the Fire and Fuel Management Resources on page 63.

Photo: S. Kocher, UC Cooperative Extension

Wildfire is a natural part of California ecosystems. The structure and composition of most California plant communities are dependent on the periodic occurrence of fire.

10.1 Fire Management Planning BMPs

Fire management activities include fuel management, fire suppression, and post-fire activities. A fire management plan provides the basis for communication, coordination, and project planning with partner agencies. Because fire, fire management, and invasive species all impact each other, natural resource managers should consider wildfire implications when designing invasive plant management programs, and consider invasive plant implications when designing wildfire management programs.

Because agencies conducting fire management activities do not always have jurisdictional authority over all of the properties that are relevant to fire management, it is important for all entities involved to work together in developing integrated fire and land management plans. Cooperative Agreements can be an effective way to establish allowable techniques for each property and include property owners in planning efforts.

It is essential that land managers understand the relationship between fire, plant communities and invasive plants in order to effectively integrate fire management activities into overall land management planning. Awareness building and training on invasive plant prevention can be integrated into fire management planning without interfering with fire management priorities.

In addition to the following BMPs, also refer to related BMPs in:

- Chapter 1: Planning BMPs for integrating prevention BMPs into land and fire management activities.

Coordinate mapping efforts for invasive plant management with mapping efforts for wildfire management to the extent possible. Photo: Forest Schafer, North Lake Tahoe Fire Protection District

FP1: Consider wildfire implications when setting overall priorities for invasive plant management programs.

a. Identify areas most susceptible to future wildfires and identify invasive plant populations within these areas. Evaluate the likely effects of wildfire on invasive plant populations and invasive plants on wildfires in these areas. Utilize this information in setting invasive plant management priorities with the intent to prevent future spread of existing populations.
   - To the extent feasible, coordinate mapping efforts for invasive plant management with mapping efforts for wildfire management.
   - For fire effect information for specific species, see the USDA Forest Service's Fire Effect Information System (FEIS) website (www.fs.fed.us/database/feis/).
   - Identify priority areas for invasive plant management. Refer to the Prioritizing BMP Implementation on page 5.

Evaluate high-potential wildfire areas where prescribed burns can be used to benefit native plant communities and species while proactively reducing the threat of invasive plant spread following a wildfire in that area.

Fire crew staging at a low elevation site for mobilization to wildfire at higher elevation. Helibases, fire camp and staging areas infested with invasive plants can be a vector of spreading invasive plants.

Photo: Athena Demetry, Sequoia and Kings Canyon National Parks

FP2: Integrate invasive plant prevention into fire management plans.

a. Use an interdisciplinary team when developing fire management plans, in order to address preventing the spread of invasive plants. Include those versed in other disciplines, such as botanists, endangered species specialists, soil scientists, hydrologists, and GIS specialists.

b. Include invasive plant prevention priorities identified in land management plans when developing fire management plans. These priorities should ideally be coordinated with existing local invasive weed committees and incorporated into an Integrated Pest Management (IPM) plan.

c. Include actions to prevent invasive plant spread in all levels of fire and fuel planning documents where appropriate. For instance, integrate appropriate measures into:
   - Fire and fuel management plans
   - Suppression Repair Plans
   - Burned Area Emergency Response (BAER) plans
   - Burned Area Rehabilitation (BAR) plans
   - Wildland Fire Decision Support System (WFDSS) protocol
   - Community Wildfire Protection Plans (CWPPs) for private lands in the Wildland-Urban Interface (WUI)
   - Minimum Impact Suppression Tactics (MIST).

d. Ensure wildfire infrastructure areas (existing or planned) are invasive plant free.
   - Initiate the establishment of a network of helibases and potential fire camp and staging areas that can be maintained in an acceptably invasive plant-free condition. Identify potential cleaning stations for those entering and leaving these areas.
   - Identify water sources infested and uninfested with aquatic and terrestrial invasive plants. Map acceptable and contaminated water sources and ensure this information is available to resource advisors and fire personnel.

e. Integrate equipment cleaning BMPs into planning for fire management activities. See PL9 on page 13.

f. Encourage sound forestry and range management practices to maintain healthy, vigorous overstory vegetation (where appropriate), which generally tends to "shade out" invasive species. Healthy forest and rangeland is typically less susceptible to intense burning conditions in the event of wildfire.

Photo: Forest Schafer, North Lake Tahoe Fire Protection District

Incorporate invasive plant information in existing fire and fuel management training.

g. Ensure that the use of fire retardant is discussed within the fire management plan. Consider the impacts of fire retardant on soil fertility.

FP3: Provide training in preventing the spread of invasive plants.

a. Include invasive plant awareness and prevention in existing fire and fuel management training.. Consider the best ways to provide information to Resource Advisors, Incident Management Teams, and agency leadership. Include information in regular trainings such as employee orientation and annual refresher courses.

b. Include consideration of invasive plant risk factors and implementation of prevention practices in Resource Advisor duties on all Incident Management teams and Burned Area Emergency Response teams.

FP4: Plan to utilize weed-free materials for post-fire activities.

a. See Chapter 2: Project Materials on page 15.

b. Consider development of as-needed contracts for weed-free materials. For example, contracting for specialized weed-free materials can take weeks to months—a timeframe that exceeds most fire emergency rehabilitation and suppression repair projects. If contracts are in place prior to fire suppression, it is more likely that weed-free materials can be effectively acquired. As-needed contracts are commonly used in other fire management activities (e.g. water tankers, helicopters, fuel management crews).

c. Consider stockpiling native and appropriate nonnative seed for use in post-fire activities. Like weed-free materials, the time needed for contracting and acquisition of seed can exceed the timeframe of most fire emergency rehabilitation and suppression repair projects.

Photo: S. Kocher, UC Cooperative Extension

Have weed-free materials ready for use in post-fire activities.

10.2 Fuel Management BMPs

Fuel management is designed to change future fire behavior, to contain fires, or to reverse negative ecosystem changes. Fire-adapted ecosystems, like those in California, will change in unnatural ways when fire is excluded. Fuel management can be used to counteract these changes so that fires are less destructive. Fuel management activities typically involve the thinning or removal of understory vegetation and the rearrangement or removal of surface fuels. Methods used in fuel management include prescribed fire, mechanical or hand thinning, mechanical mastication, machine piling, pile burning, and chipping. This work happens in both wildlands and the Wildland-Urban Interface (WUI), where property owners are often required to maintain significant safe space around structures.

Fuel management activities, themselves a type of disturbance, can potentially impact the introduction, establishment and spread of invasive plants. Vegetation clearing and soil disturbance can provide openings for invasive plants. Thus it is important to include an assessment of this potential when designing fuel management activities. There is significant variability in impact depending on ecosystem. Fuel management that reduces disturbance while meeting overall fuel management objectives can reduce the risk of introduction or spread of invasive plants. It is important to consider both human-caused factors and environmental conditions that influence invasive plant spread when developing fuel management plans.

When planning fuel management activities, consider environmental conditions that influence invasive plant spread. Photo: Forest Schafer, North Lake Tahoe Fire Protection District

The best management system for maintaining native plant diversity is likely one that mimics natural disturbance processes (including the characteristic fire regime) of the frequency, intensity, and duration of fire with which native species evolved. When this is not possible (such as when the natural disturbance is stand-replacing fire and the area is in the WUI), managing for general resiliency to climate change, fire, and invasion may be the best option. The complex and diverse ecosystems in California may require a mosaic of diagnostic and prescriptive actions to effect best management results.

In addition to the following BMPs, also refer to related BMPs in:

- Chapter 8: Vegetation Management for general prevention measures.
- Chapter 6: Waste Disposal for managing invasive plant disposal on-site and off-site.

FM1: Incorporate invasive plant considerations when developing fuel management plans.

a. Use an interdisciplinary team when developing fuel management plans, in order to address preventing the spread of invasive plants. Include those versed in other disciplines, such as botanists, endangered species specialists, soil scientists, hydrologists, and GIS specialists that are knowledgeable about invasive plants and native plant life histories. This may necessitate partnering with other agencies or organizations.

b. Survey for invasive plants to create baseline data for fuel treatments. Make sure survey data from local and state resource agencies is available and integrated.

c. Have a set of clear target conditions for vegetation and fuel. When developing these target conditions, consider both the effects of fuel treatments on invasive plants and native plants, and the effects of invasive plants on fuel treatments.

d. Assess both human-caused factors and environmental conditions that influence invasive plant spread when developing fuel management plans.

Photo: Kathy VanZuuk, National Forest

Invasive plants can spread after implementing fuel reduction/prescribed burn in areas where invasive plants were initially present.

Photo: Forest Schafer, North Lake Tahoe Fire Protection District

Include invasive plant considerations as a part of community outreach for fuel reduction projects.

- Human-caused factors include:
  - Fuel break construction methods
  - The scale of fuel breaks
  - Maintenance methods
  - Maintenance frequency
  - Connectivity to roads and trails (e.g. distance to roads and road level)
  - Extent of private inholdings in a given area
  - Fire regime changes
- Environmental conditions:
  - Proximity to populations of invasive plants
  - Overstory canopy cover
  - Litter cover, rock cover, duff depth, and bare ground
  - Vegetation type
  - Elevation
  - Slope
  - Fire regime
  - Climate change
- For information on conducting a site assessment on invasive plant infestation, see PL7 on page 12.

e. In prioritizing fuel treatment activities, consider site-specific information on the following in addition to target conditions like habitat integrity and fuel load:
- The role of invasive plants in preventing the achievement of target conditions (or vegetation management goals)
- The role of invasive plants in affecting the fire regime.

Photo: Forest Schafer, North Lake Tahoe Fire Protection District

Burned and unburned areas after a prescribed burn. Fuel management activities are themselves a type of disturbance, which can create openings for invasive plants.

f. For details on preventing invasive plant spread during vegetation management, see Chapter 8: Vegetation Management on page 29.

g. For all types of fuel treatment projects (e.g., prescribed burning, thinning and pile burning) where the potential for introduction or spread is moderate to high as a result of implementation, remove high risk areas from the project footprint, develop a pre-fire treatment prescription (including any post-fire mitigation/follow-up), or incorporate project design features to reduce the risk of spreading or introducing invasive plants.
   - Focus on invasive plant species that have been identified as local early detection priorities. For more information, see CalWeedMapper (www.calweedmapper.calflora.org).
   - Learn about how fire affects the particular species of interest. For more information, see FEIS (www.fs.fed.us/database/feis/).

h. Develop outreach and education information for adjacent property owners and fire safety councils about the effects of fuel treatments on invasive plants, and BMPs to reduce spread of invasive plants on their own property and nearby wildlands.

FM2: Maintain active management of invasive plants on fuel management sites.

a. Implement ongoing Integrated Pest Management (IPM) activities for all fuel management sites to keep invasive plants from spreading.

b. Capitalize on opportunities for coordinating efforts with those focusing on invasive plant management. There may be opportunities for supporting invasive plant management goals as well as fuel reduction goals through the efforts of multiple parties. Any activities that are counterproductive to one set of goals can be identified and revised.

FM3: Reduce disturbance when implementing fuel management activities.

a. Maintain shaded fuel breaks, where appropriate, in key fire suppression areas to reduce the need for bulldozing and cutting operations during emergency fire suppression.

b. To prevent the spread of invasive plants, remove only enough vegetation and ground cover to accomplish the fuel management and resource objectives.
   - Construct fuel breaks no wider than necessary to accomplish fuel reduction and resource objectives.
   - Remove vegetation adjacent to prescribed fire control lines only as needed to prevent additional fire spread or for safety and access.
   - For more information on preventing invasive plant spread during vegetation management, see Chapter 8: Vegetation Management on page 29.

c. Favor thinning techniques that do not result in ground disturbance—such as hand thinning, thinning using a chainsaw, mowing, or mastication—over techniques that result in ground disturbance—such as grapple piling or blading, whenever this can be done with no loss in fuel management effectiveness.
   - Ground disturbance can promote invasive plant establishment and spread. Reduce soil disturbance. See Chapter 7: Soil Disturbance on page 27.

If heavy equipment is required, use equipment with less exerted ground pressure per square inch to reduce soil compaction.

- If heavy equipment is required for thinning, use alternative mechanized equipment with greater reach or less exerted ground pressure per square inch to reduce soil compaction or the total area disturbed.
- Mow fuel breaks before invasive plants set seeds to prevent spread. For details on mowing, see VM2 on page 30.

d. Transition vegetation (trees or shrub) removal in such a way that invasive plants are less likely to become established in the interior of the fuel break or fuel management unit. For instance, when working along roads, thin vegetation in the fuel break to a minimum level in order to meet fuel objectives, thus providing a potential vegetative barrier (i.e., competition) to reduce the spread of invasive plants from the roadside to the interior.

e. Where fuel reduction and resource objectives necessitate ground disturbance and soil exposure, or substantial ground cover and canopy removal, include appropriate revegetation or invasive plant management strategies in the fuel treatment plan.
   - Rehabilitate/restore or treat disturbed areas after fuel management activities and conduct follow up monitoring on these areas susceptible to invasive plant spread.
   - Cover and reduce exposure of bare ground. Use on-site chipping or treated fuels from mastication.

FM4: Incorporate invasive plant considerations when using prescribed fire.

a. Use both invasive species-specific and site-specific knowledge when assessing the use of fire on invasive plants. Consider invasive plant biology/life cycle, site conditions, plant community composition and distribution, and fire regime.

b. Consider follow-up treatments including mechanical, chemical or re-vegetating areas treated with fire.

c. When feasible, reduce the amount of control line construction and associated soil disturbance during prescribed burning, and plan for rehabilitation where necessary. For details on control line construction, see FM3 on page 42.

d. Incorporate invasive plant information into pre-burn briefings when needed.

e. When using prescribed fire to control invasive plants, burning should be integrated into an Integrated Pest Management (IPM) prescription. Evaluate the potential impact when using fire to control invasive plants. When planning to use herbicide treatments in concert with the burn, submit pesticide use permit applications with enough lead time to secure permission prior to implementing a prescribed burn.

10.3 Fire Suppression BMPs

Firefighter and public safety is the first priority in every fire management activity. Along with resource management objectives and the ability to hold a fire line, human safety should dictate fire suppression strategy and tactics including line placement. After human safety has been accounted for, land managers should attempt to incorporate invasive plant prevention measures into fire suppression activities in order to reduce post-fire resource impacts. Fire suppression activities can spread and promote the establishment of invasive plants by disturbing soil, dispersing plant parts and seeds, and altering plant nutrient availability. For example, simple prevention practices include cleaning vehicles, equipment, clothing and gear between activity areas and avoiding invasive plant populations when constructing indirect fire lines or locating activity areas, such as staging areas.

After human safety has been accounted for, attempt to incorporate invasive plant prevention measures into fire suppression activities. Photo: Martin Hutten, Lassen National Park

In addition to the following BMPs, also refer to related BMPs in:

- Chapter 4: Tool Equipment and Vehicle Cleaning for cleaning protocols.
- Chapter 5: Clothing, Boots and Gear Cleaning for cleaning protocols.
- Chapter 7: Soil Disturbance for erosion control measures.

FS1: Develop operational procedures related to fire suppression to reduce the spread of invasive plants.

a. Incorporate the following into the Delegation of Authority given to the Incident Commander:
   - The importance of invasive plant prevention
   - The techniques to be used to prevent the spread of invasive plants

b. Incorporate prevention awareness information and operational practices in the Incident Action Plan (IAP).

c. Encourage Resource Advisors to consider invasive plant issues as part of their focus on every incident.

d. When feasible, plan travel routes to avoid spreading invasive plants from infested to non-infested areas. For details on travel route planning, see Chapter 3: Travel on page 19.

e. Develop standardized invasive plant prevention direction for use in the Wildland Fire Decision Support System (WFDSS) and make it readily available to Agency Representatives. Ensure that the direction is consistent with relevant resource and wildland fire management plans. Include incident-specific invasive plant information in the WFDSS, as needed.

FS2: Locate indirect fire lines to reduce additional disturbance and invasive plant spread where feasible.

a. Safety and holding ability remain the priority motivation for any fire line location; however, when feasible, place indirect fire lines in areas free of invasive plants.

b. Provide the Resource Advisors, the Field Observer or other appropriate personnel (crew bosses, Incident Commander, Division Supervisors, etc., depending on the size of the incident organization) with priority invasive plant identification aids and maps.

c. Tie fire lines into pre-existing fuel breaks and managed fuel zones. Use existing natural and man-made breaks (lakes, streams, roads, trails, etc.) when feasible.

d. As feasible, keep ground disturbance to a minimum.

Photo: Jeanne Pincha-Tulley, Tahoe National Forest

Soil disturbance can facilitate invasive plant spread. Where feasible, locate indirect fire lines to reduce additional disturbance.

FS3: Locate fire activity areas in locations free of invasive plants where feasible.

a. Fire activity areas include:
- Incident Base Camp and staging areas
- Fire crew camps, including spike camps
- Helibases
- Drop points
- Parking areas

b. Coordinate with the Resource Advisor in choosing fire activity areas with the most reasonable qualities of resource protection and safety concerns.
- Use pre-approved infrastructure when available. For details, see FP2d on page 38.
- Map fire activity areas for post-fire invasive plant monitoring.

c. Keep fire activity areas free of invasive plants.
- Incorporate cleaning stations in fire activity areas for equipment, personnel and vehicles.
- For BMPs on keeping activities areas clean, see PL9 and PL10 on page 13 and 14.

d. Where situations dictate that the fire activity areas must be located on a site infested with invasive plants, take actions to reduce the spread of invasive plant seeds. Examples include:
- Consider flagging, fencing, or placing cones at the perimeters of invasive plant populations to keep people out.
- Consider mowing or otherwise treating invasive plants.
- Designate travel routes to avoid invasive plants.
- Clean equipment before leaving infested sites.

e. For more information on worksite management, see PL10 on page 14.

FS4: Clean vehicles, equipment, clothing and gear before arriving and leaving fire activity areas.

a. For detailed recommended cleaning protocols, see:
- Chapter 4: Tool Equipment and Vehicle Cleaning on page 21
- Chapter 5: Clothing, Boots and Gear Cleaning on page 23
- Checklist E: Inspection and Cleaning on page 43


Photo: Garrett Dickman, Yosemite National Park

Clothing, personal protective equipment, and hand tools can spread invasive plants. Clean them between fire activity areas when feasible.


Photo: Julie Nelson, Shasta-Trinity National Forest

Remove dirt from the undercarriage of vehicles prior to entering and existing fire activity areas.

b. Inspect and clean equipment and vehicles during check-in and before demobilization from fires, especially if vehicles have been traveling from out-of state, off-road, or through areas infested with invasive plants. The following are examples only and don't represent the entire list of equipment that potentially could need to be cleaned:
   - Keep fire hoses clean and free from invasive plant parts when feasible.
   - Inspect helicopter nets for invasive plant parts and seeds. Bundle and store nets in areas free of invasive plants. Consider spreading nets on clean tarps or concrete/asphalt pads, so nets can be inspected, loaded and bundled up for storage in a weed-free state.
   - Inspect and remove weed seed and plant parts from cargo nets and other external loads.

c. Prior to arriving and leaving a fire, clean equipment. For example:
   - Personal belongings (e.g., boots, clothes, sleeping bag, tent)
   - Personal Protective Equipment (PPE) (e.g., gloves, helmet, goggles, fire pack, fire shelter)
   - Back-pack pumps
   - Hand tools (e.g., shovels, pulaskis, axes, fire rakes, and hoes).

FS5: Use water sources free of invasive plants for fire suppression when feasible.

a. Avoid use of water sources known to contain aquatic invasive plants to prevent the spread of aquatic invasive plants to other water bodies.

b. Avoid moving water on the surface of vehicles, tools and equipment from infested water sources to water sources that are not infested with invasive plants. Inspect and clean equipment prior to use in another water body.

c. Any equipment that draws water from one water source should not be drained into another water source. Flush equipment, such as portable pumps and hoses, with clean water between


Photo: Athena Demetry, Sequoia and Kings Canyon National Parks

Stage gear on tarps to avoid contact with invasive plants prior to loading and transport.


Photo: Jeanne Pincha-Tulley, Tahoe National Forest

Aquatic invasive plants can spread through water-drafting equipment, tools and vehicles. Use water sources free of invasive plants and clean equipment between water bodies when feasible.

10.4 Post-Fire Activity BMPs

uses and between fire activity areas.

Post-fire activities include four phases: Suppression damage repair, burned area emergency response (BAER), burned area rehabilitation (BAR), and restoration.

- Suppression damage repair is focused on restoring fire lines and features that were damaged by the fire suppression activities. Activities include rehabilitating fire line and staging areas, fixing roads and fences, etc.
- BAER is aimed to protect life and property from post-fire events. BAER is implemented to prevent erosion, stabilize soil, and minimize damage from post-fire flooding immediately after wildfires to prevent further damage to life, property, water quality and deteriorated ecosystems.
- BAR is implemented to restore ecosystems and repair damage caused by fire. Activities include the repair or improvement of fire-damaged lands that are unlikely to recover naturally, or repair of minor facilities damaged by fire.
- Restoration is the long term land management program.

Activities conducted for these purposes can result in invasive plant spread. Vehicles, equipment, erosion control, revegetation materials, humans, livestock, and support animals, can inadvertently spread invasive plant parts and seeds.

The effects of fire on invasive plant spread can also vary depending on the biology of the native vegetation, the level of disturbance, and the habitat condition. A ready-to-use burned-area integrated invasive plant management plan that is consistent with long term land management objectives will help identify priority areas for invasive plant monitoring, the appropriate treatments and prevention measures for post-fire activities.

Cover bare ground with non-invasive plants or weed-free erosion control materials as soon as possible following a fire. Photo: S. Kocher, UC Cooperative Extension

In addition to the following BMPs, also refer to related BMPs in:

- Chapter 2: Project Materials for procuring and managing erosion control and revegetation materials on page 15.
- Chapter 4: Tool, Equipment and Vehicle Cleaning for cleaning protocols on page 21.
- Chapter 5: Clothing, Boots and Gear Cleaning for cleaning protocols on page 23.
- Chapter 9: Revegetation and Landscaping for general prevention measures on page 31.

PF1: Manage access to burned areas.

a. Use an interdisciplinary team to determine when activities (including public access, agency work, and grazing, etc.) may resume in burned areas. The team should include natural resource staff knowledgeable about invasive plants.

b. Consider how vehicles can spread invasive plants and how to reduce their risk. For example, close public access to burned areas temporarily to reduce the risk of introduction and spread of invasive plants.

c. Restrict travel to established roads and trails to avoid compacting soil. Off-road travel could reduce the recovery of desired plants and will create additional disturbance or act as invasive plant vectors.
   - Examples include: Block access to fire lines to prevent vehicles from traveling on them. Place sufficient soil, downed trees, slash, root wads, or boulders to block vehicle access and to slow the flow of water, both of which may carry seeds of invasive plants.

d. Manage human, pack animal, and livestock entry into burned areas until desirable vegetation has recovered sufficiently to resist invasive plant establishment.

e. Consider deferring livestock grazing in burned areas until vegetation has successfully reestablished.
   - Grazing removes plant biomass, reduces levels of competition, and increases the availability of soil nutrients, thus increasing the potential for invasive plant establishment. Grazing also increases soil disturbance, thus creating a seed bed for invasive plants.
   - Grazing Management Plans and permits should emphasize the potential recovery times for burned areas to reduce conflict with permitees.

f. For additional information on access, see Chapter 3: Travel on page 19.

PF2: Use weed-free materials during post-fire activities.

a. When procuring seeds, soil stabilization and revegetation materials, see Chapter 2: Project Materials on page 15.

b. When acquiring local plant materials, see Chapter 9: Revegetation and Landscaping on page 31.

Photo: S. Kocher, UC Cooperative Extension

Use local native plant materials for revegetation.

PF3: Cover and rehabilitate soil disturbed by suppression activity.

a. Cover bare soil that results from fire lines by pulling duff, litter, and cut material back over lines as soon as possible, or by using weed-free mulch (e.g., hydromulch, chipped fuels).

b. Implement erosion control practices. See SD2 on page 28.

c. Encourage the reestablishment of native vegetation by limiting soil disturbance and ensuring invasive plants do not become established.
   - Consider planting locally collected, genetically appropriate, native species to compete with invasive plants.
   - For details, see Chapter 9: Revegetation and Landscaping on page 31.

d. Limit soil disturbance during post-fire activities.

Photo: S. Kocher, UC Cooperative Extension

Erosion control with weed-free materials post-fire is important for reducing invasive plant spread.

e. For details on rehabilitating disturbed soil, see RL3 on page 33.

PF4: Develop and implement post-fire integrated invasive plant management prescriptions.

a. Develop both short-term and long-term treatment prescriptions (including monitoring) to manage invasive plants.

b. Work with a local invasive plant specialist to develop and review BAER reports.

c. Concentrate prevention efforts in high risk areas:

- Areas highly susceptible to invasive plants establishment and spread include:
    - Areas where invasive plants are already present
    - Wet areas (creeks, seeps, meadows, and seasonal streams)
    - High severity burn areas (high overstory mortality, exposed mineral soil)
    - Burn areas adjacent to roads and trails
- Areas disturbed by fire suppression activities:
    - Dozer/hand lines (especially where they intersect pre-existing roads or trails)
    - Drop points/sling sites
    - Retardant drops
    - Fire activity areas
- Transportation corridors
    - Roads and trails
- Perpetually disturbed areas
    - Campgrounds, dumpsters, and parking lots
    - Residential areas

d. Secure funding to inventory and treat invasive plants, such as BAER and BAR funding.

e. Inspect, evaluate, control and monitor invasive plants at all fire activity areas as needed.

- Inspect for and map establishment and spread of invasive plants:
    - At fire access roads, cleaning sites, fire lines, staging areas, observation points, sling road sites, safety zones, and within areas affected by fire suppression activity (e.g., riparian areas, fire activity areas, etc.).
    - For more information on conducting a site assessment for invasive plant infestations, see PL7 on page 12.
- Evaluate invasive plant status and risks.
    - For additional suggestions on areas and species to prioritize, see Prioritizing BMP Implementation on page 5.
- Control invasive plants.
    - Practice early detection and rapid response

Photo: Garrett Dickman, Yosemite National Park

Practice early detection and rapid response during the first 5-10 years following fire to detect and control new populations of invasive plants within the fire area.

during the first 5-10 years following fire to detect and control new populations of invasive plants within the fire area.

    - Control infestations to prevent spread within burned areas; control nearby infestations to prevent spread into burned areas.
    - For a list of reference on invasive plant control and management, see General Resources on page 61.

- Monitor for new infestations of invasive plants.
    - Monitoring needs to determine whether objectives of the management actions have been achieved and the retreatments if objectives have not been met.
    - Monitoring will sometimes extend to secondary effects (i.e., the influence of fuel management on fuel characteristics, and ultimately on fire behavior and fire regimes).

PF5: Revegetate burned areas to reduce the spread of invasive plants.

a. Determine soon after a fire whether revegetation is needed to speed recovery of a desirable native plant community, or whether desirable plants in the burned area will recover naturally.

b. Secure funding and revegetate areas vulnerable to invasive plants (e.g. areas that are near existing populations of invasive plants, intersections of dozer lines with road systems).

c. Avoid use of fertilizer. Supplemental nutrients may favor growth and spread of invasive plants.

d. For details, see Chapter 9: Revegetation and Landscaping, on page 31.

e. Create a monitoring plan for revegetation.
    - Monitor burned areas until desirable vegetation is established. Burned areas may be susceptible to weed infestation for 5-10 years or more.
    - For more details on monitoring, see PL11 on page 14.

Photo: Garrett Dickman, Yosemite National Park

Determine soon after a fire whether revegetation is needed to speed recovery of a desirable native plant community, or whether desirable plants in the burned area will recover naturally.

Checklist Introduction

The following checklists contain only the BMP statements to provide a quick and portable reference for field activities. Checklists A, B, C and D are organized by land management activities, and Checklist E is organized by items to inspect and clean. These checklists can be attached to a field notebook, clipboard, or corkboard in an office for easy reference. BMP selection depends on the particular nature of the project or conditions. Land managers are encouraged to modify and develop their own invasive plant prevention checklists according to their specific needs.

Checklist A: Site Assessment, Field Mapping & Monitoring
This checklist is designed for those who perform site assessments, field mapping and monitoring.

Checklist B: Routine Vegetation Management
This checklist is designed for those who perform routine vegetation management.

Checklist C: New Project - Planning
This checklist is designed for those who perform planning tasks for new projects.

Checklist D: New Project - Implementation
This checklist is designed for those who perform pre-activity and implementation tasks for new projects. Some of these tasks include pre-work training, scheduling and revegetation and landscaping.

Checklist E: Inspection & Cleaning
This checklist is designed for use before entering and leaving worksites and should be used when acquiring inspection and cleaning equipment.

Key to BMP Chapter Acronymns

CB – Clothing, Boots and Gear Cleaning BMPs, Chapter 5, page 23

FM – Fuel Management BMPS, Chapter 10.2, page 40

FP – Fire Management Planning BMPs, Chapter 10.1, page 37

FS – Fire Suppression BMPs, Chapter 10.3, page 44

PF – Post-Fire Activity BMPs, Chapter 10.4, page 47

PL – Planning, Chapter 1 , page 9

PM – Project Materials, Chapter 2 , page 15

RL – Revegetation and Landscaping, Chapter 9 , page 31

SD – Soil Disturbance, Chapter 7 , page 27

TE – Tools, Equipment and Vehicle Cleaning, Chapter 4 , page 21

TR – Travel, Chapter 3 , page 19

VM – Vegetation Management, Chapter 8 , page 29

WD – Waste Disposal, Chapter 6, page 25

Checklist A: Site Assessment, Field Mapping & Monitoring							
BMP #	**Best Management Practice**	Project Manager	Field Supervisor	Crew	Contractor	Completed	Comments
BEFORE YOU START							
Planning							
PL6	Provide prevention training and appropriate invasive plant identification resources to staff and contractors prior to starting work.						
PL7	Review internal documentation and consult local groups and online resources for information on existing invasive plant infestations on and near worksite.						
PL8	Schedule activities to minimize potential for introduction and spread of invasive plants.						
PL9	Integrate cleaning BMPs into planning for land management activities.						
PL10c	Treat invasive plants at access roads and staging areas before using them.						
CB1	Plan to wear clothing, boots and gear that do not retain soil and plant material.						
Travel							
TR1	Plan travel to reduce the risk of invasive plant spread (avoid travel through infested areas, and travel from clean to infested worksites).						
TR2	Integrate cleaning activities into travel planning.						
Inspection & Cleaning							
TE1 & CB2	Designate cleaning areas for tools, equipment, vehicles, clothing, boots and gear.						
TE2 & TE3	Inspect and clean soil and plant materials from tools, equipment, and vehicles before entering the worksite.						
DURING							
Inspection & Cleaning							
TE2 & TE3	Inspect and clean soil and plant materials from tools, equipment, and vehicles before leaving the worksite.						
CB3	Clean clothing, footwear and gear before leaving the worksite.						
TE4	Clean livestock and support animals.						
Soil Disturbance							
SD1	Minimize soil disturbance.						

Checklist B: Routine Vegetation Management

BMP #	Best Management Practice	Project Manager	Field Supervisor	Crew	Contractor	Completed	Comments
BEFORE YOU START							
Planning							
PL6	Provide prevention training and appropriate invasive plant identification resources to staff and contractors prior to starting work.						
PL7	Conduct a site assessment for invasive plant infestations before carrying out field activities.						
VM1	Schedule vegetation management activities to maximize the effectiveness of control efforts and minimize introduction and spread of invasive plants.						
PL9	Integrate cleaning BMPs into planning for land management activities.						
PL10c	Treat invasive plants at access roads and staging areas before using them.						
CB1	Plan to wear clothing, boots and gear that do not retain soil and plant material.						
Travel							
TR1	Plan travel to reduce the risk of invasive plant spread (avoid travel through infested areas, and travel from clean to infested worksites).						
TR2	Integrate cleaning activities into travel planning.						
Inspection & Cleaning							
TE1 & CB2	Designate cleaning areas for tools, equipment, vehicles, clothing, boots and gear.						
TE2 & TE3	Inspect and clean soil and plant materials from tools, equipment, and vehicles before entering the worksite.						
Waste Disposal							
WD1	Designate waste disposal areas for invasive plant materials.						

Checklist B: Routine Vegetation Management *(continued)*

BMP #	Best Management Practice	Project Manager	Field Supervisor	Crew	Contractor	Completed	Comments
DURING							
Inspection & Cleaning							
TE2 & TE3	Inspect and clean soil and plant materials from tools, equipment, and vehicles before leaving the worksite.						
CB3	Clean clothing, footwear and gear before leaving the worksite.						
TE4	Clean livestock and support animals.						
Vegetation Management							
VM2	Manage vegetation with methods favorable to desirable vegetation.						
VM3	Retain existing desirable vegetation and canopy.						
Soil Disturbance							
SD1	Minimize soil disturbance.						
SD2	Implement erosion control practices.						
Waste Disposal							
WD2	Render invasive plant material nonviable when keeping it on-site.						
WD3	When disposing of invasive plant material off-site, contain it during transport.						
Monitoring							
PL11	Monitor the site for invasive plants after land management activities.						

Checklist C: New Project - Planning

BMP #	Best Management Practice	Project Manager	Field Supervisor	Crew	Contractor	Completed	Comments
PL2	Include invasive plant risk evaluation as a component of initial project planning and environmental analysis.						
PL3	Integrate invasive plant prevention BMPs into design, construction, vegetation management and maintenance planning activities.						
PL4	Coordinate invasive plant prevention efforts with adjacent property owners and local agencies.						
PL5	Develop monitoring plans for BMP implementation and effectiveness.						
PL9	Integrate cleaning BMPs into planning for land management activities.						
PL11	Designate staff to monitor the worksite for invasive plants after land management activities.						
RL1	Develop revegetation and landscaping plans that optimize resistance to invasive plant establishment.						
PM1	Plan to use a weed-free source for project materials.						

Checklist D: New Project - Implementation

BMP #	Best Management Practice	Project Manager	Field Supervisor	Crew	Contractor	Completed	Comments
BEFORE YOU START							
Training & Scheduling							
PL6	Provide prevention training and appropriate invasive plant identification resources to staff and contractors prior to starting work.						
PL8	Schedule activities to minimize potential for introduction and spread of invasive plants.						
TR1	Plan travel routes to reduce the risk of invasive plant spread.						
TR2	Integrate cleaning activities into travel planning.						
Site Preparation							
PL7	Refer to site assessment for locations of invasive plant infestations before carrying out field activities.						
PL10a	Protect likely invasive plant introduction sites such as pull-outs, trailheads, campgrounds and parking lots by mulching, planting or paving.						
PL10c	Treat invasive plants at access roads and staging areas before using them.						
Project Materials							
PM1	Acquire weed-free project materials.						
PM2	Prevent invasive plant contamination of project materials during transport.						
RL2	Acquire plant materials locally. Verify that species used are not invasive.						
Inspection & Cleaning							
CB1	Select clothing, boots and gear that do not retain soil and plant material.						
TE1 & CB2	Designate cleaning areas for tools, equipment, vehicles, clothing, boots and gear.						
TE2 & TE3	Inspect and clean soil and plant materials from tools, equipment, and vehicles before entering the worksite.						
Waste Disposal							
WD1	Designate waste disposal areas for invasive plant materials.						

Checklist D: New Project - Implementation *(continued)*

BMP #	Best Management Practice	Project Manager	Field Supervisor	Crew	Contractor	Completed	Comments
DURING							
Inspection & Cleaning							
TE2 & TE3	Inspect and clean soil and plant materials from tools, equipment, and vehicles before leaving the worksite.						
TE4	Clean pack, grazing and support animals.						
CB3	Clean clothing, footwear and gear before leaving the worksite.						
Project Materials							
PM1	Use a weed-free source for project materials.						
PM2	Prevent invasive plant contamination of project materials when stockpiling and during transport.						
Vegetation Management							
VM2	Manage vegetation with methods favorable to desirable vegetation.						
VM3	Retain existing desirable vegetation and canopy.						
Soil Disturbance							
SD1	Minimize soil disturbance.						
SD2	Implement erosion control practices.						
SD3	Manage existing topsoil and duff material to reduce contamination by invasive plants.						
Revegetation & Landscaping							
RL3	Revegetate and/or mulch disturbed soils as soon as possible to reduce likelihood of invasive plant establishment.						
Waste Disposal							
WD2	Render invasive plant material nonviable when keeping it on-site.						
WD3	When disposing of invasive plant materials off-site, contain it during transport.						
Monitoring							
PL11	Monitor the site for invasive plants after land management activities.						

Checklist E: Inspection & Cleaning

Clothing and Gear:

	Check for soil, seeds, and plant material	Inspected	Cleaned
1.	Hats		
2.	Hoods		
3.	Collars and cuffs		
4.	Clothing folds or flaps		
5.	Ventilation openings		
6.	Pockets		
7.	Zippers		
8.	Straps or Velcro grips		
9.	Belts or buckles		
10.	Buttons, fasteners, and rivets		
11.	Laces or ties		
12.	Gloves		
13.	Pant cuffs		
14.	Socks		

Boots or Shoes:

	Check for soil, seeds, and plant material	Inspected	Cleaned
1.	Shoelaces or ties		
2.	Straps or Velcro grips		
3.	Shoe tongues		
4.	Treads		

Hand and Power Tools:

	Check for soil, seeds, and plant material	Inspected	Cleaned
1.	Chainsaw chain		
2.	Hand saw blades		
3.	Mower deck and blades		
4.	Weed-eater blades		
5.	Crevices on other tools		

Hand and Power Tools:

	Check for soil, seeds, and plant material	Inspected	Cleaned
1.	Chainsaw chain and body		
2.	Hand saw blades		
3.	Mower deck and blades		
4.	Weed-eater blades and guard		
5.	Crevices on all other tools		

Checklist E: Inspection & Cleaning *(continued)*

Vehicles and Large Equipment (including ATVs, OHVs, motorcycles and bikes):

Check for soil, seeds, and plant material	Inspected	Cleaned
1. Truck bed		
2. Exhaust systems		
3. Vent openings		
4. Grills: Front and back		
5. Tray under radiator		
6. Top of transmission		
7. Stabilizer bar		
8. Shock absorber joint with axles		
9. Front and rear axles		
10. Top of front suspension units		
11. Wheel well/quarter panels		
12. Ledges under bumper (front and rear)		
13. Tire rims and treads		
14. Between rear wheel brake drums and the rim of the wheel		
15. At the bend in the fuel inlet tube		
16. Spare tire and mounting area		
17. Under the floor mat (inside cab)		
18. Under the seat (inside cab)		
19. Upholstery (inside cab)		
20. Beneath foot pedals (inside cab)		
21. Gear shift cover folds (inside cab)		

Livestock and Support Animals:

Check for soil, seeds, and plant material	Inspected	Cleaned
1. Underbelly		
2. Legs		
3. Hooves		
4. Coat or wool		
5. Ears		
6. Tack (saddles, blankets, panniers)		

General Resources

The following are websites that contain, and link to, significant amounts of information on invasive plant management.

California Invasive Plant Council
http://www.cal-ipc.org
This site provides a wide range of invasive plant information specific to California. Resources include prevention, invasive plant inventory, CalWeedMapper, invasive plant profiles with links to articles, publications, reports, and educational brochures.

California Department of Food and Agriculture Integrated Pest Control Branch
http://www.cdfa.ca.gov/plant/ipc/index.html
The Integrated Pest Control Branch conducts a wide range of pest management and eradication projects as part of the Division of Plant Health and Pest Prevention Services Pest Prevention Program. This site provides the Encycloweedia, noxious weeds and weed ratings, and the CalWeed Database.

Center for Invasive Plant Management
http://www.weedcenter.org
The Center for Invasive Plant Management (CIPM) is a hub for management information in the western U.S. Includes plant biology and management information; education information; and publications. CIPM also provides grants to weed projects in western states. Grant information is available at this site.

Invasive.org: Center for Invasive Species and Ecosystem Health
http://www.invasive.org
This site provides an easily accessible archive of high quality images of invasive and exotic species of North America with identifications, taxonomy and descriptions for use in educational applications.

Invasive Species Council of California
http://www.iscc.ca.gov
The invasive Species Council of California provides general information on invasive species in California including animals, plants, insects, and plant and animal disease.

National Invasive Species Council
http://www.invasivespecies.gov
The National Invasive Species Council (NISC) was established by Executive Order (EO) 13112 to ensure that Federal programs and activities to prevent and control invasive species are coordinated, effective and efficient.

National Invasive Species Information Center
http://www.invasivespeciesinfo.gov
This site is a gateway to invasive species information; covering Federal, State, local and international sources. The information center is maintained by the U.S. Department of Agriculture's National Agricultural Library.

USDA Forest Service Invasive Species Program—Control and Management http://www.fs.fed.us/invasivespecies/controlmgmt/index.shtml
This page provides links for more information on research, management planning, Forest Service activities, and pest-specific control and management.

Weed Research and Information Center
http://wric.ucdavis.edu
The University of California's Weed RIC provides control notes and photos for invasive plants as well as agricultural weeds.

Prevention Resources

A Builder and Contractor's Guide to Preventing the Introduction and Spread of Invasive Weeds
http://ucanr.org/sites/csnce/files/57340.pdf
El Dorado County's Invasive Weed Management Group provides an illustrated pamphlet with tips and considerations that contractors and landscapers can integrate into their general practice in order to stop unsightly and costly invasive plant infestations before they begin.

Hazard Analysis and Critical Control Point (HACCP) Planning for Natural Resource Pathways
http://nctc.fws.gov/EC/Resources/pdf/HACCP%20Manual.pdf
The HACCP plan is a structured process that assesses a natural resource management activity, identifies possible risks, and facilitates the removal or reduction of non-target (i.e. invasive) species. The five-step process records important elements of who, what, where, when, how and why of each activity to help manage target problems and improve best management practices.

Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species
http://www.usbr.gov/mussels/prevention/docs/EquipmentInspectionandCleaningManual2010.pdf
The U.S. Bureau of Reclamation has developed a set of procedures to address the transport of invasive species and pests through equipment movement. This manual provides guidance for inspecting and cleaning vehicles and large equipment.

Storm Water Quality Handbook: Project Planning and Design Guide http://www.dot.ca.gov/hq/oppd/stormwtr/ppdg/swdr2010/PPDG-July-2010-r2.pdf
This handbook provides guidance on the process and procedures for evaluating project scope and site conditions to determine the need for and feasibility of incorporating BMPs into projects. The key objective of this guide is to provide the overall process for selecting and designing BMPs within the Caltrans planning and design processes and incorporating those BMPs into the appropriate documents.

USDA Forest Service. The Early Warning System for Forest Health Threats in the United States
http://www.fs.fed.us/foresthealth/publications/EWS_final_draft.pdf
This is a monitoring framework for early detection and response to environmental threats (e.g., insects, diseases, invasive species, and fire) to forest lands. The framework is based on the following steps: 1) identify potential threats, 2) detect actual threats, 3) assess impacts, and 4) respond.

USDA Forest Service—Dangerous Travelers: Controlling Invasive Plants along America's Roadsides (Video)
http://www.fs.fed.us/invasivespecies/
The video outlines the best management practices that road crews should be following in their day-to-day operations. This is the first in a series on "Best Management Practices for Invasive Species Prevention." Ordered on DVD by contacting: USDA Forest Service; San Dimas Technology and Development Center; 444 East Bonita Avenue; San Dimas, CA 91773; (909) 599-1267.

Fire and Fuel Management Resources

A Manual of California Vegetation, 2nd Edition
http://www.cnps.org/cnps/vegetation/manual.php
Sawyer, J.O., Keeler-Wolf, T., and Evens, J. 2009. California Native Plant Society Press.

California Native Plant Society has adopted a definitive system for describing vegetation statewide. This standard vegetation classification has been accepted by state and federal agencies. The principal vegetation unit is called "Alliance" (or series), which is a floristically defined vegetation type identified by its dominant and/or characteristic species.

Emergency Stabilization/Burned Area Rehabilitation
http://www.fws.gov/fire/ifcc/esr/home.htm
DOI National Burned Area Emergency Stabilization and Rehabilitation Group provides policy, guidance, and reference materials on BAER, BAR and incident business management.

Fire Ecology by USGS Western Ecological Research Center (WERC)
http://www.werc.usgs.gov/ResearchTopicPage.aspx?id=6
To restore more normal fire dynamics to a particular region, managers need to know how fire has historically affected the local system, and how it functions today. Researchers at the (WERC) are making contributions to this effort through detailed studies of fire history and fire ecology in the Sierra Nevada forests, California shrublands, and Mojave and Sonoran deserts.

Fire in California's Ecosystems
http://www.ucpress.edu/book.php?isbn=9780520246058
Sugihara, N.G., Van Wagtendonk, J.W., Fites-Kaufman, J., Shaffer, K., and Thode, A. Klinger, R.C. ML. Brooks, and Randall, J.M. (eds.) 2006. The University of California Press. Berkeley, California.

Written by many of the foremost authorities on the subject, this book synthesize the knowledge of the science, ecology, and management of fire in California. It introduces the basics of fire ecology, including an historical overview of fire and vegetation in California; an exploration of the history and ecology of fire in each of California's nine bioregions; an examination of fire management in California; and discussion on current issues related to fire policy and management.

USDA Forest Service's Fire Effect Information System website (FEIS)
http://www.fs.fed.us/database/feis/
FEIS summarizes and synthesizes research about living organisms in the United States—their biology, ecology, and relationship to fire.

Wildland Fire Decision Support Systems (WFDSS)
https://wfdss.usgs.gov/wfdss/WFDSS_Home.shtml
The US Geological Survey hosts a web-based decision support system that assists fire managers and analysts in making strategic and tactical decisions for fire incidents and provides a record of these decisions.

Glossary

Ankle-gaiters: a protective covering for the lower leg and ankle designed to prevent snow, mud, gravel, or seeds from entering the top of the boot. Gaiters can also prevent seeds from adhering to pants, socks, boots and laces.

Best management practices: methods or techniques found to be the most effective and practical in achieving an objective, such as preventing or minimizing invasive plant spread, while making the optimum use of resources.

Burned Area Emergency Response (BAER): an emergency risk management action taken within one year of wildfire containment to stabilize and prevent unacceptable degradation to natural and cultural resources, to minimize threats to life or property resulting from the effects of a fire, or to repair/replace/construct physical improvements necessary to prevent degradation of land or resources. BAER should be a part of all Fire Management Plans. It should cover acceptable methods, techniques, and materials to stabilize and rehabilitate soils, native vegetation, and prevention of further damage.

Burned Area Rehabilitation (BAR): efforts undertaken within three years of wildfire containment to repair or improve fire-damaged lands unlikely to recover naturally to management approved conditions, or to repair or replace minor facilities damaged by fire. The process concludes with long-term restoration.

CEQA: California Environmental Quality Act. A statute passed in 1970 to institute a statewide policy of environmental protection. http://ceres.ca.gov/ceqa

Clean: not contaminated with viable invasive plant propagules.

Contaminated: contains viable invasive plant propagules.

Control line: an inclusive term for all constructed or natural barriers used to control a fire.

Critical control point: the best point, step, or procedure at which significant hazards can be prevented or reduced to minimum risk. Source: USFWS-NCTC. 2004. Hazard Analysis and Critical Control Point (HACCP) Planning for Natural Resource Pathways.

Delegation of Authority: an instrument signed by both the Incident Commander and Agency Administrator which identifies the acceptable methods of fire suppression and rehabilitation, notes any specific concerns (such as prevention of invasive plant spread), and names an Agency Representative that will speak for the Agency regarding resource matters.

Desiccate: to kill a plant by drying it thoroughly.

Disturbance: any activity leading to increased sunlight and bare ground, conditions that can be suitable for invasive plant introduction.

Duff: partially decomposed organic matter lying beneath the litter layer and above the mineral soil. It includes the humus and fermentation layers of the forest floor.

Early detection and rapid response (EDRR): a cost-effective approach to invasive plant management that aims to detect newly established invasive plant infestations early and to remove them before they spread.

Environmental stewardship: responsible use and protection of the natural environment through conservation and sustainable practices.

Equipment: machinery such as mowers and bulldozers used during land management activities.

Eradicate: the complete elimination of an invasive plant population, including all viable propagules.

Field Observer (FOBS): this Incident Command System position is responsible for collecting and reporting situation information for an incident through personal observations and interviews and reports to the Situation Unit Leader.

Fire activity areas: an inclusive term for areas used for fire suppression activities, which include incident areas, Incident Base Camp, staging areas, fire crew camps, spike camps, helibases, drop points, parking areas, etc.

Fire frequency: the recurrence of fire in a given area over time, stated as number of fires per unit time.

Fire line: A line to break up fire fuels. Also known as a control line, a fire line is scraped or dug, by hand or mechanically, into mineral soil.

Fire Management Plan (FMP): a plan which identifies and integrates all wildland fire management and related activities within the context of approved land/resource management plans. It defines a program to manage wildland fires (wildfire, prescribed fire, and wildland fire use). The plan is supplemented by operational plans, including but not limited to preparedness plans, preplanned dispatch plans, and prevention plans. Fire Management Plans assure that wildland fire management goals and components are coordinated.

Fire Management Unit (FMU): a land management area definable by objectives, management constraints, topographic features, access, values to be protected, political boundaries, fuel types, major fire regime groups, etc., that set it apart from the characteristics of an adjacent FMU. The FMU may have dominant management objectives and pre-selected strategies assigned to accomplish these objectives.

Fire regime: characteristic pattern of burning over large expanses of space and long periods of time. Fire regimes are described for a specific geographic area or vegetation type by the characteristic fire type (ground, surface, or crown fire), frequency, intensity, severity, size, spatial complexity, and seasonality.

Fire suppression: all work and activities connected with fire-extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

Fuel break: a generally wide (60 to 1000ft. or 18 to 305m) strip of land on which native vegetation has been permanently modified so that a fire burning into it can be more readily controlled.

Fuel treatment: manipulation or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control (e.g., lopping, chipping, crushing, piling and burning).

Fuel zone: a defined area within which fuels are managed to influence fire behavior and/or fire regimes.

Fuel: living and dead vegetation that can be ignited.

Hand line: fire line constructed with hand tools.

Impact: the cumulative effect, economic and ecological, of an invasive plant population on natural resources.

Incident Action Plan (IAP): contains objectives reflecting the overall incident strategy and specific tactical actions and supporting information for the next operational period. The plan may be oral or written. When written, the plan may have a number of attachments, including: incident objectives, organization assignment list, division assignment, incident radio communication plan, medical plan, traffic plan, safety plan, and incident map. Formerly called shift plan.

Incident Base Camp: location at the incident where the primary logistics functions are coordinated and administered. (Incident name or other designator will be added to the term Base.) The incident command post may be collocated with the base. There is only one Base per incident.

Incident Commander: this Incident Command System position is responsible for overall management of the incident and reports to the agency administrator for the agency having incident jurisdiction. This position may have one or more deputies assigned from the same agency or from an assisting agency(s).

Incident Management Team: the incident commander and appropriate general and command staff personnel assigned to an incident.

Indirect attack: A method of suppression in which the control line is located at some considerable distance away from the fire's active edge. Generally done in the case of a fast-spreading or high-intensity fire and to utilize natural or constructed firebreaks, fuel breaks and favorable breaks in the topography. The intervening fuel is usually backfired; but occasionally the main fire is allowed to burn to the line, depending on conditions.

Indirect fire line: fire line built for implementing indirect attack during fire suppression.

Infested: populated by invasive plants.

Invasive plants: non-native plants that cause economic or ecological harm. Used interchangeably with "weeds".

Land management plan: a document prepared with public participation and approved by an agency administrator that provides general guidance and direction for land and resource management activities for an administrative area. The plan identifies the need for fire's role in a particular area and for a specific benefit. The objectives in the plan provide the basis for the development of fire management objectives and the fire management program in the designated area.

Land manager: a person who manages public or private land.

Management unit: see Fire Management Unit (FMU).

Minimum Impact Suppression Tactics (MIST): the concept of using actions with a minimum amount of impact to effectively achieve the fire management protection objectives consistent with land and resource management objectives.

Monitoring: evaluating the success of prevention measures and management actions; including regular inspection of worksites to detect change, in this case the presence or absence of invasive plants.

Native plants: plants that evolved in a particular region. Plants that evolved without human intervention in a particular region, such as a California bioregion or watershed. These are usually species that occurred naturally before European colonization of North America.

NEPA: National Environmental Policy Act. A national law that established a U.S. national policy promoting the enhancement of the environment. http://ceq.hss.doe.gov

Nonviable: when a plant propagule is not able to produce a new plant.

Pathways: processes through which invasive plants can be introduced or spread.

Prescribed fire: a fire ignited on purpose, with planned oversight and specific management goals. The fire is applied to fuels in specified environmental conditions that allow the fire to be confined to a predetermined area and, at the same time, to produce fire behavior that will attain the planned management objectives.

Project materials: materials that soil and invasive plant parts and seeds can adhere to. These materials include soil, mulch (woody and straw), aggregate (sand and gravel), wood products (firewood and brush), landscape material (plants and seed), erosion control materials (silt fence, straw bales, straw wattles, geotextiles, and rip rap), pack animal feed, and packing/shipping materials.

Propagule: plant reproductive material, such as seeds, rhizomes or stolons.

Pulaski: a hand tool used in wildland fire suppression for construction firebreaks. The tool combines an axe and an adze in one head, and it can be used to both dig soil and chop wood.

Resource Advisor: personnel primarily responsible for identifying and evaluating potential impacts and benefits of fire operations (wildfire or prescribed fire) on natural and cultural resources. The Resource Advisor anticipates impacts on resources as suppression or prescribed fire operations evolve; communicates requirements for resource protection to the Incident Commander (IC) or Incident Management Team (IMT); ensures that planned mitigation measures are carried out effectively; and provides input in the development of short- and long-term natural resource and cultural rehabilitation plans.

Retardants: any substance except plain water that by chemical or physical action reduces flammability of fuels or slows their rate of combustion.

Scout: the act of searching for, locating, and documenting invasive plants on a worksite.

Seed set: the plant reproductive stage during which seeds mature.

Site assessment: the act of scouting for invasive plant species found within the worksite, including documentation of exact locations and densities of invasive plants, and determining priority areas for implementing prevention BMPs

Slash: debris resulting from such natural events as wind, fire, or snow breakage, or such human activities as road construction, logging, pruning, thinning, or brush cutting. Slash includes logs, chunks, bark, branches, stumps, and broken understory trees or brush.

Source populations: infestations of invasive plants which produce seed or other reproductive plant parts that can spread to new areas.

Spike camp: remote camp usually near a fire line, and lacking the logistical support that a larger fire camp would have.

Staging areas: locations where tools, equipment and vehicles are assembled before and during projects.

Sterile: not able to reproduce.

Support animals: dogs that provide hearing or seeing assistance.

Suppression: all the work of extinguishing a fire or confining fire spread.

Target conditions: land or resource conditions that are expected to result if goals and objectives are fully achieved.

Tools: implements used during land management activities, such as shovels and chainsaws.

Transitional pastures: designated areas where grazing animals can graze before and after being used for vegetation management.

Vectors: people or things that can carry invasive plants or their propagules from one place to another inadvertently.

Vehicle: cars, trucks, and all terrain vehicles used during land management activities.

Viable: when a propagule is able to produce a new plant.

Waste-disposal areas: locations where waste can be disposed without the risk of spreading invasive plant materials.

Water sources: natural and man-made water bodies. Water sources do not include equipment.

Weed-free forage: hay, oats, and other feed for pack and grazing animals from a clean source (not contaminated with viable invasive plant propagules).

Weed-free materials: project materials from a clean source (not contaminated with viable invasive plant propagules).

Weeds: used interchangeably with "invasive plants" (non-native plants that cause economic or ecological harm). Not all weeds are considered invasive plants, but for the purpose of this document the two terms are used interchangeably.

Wildfire: a wildland fire whose ignition is unplanned, such as a fire caused by lightning, volcanoes, unauthorized and accidental human-caused fires, and escaped prescribed fires.

Wildland Fire Decision Support Systems (WFDSS): a web-based decision support system that assists fire managers and analysts in making strategic and tactical decisions for fire incidents and provides a record of these decisions.

Wildland Fire: a general term describing any non-structure fire that occurs in wildlands. Wildland fires include wildfires and prescribe fires.

Wildland Urban Interface (WUI): the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildlands.

Worksites: locations or properties where land management activities occur.

Definitions of fire and fuel management terms in this glossary are adapted from the following references:

- Guidance from Implementation of Federal Wildland Fire Management Policy http://www.nifc.gov/policies/policies_documents/GIFWFMP.pdf
- National Wildfire Coordination Group website http://www.nwcg.gov/pms/pubs/glossary/index.htm
- The Bureau of Land Management Fire Management Glossary website http://www.blm.gov/wy/st/en/programs/Fire/glossary.2.html

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C. GEOLOGY, HYDROLOGY, AND SOILS

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NOTE 50
JANUARY 2013

Factors Affecting Landslides in Forested Terrain

Landslides and geomorphic features related to landsliding have been mapped by the Department of Conservation's California Geological Survey (CGS) on forest lands within numerous northern California watersheds under contract with the Department of Forestry and Fire Protection (CAL FIRE; see CGS Note 40). Landslide terminology used on the maps, and presented in this document, was developed in conjunction, and is compatible with, ongoing U.S. Forest Service (USFS) and California Department of Water Resources (DWR) mapping on forest lands. Descriptions presented here are excerpted from Bedrossian (1983). Definitions are consistent with those presented in Varnes (1978) and Cruden and Varnes (1996).

Factors affecting landslide potential are described according to the geological conditions, drainage characteristics, slope gradient and configuration, vegetation, removal of underlying support, and other conditions specific to each landslide related category (Figures 1-6). Management objectives and guidelines for each landslide-related category were developed primarily from field experience, recommendations made by CGS geologists during the Timber Harvesting Plan review process, practices currently required under the Z'Berg-Nejedly Forest Practice Act (Public Resources Code, 2013) and the California Forest Practice Rules (California Code of Regulations, 2013), and mitigation measures recommended in numerous geologic reports prepared for CAL FIRE, DWR, and the USFS. The guidelines address each landslide-related category and provide recommendations for forest practices related to road construction, logging, and site preparation.

LANDSLIDE TERMINOLOGY

Landslide terminology described here includes translational/rotational slide, earthflow, debris slide, debris flow/torrent track, debris slide amphitheater/slope, and inner gorge. The terms debris slide amphitheater and inner gorge refer to geomorphic features that were formed, in part, as a result of debris slide processes. Although they may be subject to continued debris slide activity, these features should not be misinterpreted as landslides. In addition, many landslides are, in reality, complex landslides subject to more than one type of landslide process. Accordingly, the management implications for such areas may be more complex than inferred here.

Most landslides are classified as active or dormant. The active or probably active slides are those which are presently moving or have recently moved, as indicated by the presence of distinct topographic slide features such as sharp barren scarps, cracks, and tipped (jackstrawed) trees. Major revegetation has not occurred on slides in the active category. Dormant slides show little evidence of recent movement; slide features have been modified by weathering and erosion and vegetation generally is well established. Although some large-scale landsliding may have developed under conditions different from today, the causes of failure may remain and movement could be renewed.

Translational/Rotational Slide

Definition. The translational/rotational slide is characterized by a somewhat cohesive slide mass and a failure plane that is relatively deep when compared to that of a debris slide of similar areal extent. The sense of the motion is linear in the case of a translational slide and is arcuate or "rotational" in the case of the rotational slide (Figure 1). Complex versions involving rotational heads with translation or earthflow downslope are quite

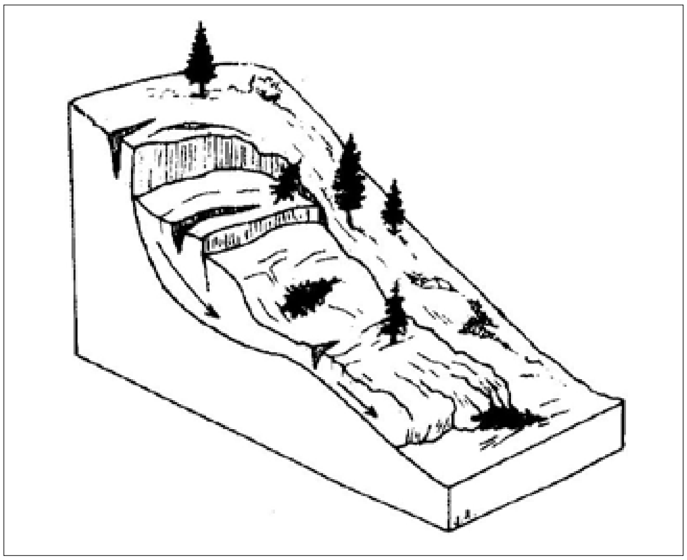

Figure 1. Diagrammatic sketch of a translational/rotational landslide. Drawing by Janet Appleby Richard Kilbourne and Thomas Spittler; modified from Varnes (1978)

State of California
Edmund G. Brown, Jr.
Governor

Natural Resources Agency
John Laird
Secretary

Department of Conservation
Mark Nechodom
Director

California Geological Survey
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State Geologist

common. When movement occurs along a planar joint or bedding discontinuity, the translation may be referred to as a block glide.

Factors affecting landslide potential. Translational/rotational slides generally occur in relatively cohesive, homogeneous soils and rock. The soil mantle may be greater than 5 feet thick, but sliding is not restricted to the zone of weathering. Failure commonly occurs along bedrock bedding planes that are deep-seated and dip in the same direction as the slope surface. In saturated conditions, incompetent clayey bedrock material may fail under overburden weight and high pore pressures, resulting in a deep-seated rotational-type failure. Translational slides commonly are controlled structurally by surfaces of weakness such as faults, joints, bedding planes, and contacts between bedrock and overlying deposits.

Impaired drainage of slide deposits may be indicated at the surface by numerous sag ponds with standing water, springs, and patches of wet ground. Phreatophytic (wet site) vegetation may be widespread and jackstrawed trees are common. The concentric, downward movement of slide materials generally exposes a near vertical scarp in the head region and, occasionally, along the lateral margins of the slide. Slide materials are characterized by hummocky topography consisting of rolling, bumpy ground, frequent benches, and depressions. The toe of the slide may be steep where slide material has accumulated.

Although the removal of root support is not likely to affect the overall stability of the slide mass, large clear-cuts (relative to slide size) could raise the ground water table and induce instability. Steep crownscarps and margins of the translational/rotational slide and toe areas of large slides may be subject to debris sliding. The removal of toe materials on smaller slides may reactivate the entire slide area.

Management objectives. The major management objectives for mitigating potential problems on translational/ rotational slides are to: minimize water concentration on the steep scarp and lateral margins of the slides, avoid undercutting of the toe areas, minimize loading the upper bench of the slide, and avoid the activation of debris sliding on steep scarp and toe areas.

Management guidelines. To enhance stability, roads and landings across translational/rotational slides should be carefully located to unload the crown area and load the toe. Where possible, benches should be utilized. Surface water should be diverted away from the slide mass and scarp areas, and long-term maintenance should be considered in the planning of site specific drainage problems. In some situations, the engineered drainage of fill materials may be required, and cut and fill slopes should be seeded. In order to avoid creating debris sliding, debris slide measures for road construction should be applied to steep scarps and toes of large slides. Consultation with a Certified Engineering Geologist is recommended in melange terrain, where large slides show activity, and in the design of road drainage.

During logging, ground disturbance in the slide area should be minimized. Along the edge of the slides, vegetation removal and physical changes should be limited to avoid the concentration of water on slide materials and the endlining of logs from outside the slide area should be considered when feasible. On large slides, water courses immediately adjacent to the slide often form inner gorges and therefore should be considered as part of the potentially unstable slide mass. Because removal of vegetation could raise the groundwater level and result in the local concentration of surface water, the size of the slide and the amount and condition of existing vegetation should be considered in determining the size and type of proposed harvest. During site preparation, physical disturbances on scarp areas and toes, where debris sliding may occur, should be minimized and overall root mass should be maintained.

Earthflow

Definition. An earthflow is a landslide resulting from slow to rapid flowage of saturated soil and debris in a semiviscous, highly plastic state. After initial failure, the earthflow may move, or creep, seasonally in response to destabilizing forces.

Factors affecting landslide potential. Earthflows are composed of clay-rich materials that swell when wet, causing a reduction in intergranular friction. When saturated, the finegrained, clay-rich matrix may carry larger, more resistant boulders with them in slow, creeping movements.

Slide materials erode easily, resulting in gullying and irregular drainage patterns. The irregular, hummocky ground characteristic of earthflows is generally bare of conifers; grasslands and meadows predominate. Failures commonly occur on slopes that are gentle to moderate (Figure 2), although they may also occur on steeper slopes where vegetation has been removed. Undercutting of the toe of an earthflow is likely to reactivate downslope movement.

Management objectives. Because earthflow materials are so easily erodible, the main objective is to minimize the physical disturbance of the slide by 1) avoiding the concentration of water onto the slide mass and 2) avoiding deep cut slopes into slide deposits.

Management guidelines. Road construction across earthflows should be avoided whenever possible. Likewise, earthflows are not appropriate locations for landing sites. When conditions necessitate road construction, the road should be carefully designed and located to use benches, avoid wet areas and seeps, and where possible, follow contour. The road should be single lane in width and outsloped

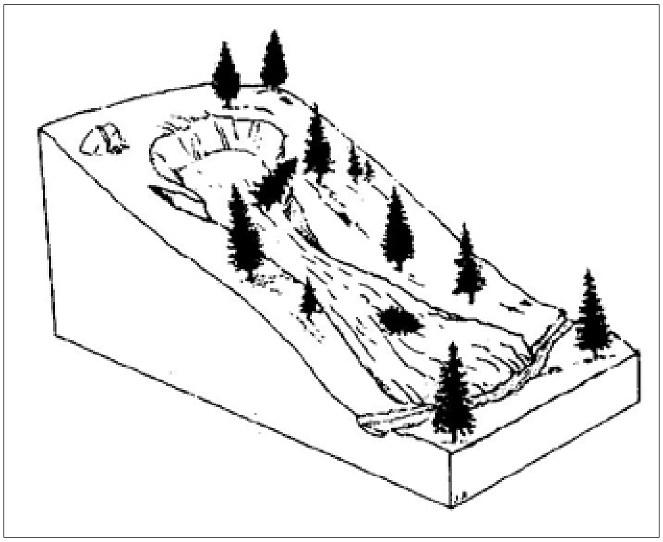

Figure 2. Diagrammatic sketch of an earthflow. Drawing by Janet Appleby and Richard Kilbourne; modified from Varnes (1978).

to avoid cutting into and concentrating water on slide materials. Areas exposed during road construction should be reseeded to minimize surface erosion. Winter construction and use is not advisable, and continued maintenance of drainage is recommended for major road construction across all earthflows.

During timber harvesting, ground disturbance should be minimized and the use of heavy equipment avoided. In logging areas adjacent to an earthflow, water should be drained from the slide to prevent gullying and reactivation of earthflow movement. Natural drainages on the earthflow should not be disrupted, for example, by the use of heavy equipment while being crossed to reach an adjacent logging site.

Debris Slide

Definition. A debris slide is characterized by unconsolidated rock, colluvium, and soil that has moved downslope along a relatively shallow translational failure plane (Figure 3). Debris slides form steep, unvegetated scars in the head region and irregular, hummocky deposits (when present) in the toe region. Debris slide scars are likely to ravel and remain unvegetated for many years. Revegetated scars can be recognized by the even-faceted nature of the slope, steepness of the slope, and the light bulb-shaped form left by many midand upper-slope failures.

Factors affecting landslide potential. Debris slides are most likely to occur on slopes greater than 65 percent where unconsolidated, non-cohesive, and rocky colluvium overlie a shallow soil/bedrock interface. The shallow translational slide surface is usually less than 15 feet deep. The probability of sliding is low where bedrock is exposed, except, where weak bedding planes and extensive bedrock joints and fractures parallel the slope.

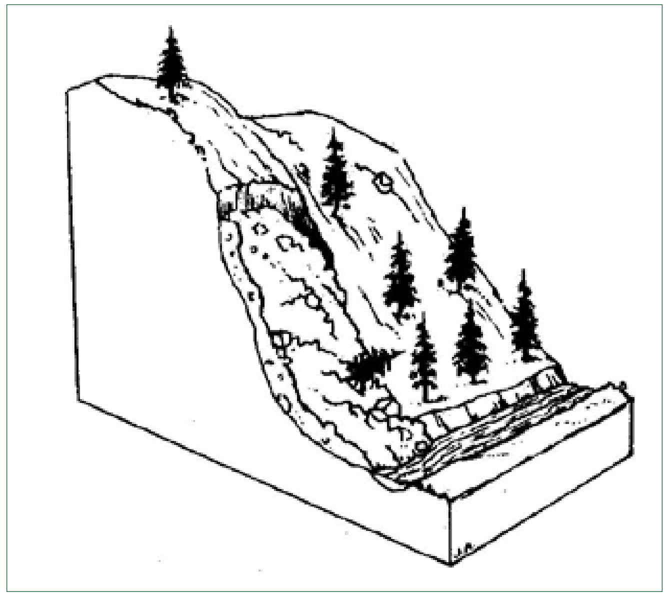

Figure 3. Diagrammatic sketch of a debris slide. Drawing by Janet Appleby and Richard Kilbourne; modified from Varnes (1978)

The presence of near surface bedrock creates a shallow, impervious slide plane that restricts the vertical movement of water and tends to concentrate subsurface water flow parallel to the slope. For this reason, sliding often occurs during high intensity storms. Springs may be present where water has concentrated along the slide plane. Because the removal of root support is likely to change the slope hydrology and shear strength of debris slide deposits, the vegetative cover where present is important to slope stability.

Management objectives. Because debris slides are characterized by unconsolidated materials above a shallow slide plane, the main management objectives are to: retain root support, minimize water flow along the soil/rock interface, avoid the undercutting of materials to the slide plane, and minimize the weighting of unconsolidated materials on steep slopes.

Management guidelines. Road construction across debris slides should be avoided where possible and existing roads used. Where active or potentially active slides on slopes over 65 percent must be crossed, the registered professional forester should consult a Certified Engineering Geologist in the preparation of the road design. Planning of the road should take into consideration a careful evaluation of both road and landing locations. Full bench cuts should be used across the slide where soils are most shallow and cut materials endhauled to minimize sidecast. If filling is necessary, fill materials should be retained during the road use and pulled before winter storms begin. Where possible, the road grade should be arched across the slide to drain water away from the slide. Where water must be drained onto the slide, energy dissipators should be used to reduce water impact on slide deposits. The undercutting of slide materials should be avoided in areas that are already buttressed; cribbing, retaining walls and/or riprap should be used where necessary. All small areas of unstable soil and debris should be removed from the roadcuts and cut and fill slopes seeded where vegetation will grow.

During logging, silvicultural practices should be designed to maintain maximum root support. In general, equipment exclusion zones and cable yarding are recommended. Site preparation burning should be designed to retain a maximum litter layer and some residual vegetation.

Debris Flow/Torrent Track

Definition. Debris flow and debris torrent tracks are characterized by long stretches of bare, generally unstable stream channel banks that have been scoured and eroded by the extremely rapid movement of water-laden debris (Figure 4). They commonly are caused by debris sliding or the failure of fill materials along stream crossings in the upper part of a drainage during high intensity storms.

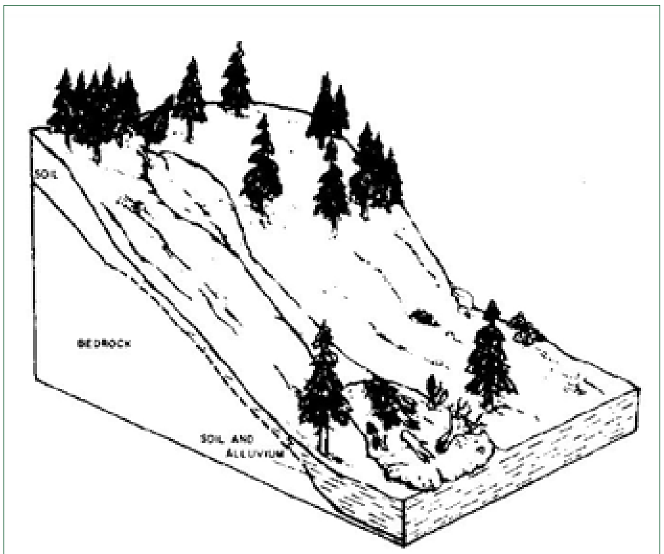

Figure 4. Diagrammatic sketch of a debris flow/torrent track. Drawing by Janet Appleby and Richard Kilbourne

Factors affecting landslide potential. Debris flow/torrent tracks are formed by the failure of water-charged soil, rock, colluvium, and organic material down steep stream channels. They are often triggered by debris slide movement on adjacent hill slopes and by the mobilization of debris accumulated in the stream channels themselves. Debris flows and torrents commonly entrain large quantities of inorganic and organic material from the stream bed and banks. Occasionally, the channel may be scoured to bedrock. When momentum is lost, scoured debris may be deposited as a tangled mass of large organic debris in a matrix of sediment and finer organic material. Such debris may be reactivated or washed away during subsequent events. The erosion of steep debris slide-prone streambanks below the initial failure may cause further failure downstream. The potential for failure is largely dependent upon the quantity and stability of soil and organic debris in a stream channel and the stability of adjacent hill slopes. The location of roads and landings upslope also affects landslide potential.

Management objectives. The main management objectives in mitigating areas containing debris flow/torrent tracks are to protect water quality and to avoid or minimize the possibilities of reactivating debris flow and debris torrent failures.

Management guidelines. Road and landing construction should be avoided across debris flow/torrent tracks. Where possible, scour-resistant crossings, such as low water crossings and rock fills, should be used.

In planning the harvesting of slopes adjacent to debris flow/torrent tracks, consideration should be given to the stability of the channel slopes. Soils exposed by logging operations adjacent to the tracks should be stabilized. Although an equipment exclusion zone around the track is recommended, the removal of logged debris below the stream transition line may be appropriate in some circumstances. A suitable overstory and understory should be left on slopes adjacent to the track.

Debris Slide Amphitheater/Slope

Factors affecting landslide potential. Debris slide amphitheaters and slopes are characterized by generally well vegetated soils and colluvium above a shallow soil/bedrock interface. The slopes may contain areas of active debris sliding or bedrock exposed by former debris sliding (Figure 5). Slopes near the angle or repose may be relatively stable except where weak bedding planes and extensive bedrock joints and fractures parallel the slope angle. Although the slopes often are smooth, steep (generally greater than 65 percent), and unbroken by benches, they are characteristically dissected by closely-spaced incipient drainage depressions. In many places, perennial channels within the amphitheaters and slopes are deeply incised with steep walls of rock or colluvial debris. The presence of bedrock or impervious material at shallow depths may concentrate subsurface waterflow, and springs may be present where permeable zones above the restrictive layer are saturated.

The presence of linear or teardrop-shaped, even-aged stands of trees, beginning at small scarps or spoon-shaped depressions, is indicative of former debris slide activity. Because soil and colluvial materials are shallow, the vegetative cover, where present, is important to slope stability and the removal of root support could change slope hydrology.

For these reasons, the intensity of road networks and the location of roads and drainage structures are particularly

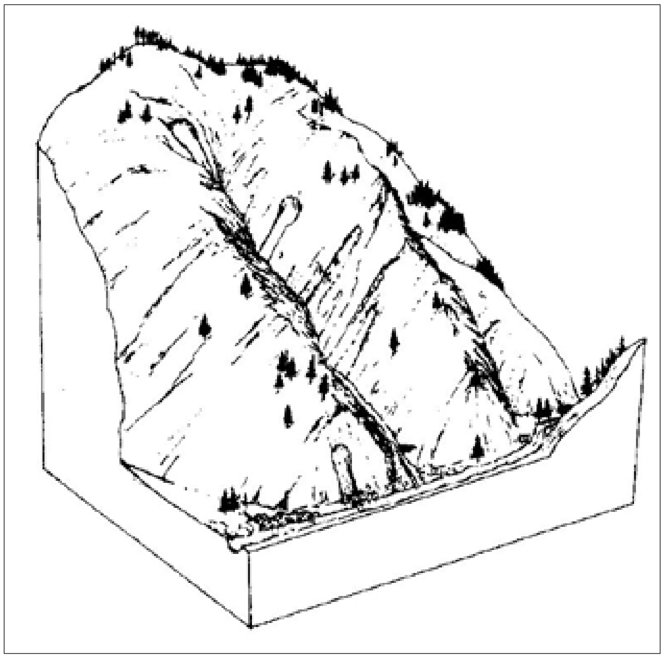

Figure 5. Diagrammatic sketch of a debris slide amphitheater and debris slide slopes. Drawing by Janet Appleby and Richard Kilbourne

important to slope stability in debris slide amphitheaters and on debris slide slopes. Areas adjacent to active slides have increased potential for sliding. The placement of fill materials on steep, unconsolidated upslope deposits also increases landslide potential.

Management objectives. The major management objectives in mitigating slope stability problems on debris slide amphitheaters and slopes are to: to retain root support, minimize water concentration in areas where soils are well-developed, and avoid large, continuous openings on steep slopes at any given period of time.

Management guidelines. Prior to road and landing construction, areas of active and potentially active debris slide movement should be identified. In areas of active and potentially active sliding, debris slide guidelines should be applied. In other areas where slopes are 65 percent or greater, the number and total length of roads should be minimized. Roads should also be located to avoid the crossing of active slides and the undercutting of buttressed slide materials.

During logging, a substantial vegetative cover should be retained by minimizing the size and continued downslope extent of vegetative openings and/or by using patch cuts. In areas with active sliding, equipment exclusion zones are recommended. On steep slopes, skyline and cable methods of logging should be used with a minimum number of blind leads. The amount of slash accumulated in deeply incised stream channels should also be minimized to reduce the chances of initiating debris flows and torrents.

During site preparation for replanting, burns should be designed to retain a maximum litter layer and residual vegetation. Equipment exclusion zones should be used around active slides.

Inner Gorge

Definition. An inner gorge is a geomorphic feature formed by coalescing scars originating from landsliding and erosional processes caused by active stream erosion. The feature is identified as that area of stream bank situated immediately adjacent to the stream channel, having a side slope of generally over 65 percent, and being situated below the first break in slope above the stream channel (Figure 6).

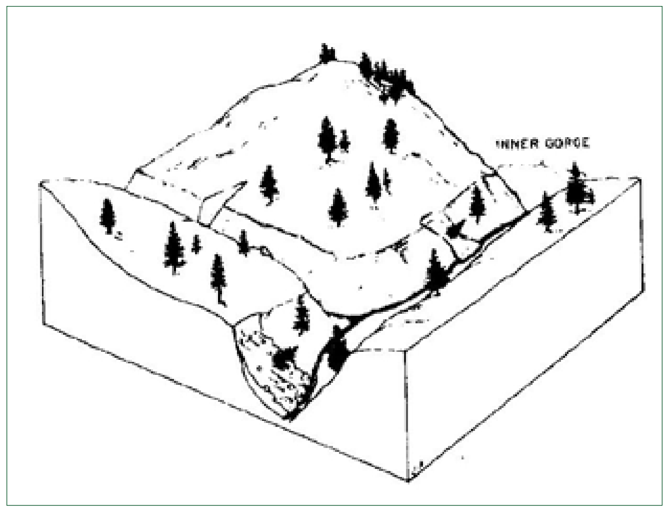

Figure 6. Diagrammatic sketch of the inner gorge. Drawing by Janet Appleby and Richard Kilbourne

Factors affecting landslide potential. Inner gorges are formed dominantly by debris slide processes that have been activated by the downcutting of stream channel bottoms. They commonly form along toes of large upslope landslides undercut by stream erosion. Where bedrock is exposed, the inner gorge may be stable. Where shallow, permeable, noncohesive soils and colluvium overlie impervious bedrock and/or slide plane materials, subsurface water flow may be concentrated along the steep streambank slopes and springs may be present. Slope stability is affected by high intensity storms and by the undercutting of stream banks by the rise in the stream water level. Roadcuts, as well as streambank erosion, are likely to activate or reactivate downslope movement. The addition of fill and/or concentration of water from roads and landings above the inner gorge could also increase landslide potential. Because unvegetated scars are likely to ravel, root support and vegetation are important to the overall slope stability.

Management objectives. The main objectives in mitigating slope stability problems in the inner gorge are to: protect water quality, protect riparian vegetation, and minimize the reactivation of debris slide failures.

Management guidelines. Where possible, road construction should be avoided within the inner gorge. Likewise, the inner gorge is an inappropriate location for landing sites. Where roads must cross the inner gorge, they should be located in rock gorge areas or other areas of stable ground, or structural supports should be used. Crossings should be engineered and designed for temporary use, that is, fill materials removed upon completion of logging and/or during the winter season. Water should be directed away from unstable inner gorge slopes and roads constructed along the upper break in slope should be full-benched and outsloped where possible to disperse water drainage and minimize failure of fill materials into the watercourse. Culverts installed within the inner gorge should be large enough to pass debris as well as water. When installed, the culverts should follow the longitudinal profile of the stream channel in order to minimize erosion of unstable stream banks. During logging, an equipment exclusion zone within the inner gorge is recommended. In addition, trees should be felled away from the stream channel. A suitable overstory and understory should be retained to provide root support and unmerchantable timber that could reach the stream should be removed or stabilized. Debris below the stream transition line should also be removed. Where possible, exposed soils should also be stabilized.

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NOTE 45
JANUARY 2013

Guidelines for Engineering Geologic Reports for Timber Harvesting Plans

The following guidelines were prepared by the Department of Conservation's California Geological Survey (CGS) in co-operation with the California Department of Forestry and Fire Protection (CAL FIRE), the State Mining and Geology Board, the State Board for Professional Engineers, Land Surveyors, and Geologists (BPELSG), and the State Board of Forestry. Note 45 was developed with input from representatives from over 30 governmental and professional organizations, universities, industry consultants and the environmental community. Significant comments were made by the Association of Engineering and Environmental Geologists, North Coast Regional Water Quality Control Board, National Marine Fisheries Service, Redwood National Park, and the U.S. Forest Service. The guidelines may be used by California Professional Geologists (PGs), California Certified Engineering Geologists (CEGs), or California Professional Geotechnical Engineers (GEs) when preparing engineering geological reports for Timber Harvesting Plans (THPs) on private, state, and local agency timberlands.

Purpose

Timber harvesting and its associated activities can affect public health and safety, listed species and their habitats, water quality, or public lands by activating landslides or increasing surface soil erosion. The purpose of these guidelines is to aid geologists and engineers in identifying and assessing the geologic framework of proposed timber harvesting operations to evaluate those effects.

An engineering geologic report prepared under these guidelines should assess how activities associated with timber harvesting could affect the physical environment, particularly with respect to sediment input to watercourses and lakes. The level of investigation conducted under these guidelines should be based on the potential risk to public health and safety, listed species and their habitats, water quality, or public lands. In some cases, portions of these guidelines may be modified or omitted due to the absence of given concerns or issues at the site; in other cases, additional geologic information may be required.

Report Contents

The engineering geologic report should be written for review by agencies and the public and be prepared so that Licensed Timber Operators can understand and implement specific mitigation measures. The report should include, at a minimum, the following information:

I. General Information

- A. Timber Owner
- B. Timberland Owner
- C. Name of THP or other identifier
- D. Location (also see section IX, b)
  1. 7.5' U.S. Geological Survey (USGS) Topographic Quadrangle
  2. Legal Description
     - a. Township, Range, Section
     - b. Assessors Parcel Number (optional)
  3. County
  4. Watershed
     - a. River System from published USGS topographic maps
     - b. Named tributary stream (from published topographic maps)
     - c. Planning Watershed as defined by CAL FIRE (to be supplied by Registered Professional Forester (RPF) preparing the THP)
- E. Methods of Investigation
  1. Reference all published and unpublished maps and reports.
  2. List all aerial photographs and other imagery used in the study. Include copies of one set of stereo aerial photographs in the report with the THP boundaries outlined.

3. List dates of field investigation/mapping.
4. Describe subsurface exploration methods (if done).
5. Include an analysis of the data (do not just give conclusions).
6. Describe applicable studies and technical models.

F. Individuals Contacted

II. Scope of Investigation

The scope of the engineering geologic investigation and report should be focused to evaluate the potential for proposed timber harvesting activities to adversely affect public health and safety, listed species or their habitat, water quality, or public lands. The scope of the report should be clearly stated and should be based on both the geologic constraints present at or near the site and the potential risk of those hazards on the environment. Where the report is focused on a single geology-related issue, an explanation of why the scope was limited should be included.

A. Public Safety
Has the RPF preparing the THP identified any houses, public buildings, roads or other features in a position where they could potentially be adversely affected by landsliding or surface soil erosion associated with the proposed timber harvesting activities?

B. Water Quality

1. Has the RPF identified that this THP has been in a watershed that has been classified as impaired by sediment by the U.S. Environmental Protection Agency or other regulatory agency?
2. Has the RPF identified any domestic water supplies that could potentially be impaired by sediment derived from timber harvesting activities? If so, these facilities should be shown on a map with respect to the proposed THP.

C. Listed Animal or Plant Species
Has the RPF identified listed rare, threatened or endangered species or their habitats within the watershed that could be adversely affected by potential landsliding or erosion associated with the proposed operations?

D. Public Lands
Has the RPF identified parks, wildlife refuges, or other public lands that could potentially be affected by landslides or soil erosion associated with the proposed timber harvesting activities?

III. Geologic Conditions

A. Bedrock Geology

1. Formation names and ages
2. Lithology (rock types)
3. Fabric (beds, joints, fractures) - The relationship of fabric and structural elements, where they are well defined and continuous, to hillslope aspects within or adjacent to the THP area should be evaluated.
4. General range in physical properties (density, hardness, strength, permeability) based on reconnaissance field work or data from other reports.

B. Seismotectonic Considerations
Provide concise information about the seismic and tectonic setting of the THP site and adjacent area and how it may relate to slope stability, surface soil erosion, or sedimentation.

C. Geomorphology

1. Landslides - Each landslide that could pose a significant risk to public health and safety, listed species or their environments, water quality, or public lands, and that may be adversely affected by proposed timber harvesting activities should be addressed in the engineering geologic report. The following information should be included:

    a. Description of type of landslide and its physical features (use nomenclature of Crudden and Varnes, 1996). Also see definitions for inner gorge, slide areas, unstable areas and unstable soils in the California Forest Practice Rules (see last page of this Note.)

    b. Documentation of landslide dimensions, including width, length, and depth and the method used to measure or estimate the dimensions.

    c. General description of type and density of vegetation and degree of revegetation in landslide area. If large trees are present in the landslide area, are any in a position where the landslide could potentially deliver woody debris to stream channels?

    d. Description of the ground slope(s) of the landslide and adjoining ground. Identify variations in slope greater than 10 percent along the landslide profile. Describe how slope measurements were made.

e. Describe the relative position of the landslide on the slope.

f. Evaluate the volume of sediment delivered to watercourses from landslides that have failed within the past 10 years.

1) Describe how sediment volumes were determined.

2) Estimate volume of sediment in a position to enter watercourses from each landslide, if any, and the relative rate of sediment delivery. Discuss the methods used to make the estimate.

g. Landslide materials (bedrock, weathered bedrock, soil, colluvium).

h. Degree of activity and/or relative stability - when was the landslide last active? Include discussion of reasoning used to determine activity and relative stability. Protocol for assessing relative stability should follow Keaton and DeGraff (1996).

i. Triggering mechanism - For historic landslides with known failure dates, did the landslide fail in response to a storm or earthquake event?

j. Slope modifications - did the landslide fail from a natural or modified slope? Have existing cuts and fills remained stable since the slopes were modified?

k. Identify springs, marshes, or wet areas.

l. Illustrations where needed, such as field-developed or interpretive cross sections, and detailed maps or illustrations of landslide features.

m. Provide other information as needed.

2. Landscape Geomorphology Indicative of Potentially Unstable Slopes

a. Inner Gorge - Refer to CGS Note 50.

b. Debris Slide Slope - CGS Note 50.

c. Other landforms, such as hummocky areas, closed depressions, disorganized drainages, disrupted linear features such as fences or roads, benches of questionable origin, tension cracks, leaning trees, or seepage sites.

d. Potential debris flow source area, such as colluvial filled swales inclined more steeply than 50 percent. Where computer models of steep topographic swales are available for a site from the landowner the RPF, or elsewhere, they should be included in the report.

D. Soil and Regolith from Published Soil Surveys or from the RPF as Modified by On-site Observations

1. Soil series

2. Soil thickness

3. Soil textural properties (grain size, plasticity, Uniform Soil Classification)

4. Soil drainage classification

5. Permeability contrasts between soil and underlying bedrock

6. Potential surface soil erosion hazard - identify how this was determined

E. Regional or local climate information as provided by the RPF. This should include, but not be limited to relative storm intensities, snow accumulations, and potential for rain-on-snow as it may affect terrain stability or surface soil erosion.

IV. Proposed Timber Harvesting Activities (obtained from THP)

A. Silviculture

B. Site Preparation

C. Yarding System(s)

D. Road and Landing Construction / Reconstruction and Maintenance

E. Winter or wet weather operations

F. Equipment operations on steep slopes

G. Other

V. Potential Effects on Slope Stability and Surface Soil Erosion from Proposed Operations

The engineering geologic report should provide a thorough, well-reasoned discussion or rationale and explicit conclusions on how the proposed timber harvesting operations may affect both short- and long- term site-specific slope stability and surface soil erosion. Potential effect-generating activities may include, but are not limited to road design and construction method, excavation and disposal of materials, road and skid trail drainage, road use and maintenance, vegetation removal, and site preparation.

VI. Cumulative Effects Assessment Related to Slope Stability, Surface Soil Erosion, and Sedimentation

A. Identify existing, ongoing problems associated with landsliding, surface soil erosion, and sedimentation within the THP area, including appurtenant and legacy roads. This will probably require interpreta-tion of historical aerial photography as well as office research, personal contacts, and fieldwork. Discuss how nearby geologically similar areas have responded to harvesting and road building in the context of significant storm events or earthquakes.

B. Discuss potential impacts from current or past activities within the watershed that could interact with potential effects from the proposed THP. These activities would include, but not be limited to, dams and water works, mining, other agriculture and grazing, urbanization, and roads.

C. From the context of geologic and geomorphic conditions and environmental concerns, evaluate how the proposed activities and any reasonably foreseeable future activities could interact with existing conditions within the watershed and how this may impact environmental issues of concern.

VII. Mitigation of Problem Areas

Identify areas of concern. Describe specific mitigative measures needed to minimize potential effects for the identified areas of concern. Where mitigations require an engineered design, the services of a civil engineer will be required. Mitigation monitoring plans developed in cooperation with the RPF should be included. The mitigations may be related to re-cent or dormant landslides, areas of surface soil erosion, new road construction, road reconstruction, stream crossings, yarding activities, silviculture, site preparation, cumulative effects within the watershed, and/or other factors. The mitigation work should be based on the potential hazard process (likelihood of landslide initiation or acceleration or an increase in surface soil erosion), the potential effects of the land-slide or increased erosion with respect to sediment mobilization or water flow, and the potential risk to public health and safety, listed species or their habitats, water quality, forest soil productivity, or public lands. The report should specify inspections and monitoring where needed.

VIII. References

All references used, including aerial photographs and other imagery, should be cited.

IX. Maps and Diagrams:

Maps and Diagrams: These should i nclude, but not be limited to the following:

A. Regional geologic and geomorphic map(s) at a scale of 1:24,000 or larger. This map should show the location of the THP and identify geologic features and downstream/ downslope resources that could affect or be affected by the proposed timber harvesting operations. This map should also provide regional information for the watershed in which the THP is being submitted to allow for an assessment of potential cumulative effects of sediment or debris identification. All maps should include a north arrow, bar scale, contour interval, and legend consistent with the guidelines defined by the BPELSG (2013).

B. Site location map, typically at a scale of 1:12,000. The scale of the site location map should be large enough to show all needed information. The map should display:

1. THP boundaries
2. Logging units
3. Road locations, characterized by width, drainage design, and surfacing; including existing, planned, and legacy roads (old and unmaintained roads)
4. Landing locations, including existing, planned, and legacy landings
5. Watercourses, springs, and wet areas
6. Silvicultural units
7. Landslides, gullies, or sediment depositional areas, including those not further discussed in the report.
8. Locations of analysis sites and mitigation points

C. Detailed site-specific maps and diagrams. Where specific information or mitigation measures are identified in the engineering geologic report, detailed maps, cross sections, diagrams, and/or schematic illustrations should be included at a scale that adequately presents the needed information.

X. Authority

The California Business and Professions Code requires that the PG, CEG, or GE must be working within his/her area of expertise and shall sign the final report. Inclusion of license numbers and/or official stamps shall be per the requirements of the licensing board.

REFERENCES

California Geological Survey Note 50, – similar to Note 52 Factors Affecting Landslides in Forested Terrain, January 2013, www.conservation.ca.gov/cgs/information/publications/cgs_notes/note-50

California Board for Professional Engineers, Land Surveyors, and Geologists, 2013, Geologists and Geophysicists Act (Business and Professions Code §§ 7800-7887, Chapter 12.5) with Rules and Regulations (California Code of Regulations, Title 16, Division 29, §§ 3000-3067) and Related Sections of the Business and Professions Code, Government Code, Penal Code and Evidence Code, January 1, 2013.

California Board for Professional Engineers, Land Surveyors, and Geologists, 2013, Professional Engineers Act (Business and Professions Code §§ 6700-6799, Chapter 7) with Rules and Regulations (California Code of Regulations, Title 16, Division 29, §§ 400-476) and Related Sections of the Business and Professions Code, Government Code, Penal Code and Evidence Code, January 1, 2013.

California Board for Professional Engineers, Land Surveyors, and Geologists, 1998, Guidelines for Engineering Geologic Reports, 8 p.

Crudden, D.M. and Varnes, D.J. 1996, Landslide Types and Processes *in* Turner, A.K. and Schuster, R.L., editors, Landslides: Investigation and Mitigation, Transportation Research Board, National Research Council Special Report 247, p. 36-75.

Keaton, J.R. and DeGraff, J.V., 1996, Surface Observation and Geologic Mapping *in* Turner, A.K. and Schuster, R.L., editors, Landslides: Investigation and Mitigation, Transportation Research Board, National Research Council Special Report 247, p. 178-230.

CALIFORNIA FOREST PRACTICE RULES - 2013

(Title 14, California Code of Regulations, Chapters 4, 4.5 and 10)

895.1.Definitions: Inner Gorge, Slide Areas, Unstable Areas, Unstable Soils

Inner Gorge means a geomorphic feature formed by coalescing scars originating from landsliding and erosional processes caused by active stream erosion. The feature is identified as that area beginning immediately adjacent to the stream channel below the first break in slope

Slide Areas are areas indicated by the following characteristics:

1. Shallow-seated Landslide. An area where surface material (unconsolidated rock, colluvium, and soil) has moved downslope along a relatively steep, shallow failure surface. The failure surface is generally greater than 65% in steepness and less than 5 feet in depth. It is usually characterized by: 1) a scarp at the top; 2) a concave scar below the scarp, where surface material has been removed; and sometimes 3) a convex area at the bottom where slide material is deposited. Vegetation is usually disturbed (tilted trees), anomalous (younger, evenaged stand), or absent (bare soil). Minor bank slumps are excluded from this definition.
2. Deep-seated Landslide. An area where landslide material has moved downslope either as a relatively cohesive mass (rotational slides and translational block slides) or as an irregular, hummocky mass (earthflow). The failure surface is generally deeper than five feet and is usually well-exposed at the head scarp. Complex failures with rotational movement at the head and translational movement or earthflows downslope are common. Vegetation on rotational and translational slides is relatively undisturbed, although trees and shrubs may be pistol-butted or tilted. Deep-seated landslides may have intermediate tension cracks, scarps, and shallow slides superimposed throughout the slide mass. Deep-seated landslide risk is usually associated with cohesive soils.

Unstable Areas are characterized by slide areas or unstable soils or by some or all of the following: hummocky topography consisting of rolling bumpy ground, frequent benches, and depressions; short irregular surface drainages begin and end on the slope; tension cracks and head wall scarps indicating slumping are visible; slopes are irregular and may be slightly concave in upper half and convex in lower half as a result of previous slope failure; there may be evidence of impaired ground water movement resulting in local zones of saturation within the soil mass which is indicated at the surface by sag ponds with standing water, springs, or patches of wet ground. Some or all of the following may be present: hydrophytic (wet site) vegetation prevalent; leaning, jackstrawed or split trees are common; pistol-butted trees with excessive sweep may occur in areas of hummocky topography (note: leaning and pistol-butted trees should be used as indicators of slope failure only in the presence of other indicators).

Unstable Soils may be indicated by the following characteristics:

1. Unconsolidated, non-cohesive soils (coarser textured than Loam , as defined in Appendix I.A.1a of Board of Forestry Technical Rule Addendum No. 1, dated December 15, 1981) and colluvial debris including sands and gravels, rock fragments, or weathered granitics. Such soils are usually associated with a risk of shallow-seated landslides on slopes of 65% or more, having non-cohesive soils less than 5 ft. deep in an area where precipitation exceeds 4 in. in 24 hours in a 5-year recurrence interval.
2. Soils that increase and decrease in volume as moisture content changes. During dry weather, these materials become hard and rock-like exhibiting a network of polygonal shrinkage cracks and a blocky structure resulting from desiccation. Some cracks may be greater than 5 feet in depth. These materials when wet are very sticky, dingy, shiny, and easily molded.

Sacramento	Los Angeles	Menlo Park
801 K Street, 14th Floor • MS 14-34	888 Figueroa Street, Suite 475	345 Middlefield Road • MS 520
Sacramento, CA 95814-3532	Los Angeles, CA 90017	Menlo Park, CA 94025
916.445.5716	213.239.0878	650.688.6327

CALIFORNIA LICENSED FORESTERS ASSOCIATION
August, 1999

Guide To Determining the Need For Input From a Licensed Geologist During THP Preparation

Registered Professional Foresters (RPF) should address the following questions during Timber Harvesting Plan (THP) preparation. RPFs are encouraged to review California Division of Mines and Geology Note 50, *Factors Affecting Landslides in Forested Terrain*.

✓ Are there unstable areas located within or adjacent to the proposed THP area?

- Were unstable areas identified on available geologic, landslide, and watershed maps, aerial photos, or previous THPs in the vicinity of the plan area? [See Page 2 for instructions on how to obtain maps and other information]

- Were unstable areas observed in the field? Features associated with unstable areas may include:

  - Hillslopes greater than 65%, including inner gorge areas
  - Loose, unconsolidated soils
  - U-shaped swales
  - Irregular topography
    - Scarps
    - Benches
    - Hummocky ground
    - Surface cracks
  - Vegetative indicators
    - Leaning trees
    - Hydrophytes
    - Isolated patches of homogeneous vegetation
  - Disorganized drainage
    - Sag ponds
    - Seeps
    - Diverted watercourse
  - Road cut-bank failure
  - Road or landing fill failure

✓ If unstable areas were identified in the THP area, proposed timber operations on, adjacent to, upslope, or downslope of these features may have the potential to affect slope stability through:

- Displacement of soil,
- Division or concentration of drainage,
- Reduction in interception or transpiration, and/or
- Reduction in root strength.

Examples of timber operations that may produce these effects are:

- Timber cutting
- Construction and maintenance of:
    - Roads
    - Stream Crossings
    - Skid trails
    - Beds for felling of trees (layouts)
    - Fire breaks
- Mechanical site preparation
- Prescribed burning

✓ If proposed timber operations have a reasonable potential to affect slope stability, and there is a potential for materials from landslides or unstable areas to affect public safety, water quality, fish habitat or other environmental resources, then a California licensed geologist with experience/expertise in slope stability should be consulted to assess slope stability and assist with designing mitigation measures**.**

A series of 7.5' quadrangle landslide maps has been developed for use in THP preparation that covers much of the California Coast Range, from Monterey through Del Norte Counties. An index for these maps, California Division of Mines and Geology Special Publication 120, is available from:

Division of Mines & Geology
Publications and Information Office
801 K Street, MS 14-33
Sacramento, CA 95814-3532
916-445-5716

Copies of the landslide maps are on file at the Division of Mines and Geology library at the above address and at the Department of Forestry and Fire Protection offices in Fortuna, Willits, Santa Rosa, and Felton.

Many of the maps that are published by the Division of Mines and Geology are available at:

www.consrv.ca.gov/dmg/index.htm

D. HERBICIDES

D.1 INTRODUCTION

This appendix describes the potential human health and ecological effects from the chemicals that are likely to be used for vegetation treatments due to implementing the VTP. The information that follows addresses the use and disposal of borax and herbicides and some of their adjuvants, metabolites, and degradates. The transport and storage of chemicals are analyzed in Section 4.4.

The information presented in this appendix describes VTP information pertaining to the direct effects of chemical use to humans and other life forms and the indirect effects associated with impacts on the environment. The information in this appendix was prepared by CAL FIRE in 2010 and was peer-reviewed and updated in 2015 by Bill Williams, Ph.D. (Williams 2015).

Pertinent information to aid in understanding the chemicals that are likely to be used for control of vegetation is included in this appendix. This appendix also contains information pertaining to the herbicide 2,4-D, which has since been removed from the list of herbicides proposed for use under the proposed VTP based on the results of the analysis by this EIR.

The following outline will aid in reviewing this appendix:

D. Herbicides D-1
D.1 Introduction....................D-1
D.2 Regulatory and Policy Restrictions on the Use of Chemicals....................D-2
D.2.1 Chemicals Analyzed D-2
D.2.2 Area Potentially Treated by Chemicals....................D-4
D.2.3 Timing of Chemical Treatments D-5
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D.2 REGULATORY AND POLICY RESTRICTIONS ON THE USE OF CHEMICALS

The laws and regulations constraining the use and disposal of chemicals are discussed in Section 4.4.1. Constraints have also been placed on the use of chemicals in the VTP and Alternatives by CAL FIRE policy. These limitations are discussed in Section 4.4 and Section 2.6 of this Program EIR.

Standard Project Requirement (SPR) HAZ-6 (see Section 2.6) requires the use of a licensed Pest Control Adviser (PCA) to develop recommendations for herbicide use. The California Forest Improvement Program (CFIP), a CAL FIRE cost-share program, also requires the use of a PCA for herbicide use. Application of herbicides on lands administered by CDFG is overseen by a staff PCA. Only Qualified Applicators treat CDFG lands with herbicide. To a great extent, the same is true for State Park lands administered by the California Department of Parks and Recreation. All of these agencies/programs have policies governing the use of pesticides.

D.2.1 CHEMICALS ANALYZED

The chemical active ingredients selected for analysis are those that were most often used in forestry and rangeland applications in California from 2001 to 2010, as reported annually in the California Department of Pesticide Regulation (CDPR) Pesticide Use Report Database (CDPR N.D.a). Analyses of these active ingredients cover the range of potential risks, hazards, unknowns, and uncertainties associated with these active ingredients and the product formulations that contain them. Particular products that are registered and commonly used in California may be mentioned for example purposes, but mention of any trade names is in no way intended by CAL FIRE to be endorsement of or promotion for the use of particular pesticide products.

With the exception of borax, which is a fungicide, and NP9E-based surfactants, the chemicals analyzed in this Program EIR appendix are herbicides. For the purposes of this analysis, the term herbicide sometimes includes borax. When the term "chemical" is used, it generally refers to herbicides, the fungicide borax, and/or NP9E-based surfactants.

By policy decision of CAL FIRE, after consultation with CDFG and U.S. FWS, atrazine and atrazine related products were removed from the list of potentially funded chemical active ingredients under the VTP and Alternatives and are therefore not analyzed in this Program EIR. All formulations of chemical containing 2,4-D were also removed from the list of fundable herbicides, due to toxicological concerns. It should be noted that most VTP treatments will occur on private property not under the control of CAL FIRE so atrazine and/or 2,4-D might be used by landowners outside of the VTP for initial or maintenance treatments.

Table 4.4.1 lists the chemicals being proposed for use under the VTP and Alternatives. Due to the uncertainty regarding which herbicides might be used, as well as when and where the chemicals will be applied, the selection of formulations and adjuvants will be made at the project-specific planning level.

One active ingredient of boron (sodium tetraborate decahydrate, also known as borax), clopyralid (monoethanolamine salt), hexazinone, imazapyr (isopropylamine salt) and sulfometuron methyl are being proposed for use. Four active ingredients of glyphosate (diammonium salt, dimethylamine salt, isopropylamine salt, potassium salt) and two active ingredients of triclopyr (butoxyethyl ester and triethylamine salt) are also being proposed for use under this Program EIR.

This risk assessment will not cover in detail the adjuvants or inert ingredients that have the potential to be used when chemicals are applied for vegetation management, with the exception of surfactants that are of high toxicological concern. Adjuvants, such as surfactants, are additives that improve the effectiveness of a formulation and are added just prior to application of a formulated product. Surfactants in particular are intended to increase the efficacy of the formulation towards eliminating or retarding the target plant (U.S. EPA 2011b).

Like adjuvants, inert ingredients are not active in directly eliminating or retarding the growth of the targeted species, but instead improve the effectiveness of the active ingredient (FIFRA Sec. 2 [7 U.S.C. 136](m); U.S. EPA 2011b). Unlike adjuvants, however, inert ingredients are combined with active ingredients to create formulations that are sold as end-use products. Inert ingredient information is considered proprietary (FIFRA Sec 10(f) and 12(a)(2)(D)) and as such is typically only disclosed by formulation registrants to the U.S. EPA. When registering a formulation that contains inert ingredients, toxicity testing is completed on both the technical grade active ingredient (TGAI) and end-use product, which allows for the toxicity of chemicals to be compared.

One surfactant of concern, nonylphenol ethoxylate (NP9E) contains the active ingredient nonylphenol (NP) and its ethoxylates (USDA/FS 2003b). Another surfactant of concern contains polyethoxylated tallow amine, which is also known as polyoxyethylene amine or POEA, (SERA 2011d). Each of these surfactants is made up of many related components, making toxicity ambiguous and challenging to classify. Currently, there is concern regarding the toxicity of NPE and POEA compounds to aquatic organisms (SERA 1997a, 2011b and USDA/FS 2003b). Estrogen mimicry, a potential for NPE, causes concern for both aquatic and terrestrial organisms. Of the active ingredients proposed for use, NP9E is commonly used with clopyralid, glyphosate and/or triclopyr formulations, whereas, POEA is predominately an unspecified inert in glyphosate formulations. NP9E data can be evaluated more easily than POEA, given that NP9E is a component of surfactants added after purchase, making information less proprietary.

D.2.2 AREA POTENTIALLY TREATED BY CHEMICALS

For analysis purposes, it is assumed that the area potentially treated with chemicals under the VTP and Alternatives is as discussed in Chapter 3. The VTP and the Alternatives propose to treat approximately 6,000 acres with chemical treatments. On the basis of area treated, if there are no significant effects from chemical treatments in the VTP, there will be no significant effects in the Alternatives.

Chemical treatments will potentially occur only on Local Responsibility Area (LRA) or State Responsibility Area (SRA) lands where CAL FIRE has fire suppression responsibility. There are approximately 24 million acres of SRA and LRA lands available for treatment under the VTP on which chemical treatments could potentially occur (see section 2.5, Table 2.5-1 of this document).

There are two basic project initiators for chemical treatments under the VTP, either state or private land managers. On state lands (State Forests, State Parks, Ecological Reserves, and Wildlife Areas), VTP projects are initiated by state agencies (CAL FIRE, the CA Department of Parks and Recreation, or CDFG). There are 71,000 acres of State Forests, ~1,500,000 acres of State Parks, 129,000 acres of CDFG Ecological Reserves, and ~563,000 acres of Wildlife Areas, for a total of ~2,263,000 acres. Because these are public lands, inadvertent exposure of the public to chemicals is potentially greater than on private lands.

On private lands, landowners working in partnership with CAL FIRE are the project initiators. Use of such lands is not considered public use, as people can legally gain access only by invitation of the landowner. Some potential chemical exposure routes to the public, such as eating berries or coming into direct contact with sprayed vegetation, are therefore unlikely.

Herbicide use may occur on any acre available for treatment under the proposed VTP subject to the constraints outlined in the SPRs and necessary Project Specific Requirements (PSRs) identified through the Project Specific Analysis (PSA). It is not possible to know exactly where chemical treatments will be located in the State or how many projects will be in any bioregion in any given year. The percentage of the VTP area potentially treated each year with chemicals is 10%, or 6,000 acres. The area treated in each Alternative is similar to the VTP, therefore each of the alternatives will have a similar impact (see Chapter 3).

D.2.3 TIMING OF CHEMICAL TREATMENTS

Under the VTP and Alternatives, herbicides could be used as the initial vegetation treatment or for maintenance of previously treated areas. In shrubland treatments, herbicides are sometimes applied a year prior to prescribed burns to enhance the flammability of shrubs and reduce emissions from burning, by causing shrubs to die and desiccate ("brown") before ignition. Initial treatments in shrubland are unlikely to use herbicides independent of some type of follow-up treatment to remove the dead fuels. Noxious weeds could also be controlled primarily by herbicide treatments.

Many of the maintenance treatments are expected to utilize herbicides. As discussed in Chapter 2, maintenance treatments are generally related to vegetation habitat, landscape location, and treatment type. For analysis purposes, maintenance with herbicides is assumed to occur at the following time intervals:

- Grasslands – 2-3 years after previous treatments
- Shrublands – 5-10 years after initial treatment
- Forestland – 10-15 years after initial treatment

These maintenance intervals could vary by as much as 2-15 years for specific vegetation types depending on species composition and site quality. Forestland herbicide treatments to establish regeneration following timber harvesting are typically done only once or twice in a 40-70 year rotation. Treatments with borax are likely to occur only once, immediately after trees are cut in thinning operations.

Because the VTP is based on willing landowner participation, not every acre initially treated by whatever method, will receive a maintenance treatment. Some landowners are not receptive to herbicide use as an initial or maintenenace treatment. Alternatives, such as manual, herbivory, and mechanical treatments are also likely to be utilized for maintenance treatment under the VTP.

D.2.4 APPLICABILITY OF EXISTING RISK ASSESSMENTS

The human and ecological risks associated with all active ingredients being proposed for use in the Program and Alternatives have been assessed for the USDA/FS vegetation management program by the Forest Service and Syracuse Environmental Research Associates, Inc. (SERA). A review was made of the USDA/FS program for which the risk assessments (RAs) were prepared and in all cases the VTP and Alternatives fall well within the parameters of the Forest Service program, so the conclusions of the risk assessments are generally applicable and there is no need to conduct a new and original RA for each chemical (see Title 14, California Code of Regulation –CCR- § 15148). Instead, the conclusions of these risk assessments were used as a basis for identifying known hazards for each chemical being proposed for use. Information from U.S. EPA chemical evaluations was used to both supplement and update materials in the SERA and Forest Service risk assessments. Scientifically accurate information from open literature was added, as referenced below, to elaborate on or update any material in U.S. EPA, SERA, and Forest Service assessments.

The full U.S. EPA and USDA/FS risk assessments are available via the Internet. U.S. EPA documents can either be obtained online through the Agency website (http://www.epa.gov/) or the federal regulations database (www.regulations.gov). The most current USDA/FS risk assessments and associated 2012 Excel workbooks with assessment calculations, which are typically completed by SERA consultants, can be downloaded at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml.

Consultants at SERA developed specific risk assessment methodologies and programs in collaboration with the Forest Service. SERA consultants, for example, currently use a program associated with the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS), which is referred to as Gleams-Driver version 1.9.3 (see user guide, SERA 2007a), to model the fate of chemicals in the environment. Likewise, a downloadable Excel application called WorksheetMaker was created by SERA and the Forest Service to make human and ecological health risk assessment calculations, and this application is regularly updated as new information becomes available. SERA risk assessment methods and user guides, as well as programs and applications, such as Gleams-Driver and WorksheetMaker, are updated frequently. The most current information can be downloaded directly from the SERA website (www.sera-inc.com).

Human and ecological risk values disclosed in Forest Service chemical risk assessments were determined using calculation and scenario methods current at the time that each assessment was completed; however, risk evaluation methods change frequently. As a result, values in risk assessments do not always reflect the current evaluation methods. Thus, for the assessment of chemicals in this PROGRAM EIR, risk calculations have been updated using the most current version of the Excel application FS WorksheetMaker (version 6.00.10). Generally, for each chemical, separate workbooks were completed for the typical and upper application rates (lbs/acre) for each category of application method applicable (e.g. backpack directed foliar, ground broadcast foliar, or stump application). For example, four workbooks were created for 2,4-D, because it has different typical and upper application rates and is applied using both backpack directed foliar and ground broadcast foliar application methods.

The only chemical risk calculations not updated using the most current version of WorksheetMaker (6.00.10) are the two chemical impurities of concern, hexachlorobenze and NP9E, as these compounds are not included in the current WorksheetMaker application. Hexachlorobenzene calculations were updated as suggested by Patrick Durkin of SERA Inc. using provided workbooks that were created using WorksheetMaker version 6.00.07 (see workbook revisions tab for details). For NP9E, values were taken directly from the USDA/FS (2003b) risk assessment written by David Bakke, as the worksheets have not been updated. Worksheets completed for the chemicals analyzed in this PROGRAM EIR are in Oliver, 2012.

All of the chemicals proposed for use in the VTP and Alternatives have also been extensively evaluated by the U.S. EPA. Conclusions made by the U.S. EPA (also referred to as the Agency) are usually based on findings from a suite of studies completed by the chemical registrants. Although there is disagreement over the validity of such studies, the Agency enforces stringent guidelines for each type of test required during the registration process (see 40 CFR 158.5 for study requirements). If standard protocols are not followed by the registrant, or test requirements should change over time, studies are considered unacceptable and must be repeated and resubmitted to the Agency in order for the active ingredient to become or remain registered. If there have not been changes to standard protocols for a given test since initial chemical registration, then the test will continue to be used any time the active ingredient is re-evaluated by the U.S. EPA. A single study completed by the registrant may qualify to fulfill multiple data requirements, which allows registrants to reduce the number of laboratory animals used. For example, a study may be conducted to evaluate dermal irritation and dermal sensitization. The guidelines and standards set by the Agency ensure some level of consistency and allow for comparability of test results for a particular chemical, as well as between multiple chemicals. The Agency evaluates tests for a given active ingredient and summarizes the findings in various Re-registration Eligibility Decision (R.E.D.), or more recently, in Registration Review Decisions and other chemical assessment documents.

Until recently, the U.S. EPA released copies of registrant studies under the Freedom of Information Act, but now most studies are considered proprietary information and are no longer released to the public. Fortunately, most U.S. EPA guidelines have not changed since the initial submission of acceptable studies, so older studies are still acceptable. All Forest Service risk assessments include detailed information regarding U.S. EPA-submitted studies that were acquired prior to 2011 from the U.S. EPA, as well as directly from the chemical registrants. These Forest Service assessments are typically completed under contract by Dr. Patrick Durkin and other consultants from SERA. When contracted to completed Forest Service risk assessments for active ingredients, SERA consultants evaluate these U.S. EPA studies, as well as, toxicology databases, and an enormous amount of open literature, making them particularly valuable resources.

The U.S. EPA and the Forest Service regularly evaluate and re-evaluate new information regarding the human and ecological risks associated with the chemicals proposed for use under the VTP and Alternatives. The U.S. EPA reviews the hazards of pesticide active ingredients, as well as surfactants, inerts and/or metabolites of toxicological concern, during the registration, tolerance, and re-registration evaluation process. Similarly, the Forest Service contracts (i.e.,, usually SERA) to have chemical risk assessments created and updated regularly. The U.S. EPA and USDA/FS risk assessment and review history for each chemical proposed under the VTP and Alternatives is as follows:

Borax (tetraborate decahydrate) - A R.E.D. was completed by the U.S. EPA (1993b) for boric acid and its salts. Subsequently, certain aspects of toxicity for boric acid and its salts were re-examined in a Tolerance Re-registration Eligibility Decision (T.R.E.D.) and again when scoping in preparation for a R.E.D. that is expected in 2014 (U.S. EPA 2006e and 2009a respectively). The most recent USDA/FS risk assessment for borax, completed by SERA (2006a), specifically assessed the fungicidal product Sporax®, which is 100% sodium tetraborate decahydrate. Note that Cellu-Treat is also a borax product registered for use in California, which is 98% disodium octaborate tetrahydrate and 2% water. Cellu-Treat, however, is not proposed for use in this document because the SERA risk assessment does not cover the use pattern of this product.

Clopyralid - While extensive toxicity data was submitted to the U.S. EPA by clopyralid registrants, the Agency has yet to complete or propose a R.E.D. for this active ingredient. Despite this, clopyralid tolerance and acute and chronic toxicity information was released by the U.S. EPA after new clopyralid crop uses were evaluated (FR 2002a, 2002b; U.S. EPA 2009b). The initial USDA/FS risk assessment for clopyralid specifically evaluated the product Transline®, which contains the monoethanolamine salt of clopyralid (SERA 1999). Since then, another assessment of clopyralid was completed by SERA (2004a).

Glyphosate - A R.E.D. has been completed for glyphosate by the U.S. EPA (1993c), though toxicity and tolerances have been re-evaluated several times as a result of additional chemical uses, as well as new glyphosate salts being registered (e.g. FR 2007, 2011; U.S. EPA 2006b, 2006c). Glyphosate was also recently evaluated by the U.S. EPA in scoping documents for a proposed R.E.D. expected in 2015 (U.S. EPA 2009c). As for the USDA/FS, specific glyphosate formulations and surfactants were evaluated in the mid-1990s (SERA 1996a & 1997a respectively). Since then, complete glyphosate risk assessments have been done multiple times (e.g. SERA 2003a). The USDA/FS contracted SERA to update a glyphosate program description, as well as a human and ecological health risk assessment (SERA 2010 & 2011b respectively).

Rather than simply evaluating the active ingredient, the most recent assessment for glyphosate considered the relative toxicity of technical grade glyphosate, glyphosate formulations, and the POEA surfactant.

Hexazinone - This chemical was first registered in 1975 and several years later a R.E.D. was completed by the U.S. EPA (1994). Later, some tolerance data was revised due to evaluation changes (U.S. EPA 2002a and 2002b). A U.S. EPA (2010c) registration review for hexazinone is expected in 2016. Initially, SERA (1997b) was only contracted by the Forest Service to evaluate selected formulations of hexazinone, though SERA (2005) later fully assessed the active ingredient.

Imazapyr - Technical grade imazapyr was first registered in 1985, though the first grassland uses were not registered until 2003, as discussed in a recent R.E.D. (U.S. EPA 2006d). A subsequent addendum was released in 2008. A USDA/FS human and ecological health risk assessment was completed for imazapyr, which was later updated (SERA 2004b & 2011c, respectively).

Sulfometuron methyl - This chemical was first registered in 1982, but no tolerance studies have been completed since there are no food or feed uses for this herbicide. A R.E.D. (U.S. EPA 2008a) was done in 2008 and a subsequent amendment was completed in 2009. Initially, SERA (1998b) assessed sulfometuron methyl by evaluating the commercial formulation Oust®, as that was the only sulfometuron methyl product used by the USDA/FS. Subsequently, SERA (2004c) completed a full assessment of sulfometuron methyl.

Triclopyr - This chemical was most recently evaluated by the Agency in a R.E.D. (U.S. EPA 1998). Similarly, during the mid-1990's, SERA (1996b) assessed commercial formulations of triclopyr (Garlon 3A and Garlon 4). Since then, multiple evaluations of triclopyr have been completed (SERA 2003b & 2011d).

NP9E - A hazard characterization of alkylphenols, including *p*-Nonylphenol (NP) compounds, was completed by the U.S. EPA and subsequently an action plan was conducted specifically for NP and NPE compounds (U.S. EPA 2009f & 2010e). David Bakke, USDA/FS Region 5 Pesticide Use Specialist, evaluated the surfactant NPE in 2003 because it is commonly used in forestry and sometimes as an active ingredient (USDA/FS 2003b).

D.2.5 CHEMICAL APPLICATION RATES

Pesticide product labels are regulated by the U.S. EPA and are required to specify maximum product application rates (see Appendices E & F). These rates are based on the specific composition of the product and the labeled product uses. The concentration and form (e.g. salts, esters or amines) of herbicidal ingredients, the presence or absence of "other" or inert ingredients (including water), and the concentration of other ingredients are all factors that influence the composition and potency of a product. Each product is labeled to be used for controlling specific target species on certain types of sites for particular purposes. Each of these factors also influences the application rates specified on the label. Formulation composition and use factors are both considered to determine all application rates on a product label, including those for specific purposes, as well as the maximum rate for each product.

The proportion of a pesticidal ingredient in a formulation directly influences the labeled application rates. It is disclosed differently on labels depending on the composition of the pesticide. Derivatives, such as salts, esters, or amines, are often formulated with the pesticidal/herbicidal compounds to increase the efficacy of pesticide activity (Hager 2009). For example, formulating glyphosate with a salt compound may allow glyphosate to act against the target plant more effectively, because the salt allows for higher absorption of glyphosate through the waxy cuticle of the plant. The presence or absence of derivatives influences how the proportion of pesticidal ingredients is measured and printed on product labels, with the proportion being expressed as either active ingredient (a.i.) or acid equivalent (a.e.) per pound or gallon. “Active ingredient (a.i.)” is commonly used on labels when pesticidal acid compounds are formulated with derivatives, and the derivatives are included in the proportion of the pesticide. The term a.i. is also used on labels of products when there is only one form of a pesticidal compound sold (*ibid*). By contrast, “Acid equivalent (a.e.)” is used when the proportion includes only the amount of pesticidal parent acid that could be theoretically derived from a formulation containing derivatives (*ibid*). Using a.e., rather than a.i., allows for easy comparison of pesticide concentrations between products that use the same pesticide but different derivatives.

In the Forest Service risk assessments, active ingredients are often evaluated in terms of estimated expected lower, upper, and typical rates of application, which are based on past USDA/FS use of each active ingredient for forestry related applications (see Table D.2-1). In these assessments, application rates were stated as either pounds of a.i. or pounds of a.e. per acre per treatment, as appropriate. For the analysis in this PROGRAM EIR, the typical and upper application rates were usually used when updating Forest Service risk assessment calculations using FS WorksheetMaker 6.00.10. While application rates determined by the USDA/FS are used in most cases throughout this PROGRAM EIR, an adjustment for clopyralid was made because California law mandates lower application rates for this active ingredient. The clopyralid product labels registered in California restrict the application rate of clopyralid to a maximum of 0.25 lbs a.e./ac/year, whereas this chemical can be applied at a maximum rate of 0.5 lbs a.e./ac/year in other states.

Though the maximum rates were calculated for comparison and discussion purposes in SERA risk assessments, the USDA/FS actual application rates in the field usually parallel the typical application rates. The application rates potentially used under the VTP and Alternatives are expected to be similar to the typical rates projected by the U.S. Forest Service. The SERA risk assessments often use higher maximum application rates (of a.e. or a.i.) for calculations than are actually allowed by product labels. In such cases, the formulation label will always supersede the upper bound specified in SERA assessments, as law prohibits the use of application rates higher than those written on a label. Conversely, for those products that have higher application rates specified on the label than the applicable risk assessment specifies (i.e., glyphosate Accord® products), the U.S. Forest Service maximum rates will not be exceeded under the VTP and Alternatives.

Table D.2-1

Chemical Application Rates Proposed for Use Under the Program & Alternatives [1]

Active Ingredient	Ground Application			References
	Typical Applied (lbs /acre)	Lower Range (lbs /acre)	Upper Range (lbs /acre)	
Borax, sodium tetraborate decahydrate	1.0 a.i.	0.10 a.i.	5.00 a.i.	SERA 2006a, p. 2-2
Clopyralid, monoethanolamine salt	0.25 a.e. [2]	0.10 a.e.	0.25 a.e. [2]	SERA 2004a, p. 2-3
Glyphosate	2.0 a.e.	0.29 a.e.	8.00 a.e.	SERA 2011b, Table 7, p. 16-17 & 289
Hexazinone	2.0 a.i.	0.50 a.i.	4.00 a.i.	SERA 2005, p. 2-4
Imazapyr, isopropylamine salt	0.30 a.e.	0.125 a.e.	1.5 a.e.	SERA 2011c, Table 3 & 4, p. 9 & 133
Sulfometuron methyl	0.045 a.i.	0.03 a.i.	0.38 a.i.	SERA 2004c, p. 2-1
Triclopyr	1.0 a.e.	0.10 a.e.	6.60 a.e. [3]	SERA 2011d, p. 10; SERA 2003b, p. 2-5
NP9E	1.67 a.i.	0.167 a.i.	6.68 a.i.	USDA/FS 2003b, p. 4

a.e. = acid equivalent isomer of active ingredient, a.i. = active ingredient. Typical = refers to the average application rate used by the USDA/FS, high/low = refer to upper and lower application rate limits used by the USDA/FS; [1] Application rates are based on those disclosed in Forest Service risk assessments for each chemical, unless otherwise noted. [2] The typical and upper application rates for Clopyralid are 0.35 and 0.50 lbs a.e. per acre respectively for the USDA/FS. In California, however, the maximum application rate is restricted to 0.25 lbs a.e. per acre per year, and as such 0.25 is conservatively used for both the typical and upper application rate throughout this PROGRAM EIR; [3] A few uses for triclopyr have application rates as high as 10 lbs. a.e./acre, though 6.63 lbs a.e. per acre was the maximum used by the USDA/FS in 2004.

D.2.6 CHEMICAL PROPERTIES AND MOBILITY

Humans could potentially be exposed to herbicides in several ways such as by direct contact, by contact with or inhalation of spray, by ingestion of contaminated materials (such as vegetation, water, fish and game), or by contact with contaminated vegetation. It is therefore imperative to consider the mobility and persistence of proposed herbicides, as well as their rate of absorption and degradation in nature.

In order for herbicides to adversely affect humans offsite from where the chemicals are applied, they must be able to move from the treatment site in sufficient quantities to expose people to harmful doses. Chemicals are mobile to different degrees and for different lengths of time. Pesticide mobility is greatly affected by microsite conditions, such as soil pH, texture, depth, and organic matter content. Climatic conditions, such as a precipitation, temperature, humidity, and wind speed, may also affect how herbicides spread or drift from the area of application.

The ability of chemicals to affect living organisms over time is determined in part by their persistence in the environment. Persistence is determined for both soil and aqueous environments and is measured by the time it takes for one-half of the chemical to become inactive (degraded) in its ability to affect target species. Persistence in soil is primarily affected by soil texture, climate, and microbial action. Persistence in water is primarily affected by temperature, sunlight, flow, and by the type(s) of sediment in the water. Potential modes of transport of chemicals are as follow:

a) Direct spray of waterbodies, special status species, or receptors
b) Off-site drift of spray to waterbodies and terrestrial areas
c) Runoff of surface water from the application area to off-site waterbodies or soils
d) Accidental spills to waterbodies
e) Contamination of water used for irrigation
f) Infiltration into and leaching through soil to groundwater
g) Wind erosion resulting in deposition of contaminated dust
h) On-site volatilization from sprayed surfaces
i) On-site volatilization by burning of sprayed vegetation

Table D.2-2 displays the differences in mobility of the chemicals potentially used in the VTP and Alternatives. This table is a synthesis of information from a number of sources, including USDA/FS and SERA risk assessments, the U.S. EPA, the HFQLG FSEIS (in Appendix F-Environmental Fate of Proposed Herbicides) (USDA/FS 2003a), the Diamond Project DEIS (USDA/FS 2006b), the USFWS (USDI U.S. FWS 2007), CDPR Environmental Fate Reviews (http://www.cdpr.ca.gov/docs/emon/pubs/envfate.htm), and other sources. The ratings in this table are not absolutes and should be taken with caution, as mobility of chemicals is variable and highly complex. Substantially different estimates of mobility could be made when different site-specific factors are considered. Estimates of exposure risk based upon movement of chemicals should be considered only as crude approximations of environmentally plausible consequences.

Table D.2-2 Modes of Off-Site Transport for Chemicals Proposed for Use Under the Program & Alternatives					
Chemical	**Drift**	**Volatilization**	**Runoff**	**Leaching**	**Wind** [3]
Borax, Sodium Tetraborate Decahydrate	L	L	L	L	M
Clopyralid, Monoethanolamine Salt	L	L	H	L [2]	L
Glyphosate, Diammonium Salt	L	VL	L	L	H
Glyphosate, Dimethylamine Salt	L	VL	L	L	H
Glyphosate, Isopropylamine Salt	L	VL	L	L	H
Glyphosate, Potassium Salt	L	VL	L	L	H
Hexazinone	L	L [4]	H	H	L
Imazapyr, Isopropylamine Salt	L	L	H	H	L
Sulfometuron-Methyl	L	VL	M	M	L
Triclopyr, Butoxyethyl Ester (BEE)	M	M	L	L	M
Triclopyr, Triethylamine Salt (TEA)	L	L	L	L	M

H = high mobility, M = moderate mobility, L = low mobility, VL = very low mobility. [1]Also formerly known as isooctyl ester (U.S. EPA 2005d); [2] Field studies indicate minimal leaching due to rapid degradation in soil; [3] Transport of soil particles by wind; [4] Volatilization of the liquid form of Velpar is higher.

Two models are used to evaluate chemical mobility and fate in Forest Service risk assessments: AgDRIFT® and GLEAMS-Driver (SERA 2012). AgDRIFT® is a cooperative development effort between the U.S. EPA-ORD, USDA Agriculture Research Service, USDA Forest Service, and the Spray Drift Task Force, a consortium of approximately 42 agricultural chemical registrants. AgDRIFT® was developed to provide the U.S. EPA with an evaluation tool to estimate the environmental exposure from spray drift at the time chemicals are applied. GLEAMS (Groundwater Loading Effects of Agriculture Management Systems), by contrast, is a root zone model developed by the USDA Agricultural Research Service to assess the fate of chemicals applied to a variety of soils under varying hydrogeological and meteorological conditions. Gleams-Driver was developed by the USDA Forest Service in Region 8 as a "*user-friendly Windows program that serves as a pre-processor and post-processor for GLEAMS. It prepares input files for GLEAMS, runs the GLEAMS program, and then reads and processes the output from GLEAMS to make estimates of concentrations of pesticides in soil (target and nontarget fields) as well as* *surface water (streams and ponds)*" (SERA 2006b). Metabolite information is also sometimes modeled when using Gleams-Driver. Information from AgDRIFT® and GLEAMS-Driver modeling is important to assess exposures relevant to both human and ecological risk assessment

In Forest Service risk assessments, GLEAMS models are used to evaluate how the properties of a chemical influence their spread through the environment. Chemical properties required include foliar, aquatic sediment, soil and water halftimes. Additionally, chemical solubility in water and the fraction of a chemical that washes off of foliage were used. Coefficients relating to chemical concentrations in water and sediment, as well as soil absorption, were also established for USDA/FS models. Since chemical binding to soil is influenced by the specific characteristics of different soils, Forest Service risk assessments usually modeled three soil textures: clay, loam, and sand (SERA 2006b). Table D.2-3 shows the chemical and site parameters used in the modeling for loam (a combination of clay and sand) in USDA Forest Service risk assessments evaluated for this PROGRAM EIR. For further details regarding the GLEAMS models refer to the Gleams-Driver User Guide (SERA 2007a) and Modifications to Gleams-Driver Version 1 (SERA 2006b) documents.

Very small amounts of chemicals are likely to be used under the VTP and Alternatives relative to agricultural, urban, and other uses of pesticide. A review of scientific literature on drinking water from forests and grasslands in North America did not identify the chemicals analyzed in this Program EIR "in surface or ground water at sufficiently high concentrations as to cause drinking water problems. Their rapid break down by physical, chemical, and biological routes coupled with use patterns precludes the development of water contamination problems unless they are applied directly to water" (USDA Forest Service 2002a). Chemicals will not be applied directly to water under the VTP and Alternatives.

Surface water monitoring conducted in 1999-2002 to measure off-site transport of atrazine, 2,4-D, glyphosate, and triclopyr in the lower Klamath River watershed found that there was no detectable off-site movement of atrazine or triclopyr following the first rainfall event after ground applications. Glyphosate and 2,4-D were not applied by ground application, so those results are not reported here (CDPR 2003, Table 18, p. 40).

Ground water monitoring conducted in the late 1990s to measure off-site transport of ground applications of hexazinone applied in pellet form at rates of 34.7 and 41.4 kg/ha (31 and 37 lbs/acre) on the Stanislaus National Forest found no detectable amounts in monitoring wells in the first year of application. In the following six years of monitoring in one well, detectable amounts (0.44-3.1 µg/L) were found until the last year of monitoring. In the following four years of monitoring in the other well, detectable amounts (0.16-2.2 µg/L) were found until the last year of monitoring. For both wells, the detectable amount of hexazinone was far less than the California Department of Water Resources' water quality standard of 400 µg/L. (DeGraff, et. al. 2007, p. 359)

Monitoring of a ground application of liquid hexazinone on the Sierra National Forest demonstrated that hexazinone penetrated a significant distance into a 25-foot buffer zone on either side of a Class 4 (CA Forest Practice Rules Class III) channel centerline. It penetrated at least 15 feet into the buffer zone in surface water, at least 10 feet in surface soil, and leached to a depth of 6 feet at 20 feet into the buffer zone. However, the detectable concentrations were a full magnitude lower than the California Department of Water Resources' water quality goal. "The pattern of mobility at these sensitive sites clearly shows peak concentrations of hexazinone in surface water following the first storm event and a gradual rise to peak concentrations of hexazinone in the vadose zone water after several storm events." (DeGraff, et. al., 2007)

Table D.2-3

Chemical & Site Parameters Used in GLEAMS Modeling

Active Ingredient	Foliar wash-off fraction [1]	Soil Adsorption Coefficient ($K_{o/c}$) [2]	Sediment-Water Distribution Coefficient (K_d) [3]	Water Solubility (mg/L)	Persistence (Half-Life in Days) [4]				Primary Degradation Processes	Reference
					Foliar	Soil	Water	Aquatic Sediment		
Borax, sodium tetraborate decahydrate	1.0	0.11	0.0165	42,700	10,000	10,000	infinity	infinity	NA (not microbial)	SERA 2006a Table 3-1
Clopyralid	0.95	3.15	0.02	1,000	2	25	261	1,000	slow microbial	SERA 2004a, Table 3-1
Glyphosate	0.6	3,100 (2,000-24,000)	420 (18-1,000)	12,000	10	5.4	21	208	slow microbial	SERA 2011b Table 15
Hexazinone	0.9	54	0.59	33,000	30	120	730	230	slow microbial, photolysis	SERA 2005 Table 3-4
Imazapyr, isopropylamine salt	0.9	53 (8-110)	0.64 (0.07-3.4)	11,100	30 (15-37)	2,150 (313-2,972)	19.9-199	5,000	slow microbial	SERA 2011c Table 10
Sulfometuron methyl	0.65	78	0.6	300	10	30	113	60	hydrolysis, microbial,	SERA 2004c Table 3-1
Triclopyr, butoxyethyl ester (BEE)	0.7	1,233 (640-1,650)	NA	7.4	26.9 (16.5-73)	0.2	0.5	4.1 (1.1-15)	hydrolysis, photolysis, microbial	SERA 2011d Table 22
Triclopyr, triethylamine salt	0.95	59 (25 to 134)	NA	440	26.9 (16.5-73)	14 (8 - 28.4)	426	6.2 (2.6 – 15)	hydrolysis, photolysis,	SERA 2011d Table 22

(TEA)									microbial	

[1] Fraction of a chemical on the foliage of plants available for washoff by rainfall; [2] organic carbon partition coefficient; [3] skin permeability coefficient; [4] Time for 1/2 of total chemical applied to be dissipated; NA = Not Available. NP9E has not been analyzed using GLEAMS modeling, hence its absence from this table.

The mobility of chemicals is of particular concern to the Native American community, including the California Indian Basketweavers Association, due to the potential for contamination of plants traditionally used in their culture. Such plants are still used and are gathered by hand, in the traditional manner, primarily on public wildlands and tribal reservations. Plants that are used for weaving baskets are handled with bare hands and are often placed in the mouth at some time during the weaving process. Other plants, or plant parts, are used as food, or have additional uses.

There have been a number of studies in the field to assess the effects of herbicides on plants important to Native Americans. A four-year study from 1997-2001 by the CDPR monitored residues of glyphosate (Accord®), triclopyr (Garlon® 4), and hexazinone (Velpar® L – liquid form & Pronone® 10G – granular form) on bracken fern, buckbrush, golden fleece, and manzanita on three national forests (CDPR 2002). The study also determined herbicide dissipation rates and estimated the potential for off-site movement (Table D.2-4) The half-lives of these chemicals are also well documented (Table D.2-5).

Table D.2-4

The Mean Number of Weeks Observed from the Maximum Herbicide Concentration to the Non-Detectable Level

Herbicide	Plant Part Sampled			
	Bracken Fern Roots	**Buckbrush Shoots**	**Golden Fleece Foliage**	**Manzanita Berries**
Glyphosate	6 weeks	NA[1]	42 weeks	NA
Triclopyr	11 weeks	NA	56 weeks	NA
Hexazinone - Velpar® L	4 weeks	130 weeks	20 weeks	6 weeks
Hexazinone - Pronone® 10G	29 weeks	4 weeks	15 weeks	8 weeks

Source: CDPR 2002, Table 7. [1] NA means a non-detectable level was not recorded, either because there was no vegetation left to sample, or the non-detect level was never reached.

Table D.2-5

Mean Half-Life of Four Forestry Herbicides In Plant Parts Used by California Indians

	Mean Half-Life for Plant Media Sampled (weeks)			
Herbicide	**Bracken Fern Roots**	**Buckbrush Shoots**	**Golden Fleece Foliage**	**Manzanita Berries**
Glyphosate	11.5 (1) [1]	9.8 (3)	8.2 (2)	NA [2]
Triclopyr	6.1 (2)	2.4 (3)	5.1 (3)	NA
Hexazinone - Velpar® L	18.5 (1)	17.6 (2)	0.6 (2)	NA
Hexazinone - Pronone® 10G	NA	NA	NA	1.7 (1)

Source: CDPR 2002, Table 8. [1] The number in parentheses indicates the sample size used for the calculation of the mean. [2] NA denotes that no meaningful regression could be obtained and, therefore, no mean half-life was calculated.

Herbicide half-lives were variable, ranging from 1 to 19 weeks. The CDPR (2002) study found, "[i]n decreasing order, half-lives were longest for liquid hexazinone, glyphosate, triclopyr, and then granular hexazinone treated plant materials."

It can be seen from these Tables that there is considerable variation in the dissipation rates between the herbicides themselves and between the various plant parts that were tested. For example, hexazinone in the granular form had the slowest dissipation rate by far in bracken fern roots and the fastest in golden fleece foliage, while the liquid form had the fastest rate in bracken fern roots and the next to the fastest rate in golden fleece foliage. Residues dissipated most slowly in buckbrush shoots.

The highest residue levels on the day of application were with glyphosate treated plants, followed by those treated with liquid hexazinone, triclopyr, and then granular hexazinone. Although granular hexazinone had the lowest residue level, by the 28th week following application, both liquid and granular hexazinone had similar residue levels in roots, shoots, and foliage.

A residue study in redbud, used for making baskets, following application of hexazinone around the base of plants showed no hexazinone in plant shoots after 0, 4, 8, and 12 weeks. The maximum detectable level of herbicide for redbud is 0.05 ppm. (CDPR 2002) Native Americans are also concerned about herbicide residues in oak acorns, which are used for food. Several studies of residues in acorns have been done by CDPR. Acorns were collected from under trees 28-36 days after spraying with liquid and granular hexazinone and glyphosate. No herbicide residues were found (at a 0.1 ppm maximum detectable level) for either of the chemicals (*ibid*).

Monitoring conducted in 1999-2002 to measure impacts to culturally significant plants (i.e., beargrass: stems and leaves, huckleberry: berries, yarrow: stems and leaves, manzanita: berries, Oregon grape: roots, willow: shoots, and tanoak: acorns) from off-site transport of 2,4-D and triclopyr in the lower Klamath River watershed found that drift from aerial applications at 10-50 feet above the ground (no ground applications were monitored) of the herbicides was detectable at two of four application sites. The farthest distance that residues were detected on plants was 30 to 41 feet outside the application area, where plant samples averaged 0.14 ppb and 0.10 ppb for triclopyr and 2,4-D, respectively. Dissipation of herbicides after application was monitored over time at six sites in five treatment areas. Plants in four of the sites contained no detectable herbicide residues by approximately 150 days. The other two sites had measurable amounts of herbicide at approximately day 60, but contained no residues at the next sampling date of 370 days (53 weeks). Samples of new growth on plants collected more than a year after application contained no detectable amount of triclopyr or 2,4-D (CDPR 2003).

D.3 DIRECT EFFECTS FROM IMPLEMENTING THE VTP AND ALTERNATIVES

As mentioned in Chapter 4.4, the U.S. EPA and States register and license pesticides in the United States under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The U.S. EPA is also responsible for issuing “Experimental Use Permits”, required to test an unregistered product. Additionally, the Agency continually reviews new information available on each active ingredient in an attempt to keep pace with new scientific findings and changes in policy and practices. This information is made available to the public in a Re-registration Eligibility Decision (RED) or in Registration Review Decisions. Before a new chemical can be registered, or an existing chemical registered for a new use, the U.S. EPA requires a minimum of 120 different scientific studies and tests from the applicants (usually registrant chemical companies), which can take up to 15 years to complete. These studies are reviewed by the U.S. EPA to determine, with reasonable certainty, that the use of the chemical will not pose a risk to human health or the environment.

State agencies further regulate pesticides according to state laws. California State laws that regulate pesticide use, which are enforced by the CDPR, are more restrictive than regulations of the U.S. EPA and most other states. Therefore, pre-registration and registration requirements are more stringent than in other parts of the United States. CDPR reviews the studies submitted to the U.S. EPA and evaluates its findings, as well as State laws, to determine if additional label requirements or studies are needed.

D.3.1 HUMAN HEALTH RISK ASSESSMENT

D.3.1.1 Introduction

There is considerable concern among some members of the public over the long-term health risks of chemicals used in forest and rangeland management. Particular concern comes from the belief that exposure to even small amounts of these chemicals will result in cancer or other debilitating or life-threatening diseases. It is generally thought that the level of agricultural pesticide use in California is excessive and that any use in forested areas, which are generally the headwaters of much of California's water supply, is increasing the risks to public health.

When considering risk, it should be recognized that nothing we do is risk free. Driving a car, swimming, climbing a ladder, or having a medical X-ray all have risks. Calculations by the U.S. Forest Service of cancer risk to the general public from forestry herbicides used on National Forests in the Southeast showed a 1 in 10 million risk (the risk of getting cancer following an X-ray treatment is 7 in 1 million). This estimate is:

> *[B]ased on an extremely conservative approach, which assumed that the herbicides were carcinogenic (cancer causing) and exposure levels were high over long periods of time (70 years). The fundamental assumption of carcinogenicity is subject to much debate and to date no forestry herbicide has been conclusively shown to be carcinogenic (McNabb 1997).*

Although there are risks associated with the use of the chemicals likely to be used in the VTP and Alternatives, not using these chemicals will not necessarily result in a higher margin of public safety. Other methods for treating vegetation have their own unique risks, to workers and the public. For example, manual methods can lead to worker injuries, manual (chainsaw) and mechanical methods produce greenhouse gases and other pollutants, prescribed fire produces greenhouse gases, smoke pollution, and escaped fires, and prescribed herbivory can increase water pollution. All of these treatments are generally more expensive than herbicide treatments, and will thus deplete public and private funds more rapidly, resulting in fewer acres treated under the VTP and Alternatives. There are risks associated with treating fewer acres due to fiscal constraints, such as less protection from wildfire and fewer acres of noxious invasive plants treated.

Herbicides are designed to kill or retard plants by disrupting or altering one or more of their metabolic processes or by disrupting some physical structure, such as cell membranes. Borax can be used as an insecticide, but under the VTP and Alternatives will only be used as a fungicide to prevent infection of heterobasidion root disease in conifers. While few adverse effects to humans or animals are likely, as herbicides primarily affect processes exclusive to plants and borax is a common natural compound found in soil, any chemical in great enough quantities can have adverse effects. Therefore, risk analyses conducted by the Forest Service and others relating to forestry and rangeland management, were used and referenced for this Program EIR.

There are many important factors that must be considered when evaluating the potential risks of chemical use to human health. The level of risk depends on the inherent toxicity of end-use products, additives, and chemical mixes being used in the field. Risk is also dependent on the chemical concentrations, route of exposure, and the duration of chemical exposure. When humans are briefly exposed to pesticides, they may experience acute (short-term) toxicity symptoms, such as irritation of the eyes, skin or throat (causing coughing), as well as headaches and/or dizziness. When humans are exposed to chemicals over longer time periods (sub-chronically or chronically) adverse signs or symptoms of toxicity, such as cancer, the heritable mutations, reproductive issues, and/or neurotoxicity, may be observed. Individuals often respond to chemicals differently, with some being more sensitive than others. Additionally, most conclusions relating human health effects, including chemical toxicity, exposure, and risk characterization, are derived from studies using surrogate mammals, such as rodents, rabbits and dogs. These factors and others add different levels of variability and uncertainty.

With this in mind, USDA/FS risk assessments take a conservative approach when assessing acute and chronic exposure for the public and workers, by using worst case scenarios for each type of exposure (e.g. dermal, consumption of contaminated water). However, it should be kept in mind whenever conclusions of acceptable or minimal risk are presented in this document that **the use of chemicals is never without risk and that precautions should be taken to minimize human exposure to chemicals**. Adequate warning signage, for example, must be posted to lessen exposure to members of the public, while workers applying chemicals must wear personal protection equipment. Mitigation measures (e.g. streamside buffer zones) outlined in Section 4.4.3 and additional measures created at the project level must be followed to further protect humans.

This PROGRAM EIR does not specify which herbicide will or should be used in what bioregion. This would be unrealistic, given the immense scope of the VTP and the tremendous variation in vegetation management needs, ecosystems, environmental fate conditions, land use, etc. across the program area. Such decisions will be made on the project level. Proposed chemicals are assessed for human health risks based on the assumption that chemicals are used. In this Program EIR, herbicides and one fungicide will potentially be used in the VTP and Alternatives (see Chapter 3). Thus, all sections and appendices relating to the use of chemicals are relevant to the VTP and Alternatives.

Following the U.S. EPA and the Forest Service protocol, the human health risk assessment in this appendix will follow the four steps established by the National Research Council of the National Academy of Sciences to evaluate both human health risks and ecological effects associated with herbicide use. The steps include 1) hazard identification, 2) exposure assessment, 3) dose-response assessment, and 4) risk characterization (NRC 1983, as ordered by section in SERA 2012). Hazard identification assesses the toxicity of a given chemical agent to different organisms through different routes, doses and durations of exposure. Exposure assessment evaluates potential routes of exposure to workers and the public and to other organisms. Dose-response assessment evaluates the magnitude of exposure and the likelihood that adverse effects occur due to exposure. The risk characterization sections indicate the magnitude of risk once uncertainty factors are incorporated.

D.3.1.2 Hazard Identification

A suite of studies are commonly completed and/or evaluated by pesticide companies, regulatory agencies, and independent institutions to determine the risks of adverse human health effects related to the use of pesticides. Studies are often conducted to understand the effects of exposure duration (i.e., acute, sub-chronic, and chronic) and dose-response relationships. Other studies are conducted to specifically test for developmental toxicity and reproductive issues or test for mutagenicity and carcinogenicity. Additionally, specific studies are sometimes conducted to consider immunotoxicity, neurotoxicity, and endocrine disruption. Conclusions made by the U.S. EPA and SERA for each of these areas of toxicological concern are summarized throughout this section. Chemical properties, such as how chemical agents are metabolized and moved through the body (pharmacokinetics), are also important to hazard identification. Through these studies, the overall toxicity assessment of active ingredients and new formulations can be completed.

The U.S. EPA requires registrants of any new active ingredient or product to submit human health data from the studies discussed above, for technical grade active ingredient (TGAI), end-use product, and/or manufacturing-use product, depending on what is being registered (see 40 CFR 158.5 for study requirements). In particular circumstances, however, the U.S. EPA waives acute toxicity data requirements or allows registrants to fulfill these requirements with substitution of data from another product (U.S. EPA 2011a). Waivers may be granted, for example, if an acute oral toxicity study is inappropriate because the chemical exists in only a gas form (*ibid*). By contrast, data substitution (referred to as *data bridging*) may only occur when identical products are registered and re-packaged, or a new formulation is sufficiently similar to an existing formulation (*ibid*).

Given ethical constraints for chemical toxicity testing on human subjects, extensive toxicity tests are conducted on other physiologically similar mammals, primarily rodents, rabbits and dogs (see 40 CFR 158.5). This data on surrogate mammal species then provides a pesticide toxicology profile for each active ingredient. Judgments are made by the scientific community and regulatory agencies regarding the equivalency of the results to evaluate the potential adverse effects of chemicals towards humans. When available, documented incidents of human poison and human population effects are evaluated in conjunction with mammalian toxicity data.

The Office of Prevention, Pesticides and Toxic Substances (OPPTS), the U.S. EPA department responsible for developing test guidelines relating to pesticides, is now named the Office of Chemical Safety and Pollution Prevention (OCSPP), though guidelines are still often labeled using the acronym OPPTS. The OCSPP recently “harmonized” multiple test guidelines, which are listed and linked to pdf documents at http://www.epa.gov/ocspp/pubs/frs/home/ guidelin.htm. Harmonized human health effects test guidelines are as linked in Series 870. Similarly, U.S. EPA Endocrine Disruptor Screening Program (EDSP) guidelines are in series 890, with current EDSP information found at: http://www.epa.gov/scipoly/oscpendo/index.htm. Alternatively, guidelines can be located directly at www.regulations.gov by OPPTS number.

D.3.1.2.1 Form Equivalency

When initial studies were conducted for the registration of a new active ingredient, chemical and toxicology properties were compared to any similar active ingredients already registered, in order to assess for chemical equivalency. Currently, for example, nine active ingredients exist in the 2,4-D case file, including an acid, salts, and esters, and these forms were all found to have equivalent properties, with only a few exceptions (WHO 1996, 1997, 1998 as referenced in USDA/FS 2006a). Generally speaking, when multiple active ingredients are found to be equivalent in chemical properties and toxicity, the group was discussed generically, such as 2,4-D, without specifying form information. Moreover, in these cases data from one active ingredient form is chosen to represent the group of active ingredients, with any equivalency exceptions being clearly disclosed in risk assessment documents.

Like 2,4-D, the acid forms of borax, clopyralid, glyphosate and imazapyr are generally representative toxicologically to salt forms proposed for use in this PROGRAM EIR. On the other hand, the BEE and TEA forms of triclopyr are not always toxicologically equivalent to the acid form, so each of these two active ingredients are usually considered separately in USDA/FS and U.S. EPA documents. Hexazinone and sulfometuron methyl are each only used as a single active ingredient. Any important exceptions to these generalizations are clarified as needed.

D.3.1.2.2 Acute Toxicity

Acute toxicity is determined for oral, dermal, inhalation, and ocular routes of exposure. In general, exposure during these studies is by a single dose of the chemical agent. For background information regarding acute toxicity testing, refer to the U.S. EPA's guidelines (OPPTS 870.1000).

Acute oral and dermal toxicity studies assess systemic effects of exposure to the chemical agent. Results are quantified using "Lethal Dose 50" (LD_{50}), which estimates the amount of a pesticide per test animal bodyweight (usually displayed as mg/kg) required to kill 50% of a test animal population over a specific period of time (WHO 2009; Marer 1999). For acute oral testing, rodents (preferably rats) are usually fed a single dose of the chemical agent by gavage (OPPTS 870.1100) and observations are made to document any signs of systemic toxicity. For the acute dermal toxicity test, chemicals are applied to the skin in graduated doses to several groups of experimental animals (usually albino rabbits), with one dose being used per group and the study is typically conducted for 14 days (OPPTS 870.1200). Results establish a baseline systemic toxicity (via LD_{50}) and effects resulting from exposure. Sometimes detailed information on absorption is also obtained from this study.

Skin is also tested for irritation and sensitization effects. When assessing dermal irritation the test animal (usually a rabbit) has the chemical applied directly to only one patch of shaven skin and an area of the skin without chemical treatment serves as the control (OPPTS 870.2500). This study determines if the chemical causes irritation and/or corrosion to the skin, as well as irreversibility/reversibility of the effects, for no more than 14 days. Dermal sensitizations studies typically use one of three methods, with the most common being the Guinea-Pig Maximization Test (GPMT), which is the test used for active ingredients assessed in this PROGRAM EIR (OPPTS 870.2600). The GPMT is intended to test for whether the test agent is likely to cause or elicit skin sensitization reactions (allergic contact dermatitis). This study may also indicate systemic toxicity symptoms associated with repeated exposures to the chemical agent. Dermal sensitization is categorized as either being present or absent.

Like oral and dermal tests, the acute inhalation and eye irritation tests follow standard protocols. Unlike acute oral tests, however, inhalation is measured by "Lethal Concentration 50" (LC_{50}), which is typically measured by the concentration of a chemical in the air (mg of chemical per liter of air) that it takes to kill 50% of the test animals over a set time (WHO 2009; Marer 1999). Acute inhalation studies are intended to determine the effects and mortality from inhaling pesticide vapor using graduated dosing with rodents (OPPTS 870.1300). In general, chemicals have greater toxicity via inhalation relative to ingestion (oral) routes of exposure, due to factors such as more rapid absorption and distribution of the chemical through the body. The eye irritation studies measure whether the test chemical has irritating or corrosive effects on the eye and if effects are reversible, usually by adding test material to one eye of a rabbit, while the other eye serves as a control (OPPTS 870.2400). Observations of the eyes are taken anywhere from 72 hours to 21 days after application.

Results from each study discussed above, with the exception of dermal sensitization, are categorized into one of four toxicity categories, in order to easily compare relative acute toxicity from each potential exposure route (Table 5.17.12). During studies any behavioral or physiological changes (e.g. gross lesions, body weight changes) are evaluated, as well as the reversibility of observed anomalies, animal mortality, and any other toxic effects. The U.S. EPA uses initial acute toxicity categories to establish dosing information for chronic and subchronic testing, as well as to establish an overall hazard potential of the chemical agent and to determine label requirements.

Acute toxicity category information, as well as inert ingredient information, is also used to determine product labeling requirements. The U.S. EPA requires that all chemicals that are considered to have toxic properties have a precautionary statement on the label. This statement is determined by the acute test with the most severe toxicity category, or the presence of a special inert at a concentration of 4% or more (U.S. EPA no date). Labels for each category are as follows:

Toxicity Category I or special inert	*DANGER*
Toxicity Category II	*WARNING*
Toxicity Category III	*CAUTION*
Toxicity Category IV	*None Required*

Though a signal word is not required if a chemical meets Category IV criteria, when a signal word is used the word must be CAUTION (U.S. EPA N.D.). In addition to this labeling, the term POISON, as well as a skull and crossbones symbol, are required by the U.S. EPA if either a) any of the acute dermal, oral, or inhalation tests result in a Toxicity Category I classification, or b) there is 4% or more of a known toxic inert, particularly methanol, in any formulation (see Table D.3-1 for labeling examples). This additional labeling must be in red on a contrasting background. All pesticide labels must have a “Keep out Of Reach of Children” warning (U.S. EPA N.D.).

Table D.3-1

Acute Toxicity Criteria Used by the U.S. EPA for Pesticide Classification & Labeling

Study	Category I DANGER	Category II WARNING	Category III CAUTION	Category IV Not Required
Acute Oral Toxicity OPPTS 870.1100	≤ 50 mg/kg body weight	> 50 - 500 mg/kg body weight	> 500 - 5,000 mg/kg body weight	> 5,000 mg/kg body weight
Acute Dermal Toxicity OPPTS 870.1200	≤ 200 mg/kg body weight	> 200 - 2,000 mg/kg body weight	> 2,000 - 5,000 mg/kg body weight	> 5,000 mg/kg body weight
Acute Inhalation* Toxicity OPPTS 870.1300	≤ 0.05 mg/liter	> 0.05 - 0.5 mg/liter	> 0.5 - 2 mg/liter	> 2 mg/liter
Acute Eye Irritation OPPTS 870.2400	Corrosive (irreversible destruction of ocular involvement or irritation persisting for more than 21 days	Corneal involvement or other eye irritation clearing in 8-21 days	Corneal involvement or other eye irritation clearing in 7 days or less	Minimal effects Clearing in Less than 24 hours
Acute Skin Irritation OPPTS 870.2500	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation at 72 hours (no irritation or slight erythema)

*4 hr exposure; Adapted from U.S. EPA N.D., Table 1, p. 7-2 to 7-3. The dermal sensitization results are not used for labeling information

Table D.3-2

Examples of U.S. EPA Signal Word Determination

Type of Study	Product A	Product B	Product C*	Product D	Product E*
Acute Oral Toxicity	III	IV	I*	III	II
Acute Dermal Toxicity	IV	III	III	IV	II
Acute Inhalation Toxicity	III	IV	III	III	II
Acute Eye Irritation	III	II	I	I	II
Acute Skin Irritation	IV	IV	II	IV	II
Special Inert, e.g., methanol	No	No	No	No	Yes*
SIGNAL WORD	**CAUTION**	**WARNING**	**DANGER & POISON**	**DANGER**	**DANGER & POISON**

Source: U.S. EPA N.D., Table 2, p 7-4. *Product C and Product E must have additional labeling of a skull & crossbones symbol in close proximity to the word "POISON". This is as a result of Product C having a Category I classification for one of the first three acute toxicity studies (oral in this case) and Product E being made of at least 4% of a special inert.

During U.S. EPA pesticide evaluation processes, most relevant registrant-submitted studies and any new information are continuously reviewed. The most current findings for each active ingredient proposed for use are in Table D.3-3. All chemicals potentially used under the VTP and Alternatives have low (Categories III or IV) acute oral, dermal and inhalation toxicity and also low (all Category IV) acute dermal irritation. Acute eye irritation is minimal (Category III) for monoethanolamine salt of clopyralid, glyphosate, sulfometuron methyl, and triclopyr BEE. Acute eye irritation is moderate (Category II) for NP9E, and thus products with this active ingredient must have a WARNING on the label. However, acute eye irritation is high (Category I) for borax, clopyralid acid, hexazinone, and triclopyr TEA, and thus products with these active ingredients must have DANGER on the label. Imazapyr is listed as Category I or III, depending on the percent of technical grade active ingredient used in the test study. Proposed chemicals are not dermal sensitizers, with the exceptions of triclopyr BEE and TEA. Nonylphenol and its ethoxylates (on average 9 ethoxylates, so abbreviated NP9E) are severe eye and skin irritants, but this chemical mixture is not a skin sensitizer. There is currently no inhalation study for NP9E. Given the low acute oral, dermal, and inhalation toxicity, none of the proposed chemicals are required to be labeled with the word POISON and a skull and crossbones, according to U.S. EPA regulations, unless a particular formulation has a special inert that warrants additional labeling.

Table D.3-3

Acute Toxicity of Proposed Chemicals According to the U.S. EPA [*, 1]

Acute Oral Toxicity OPPTS 870.1100	MRID	Results	Toxicity Category	Reference
Boric acid	00006719	rat LD_{50} males = 3,450 mg/kg rat LD_{50} females = 4,080 mg/kg	III	U.S. EPA 2006e, Table 1, p. 3
	00064208	beagle dog LD_{50} > 631 mg/kg		
Borax, sodium tetraborate decahydrate	40692303	rat LD_{50} males = 4,550 mg/kg rat LD_{50} females = 4,980 mg/kg	III	U.S. EPA 2006e, Table 2, p. 3
	40692304	dog LD_{50} > 974 mg/kg		
Clopyralid, acid	41641301	rat LD_{50} > 5,000 mg/kg (M+F)	IV	U.S. EPA 2009b, Table A2.a, p. 27
Clopyralid, monoethanolamine salt	00147690	rat LD_{50} > 5,000 mg/kg	IV	SERA 2004a, Table Appendix 1, Appendix 1-1
Glyphosate [2]	41400601	LD_{50} > 5,000 mg/kg	IV	U.S. EPA 2006b, Table 4.1a, p. 9
Hexazinone	41235004	rat LD_{50} = 1,200 mg/kg	III	U.S. EPA 2010d, Table 4, p. 16
Imazapyr	41551002 93048016	rat LD_{50} > 5,000 mg/kg	IV	U.S. EPA 2005c, Table 4.1a, p. 15
Sulfometuron methyl	43089201	rat LD_{50} > 5,000 mg/kg (M+F)	IV	U.S. EPA 2008a, Table 2, p. 8
Triclopyr, butoxyethyl ester (BEE)	40557004	rat LD_{50} = 578 mg/kg (F)	III	SERA 2011, Appendix 2, Table 1, p. 3
Triclopyr, triethylamine salt (TEA)	41443301	rat LD_{50} = 1,847 mg/kg (F)	III	U.S. EPA 1998, Table 3, p. 7; SERA 2011d, p. 21

NP9E	none	rat LD_{50} = 1,410-5,600 mg/kg rabbits, mice LD_{50} = 620 – 4,400 mg/kg	III	USDA/FS 2003b, Appendix 3-Table 1, p. A-12
Acute Dermal Toxicity **OPPTS 870.1200**	**MRID**	**Results**	**Toxicity Category**	**Reference**
Boric acid	00106011	rabbit LD_{50} > 2,000 mg/kg	III	U.S. EPA 2006e, Table 1, p. 3
Borax, sodium tetraborate decahydrate	43553201	rabbit LD_{50} > 2,000 mg/kg	III	U.S. EPA 2006e, Table 2, p. 3
Clopyralid, acid	41641302	rat LD_{50} males > 5,000 mg/kg rat LD_{50} females > 5,000 mg/kg	IV	U.S. EPA 2009b, Table A2.a, p. 27
Clopyralid, monoethanolamine salt	none	None	IV	U.S. EPA 2009b, p. 8
Glyphosate	41400602	LD_{50} > 5,000 mg/kg	IV	U.S. EPA 2006b, Table 4.1a, p. 9
Hexazinone	00104974	rabbit LD_{50} > 5,278 mg/kg	IV	U.S. EPA 2010d, Table 4, p. 16
Imazapyr	41551003 93048017	rabbit LD_{50} > 2,000 mg/kg	III	U.S. EPA 2005c, Table 4.1a, p. 15
Sulfometuron methyl [3]	43089202	rabbit LD_{50} > 2,000 mg/kg	III	U.S. EPA 2008a, Table 2, p. 8
Triclopyr, butoxyethyl ester (BEE)	40557005	rabbit LD_{50} > 2,000 mg/kg	III	U.S. EPA 1998, Table 4, p. 7, 187 & 199
Triclopyr, triethylamine salt (TEA)	41443302	rabbit LD_{50} > 2,000 mg/kg	III	U.S. EPA 1998, Table 3, p. 7, 180 & 201
NP9E	none	rabbit LD_{50} > 2,830 mg/kg	III	USDA/FS 2003b, Appendix 3, Table 1, p. A-12
Acute Inhalation Toxicity **OPPTS 870.1300**	**MRID**	**Results**	**Toxicity Category**	**Reference**
Boric acid	00005592	rat LC_{50} > 0.16 mg/L (no deaths)	II [4]	U.S. EPA 2006e, Table 1, p. 3
Borax, sodium tetraborate decahydrate	43500801	rat LC_{50} > 2.03 mg/L	IV	SERA 2006a, p. Appendix 1-17

Clopyralid, acid	41848300	rat LC_{50} males > 5.0 mg/L (M+F)	IV	U.S. EPA 2009b, Table A2.a, p. 27
Clopyralid, monoethanolamine salt	none	none	IV	U.S. EPA 2009b, p. 8
Glyphosate [5]	none	LC_{50} requirement waived	none	U.S. EPA 2006b, Table 4.1a, p. 9
Hexazinone [6]	41756701	rat LC_{50} > 3.94 mg/L (4 hr)	III	U.S. EPA 2010d, Table 4, p. 16
Imazapyr	00132032 93048018	rat LC_{50} > 1.3 mg/L (gravimetric) rat LC_{50} > 5.1 mg/L (nominal)	III	U.S. EPA 2005c, Table 4.1a, p. 15
Sulfometuron methyl	43089203	rat LC_{50} > 5.0 mg/L	IV	U.S. EPA 2008a, Table 2, p. 8
Triclopyr, butoxyethyl ester (BEE)	40557006	rat LC_{50} > 4.8 mg/L	IV	U.S. EPA 1998, Table 4, p. 7 & 187
Triclopyr, triethylamine salt (TEA)	41443303	rat LC_{50} > 2.6 mg/L	IV	U.S. EPA 1998, Table 3, p. 7 & 181
NP9E	none	none	NA	no data
Acute Eye Irritation OPPTS 870.2400	**MRID**	**Results**	**Toxicity Category**	**Reference**
Boric acid	00064209	rabbit - conjunctiva irritation clearing by Day 4	III	U.S. EPA 2006e, Table 1, p. 3
Borax, sodium tetraborate decahydrate	43553203	rabbit - corrosive	I	U.S. EPA 2006e, Table 2, p. 3
Clopyralid, acid	41641304	rabbit - severe irritation at 7 days (corrosive)	I	U.S. EPA 2009b, Table A2.a, p. 27
Clopyralid, monoethanolamine salt	none	slight eye irritant or not irritant	none	U.S. EPA 2009b, p. 8
Glyphosate	41400603	corneal opacity or irritation clearing in 7 days or less	III	U.S. EPA 2006b, Table 4.1a, p. 9
Hexazinone	00106003	rabbit - severe irreversible corneal opacity	I	U.S. EPA 2010d, Table 4, p. 16

Imazapyr	41551001 93048019	rabbit - 2/6 with corneal opacity at 21 days; discharge in 1/6 at 21 days; vascularization of cornea in 1/6 at 21 days; irreversible eye damage	I Tested with 99.3% technical fine powder	U.S. EPA 2005c, Table 4.1a, p. 15
	Accession # 252004	rabbit - corneal opacity cleared within 72 hrs; conjunctivitis reversible by day 7	III Tested with 93% technical	
Sulfometuron methyl	00071412	rabbit - minimally irritating	III	U.S. EPA 2008a, Table 2, p. 8
Triclopyr, butoxyethyl ester (BEE)	40557007	rabbit - minimally irritating	III	U.S. EPA 1998, Table 4, p. 7 & 187
Triclopyr, triethylamine salt (TEA)	41443304	rabbit - corrosive	I	U.S. EPA 1998, Table 3, p. 7 & 181
NP9E	none	rabbit - moderate to highly irritating	II	USFS/FS 2003b, Appendix 3, Table 1, p. A-12
Acute Dermal Irritation **OPPTS 870.2500**	**MRID**	**Results**	**Toxicity Category**	**Reference**
Boric acid	00106011	rabbit - skin irritant	III	U.S. EPA 2006e, Table 1, p. 3
Borax, sodium tetraborate decahydrate	43553202	rabbit - not a skin irritant	IV	U.S. EPA 2006e, Table 2, p. 3
Clopyralid, acid	41641305	rabbit - not a skin irritant	IV	U.S. EPA 2009b, Table A2.a, p. 27
Clopyralid, monoethanolamine salt	none	not a skin irritant	IV	U.S. EPA 2009b, p. 8
Glyphosate	41400604	mild or slight skin irritant	IV	U.S. EPA 2006b, Table 4.1a, p. 9
Hexazinone	00106004	rabbit - mild skin irritant	IV	U.S. EPA 2010d, Table 4, p. 16
Imazapyr	41551004 93048020	rabbit - non-irritating to slight erythema and edema	IV	U.S. EPA 2005c, Table 4.1a, p. 15
Sulfometuron methyl	41672808	rabbit - not a skin irritant [3]	IV	U.S. EPA 2008a, Table 2, p. 8
Triclopyr, butoxyethyl ester (BEE)	40557008	rabbit - not a skin irritant	IV	U.S. EPA 1998, Table 4, p. 7 & 187

Triclopyr, triethylamine salt (TEA)	41443305	rabbit - not a skin irritant	IV	U.S. EPA 1998, Table 3, p. 7 & 181
NP9E	none	rabbit - minimally to severely irritating	II	USFS/FS 2003b, Appendix 3, Table 1, p. A-12
Skin Sensitization OPPTS 870.2600	**MRID**	**Results**	**Toxicity Category**	**Reference**
Boric acid / Sodium borate salts	none	no evidence of absorption across intact skin	N/A	U.S. EPA 2006e, Table 3, p. 6
Clopyralid, acid	41641306	guinea pig - not a skin sensitizer	N/A	U.S. EPA 2009b, Table A2.a, p. 27
Clopyralid, monoethanolamine salt	none	not a skin sensitizer	N/A	U.S. EPA 2009b, p. 8
Glyphosate	41642307	guinea pig - not a skin sensitizer	N/A	U.S. EPA 2006b, Table 4.1a, p. 9
Hexazinone	4123005	guinea pig - not a skin sensitizer	N/A	U.S. EPA 2010d, Table 4, p. 16
Imazapyr	00131607 93048021	guinea pig - not a skin sensitizer	N/A	U.S. EPA 2005c, Table 4.1a, p. 15
Sulfometuron methyl [7]	43089204	[guinea pig] - not a dermal sensitizer	N/A	U.S. EPA 2008a, Table 2, p. 8
Triclopyr, butoxyethyl ester (BEE)	40557009	guinea pig - sensitizer	N/A	U.S. EPA 1998, Table 4, p. 7 & 187
Triclopyr, triethylamine salt (TEA)	41443306	guinea pig - sensitizer	N/A	U.S. EPA 1998, Table 3, p. 7 & 181
NP9E	none	guinea pig - not a skin sensitizer	N/A	U.S. EPA 2009f, Table 4, p. 33 & 38

*2,4-D acid, boric acid, and clopyralid acid were shown for comparison purposes and are not proposed for use in this program. [1] Technical grade active ingredient (TGAI) was specified as used for all acute toxicity tests of imazapyr and sulfometuron methyl (SMM: at least 98.8%, purity), triclopyr (BEE: 97.1% a.i. & TEA: 44.4% a.i.) and, though not specified in all U.S. EPA documents, use of TGAI is likely for other ingredients as well. [2] All glyphosate salts disassociate to the acid and associated ions (FR 2007), and thus independent hazard characterization and toxicology studies are not required for each salt active ingredient. [3] From the sulfometuron methyl R.E.D. (U.S. EPA 2008a): "Minimal skin irritation was [also] noted in the acute dermal toxicity study [using rats] (MRID No. 43089202) and an older dermal irritation study [using rabbits] of a 75% formulation (MRID No. 00071411)". [4] The TRED report (U.S. EPA 2006e, p. 3, Table 1) expressed values show, though the U.S. EPA Health Effects Division stated in the earlier preparation documents “[b]oric acid is classified as Toxicity Category II by the inhalation route but only a single dose was tested and an LC50 was not determined”, and the subsequent R.E.D. scoping document (U.S. EPA 2009a, p. 2) listed inhalation as Category III for both acid and borax inhalation. [5] Technical grade glyphosate was used as used for acute tests listed in the R.E.D. and it was specified the "[a]cute inhalation study was waived by the Agency since glyphosate technical is a nonvolatile solid and adequate inhalation studies were conducted on the end-use product formulations (U.S. EPA 1993c)." [6] Given the test result, it is unclear why the acute inhalation was not listed as category III and not IV. [7] Incorrectly labeled as rabbit in original Table given, the Append. D citation specifies guinea pig. [4] The TRED report (U.S. EPA 2006e, p. 3, Table 1) expressed values show, though the U.S. EPA Health Effects Division stated in the earlier preparation documents "[b]oric acid is classified as Toxicity Category II by the inhalation route but only a single dose was tested and an LC50 was not determined", and the subsequent R.E.D. scoping document (U.S. EPA 2009a, p. 2) listed inhalation as Category III for both acid and borax inhalation.

The WHO, like the U.S. EPA, places pesticides in categories based on hazard potential and promotes the use of statements on labels that reflect chemical hazards (Table D.3-4; also see WHO 2009). Since 1975 the WHO classification system has used five categories, rather than the U.S. EPA's four, and precautionary language is required for all chemical products, even if found to be virtually non-toxic. Also different from the U.S. EPA classification system, the WHO primarily uses only oral and dermal acute toxicity test results to determine classification. The WHO (2009) did not find any chemicals potentially used in the VTP and Alternatives to be extremely or highly hazardous (Table D.3-6).Hexazinone, and triclopyr are categorized as moderately hazardous and borax, clopyralid and glyphosate are only slightly hazardous. Imazapyr and sulfometuron methyl were found to be unlikely to present acute hazard in normal use.

In December of 2002 the WHO refined its classification system (see Table D.3-5) when:

> *. . the United Nations Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labeling of Chemicals (UNCETDG/GHS) approved a document called "The Globally Harmonized System of Classification and Labeling of Chemicals" with the intent to provide a globally-harmonized system1 (GHS) to address classification of chemicals, labels, and safety data sheets. The GHS (with subsequent revisions) is now being widely used for the classification and labeling of chemicals worldwide . For this revision of the Classification the WHO Hazard Classes have been aligned in an appropriate way with the GHS Acute Toxicity Hazard Categories for acute oral or dermal toxicity as the starting point for allocating pesticides to a WHO Hazard Class (with adjustments for individual pesticides where required) . It is anticipated that few of the more toxic pesticides will change WHO Hazard Class as a result of this change. (WHO 2009)*

The WHO classifications are for the active ingredients only and are not for any specific formulation. The final classification of these chemicals might be different, depending upon their formulation. However, evidence suggests that overall, whether assessed by the U.S. EPA or the WHO, chemicals potentially used in the VTP and Alternatives do not pose a high acute toxicity hazard except for those few that are severely or moderately irritating to the eye.

Table D.3-4

Acute Toxicity Criteria Used by the WHO for Pesticide Hazard Classification

Study	Class Ia Extremely Hazardous	Class Ib Highly Hazardous	Class II Moderately Hazardous	Class III Slightly Hazardous	Class U Unlikely to Present acute Hazard
Acute Oral Toxicity (rat LD_{50})	< 5 mg/kg body weight	5 - 50 mg/kg body weight	50 - 2,000 mg/kg body weight	Over 2,000 mg/kg body weight	5,000 mg/kg body weight or higher
Acute Dermal Toxicity (rat LD_{50})	< 50 mg/kg body weight	50 - 200 mg/kg body weight	200 - 2,000 mg/kg body weight	Over 2,000 mg/kg body weight	5,000 mg/kg body weight or higher

WHO = World Health Organization; Adapted from WHO 2009, p. 10

Table D.3-5

Acute Toxicity Criteria Used by the WHO for the Globally Harmonized System (GHS) for Pesticide Hazard Classification

Study	Category 1 Fatal if Swallowed or in Contact with Skin	Category 2 Fatal if Swallowed or in Contact with Skin	Category 3 Toxic if Swallowed or in Contact with Skin	Category 4 Harmful if Swallowed or in Contact with Skin	Category 5 May Be Harmful if Swallowed or in Contact with Skin
Acute Oral Toxicity (rat LD_{50})	< 5 mg/kg body weight	5 - 50 mg/kg body weight	50 - 300 mg/kg body weight	Over 300 - 2,000 mg/kg body weight	2,000 - 5,000 mg/kg body weight
Acute Dermal Toxicity (rat & rabbit LD_{50})	< 50 mg/kg body weight	50 - 200 mg/kg body weight	200 - 1,000 mg/kg body weight	Over 1,000 - 2,000 mg/kg body weight	2,000 - 5,000 mg/kg body weight

WHO = World Health Organization; Adapted from WHO 2009, p. 10

Table D.3-6

Acute Toxicity of Chemicals Potentially Used Under the VTP & Alternatives, as Reported by the WHO [1/]

Common Name as Listed by WHO	Equiv. Names Used by U.S. EPA	CAS no	Classification		LD_{50} mg/kg	WHO Remarks	Reference
			WHO	GHS			
Borax [ISO]	Borax, sodium tetraborate decahydrate	1303-96-4	III	5	4,000	ICSC 567	WHO 2009, Table 4, p. 34
Clopyralid	Clopyralid, monoethanolamine salt	57754-85-5	III	5	4,300	Severe irritant to eyes; ICSC 443	WHO 2009, Table 4, p. 35
Glyphosate [ISO]	Glyphosate	1071-83-6	III	5	4,230	EHC 159, DS 91; ICSC 160; JMPR 1987a	WHO 2009, Table 4, p. 36
Hexazinone [ISO]	Hexazinone	51235-04-2	II	4	1,690		WHO 2009, Table 3, p. 28
Imazapyr	Imazapyr (CAS # Arsenal)	81334-34-1	U	5	> 5,000	Irritant to eyes	WHO 2009, Table 5, p. 42
Sulfometuron	Sulfometuron methyl	74223-56-6	U	5	> 5,000		WHO 2009, Table 5, p. 45
Triclopyr [ISO]	Triclopyr (salts and esters)	55335-06-3	II	4	710		WHO 2009, Table 3, p. 32

WHO = World Health Organization; Information adapted from WHO 2009; See Table 5.17.8 for WHO Classification definitions. Sulfometuron methyl (CAS no. 74222-97-2) not listed, though Sulfometuron (CAS no. 74222-97-2) was listed as a Classification U - Unlikely to present acute hazard in normal use. * 2,4- D is a Phenoxyacetic acid derivative. TERMS: DS denotes a WHO/FAO Data Sheet on Pesticides, EHC an Environmental Health Criteria monograph, HSG = Health and Safety Guide, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, ICSC an International Chemical Safety Card, JMPR an evaluation by the Joint FAO/WHO Meeting on Pesticide Residues. [ISO] denotes common name of the a.i. approved by the International Organization for Standardization.

D.3.1.2.3 Subchronic and Chronic Toxicity

Subchronic and chronic toxicity studies form the basis of most quantitative values used in risk assessments. In contrast to acute testing, subchronic and chronic testing involves laboratory animals being given repeated doses. At least two different chemical doses are tested on separate, but otherwise identical, same-sexed groups of animals for both subchronic and chronic tests.

Subchronic and chronic toxicity are typically measured by determining the *No-observed-adverse-effect-level* (NOAEL) or *No-observed-adverse-effect-concentration* (NOAEC), which is defined as "effects that are attributable to treatment but do not appear to impair the organism's ability to function and clearly do not lead to such an impairment" (SERA 2012). The measure of *lowest-observed-adverse-effect-level* or *concentration* (LOAEL or LOAEC) is also often used, and is defined as the lowest exposure level or concentration associated with an adverse effect (SERA 2012). NOAELs/NOAECs and LOAELs/LOAECs are usually expressed as milligrams of chemical per kilogram of test animal body weight per day and notated as mg/kg bw/day (or just mg/kg bw). This section summarizes general signs of systemic toxicity and quantifies no-observable-adverse-effect levels (NOAELs) for the identified endpoints, as well as levels associated with adverse effects such as LOAELs.

Subchronic tests may include repeated doses via consumption in 28-day (OPPTS 870.3050) or 90-day studies, using rodents - preferably rats - (OPPTS 870.3100), as well as a 90-day study using a non-rodent species, which is typically dog (OPPTS 870.3150). Other subchronic studies include 21/28-day and 90-day skin exposure tests using rats, rabbits, or guinea pigs (OPPTS 870.3200 and 870.3250 respectively). Along with these tests, a 90-day inhalation study (OPPTS 870.3465) using a rodent species (preferably rats) may be conducted. Additionally, reproduction (including fertility) and development toxicity screening tests with repeat dosing are also completed using rats as part of the subchronic process (OPPTS 870.3550, 870.3800, 870.3700 and 870.3650). Symptoms of neurotoxicity, immune toxicity, and endocrine disruption are also evaluated as part of the subchronic and chronic testing suite.

Chronic toxicity evaluates the effects of repeated daily exposure of experimental animals to a chemical by the oral, dermal, or inhalation routes of exposure for a minimum of 12 months (OPPTS 870.4100). Chronic toxicity and carcinogenicity studies (OPPTS 870.4200) should be completed using two mammal species. Alternatively, registrants often examine both chronic toxicity and carcinogenicity of a chemical using a single combined study (OPPTS 870.4300). Chronic toxicity studies typically use rat and dog species, while rat and mice species are preferred in carcinogen studies. When the combined chronic toxicity and carcinogenicity alternative is used, rats are the preferred species for oral and inhalation routes of exposure and mice are preferred for dermal exposure (OPPTS 870.4300).

No attempt is made in this document to display all completed subchronic and chronic toxicity-associated studies, or all associated endpoints, as this is beyond the scope of this assessment. Instead, the most significant findings that resulted from subchronic and chronic dosing are summarized below (Table D.3-7). For further details regarding endpoints for specific tests, refer to the U.S. EPA and SERA risk assessments referenced throughout this subchronic and chronic section and other sections below, which evaluate more specifically effects associated with reproduction and development, carcinogenicity and mutagenicity, or effects on nervous, immune, and endocrine systems. Since effects are only summarized, refer to the sources for information by the author(s) of the original study.

Borax (Source: SERA 2006a) - The developing fetus and the male reproductive system are the primary targets for borate-inducted toxicity during developmental, subchronic and chronic toxicity studies. Gestational exposure of rodents and rabbits to boric acid resulted in increased fetal deaths, decreased fetal weight, and increased fetal malformations (e.g. abnormalities of the eyes, skeleton, central nervous and cardiovascular system) in one or both species. Testicular atrophy, degeneration of the spermatogenic epithelium and spermatic arrest were observed during subchronic exposure of rats and dogs via food and water.

Other considerations regarding repeated doses of 2,4-D, include systemic effects and inhalation. The acute dermal exposure for borax is rated as Category 3, as no significant signs of toxicity developed. Single dose inhalation exposure of borax resulted in ocular and nasal discharge, hunched posture, and hypoactivity. This limited data suggests that borax has the potential to cause irritant and systemic toxic effects following inhalation by laboratory mammals.

Clopyralid (Source: SERA 2004a) - While several studies have been submitted to the U.S. EPA during registration, no studies are currently published as open literature. Some information is available from the U.S. EPA as a result of reviews conducted for registration of new uses for clopyralid (e.g. U.S. EPA 2009b) since the 2004 Forest Service risk assessment was completed.

Decreased body weight as well as increases in relative kidney and liver weights consistently result from dietary exposures to clopyralid, though when looking at the indicators for liver damage, histopathologic damage was not apparent. The U.S. EPA determined the chronic NOAEL to be 15 mg/kg/day based on gastric epithelial hyperplasma at the LOAEL of 150 mg/kg/day.

Significance of effects during skin, eye, and inhalation studies varied for clopyralid. Persistent eye damage, characterized by redness, conjunctiva swelling and discharge, is known to result from directly applying clopyralid to the eye. While redness to the skin may occur just after application of clopyralid, there are no symptoms that indicate this chemical is a potent skin irritant for either the penta process clopyralid or electrochemical process clopyralid. The only effects noted during acute inhalation studies for registration were labored breathing and red stains around nares, as well as lung discoloration.

Glyphosate (Source: SERA 2011b) - The U.S. EPA evaluated subchronic and chronic exposure during registration processes, using studies that tested with technical grade glyphosate. These studies are summarized in the SERA (2011b) risk assessment and associated appendix. Decreased body weight gain is the most consistent signs of subchronic, chronic, and reproductive exposure for test mammals (i.e., rats, mice and rabbits) using technical grade glyphosate. Decreases in body weight may be attributed to glyphosate possibly being an uncoupler of oxidative phosphorylation and/or may be secondary to decreased consumption of food. Other signs of toxicity resulting from technical grade glyphosate seem inconsistent, general and non-specific. Changes in liver weight, kidneys, and blood chemistry have been reported in some studies.

Separate, more specific subchronic and chronic toxicity studies for each glyphosate formulation are not required for pesticide registration by the U.S. EPA, and thus no such studies have been identified in U.S. EPA reports. Only one study evaluating subchronic toxicity was discussed in the SERA (2011b) report as being found in open literature, though the study was on a Brazilian formulation and the study was ambiguous in several regards, including test doses used. Nevertheless, results of the study did not substantially differ from those in the studies submitted to the U.S. EPA, with liver pathology being observed only at the highest dose. No overt toxic effects were noted at dose up to 360 mg a.e./kg bw/day, which is consistent with the NOAEL of 500 mg a.e./kg bw/day from a 90-day study in mice submitted to the U.S. EPA.

The primary signs of subchronic and chronic toxicity to the POEA surfactant included gastrointestinal irritation in rats and dogs. This effect was also noted and attributed to the POEA surfactant for humans in cases of suicidal ingestion of glyphosate formulations. The NOAEL of POEA in rats appears to be about 36 mg/kg bw. The studies inconsistently indicated that POEA by itself appears to be more toxic than technical grade glyphosate. Specific effects in dogs are well characterized, with the toxicity of POEA higher than technical grade glyphosate by a factor of 10, though results with other mammals are less clear.

Hexazinone (Source: SERA 2005) - No studies indicate a specific target organ or mode of action. Decreases in body weight, increases in liver weight, and changes in blood enzyme levels associated with liver toxicity are the effects most commonly observed during long-term exposure. While the decrease in body weight often appears to be a secondary effect related to a decrease in food consumption in dogs and rodents, evidence for female rats in one study suggests instead that decrease in body weight sometimes relates to food conversion efficiency (i.e., in female rats). Thus, the U.S. EPA used such weight-related evidence to establish a chronic RfD.

Imazapyr (Source: SERA 2011c) - The commonality between all studies was the lack of any adverse effects noted at doses at about 2,000 mg/kg bw/day in rodents and about 250 mg/kg bw/day in dogs. Increased food consumption for rats and mice was sometimes observed, but there was no significant corresponding weight gain. The reasons behind these observations remain unclear. The NOAEL of 1,700 mg/kg bw/day was established based on the highest dose tested in rats. While the dog NOAEL is much lower, this is because of study design and doses used, rather than an indication of imazapyr being more toxic to dogs than other mammals. Nevertheless, the current chronic RfD of 2.5 mg/kg bw/day is from the study using dogs.

NP9E (Source: USDA/FS 2003b) - Target organs for both NP9E and NP appear to be the liver and kidneys, based on subchronic and chronic exposure studies. The mitochondria of cells appeared to be affected by long-term NP exposure, though they were not affected with NP9E exposure. Subchronic and chronic studies of NP9E most commonly revealed changes to liver, kidney and sometimes spleen (e.g. increased weight), as well as weight loss in dogs and/or rats. As with NP9E, liver and kidney weights, as well as decreases in body weight and food consumption, appear to most commonly characterize subchronic and chronic exposure effects of NP.

Sulfometuron methyl (Source: SERA 2004c) - Sulfometuron methyl toxicity often involves changes in blood and decreased body weight, though some other more general signs also occurred inconsistently. Changes in blood appear to be consistent with hemolytic anemia. Inconsistent symptoms of sulfometuron methyl include reduced testicular size in a rat, mild testicular lesions in another rat, increased alkaline phosphatase activity and increased serum cholesterol (in females), as well as decreased serum albumin and creatinine. Likewise, increased liver weights and thymus were also observed in particular sexes.

Triclopyr (Sources: SERA 2011d, g) - When mammals are exposed to triclopyr, the kidneys appear to be the most targeted organ and dogs are more sensitive than other lab mammals tested. The LOEL in dogs is 2.5 mg/kg/day and is associated with phenolsulfonphthalein (PSP) urinary excretion, as well as reduced absolute and relative kidney weights. This value was initially used by the U.S. EPA to establish a provisional RfD of 0.025 mg/kg/day for humans. In a subsequent study, the same dose was associated with increases in serum urea nitrogen and creatinine in male dogs. This study resulted in the U.S. EPA lowering the provisional RfD to 0.005 mg/kg/day. Kidney effects were observed in rodents (i.e., hematological and histopathological changes and increased kidney weight) in a 90-day subchronic study at doses as low as 70 mg/kg/day. The other general systemic toxic effects of triclopyr are unremarkable. At high doses, signs of liver damage may be apparent, as well as decreases in food consumption, growth rate, and gross body weight.

Table D.3-7

Human Health Toxicological Reference Doses, Target Organs, and Endpoints of Chemicals Proposed for Use Under the VTP & Alternatives

Active Ingredient	Exposure Scenario	NOAEL Dose	UF	RfD Dose	Study and Toxicological Effects Used For RfD	Target Organs and Most Sensitive Endpoints	References
Borax	**Acute**	chronic used[1]			**Two developmental toxicity studies in rats** - LOAEL for each study ~13.6 and ~13.3 mg B/kg/day based on decreased fetal weight. One study lacked a defined NOAEL, while the other had one of 9.6 mg B/kg/day.	The male reproductive system and the developing fetus appear to be the most sensitive endpoints, with the developing fetus more sensitive than the male reproductive system. Toxicity effects related to fetal development include fetal deaths, decreased in fetal weight, and increased fetal malformations. The testis is a primary target organ for borates based on atrophy, degeneration of the seminiferous epithelium, and sterility (i.e., NOAEC = 25 with an LOAEC of ~50 mg B/kg/day).	SERA 2006i, p. 3-8 & 3-21
	Chronic	NOAEL= 10.6 mg/kg/day	UF = 66	RfD = 0.2 mg/kg/day			
Clopyralid	**Acute**	NOAEL= 75 mg/kg/day	UF = 100	RfD = 0.75 mg/kg/day	**Developmental toxicity studies in rats (gavage)** - decreased maternal body-weight gain and reduced food consumption at the LOAEL of 250 mg/kg/day.	Only non-specific toxicity effects observed. Thus, no primary target organ is indicated during subchronic and chronic toxicity testing; anticipated exposures do	SERA 2004a, p. 3-27

	Chronic	NOAEL= 15 mg/kg/day	UF = 100	RfD = 0.15 mg/kg/day	**2-year combined chronic/carcinogenicity rat feeding study** - histopathology in stomach at the LOAEL of 150 mg/kg/day.	not exceed the RfD values. Contamination of hexachlorobenzene and pentachlorobenzene is not significant in terms of potential systemic-toxic effects.	U.S. EPA 2009b, p. 13
Glyphosate	**Acute**	chronic used			**Developmental toxicity study in rabbits** - LOAEL of 350 mg/kg/day based on diarrhea, nasal discharge and death in maternal animals. Both rabbit and rat dams appear more sensitive than offspring. Represents all populations.	Chronic feeding/carcinogenicity studies in rats revealed systemic effects only at the highest test dose and LOAEL of 940 mg/kg/day, based on decreased body-weight gain in females and increased cataracts and lens abnormalities, decreased urinary pH, increased absolute liver weight, and increased relative liver weight/brain weight in males. Suggestions that glyphosate targets testes are not substantiated using U.S. formulations at doses below or equal to the NOAEL.	SERA 2011b, p. 52, 61 & 102 U.S. EPA 2009c, p. 5 & 22
	Chronic	NOAEL= 175 mg/kg/day	UF = 100	RfD = 2.0 mg/kg/day [2]			
Hexazinone	**Acute**	NOAEL= 400 mg/kg/day	UF = 10	RfD = 4.0 mg/kg/day	**Developmental toxicity study in rats** - LOAEL of 900 mg/kg/day based on decreased male and female fetal weight, kidneys with no papilla and misaligned sternebrae. Protective of females 13-50 years of age	No effects were observed in reproductive tissues (i.e., testes and ovaries) that indicated direct toxicological effects of hexazinone exposure. Decrease weights of testes and other organs during a chronic feeding study with dogs, and multigenerational study with rats, appear to be incidental and not associated with organ specific	SERA 2005, p. 3-10 & 3-35 U.S. EPA 2010d, p. 16
	Chronic	NOAEL= 5.0 mg/kg/da	UF = 10	RfD = 0.05 mg/kg/day	**Chronic dog feeding study** - LOAEL of 41.24/37.57 (m/f) mg/kg/day based on severe body weight		

		y			decrements and clinical chemistry changes.	toxicity.	
Imazapyr	**Acute**	chronic used			**1-year dog feeding study** - due to an absence of an appropriate endpoint attributable to a single dose, the USDA/FS used this study to establish both acute and chronic RfD values. No LOAEL was demonstrated with imazapyr at doses up to 250 mg/kg/day [the highest dose of the study].	The most remarkable aspect of all of the subchronic and chronic studies is the failure to note any adverse effects at doses of up to about 2000 mg/kg /day in rats and mice and about 250 mg/kg /day in dogs.	SERA 2011c, p. 20 & 47 U.S. EPA 2006d, p. 7
	Chronic	NOAEL= 250 mg/kg/day	UF = 100	RfD = 2.5 mg/kg/day			
NP9E	**Acute**	chronic used			**2-generation rat reproduction study (nonylphenol)** - LOAEL of 50 mg/kg/day, based on increases in pituitary weight (F0 males), decreased ovary weight (F0 females), accelerated vaginal opening (F1 females), decreases in # of implanted and live F2 pups (NOAEL 10 mg/kg/day). **3-generation rat reproduction study (nonylphenol)** - LOAEL of 30 mg/kg/day based on acceleration of vaginal opening by ~2 days and ~6 days in F1, F2 and F3 generations following dietary exposure at 30 and 100 mg/kg/day respectively (NOAEL ~9 mg/kg/day).	In studies of nonylphenol, the kidney has been identified as a target organ based on increased kidney weight, tubular dilatation, and cyst formation. Evidence further suggests the liver is a target organ, which is indicated by effects such as decrease in liver polysaccharides at a dose of 50 mg/kg/day (the LOAEL) in one study.	USDA/FS 2003b, p. 29 U.S. EPA 2010f, p. 20
	Chronic	NOAEL= 10 mg/kg/day	UF = 100	RfD = 0.10 mg/kg/day			

Sulfometuron methyl [3]	**Acute**	NOAEL= 86.6 mg/kg/day	UF = 100	RfD = 0.870 mg/kg/day	**Acute teratology study in rats** - NOAEL is based on decreased maternal and fetal body weights in rats after 10-day gestational exposure of dams.	No specific organs appear to be targeted by sulfometuron methyl, though hemolytic anemia and decreased body-weight gain were found. These effects are the basis of the past acute and chronic RfD of 0.27 mg/kg/day, which were derived from a study with a NOAEL of 27.5 mg/kg/day and LOAEL OF 148.5 mg/kg/day in both sexes. It is plausible that effects on blood are likely, at least in part, to be attributable to sulfonamide and saccharin.	SERA 2004c, p. 3-23 U.S. EPA 2008a, p. 8
	Chronic	NOAEL= 2.0 mg/kg/day	UF = 100	RfD = 0.02 mg/kg/day	**2-year rat feeding study** - NOAEL is based on hematological effects in male rats at higher doses, with a NOAEL of 3 mg/kg/day for comparable hematological effects in females.		
TCP	**Acute**	NOAEL= 25 mg/kg/day	UF = 1000	RfD = 0.025 mg/kg/day	**Developmental toxicity study in female rabbits** - a LOAEL of 100 mg/kg/day based birth defects including hydrocephaly and dilated ventricles. No dietary RfD is derived for members of the general population.	3,5,6-trichloro-2-pyridinol (TCP) is a major metabolite of triclopyr in both mammals and the environment. This compound does not have the phytotoxic potency of triclopyr; however, according to the RfD values used by the U.S. EPA, TCP is more toxic than triclopyr to mammals and other aquatic animals.	SERA 2011d, p. 16 & 71
	Chronic	NOAEL= 12 mg/kg/day	UF = 1,000	RfD = 0.012 mg/kg/day	**Chronic toxicity study in dogs** - an LOAEL of 48 mg/kg/day is based on clinical chemistry.		
Triclopyr	**Acute**	NOAEL= 100 mg/kg/day	UF = 100	RfD = 1.0 mg/kg/day	**Developmental study in female rats with triclopyr BEE** - NOT APPLICABLE TO FEMALES OF CHILDBEARING AGE. The more protective chronic RfD is used as	The liver and kidney are suggested to be primary target organs. Like most weak acids, triclopyr is excreted primarily in the kidney by an active transport process. At very	SERA 2011d, p. 71 & 232

					the acute RfD for such females. The LOAEL is based on severe maternal toxicity.	high doses, this process may become saturated causing triclopyr to reach toxic levels. At sufficiently high doses, triclopyr may cause toxic effects, including death. Nonetheless, triclopyr has a low order of acute lethal potency. The dog appears to be the most sensitive test species.	
	Chronic	NOAEL= 5.0 mg/kg/da y	UF = 100	RfD = 0.05 mg/kg/day	**Two generation dietary reproduction study with triclopyr acid** - this RfD is used for all occupational exposures, acute exposure for women of childbearing age and chronic exposure of individuals. The LOAEL is based on kidney toxicity.		

NOAEL = no observed adverse effect level; LOAEL - lowest observed adverse effect level; UF = uncertainty factor; RfD = reference dose; [1] Typically, the chronic NOAEL is used for the acute RfD calculation in USDA/FS risk assessments when a dose in a single day did not result in toxic effects. [2] The chronic RfD used by the U.S. EPA is 1.75 mg/kg/day, and this value was rounded to 2.0 in the SERA risk assessment. [3] The U.S. EPA (2008a) R.E.D. for sulfometuron methyl listed equal acute and chronic RfD values (0.275 mg/kg/day) for drinking water exposure and dietary RfD values were not calculated since this chemical is not used on food commodities; in lieu of this, the more detailed RfD values from the SERA (2004c) risk assessment used throughout this PROGRAM EIR.

D.3.1.2.4 Reproductive and Developmental Effects

The analysis in this Program EIR distinguishes between *reproductive* and *developmental toxicity*, as defined by the U.S. EPA (1991, 1996). The U.S. EPA human health effects test guideline for reproduction and development include OPPTS 870.3550, 870.3650, 870.3700, and 870.3800.

In the *U.S. EPA Guidelines for Reproductive Toxicity Risk Assessment*, reproductive toxicology is defined as (U.S. EPA 1996):

> *The occurrence of biologically adverse effects on the reproductive systems of females or males that may result from exposure to environmental agents. The toxicity may be expressed as alterations to the female or male reproductive organs, the related endocrine system, or pregnancy outcomes. The manifestation of such toxicity may include, but not be limited to, adverse effects on onset of puberty, gamete production and transport, reproductive cycle normality, sexual behavior, fertility, gestation, parturition, lactation, developmental toxicity, premature reproductive senescence, or modifications in other functions that are dependent on the integrity of the reproductive systems.*

Multigenerational reproduction studies with rats are conducted as outlined in guidelines (OPPTS 870.3800) using standardized protocols as part of the reproduction test suite. In general for these studies, males and females are dosed equally via oral route with the chemical agent at 5 to 9 weeks old. These males and females serve as the parental (P) animals and are mated. Chemical doses are often given continuously through weaning of offspring (F1). If a second generation study is conducted, these steps are repeated with F1 male and female offspring to produce a second generation of offspring (F2). During experiments, animals are observed for gross signs of toxicity and other effects, such as length of the estrous cycle, assays on sperm and other reproductive tissue, and the number, viability, and growth of offspring.

In the *U.S. EPA Guidelines for Developmental Toxicity Risk Assessment*, developmental toxicology is defined as (U.S. EPA 1991):

> *The study of adverse effects on the developing organism that may result from exposure prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the lifespan of the organism. The major manifestations of developmental toxicity include: (1) death of the developing organism, (2) structural abnormality, (3) altered growth, and (4) functional deficiency.*

In summary, developmental studies are designed to exam whether a compound has the potential to cause birth defects. Chemicals in these studies are typically administered to rats or rabbits using gavage or dermal application methods. The U.S. EPA generally is not concerned with reproductive and developmental effects that are experienced at dosages that cause toxicological maternal or parental effects. According to U.S. EPA chemical assessments, toxicity symptoms only occurred at chemical dosages that were *above/at the threshold of parental toxicity* (ATPT) for chemicals potentially used in the VTP and Alternatives, with the exception of borax (Table D.3-8). None of the chemicals potentially used are listed on the California U.S. EPA's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) as chemicals known to cause reproductive toxicity (OEHHA 2011).

Table D.3-8

Reproductive and Developmental Toxicity of Chemicals Proposed for Use Under the VTP & Alternatives

Active Ingredient	Reproductive Toxicity	Developmental Toxicity	Reference
Boric acid/ borate salts	at LOAEL testicular atrophy and reduced sperm production leading to reduced male fertility; reduced survival when doses are ATPT	decreased fetal weight and skeletal abnormalities sometimes when doses are BTPT; visceral, heart/vessel, and brain abnormalities when doses are ATPT	U.S. EPA 2006a, p. 1 U.S. EPA 2006e, p. 4 U.S. EPA 2009a, p. 3
Clopyralid	no effects when doses are BTPT; effects sometimes when doses are ATPT (e.g. changes in pup body and liver weights)	no effects when doses are BTPT; sometimes decreased fetal body weight and hydrocephalus when doses are ATPT	U.S. EPA 2009b, p. 8
Glyphosate	no significant effects when doses are BTPT; effects sometimes when doses are ATPT include decrease in implantation	no significant effects when doses are BTPT; sometimes symptoms when doses are ATPT (e.g. decrease in mean fetal body weight and increase in fetuses with unossified sternebrae)	U.S. EPA 2010b, p. 4 & 11
Hexazinone	no significant effects, with both fetal and maternal endpoints based on decreased body weights	no significant effects, with both fetal and maternal endpoints based on decreased body weights	U.S. EPA 2010d, p. 5

Imazapyr	no reproductive effects up to highest dose tested	no developmental effects up to highest dose tested	U.S. EPA 2006d, p. 7 FR 2003, Table 2, p. 55478
Sulfometuron methyl	no effects on fetal or maternal endpoints at the highest tested dose; abortions when doses were ATPT; note that some studies had deficiencies	no effects on fetal or maternal endpoints at the highest tested dose; abortions when doses were ATPT; note that some studies had deficiencies	U.S. EPA 2008a, p. 8,9 & 18
Triclopyr	no effects when doses are BTPT for BEE or TEA; systemic effects occur when doses are ATPT (e.g. decreased litter size, # of litters, and mean pup weight, decreased parent body weight and weight gain, and increased pup death and proximal tubular degeneration)	no effects when doses are BTPT for BEE or TEA; effects occur when doses are ATPT (e.g. decreased # live fetuses and mean fetal weight gain, increase in fetal death and post-implantation loss, increased incidence bone abnormalities)	U.S. EPA 1998, p. 11-14 & 29 SERA 2011d, p. 25
NP9E	no significant effects when doses BTPT; when doses ATPT effects on adults included less food consumption and decreased weight gain, as well as a decrease in sperm for males, and for females increased estrous cycle length and decreased ovarian weights and decrease in number of implants	when doses BTPT acceleration in the vaginal opening in pups; no evidence when doses are ATPT though kidneys, liver and spleen thought to target organs from general toxicity; weak estrogenic effects at high doses that decrease with increased ethoxylate numbers	USDA/FS 2003b, p. 6, 8 & 11 U.S. EPA 2009f, p. 23, 24 & 28

ATRC = at/above threshold of renal clearance, ATPT = at/above threshold of parental toxicity, BTPT = below threshold of parental toxicity. [1] Only 2,4-D acid and DEA forms have any effects when ATPT

D.3.1.2.5 Carcinogenic and Mutagenic Effects

CAL FIRE defers to the U.S. EPA and CDPR on issues relating to quantitative risk assessment for potential carcinogenic and mutagenic effects in humans. Carcinogenicity refers to the ability of an agent, in this case a pesticide, to cause cancer. Generally, results from chemical effects studies, such as mammal acute, subchronic, and chronic toxicity studies, as well as genetic toxicity (including mutagenicity) studies are used to assess the likelihood a chemical may be a carcinogen. Carcinogenicity is also evaluated by examining chemical profile studies (e.g. metabolism, environmental fate) for indications of whether cancer is a feasible hazard. Some studies are designed to evaluate carcinogenicity of a chemical directly as well (OPPTS 870.4200 and 870.4300). Each chemical is categorized based on carcinogenic likelihood. Since 1999 five carcinogenicity standard hazard descriptors have been recommended for use by the U.S. EPA: *"Carcinogenic to Humans," "Likely to Be Carcinogenic to Humans," "Suggestive Evidence of Carcinogenic Potential," "Inadequate Information to Assess Carcinogenic Potential," and "Not Likely to Be Carcinogenic to Humans"* (U.S. EPA 2005b).

However, many existing U.S. EPA and USDA/FS risk assessments use the earlier (1986) classification system, which has the following six general categories (often with slight variation): *"A – human carcinogen," "B1 – probably carcinogen, limited human evidence," "B2 - probable carcinogen, sufficient evidence in animals," "C - possible human carcinogen," "D – not classifiable," and "E – evidence of noncarcinogencity."*

In the context of evaluating the effects of pesticides, mutagenicity is defined as the capacity of a chemical to induce transmitted genetic changes or increase their frequency. The mutagenic effects of a pesticide on humans are associated with changes in gamete (germ cell) and/or somatic (tissue/organ) cells (U.S. EPA 1986). Mutations that occur in gamete cells, such as eggs and sperm, have the potential to be inherited by the next generation. Somatic cell mutations, by contrast, effect tissues and organs of the affected individual, and are thought to subsequently cause several disease states (e.g. cancer). Point mutations (i.e., changes in DNA sequence) and structural or numerical chromosome aberration, for example, are mutations that have the potential to cause adverse effects in humans (U.S. EPA 1986). Mutations, however, may not alter DNA directly, but instead interfere with mechanisms essential to cells, such as DNA synthesis or nuclear division processes (ibid). When such mutations occur in gamete cells, offspring may develop skeletal abnormalities, cataracts, or other morphological anomalies. Background, risk assessment, and toxicity study information for various mutation types can be found in *Guidelines for Mutagenicity Risk Assessment* (U.S. EPA 1986) and test guidelines 870.51 through 870.59. Additionally, information relating to hazard identification and toxicity tests for cancer and mutations thought to cause cancer may be found in *Guidelines for Carcinogen Risk Assessment* (U.S. EPA 2005b).

According to the U.S. EPA, none of the active ingredients proposed for use in the VTP and Alternatives are known carcinogens or mutagens (Table D.3-9). Similarly, none of the chemicals proposed for use are on the California EPA's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) list of chemicals that are known to cause cancer (Cal EPA 2011). While clopyralid is not thought to be a carcinogen, hexachlorobenzene is a carcinogenic impurity of particular concern. Thus, the carcinogenicity of this impurity is considered in this risk assessment.

Table D.3-9

Carcinogenicity and Mutagenicity of Chemicals Proposed for Use Under the Program & Alternatives

Active Ingredient	Carcinogen Class	Mutagenicity	Reference
Boric acid/ borate salts	"not likely to be carcinogenic to humans"	Negative for mutagenic effects	U.S. EPA 2009a, p. 9
Clopyralid	"not likely to be carcinogenic to humans"	Negative for mutagenic effects	U.S. EPA 2009b, p. 8-9
Glyphosate	Group E [evidence of non-carcinogenicity for humans]	Negative for mutagenic effects	U.S. EPA 2010b, p. 27
Hexazinone	Group D [not classifiable as to human carcinogenicity]	Negative for mutagenic effects usually, though structural chromosomal aberrations occurred during one study.	U.S. EPA 2010d, Table 5, p. 17 U.S. EPA 2002b, Table 2, p. 10-12
Imazapyr	Group E [no evidence of carcinogenicity in at least 2 adequate animal tests in different species]	Negative for mutagenic effects	U.S. EPA 2006d, p. 7 FR 2003, Table 2 & 3, p. 55475-55479
Sulfometuron methyl	no evidence of carcinogenicity reported from current toxicity studies	Negative for mutagenic effects	U.S. EPA 2008a, p. 8 SERA 2004c, p. 3-1
Triclopyr	Group D [not classifiable as to human carcinogenicity]	Negative for mutagenic effects	U.S. EPA 1998, p. 14 & 18 SERA 2011d, p. 27
NP9E	no evidence of carcinogenicity reported from current toxicity studies	Negative for mutagenic effects	U.S. EPA 2010e, p. 4 U.S. EPA 2009f, p. 30 & 32 USDA/FS 2003b, p. 4

D.3.1.2.6 Effects on Nervous System

Neurotoxicants are chemical agents that disrupt the function of neurons, either by interacting with neurons specifically, or with supporting cells in the nervous system (e.g., neuroglia, Schwann cells, sensory receptors). The above definition

> *is central to this discussion because it distinguishes agents that act directly on the nervous system (direct neurotoxicants), from those agents that might produce neurologic effects that are secondary to other forms of toxicity (indirect neurotoxicants) (O'Donoghue, 1994). SERA (2002)*

While specific neurotoxicity studies are now required as a part of new data requirements in the 40 CFR §158 (OPPTS 870.6100, 870.6200, 870.6300, 870.6500, 870.6850, and 870.6855), these tests have not yet been completed for all chemicals proposed for use under this Program EIR. Nevertheless, it is likely that any effects to the nervous system after exposure to a chemical would be observed during other toxicology studies for chemicals that are neurotoxic. While only direct effects are relevant to evaluating neurotoxicity, in some cases, it can be difficult to determine if the observed effects are a result of direct or indirect neurotoxicity. Currently, most conclusions regarding neurotoxicity of chemicals are usually based on observations from toxicological studies not specific to evaluating the nervous system (see Table D.3-10). Of chemicals potentially used in the VTP and Alternatives, direct effects to the nervous system were only found for boric acid/ borate salts at high dosages.

D.3.1.2.7 Effects on Immune System

> *Immunotoxicants are chemical agents that disrupt the function of immune system. These agents can impair immune responses (immune suppression) or produce inappropriate stimulation of immune responses (hyperreactivity). Suppression of immune responses to microbes or abnormal cells can enhance susceptibility to infectious diseases or cancer. Hyperreactivity can give rise to allergy or hypersensitivity, in which the immune system or genetically predisposed individuals inappropriately responds to chemical agents (e.g., plant pollen, cat dander, flour gluten) that pose no threat to other individuals or autoimmunity, in which the immune system produces antibodies to self components leading to destruction of the organ or tissue involved. SERA (2002)*

While immunotoxicity studies are now required as a part of new data requirements in the 40 CFR §158 (OPPTS 870.7800), these tests have not yet been completed for all chemicals proposed for use in the Program. Nevertheless, it is likely that any effects to the immune system after exposure to a chemical would be observed during other toxicology studies for chemicals that are immunotoxic. While only direct effects are relevant to evaluating immunotoxicity, it can be difficult in some cases to determine if the effects observed are a result of direct or indirect immunotoxicity. Currently, most conclusions regarding immunotoxicity of chemicals are usually based on observations from toxicological studies not specific to evaluating the immune system (see Table D.3-10). Direct immunotoxicity effects were not observed for any herbicides proposed for use under the VTP.

D.3.1.2.8 Effects on Endocrine System

> *An endocrine disruptor is an exogenous agent (from outside of the body) that produces adverse effects on an organism or population of organisms by interfering with endocrine function (Kavlock et al., 1996). The endocrine system is highly regulated to achieve hormone activities in amounts needed to respond to physiological demands. Endocrine disruption is a state of uncontrolled hormone action, in which hormone responses are absent or insufficient when needed, or occur inappropriately when they are not needed. These can result in abnormalities in growth and development, reproduction, body composition, homeostasis, and behavior. (SERA 2002)*

At the time this appendix was prepared, the U.S. EPA had recently developed an Endocrine Disruptor Screening Program (EDSP), the guidelines for which are in series 890. Current information regarding the program and which herbicides are to be assessed can be found at: http://www.epa.gov/scipoly/oscpendo/index.htm. In short, Tier 1 consists of several assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid hormonal systems. If it is found that there are direct effects on these systems resulting from chemical exposure, a second group of tests will be chosen as appropriate, given initial results. This second group of studies, referred to as "Tier 2", is used to identify any adverse endocrine related effects caused by the substance, as well as to establish a dose-response relationship between the dose and any effects found on the estrogen, androgen, and/or thyroid hormonal systems.

While all chemicals may be subject to additional screening and/or testing to specifically assess endocrine disruption potential in the future, evaluation of chemicals for endocrine disruption has been prioritized based on the potential for human exposure (e.g. via food and water, residential activity) and effects observed during previous studies evaluating all aspects of chemical toxicity. Currently, information regarding endocrine disruption is vague, though according to U.S. EPA and USDA/FS risk assessments, glyphosate, hexazinone, imazapyr and sulfometuron methyl are thought to have the potential to cause effects on the endocrine system with exposure, though it remains unclear if the effects are direct or indirect (see Table D.3-10).

Table D.3-10

Neurotoxicity, Immunotoxicity, and Endocrine Disruption of Chemicals Proposed for Use Under the VTP & Alternatives

Active Ingredient	Neurotoxicity	Immunotoxicity	Endocrine Disruption	Reference
Boric acid/ borate salts	evidence of neurotoxicity from toxicity studies at high dose levels (e.g. depression, ataxia and convulsion)	no conclusive evidence of direct immunotoxicity from any toxicity studies	no evidence of direct endocrine disruption; changes in hormones thought indirect resulting from testicular toxicity	U.S. EPA 2006a, p. 17 & 42 U.S. EPA 2006e, p. 4 & 13 SERA 2006a, p. 3-1, 3-6 to 3-8
Clopyralid	no conclusive evidence of direct neurotoxicity from any toxicity studies	no conclusive evidence of direct immunotoxicity from any toxicity studies	no conclusive evidence of direct endocrine disruption from any toxicity studies	U.S. EPA 2009b, p. 4, 10 & 18 SERA 2004a, p. 3-5 & 3-6
Glyphosate	no conclusive evidence of direct neurotoxicity from any toxicity studies	no conclusive evidence of direct immunotoxicity from any toxicity studies	potential evidence of direct endocrine disruption; effects observed may be indirect	U.S. EPA 2010b, p. 4, 11 to 15 SERA 2011b, p. 40 to 51
Hexazinone	no conclusive evidence of direct neurotoxicity from any toxicity studies	no conclusive evidence of direct immunotoxicity from any toxicity studies	potential evidence of direct endocrine disruption; effects observed may be indirect	U.S. EPA 2010d, p. 5 U.S. EPA 2002b, p. 3 SERA 2005, p. 3-7 to 3-9
Imazapyr	no conclusive evidence of direct neurotoxicity from	no conclusive evidence of direct immunotoxicity from	no conclusive evidence of direct endocrine disruption from any	U.S. EPA 2006d, p. 7 & 27 FR 2003, p. 55481

	any toxicity studies	any toxicity studies	toxicity studies	SERA 2011c, p. 23
Sulfometuron methyl	no conclusive evidence of direct neurotoxicity from any toxicity studies	no conclusive evidence of direct immunotoxicity from any toxicity studies	potential evidence of direct endocrine disruption; effects observed may be indirect	U.S. EPA 2008a, p. 8 & 14 SERA 2004c, p. 3-6 to 3-7
Triclopyr	no conclusive evidence of direct neurotoxicity from any toxicity studies	no conclusive evidence of direct immunotoxicity from any toxicity studies	no conclusive evidence of direct endocrine disruption from any toxicity studies	U.S. EPA 1998, p. 14 & 18 SERA 2011d, p. 22 to 25
NP9E	no conclusive evidence of direct neurotoxicity from any toxicity studies	no conclusive evidence of direct immunotoxicity from any toxicity studies	no conclusive evidence of direct endocrine disruption from any toxicity studies	U.S. EPA 2009f USDA/FS 2003b, p. 4

D.3.1.2.9 Metabolites and Impurities

No chemical exists without some metabolites and impurities. When evaluating human health effects related to chemical use, it is important to consider how a chemical is metabolized, what byproducts result, what other impurities exist, and the toxicity of any unintended compounds. As chemicals are broken down, either through energy production by a living organism (aka metabolism) or environmental degradation processes (aka environmental fate), metabolites are created. During the synthesis of technical grade product, there may be unintended impurities including un-reacted starting material, side reaction products, contaminants, and degraded products (as listed in 40 CFR 158.153(d)). There is concern regarding the toxicity of metabolites and impurities, but this is lessened by the fact that tests are completed using the technical grade product of each active ingredient that includes metabolite production and contains impurities. Thus, any toxicity effects of metabolites and impurities would be encompassed in the technical grade of the active ingredient (TGAI) toxicity evaluation.

All known metabolites and impurities in chemicals proposed for use under this Program EIR were identified and examined for toxicity concerns (see Table D.3-11). Of the chemicals potentially used in the VTP and Alternatives, only triclopyr produces a metabolite [i.e., 3,5,6-trichloro-2-pyridinol (3,5,6-TCP)] that is toxic beyond the level of concern in some scenarios. Clopyralid contains the impurities hexachlorobenzene and pentachlorobenzene, which are known carcinogens. Similarly, some formulations of glyphosate that contain POEA surfactants contain the known carcinogenic contaminant 1,4-dioxane. These three carcinogens, however, are at concentrations well below the cancer risk level used by the USDA/FS and U.S. EPA when assessing carcinogenicity. Nicotinic acid, which is also known as Vitamin B3, is a metabolite of imazapyr and is a known neurotoxin; however, the minute amount in imazapyr poses no toxicity concern.

Table D.3-11

Metabolism, Metabolites and Impurities from Chemicals Proposed For Use Under the VTP & Alternatives

Active Ingredient	Metabolism	Metabolites/Degradates	Metabolite Concern	Impurities/Contaminants	Impurities Concern	Reference
Boric acid/ borate salts	in mammals, not metabolized, so is eliminated in urine unchanged; in the environment, at physiological pH borate salts convert to boric acid	boric acid	no concern; assessed as active ingredient	none identified	NA	U.S. EPA 2009a, p. 8 & 20 SERA 2006a, p. 3-11
Clopyralid	in mammals, rapidly absorbed and then excreted in urine, primarily unchanged or as parent	parent clopyralid	assessed as active ingredient	4,5,6-trichloro-2-pyridinecarboxylic acid (<0.1%)	no concern	U.S. EPA 2009b, p. 4, 7 & 19
		3,6-DCPA-glycine		hexachlorobenzene [*, 1]	no concern given cancer risk level for these two impurities of	SERA 2004a, p. 3-2, 3-9, 3-28 to 3-31, 3-33 & 3-38

	compound			pentachlorobenzene [*, 1]	3 in 100,000,000 is well below trigger level of 1 in 1,000,000 used by USDA/FS and U.S. EPA; cancer risk factor=1.6 (mg/kg/day)-1	
Glyphosate	in mammals, primarily excreted in the feces and urine unchanged	aminomethyl phosphonate (AMPA)	no concern	N-nitrosoglyphosate (NNG) *	no concern	U.S. EPA 2009c, p. 2, 6 & 7
		N-acetyl-AMPA		1,4-dioxane [*, 1]	no concern given cancer risk level of 1	U.S. EPA 2010b, p. 4, 12

		N-acetyl-glyphosate	no concern; equivalent to glyphosate	(contaminant in POEA)	in 1,500,000 below trigger level of 1 in 1,000,000 used by the USDA/FS and U.S. EPA; cancer potency factor=0.011 $(mg/kg/day)^{-1}$	SERA 2011b, p. 83-86
Hexazinone	In mammals, rapidly metabolized by hydroxylation and demethylation, and eliminated in urine and feces; in the environment, the data indicate that hexazinone is metabolized by hydroxylation to metabolite	3-(4-hydroxycyclohexyl)-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione) 3-cyclohexyl-6-(methylamino)-1-methyl-1,3,5-triazine-2,4-(1H,3H)-dione 3-(4-hydroxycyclohexyl)-6-(methylamino)-1-methyl-1,3,5-triazine-2,4-(1H,3H)-dione 3-cyclohexyl-1-methyl-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione	no concern; tolerance expressions include hexazinone (parent) and metabolites; hexazinone and its metabolites do not exceed level of concern	names not released by the U.S. EPA	no concern	U.S. EPA 2010d, Tables 1+7, p. 5-7 U.S. EPA 2002b, p. 5 U.S. EPA 1994, p. 14-16 SERA 2005, p. 3-16 & 3-17

	A which is then metabolized to metabolite C by demethylation and to metabolite E after oxidation.	3-(4-hydroxycyclohexyl)-1-methyl-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione				
		3-cyclohexyl-6-amino-1-methyl-1,3,5-triazine-2,4-(1H,3H)-dione				
Imazapyr	in mammals, rapidly absorbed when administered orally and then excreted in urine and feces, primarily unchanged; in the environment, photolysis is the only identified mechanism for imazapyr degradation	pyridine hydroxy-dicarboxylic acid	no concern; no more toxic than parent	names not released by the U.S. EPA	no concern given TGAI mammal toxicity tests	U.S. EPA 2006d, p. 17
		pyridine dicarboxylic acid				
		nicotinic acid (aka Vitamin B3)*[2]	no concern for low exposures			SERA 2011c, p. 31

Sulfometuron methyl	in mammal, nearly all is excreted in urine; in both mammals and bacteria, sulfometuron methyl is degraded similarly in multiple stages	sulfometuron pyrimidine amine	no concern given TGAI mammal toxicity tests	no information	no concern given TGAI mammal toxicity tests	U.S. EPA 2008a, p. 10 SERA 2004c, p. 3-11
		sulfometuron sulfonamide				
		saccharin				
Triclopyr	in mammals, excretion is rapid though urine typically unchanged at low doses; in the environment, it degrades slowly under aerobic aquatic conditions by aqueous photolysis, in soil it is degraded by biotic mechanisms	3,5,6-trichloro-2-pyridinol (3,5,6-TCP)*	more toxic than a.i. to mammals and aquatic organisms; exceeds level of concern for contaminated vegetation and fruit at upper bounds of analysis	none identified	NA	U.S. EPA 1998, p. 16, 30, 34 & 51 SERA 2011d, p. 4, 15, 80-81
		glucuronide	no concern			
		sulfate conjugates of 3,5,6-TCP				

NP9E	appears to be rapidly metabolized and excreted primarily through feces and secondarily in urine.	nonylphenol (conjugates/ neutral and acidic species)	act as estrogen mimics; also concern for aquatic spp.	ethylene oxide [*,1, 3]	carcinogen risk is an acceptable level for USDA/FS (both carcinogens well below the 1 per 1 million cancer risk potential)	USDA/FS 2003b, p. 5 & 18
		sulphate conjugates	no concern	1,4-dioxane [*, 1]		U.S. EPA 2010e, p. 4
		glucuronide				

* Potentially toxic if in high enough quantities; [1] Probable human carcinogen according to U.S. EPA; [2] Possible neurotoxin; [3] Possible mutagen

D.3.1.3 Exposure Assessment

D.3.1.3.1 Chemical Exposure

In Forest Service risk assessments, chemical exposure of workers and members of the general public are considered. Each of these groups is assessed in terms of general exposure and accidental/incidental exposure (SERA 2012). General exposure refers to exposure that is expected to occur from normal chemical use, whereas accidental/incidental exposure results from unforeseeable events and improper handling of chemicals. There are innumerable potential circumstances that lead to chemical exposure, though it is most important in all cases to assess the level of exposure (i.e., percentage of body exposed), the chemical concentration, and the duration of the exposure (*ibid*). In order to assess potential chemical exposure, several scenarios were created for the USDA Forest Service risk assessments (Table D.3-12). These standard sets of scenarios were designed with the intention of being conservative (in the sense of over-estimating risks) and applicable to a wide range of circumstances.

Exposure scenarios are only summarized in the worker and public exposure subsections below. For further details regarding scenarios, including calculation methods and values, refer to SERA 2012, specific chemical risk assessments, and associated Excel workbooks. In depth calculations for each scenario are on worksheets within workbooks generated by FS WorksheetMaker for each chemical (Table D.3-12). The worker and public exposure results are also summarized on worksheets E01 and E03 respectively in each workbook. Once the levels of exposure are determined for each scenario, the dose responses of the chemicals are assessed and the risk of exposure is then characterized.

As discussed previously, methodologies and information regarding chemical exposure continuously changes. Empirical evidence, such as study information, from SERA, USDA/FS, and U.S. EPA reports was used extensively to complete human health risk summaries for each chemical. Calculations from the latest FS WorksheetMaker, however, were used to update values in previous USDA/FS risk assessments using revised methods. Calculations changed for several of the chemicals, though sometimes only to a minor extent. In all cases, the newest calculations and methodologies have been used throughout this appendix, replacing those disclosed in original USDA/FS risk assessments and workbooks.

Different scenarios were designed for occupational (worker) exposure to chemicals than for public exposure, which is discussed in more detail below. There are, however, commonalities among all scenarios used in Forest Service risk assessments. While humans may be exposed through oral, inhalation and ocular routes, clear empirical evidence is limited, with studies having inconsistent findings (SERA 2012). Dermal absorption information, however, is relatively well characterized and understood for most chemicals.

Thus, this data is often used directly, or models are created to approximate how dermal absorption relates to other routes of exposure, such as inhalation, when risk assessments are conducted for the Forest Service (*ibid*).

Table D.3-12

Standard Scenarios Used in USDA/FS Risk Assessments

Scenario	**Receptor**	**Worksheet**
OCCUPATIONAL EXPOSURE		
Accidental/Incidental Acute Exposures (dose in mg/kg bw/event)		
Contaminated gloves, 1 minute	Worker	C02a
Contaminated gloves, 1 hour	Worker	C02b
Spill on hands, 1 hour	Worker	C03a
Spill on lower legs, 1 hour	Worker	C03b
General Chronic Exposures (doses in mg/kg bw/day)		
Directed foliar ground applications	Worker	C01
Broadcast ground applications	Worker	C01
Other ground applications (e.g. directed soil and stump)	Worker	C01
PUBLIC EXPOSURE		
Accidental/Incidental Acute Exposures (dose in mg/kg bw/event)		
Direct spray of child, whole body	Child	D01a
Direct spray of woman, feet and lower legs	Adult female	D01b
Water consumption (spill)	Child	D05
Fish consumption (spill)	Adult male	D08a
Fish consumption (spill)	Subsistence populations	D08b
Non-Accidental Acute Exposures (dose in mg/kg bw/event)		
Vegetation contact, shorts and t-shirt	Adult female	D02
Contaminated fruit consumption	Adult female	D03a

Contaminated vegetation consumption	Adult female	D03b
Swimming, one hour	Adult female	D11
Water consumption	Child	D06
Fish consumption	Adult male	D09c
Fish consumption	Subsistence populations	D09d
Chronic/Longer Term Exposures (dose in mg/kg bw/day)		
Contaminated fruit consumption	Adult female	D04a
Contaminated vegetation consumption	Adult female	D04b
Water consumption	Adult male	D07
Fish consumption	Adult male	D09a
Fish consumption	Subsistence populations	D09b

D.3.1.3.1.1 Workers

General occupational exposure scenarios relate to exposure while handling chemicals during normal use, whereas accidental/incidental exposure scenarios account for occurrences of misuse, mishandling and unexpected events that result in exposure higher than expected during typical chemical application. For USDA/FS risk assessments, dermal exposure is assessed in terms of absorption-based modeling, where the amount of chemical handled is used to estimate the amount of chemical absorbed through the skin (SERA 2012). While such estimates are often considered crude, additional information is incorporated into risk assessments for each chemical, as available (*ibid*).

While aerial application is assessed in USDA/FS risk assessments, it is not under consideration in the VTP and Alternatives and is thus not assessed. According to SERA (2012), ground application methods are grouped into two predominate categories in USDA/FS risk assessments:

(1) directed foliar applications (i.e., cut surface, backpacks), and

(2) broadcast foliar applications

At first glance these grouping may seem unexpectedly broad, however current empirical evidence does not indicate that more detailed application categories are usually necessary, as the degree of chemical exposure does not significantly vary between specific methods within each application category (*ibid*). A standard set of dermal absorption rates was established using nine commonly used chemicals (SERA 2012 and Table D.3-13).

Generally, these estimated dermal absorption rates, which are in terms of the amount of chemical handled, are used to calculate estimates of worker and public chemical exposure. The one exception for chemicals assessed in this Program EIR is triclopyr BEE, which has been found to have higher dermal absorption rate than the other chemicals considered (SERA 2011d). There are different exposures rates for each category of application due to the different amounts of dermal exposure. Worker exposure estimates are a product of the exposure rate (in mg/kg bw/lb of chemical handled) and the pounds of chemical handled per day or event (SERA 2012). The resulting chemical exposures are expressed as milligrams of chemical per kilograms of body weight per day or event (mg/kg bw/day or mg/kg bw/event).

Table D.3-13

Occupational Exposure Rates Used In Forest Service Risk Assessments

Worker Application Group	Rate (mg/kg bw/lb chemical handled)			References
	Central	Lower	Upper	
Directed foliar	0.003	0.0003	0.01	SERA 2012, Table 6
Broadcast foliar	0.0002	0.00001	0.0009	SERA 2012, Table 6
Triclopyr BEE directed foliar *	0.0058	0.00086	0.039	Middendorf 1992b as referenced in SERA 2011d, Table 18
Triclopyr BEE broadcast foliar *	0.00038	0.00003	0.0035	Adjusted [1]

*Evidence suggests triclopyr BEE has higher rates of exposure than triclopyr TEA and other chemicals. [1] Adjusted as defined in SERA 2011d: "The ratio of rates from Middendorf (1992b) to standard Forest Service rates for directed foliar spray are approximately 1.9, 2.9, and 3.9 based on the central estimate, lower bound, and upper bound. These ratios are used to adjust rates for ground boom…applications of triclopyr BEE based on the standard rates for these application methods."

Accidental/incidental exposures to workers are most likely related to accidental spills or splashing the chemical agent on skin or in eyes. Information on ocular exposure primarily refers to effects, so qualitative discussion is reserved for the risk characterization. Dermal exposure is the predominant exposure route and is studied in depth, so it is assessed quantitatively in USDA/FS risk assessments (SERA 2012). Some standard scenarios involve the amount of dermal absorption associated with direct contact, by wearing contaminated gloves or by full immersion of the hands in a field solution over specific time intervals (i.e., usually one minute and one hour). Other scenarios involve spilling the chemical agent directly onto hands or lower legs (Table D.3-12). For these scenarios, the exposure rate is measured as milligrams of chemical per kilogram of body weight per event (mg/kg bw/event) in USDA/FS risk assessments.

D.3.1.3.1.2 General Public

The general public may be exposed to chemicals acutely or chronically through several routes. Chemical exposure has the potential to occur to members of the public via direct spray or indirect contact by wind-drifted spray. Exposure may also occur by consumption of, or contact with, contaminated surface or ground water. Consumption and/or contact with contaminated fish, game or plants may also be routes of undesired chemical exposure.

Potential exposure to humans in part depends on the ownership of land being treated with herbicides. VTP treatments may occur on public lands such as State Parks, State Recreation Areas, and lands owned by the Department of Fish and Wildlife. Chemical treatments on these lands have a greater possibility of directly impacting members of the public, at least in part because more people are likely to be exposed on public lands relative to private lands. Under the VTP and Alternatives, private lands make up the bulk of the landscape available for treatment. Given that members of the public have limited access to private lands (i.e., by invitation only) the risk of direct chemical exposure is minimal.

While relatively few public lands are proposed for treatment, developed recreation areas, which include trailheads, campgrounds, picnic areas, recreation sites, boat ramps, ski areas, and work centers, have the potential to be chemically treated, especially on State Park lands. Treatments in or near these areas would have the greatest potential for exposing the public to chemicals. Under normal (non-accidental) application conditions, there is no expectation that the public will be exposed to chemicals above acceptable risk levels, given protections required by law and the mitigation measures outlined in Section 4.4.3. Decisions to treat vegetation with chemicals under this program will ultimately be made by landowners and CAL FIRE project leaders.

Similar to workers in Forest Service risk assessments, exposure to members of the public is grouped into *general exposure* from normal use of chemicals and more severe *accidental/incidental exposure* resulting from misuse or unusual circumstances (SERA 2012). In Forest Service risk assessments, a number of specific scenarios are consistently used to characterize exposure of the general public (*ibid* and Table D.13-12).

The exposure assessments developed in Forest Service risk assessments are based on Extreme Values rather than a single value. Extreme value exposure assessments, as the name implies, bracket the most plausible estimate of exposure (referred to statistically as the central or maximum likelihood estimate) with lower and upper bounds of credible exposure levels. This Extreme Value approach is essentially an elaboration on the concept of the Most Exposed Individual (MEI), sometime referred to as the Maximum Exposed Individual. As this name implies, exposure assessments that use the MEI approach attempt to characterize the extreme but still plausible upper limit on exposure. This common approach to exposure assessment is used by the U. S. EPA, other government agencies, and the International Commission on Radiological Protection. In most Forest Service risk assessments, upper bounds on exposure are intended to encompass exposures to the MEI.

As with workers, exposure to the general public is assessed in USDA/FS risk assessments using acute and chronic exposure scenarios (Table D.3-12). Some scenarios involve direct sprays and are modeled for ground application in a similar way to accidental spills for workers. For such scenarios it is assumed that some of the chemical remains on the skin and is absorbed by first-order kinetics (SERA 2012). Another scenario involves dermal exposure, which assumes that an adult woman is wearing shorts and a t-shirt when coming into contact with contaminated vegetation. The outcome of this scenario depends on estimates of dislodgeable reside and dermal transfer rates (*ibid*). There are multiple scenarios involving contaminated water, which are broken into categories involving accidental spill as well as accidental direct spray of or drift to a pond or stream (*ibid*). Several scenarios also evaluate the acute and chronic consumption of contaminated fish, broadleaf vegetation, and fruit. One scenario also involves the dermal exposure from swimming in contaminated surface water, which is calculated essentially identically to the contaminated glove scenario for worker exposure (*ibid*). Short- term peak and long-term average water contamination rates (WCRs) are determined for the scenarios involving water as shown in Table D.3-14. Together, these scenarios assess a wide range of potential chemical exposure outcomes.

Table D.3-14

Water Concentration Rates of Chemicals Proposed for Use*

	Short-term peak concentrations (mg/L)			Longer-term average concentrations (mg/L)		
	Peak			**Average**		
Chemical	*Central*	*Lower*	*Upper*	*Central*	*Lower*	*Upper*
Borax	0.03	0.006	0.1	0.014	0.002	0.07
Clopyralid	0.02	0.005	0.07	0.007	0.001	0.013
Glyphosate	0.011	0.0013	0.083	0.00019	0.000088	0.0058
Hexachlorobenzene	N/A	N/A	N/A	0.00039	0.00004	0.005
Hexazinone	0.1	0.0005	0.4	0.02	0.00001	0.07
Imazapyr	0.02	0.000009	0.26	0.007	0.000003	0.12
NP9E	6.1	3.0	15.1	0.007	0.0	0.014
Sulfometuron methyl	0.001	0.00006	0.02	0.00004	0.00001	0.00007
Triclopyr BEE	0.0004	0.00000015	0.03	0.000002	2.0×10^{-10}	0.00007
Triclopyr TCP	0.0009	0.00000001	0.028	0.00005	3.0×10^{-12}	0.002
Triclopyr TEA	0.003	0.000001	0.24	0.001	2.0×10^{-10}	0.06

*All values calculated using FS WorksheetMaker workbooks (worksheets B04Rt and B04a), except those for NP9E that come from USDA/FS 2003b

An important consideration for scenarios involving consumption of fish is the propensity of a chemical to accumulate in fish tissues. The ratio of chemical concentration in fish tissue relative to the chemical concentration in water is referred to as the bioconcentration factor (BCF). If, for example, the concentration in an organism is 5 mg/kg and the concentration in the water is 1 mg/L, the bioconcentration factor (BCF) is 5 L/kg [5 mg/kg ÷ 1 mg/L] (SERA 2012). BCF values ≤1 indicate that chemicals are not expected to bioconcentrate in fish (USDA/FS 2006a). Generally speaking, the amount of chemical accumulation depends on the concentration of the chemical agent in the water and the maximum concentration that can occur in the tissue of the organism (*ibid*; see OPPTS 850.1730 for U.S. EPA test protocols). As with most absorption processes, bioconcentration depends initially on the duration of exposure, but eventually reaches a steady state (SERA 2012). Separate BCF values are calculated for acute (24 hour) and long-term (steady state) exposures and are used in respective scenarios to determine plausible exposure through consumption of contaminated fish (Table D.3-15).

Table D.3-15

Bioconcentration Factors of Chemicals Proposed for Use As L/Kg Fish*

Chemicals	Edible portion, acute	Edible portion, chronic	Whole fish, acute	Whole fish, chronic
Borax	1.0	1.0	1.0	1.0
Clopyralid	1.0	1.0	1.0	1.0
Glyphosate	0.38	0.38	0.52	0.52
Hexachlorobenzene	2,000	20,000	2,000	20,000
Hexazinone	1.0	2.1	2.0	5.5
Imazapyr	0.5	0.5	0.5	0.5
NP9E	1.0	1.0	1.0	1.0
Sulfometuron methyl	3.0	3.5	7.0	6.0
Triclopyr BEE	0.06	0.06	0.83	0.83
Triclopyr TCP	0.06	0.06	0.83	0.83
Triclopyr TEA	0.06	0.06	0.83	0.83

*All values calculated using FS WorksheetMaker except those for NP9E, which are disclosed in USDA/FS 2003b

D.3.1.3.2 Chemical Dose Assessments

The most recent SERA and USDA/FS risk assessments for each chemical were used to summarize the exposure assessment in this Program EIR. Values disclosed in this section, however, have been updated using the most current version of FS WorksheetMaker for each chemical. As done for Forest Service risk assessments, exposure is summarized in terms of the typical application rate and discussions regarding the potential impacts of higher application rates are restricted to the risk characterization section for each chemical.

Borax (Sources: FS WSM ver. 6.00.10; SERA 2006a)

The chemical sodium tetraborate decahydrate, alternatively called borax, is a fungicide used to treat heterobasidion root disease. As well as being a fungicide, the application methods of this chemical are different than any other chemicals proposed in the Program EIR, because the chemical is only applied directly to freshly cut tree stumps. Thus, many of the scenarios are not appropriate for the application of borax. The per acre application rate is approximate, based on the cumulative area of freshly cut stump surface. One product registered in California for forestry use is Sporax, which is a granular product composed only of sodium tetraborate decahydrate. The USDA/FS risk assessment is only written in terms of Sporax, and not other products. Thus, for the purposes of this document, references to borax are specifically referring to sodium tetraborate decahydrate and the associated product Sporax, and not other boron derived products. Since the chemical component of concern is boron, toxicity information above and all exposure information is expressed in boron equivalents (B).

Boron is a naturally occurring element that is ubiquitous in nature. The use of borax by the Forest Service is not thought to substantially contribute to human exposure through soil and water, except perhaps in extreme cases. Given that Sporax is only applied in a granular form in a specialized way, several of the standard exposure scenarios are not applicable. Other scenarios were adapted in the USDA/FS risk assessment to more accurately reflect potential exposures. Inapplicable scenarios relating to general worker exposure, direct spray, oral exposure by ingestion of contaminated vegetation, fruit, or fish, and direct exposure from contaminated vegetation were omitted from the Forest Service risk assessments. The scenario involving a child being directly sprayed with a chemical was adapted to a child ingesting borax directly from a freshly treated stump. Scenarios considered in the human health risk assessment also include contact with contaminated gloves for workers and exposure via consumption of water contaminated by an accidental spill or by run-off.

Only the most extreme scenarios related to borax applications by the Forest Service are likely to substantially contribute to levels of boron exposure in humans. The modeled exposures for workers relate to wearing contaminated gloves for 1 minute or 1 hour, with upper bounds at an application rate of 1 lbs a.i. per acre being 2.88×10^{-5} and 2.30×10^{-4} mg/kg bw/event respectively. The scenario of a child consuming Sporax directly from a tree stump resulted in the greatest exposure, with an upper bound of 3.24 mg B/kg bw/day. This estimate was calculated for the Forest Service using the average daily soil consumption by a child. All other public exposures were substantially lower, with remaining upper bounds ranging from 0.0024 to 0.14 mg B/kg bw/event, relating to chronic ingestion of contaminated water by an adult male and acute ingestion of contaminated pond water by a child after a spill respectively.

Clopyralid (Sources: FS WSM ver. 6.00.07 & 6.00.10; SERA 2004a)

The typical rate of application for clopyralid in the USDA/FS programs is 0.35 lb/acre and this was the rate used to calculate exposure values in the SERA 2004a risk assessment. In California, however, the maximum application rate for clopyralid is restricted to 0.25 lbs/acre, and thus clopyralid exposure is anticipated to be lower under the VTP and Alternatives than predicted for Forest Service projects. Given the clopyralid restrictions in California, the application rate of 0.25 lb/acre was used as both a typical and upper application rate for calculations.

For acute or chronic exposure scenarios of the public, the scenario relating to a child consuming water after the contamination of a small pond had the highest exposure estimate (e.g. an upper bound of 1.28 mg/kg bw). All other occupational and public scenarios result in often substantially lower exposures. General occupational exposures for terrestrial applications, for example, range from the lowest bound of 1.13×10^{-4} mg/kg bw/day for direct foliar spray, to the upper bound of 0.038 mg/kg bw/day for broadcast spray at an application rate of 0.25 lb a.e./acre. All occupational exposures associated with accidental/incidental events lead to exposures below the broadcast spray upper bound for general occupational exposures. This is in large part because all incidental exposure scenarios involve dermal absorption, and clopyralid is not readily absorbed through the skin. With public exposure scenarios, the upper bounds for non-accidental public exposure range from 3.0×10^{-8} mg/kg bw to 0.338 mg/kg bw, which resulted from the scenarios involving an adult female swimming in contaminated water for one hour, and one consuming contaminated vegetation, respectively. All chronic exposures for the general public result in doses lower than the upper bound for contact with contaminated vegetation.

Important impurities of technical grade clopyralid are hexachlorobenzene and pentachlorobenzene, which are found at average concentrations of about 2.5 ppm and 0.3 ppm respectively. Hexachlorobenzene is a common contaminate found in industrial emissions, at hazardous waste sites and on contaminated foods. This impurity is thus found in detectable concentrations in most individuals, and background levels of exposure are thought to be around 1.0×10^{-6} mg/kg/day. The use of clopyralid in the VTP and Alternatives are not thought to contribute substantially to ambient levels of the impurity.

Local exposure to hexachlorobenzene, however, for workers and the public from the use of clopyralid was empirically evaluated and discussed in the SERA 2004a risk assessment for clopyralid. Calculations were updated in 2006 using version 4.04 of WorksheetMaker. These calculations were outdated, however, so Patrick Durkin of SERA Inc. graciously provided a workbook completed using WorksheetMaker 6.00.07 that evaluated hexachlorobenzene in picloram, and suggested changing the application rate to that applicable to clopyralid (i.e., 8.75×10^{-7} lb/acre). For workers, the highest dose is associated with the upper bound of broadcast spray (1.32×10^{-7}), which is well below the background level of hexachlorobenzene ($>1 \times 10^{-6}$). In the new version 6.00.7 workbooks, there are no exposure values or assessments for either accidental exposure of workers, or acute exposure of the public. All chronic exposures to the general public lead to exposures less than the background levels of the compound.

Glyphosate (Sources: FS WSM v. 6.00.10; SERA 2011b)

Workbooks were created for each applicable application method (broadcast and direct foliar), as well as for more and less toxic formulations for glyphosate using WorksheetMaker. The level of exposure did not vary between the more and less toxic formulations of glyphosate. When considering general occupational exposure, the central estimate for directed foliar spray (0.026 mg/kg bw/day) is lower than the broadcast foliar spray estimate (0.045 mg/kg bw/day) at 2 lb a.e./acre. The upper bounds of exposure are 0.16 mg/kg bw/day for directed foliar exposure, whereas the upper bound for broadcast exposure was 0.30 mg/kg bw/day. All accidental worker exposure scenarios resulted in estimates that were lower than those associated with general worker exposure of the equivalent bound, in part because this chemical is not readily absorbed through the skin.

When considering exposure of the public, there is a wide range of estimated exposures, ranging from the lower bound of 2.54×10^{-10} mg/kg bw for the scenario of a woman swimming for one hour, to the highest upper bound of 4.10 mg/kg bw for exposure resulting from the scenario of a child consuming contaminated water after a spill in a small pond. The second highest estimated exposure for the public, at an application rate of 2 lb a.e./acre, is 2.70 mg/kg bw for an adult woman who consumes contaminated vegetation. All other acute scenarios for accidental and incidental events led to exposure estimates lower than 2.70 mg/kg bw, and corresponding estimates for chronic exposure were smaller still.

Hexazinone (Sources: FS WSM v. 6.00.10; SERA 2005)

The USDA/FS uses both liquid and granular formulations of hexazinone for vegetation management. Both of these formulations will be potentially used under the VTP and Alternatives. It should be noted that some granular formulations, such as Velpar DF, are mixed with water prior to application, and such formulations are evaluated as equivalent to liquid formulations in terms of exposure in USDA/FS risk assessments, as the foliage application is the same. Only formulations such as Velpar ULW, which are applied in the granular form directly to soil, are considered using granular workbooks. The typical application rate of 2 lbs a.i./acre has been used both liquid and granular formulations.

Evidence shows that general worker exposure rates do not differ whether the formulation is liquid or granular, whereas accidental exposures do vary between liquid and granular formulations. For general worker exposure, broadcast foliar spray has the highest upper bound (0.30 mg/kg bw/day) relative to exposure during direct soil or foliar application (0.16 mg/kg bw/day). When considering accidental exposures to workers, scenarios involving spills are not applicable for granular formulations, while scenarios of wearing of contaminated gloves are relevant.

While most applicable exposure scenarios were below the levels of the general worker exposure, this was not the case for all central, upper and lower bounds with the scenario involving a contaminated glove being worn for 1 hour. The upper bound for this scenario for liquid and granular formulations was 0.33 and 0.23 mg/kg bw/event, respectively. The point was made in the SERA assessment that the:

> *. . relatively minor difference* [between upper bounds of granule and liquid formulations] *is due to the fact that the upper range of exposure to liquid formulation exceeds the solubility of hexazinone in water, a limiting factor in exposures for the granular formulation. The high exposure to the liquid formulation appears to be associated with the presence of adjuvants in the liquid formulation (probably ethanol) that functionally increases the solubility of hexazinone in the field solution.* (SERA 2005, p. 3-18)

For the general public, most accidental and non-accidental exposure scenarios pertain to both granular and liquid formulations, though direct spray scenarios were not applicable to granular application. Doses from acute accidents were lowest for the scenario of a male consuming fish after a spill, with granular and liquid lower bounds at 0.016 and 0.0016 mg/kg bw/event respectively. By contrast, the highest dose from acute accidents was for the scenario that a child consumed water after a spill into a small pond, with both granular and liquid upper bounds being about to 4.1 mg/kg bw/event. The acute non-accident scenario that indicates the lowest dose relates to a female swimming for one hour in contaminated water, with a lower bound of 6.3×10^{-8} mg/kg bw/event for both granular and liquid formulations. The highest dose for non-accident scenarios, by contrast, relates to an adult female consuming contaminated vegetation, with upper bounds of 2.7 and 1.1 mg/kg/event for liquid and granular formulations respectively.

Overall, chronic exposure scenarios resulted in estimates much lower than acute scenarios respectively for both liquid and granule products. The most substantial chronic exposure difference between liquid and granular formulations involved chronic exposure to contaminated vegetation. The granule formulation ranged from 0.001 to 0.045 mg/kg bw/day, whereas the liquid formulation ranged from 0.0095 to 1.14 mg/kg bw/day for the contaminated vegetation scenario. The difference between the upper bounds of the two formulations is a factor of 25, which likely results from the propensity of the liquid to deposit onto vegetation more readily than granules of hexazinone.

For hexazinone the assumption is made that there is no dissipation in plants over the course of the chronic contaminated vegetation scenario. This is due to the soil-active nature of hexazinone and its continual uptake into plants through the root system (SERA 1997b). This assumption is consistent with a study conducted by the California Department of Pesticide Regulation in which low but persistent levels of hexazinone were found in four species of plants of interest to Native Americans (CDPR 2002).

Imazapyr (Sources: FS WSM v. 6.00.10; SERA 2011c)

While both direct foliar and broadcast application methods are assessed for worker exposure in this document, it is acknowledged that broadcast application is not likely with imazapyr. When examining general worker exposure, the upper bound of direct foliar application is 0.02 mg/kg/day, whereas broadcast application leads to an upper bound of 0.045 mg/kg/day at the typical USDA/FS application rate of 0.3 lb a.e./acre. Occupational exposure estimates for accidental or incidental exposure scenarios were lower than estimates for general daily occupational exposure. The estimate for wearing contaminated gloves for 1 hour, for instance, has the highest upper limit for the accidental/incidental exposure scenarios, at only 0.009 mg/kg bw/event.

When considering the general public, the highest upper limit estimate for the acute accident scenario of a child consuming contaminated water just after a spill is 0.6 mg/kg bw/event at a 0.3 lb a.e./acre application rate. As with other chemicals, the parameters for this scenario are considered highly arbitrary. The non-accidental acute exposure levels are highest with the consumption of contaminated vegetation scenario (i.e., upper bound of 0.41 mg/kg bw/day event at 0.3 lb a.e./acre), though most are considerably lower. The lowest estimate results from the scenario of an adult female swimming in contaminated water (2.0×10^{-11} mg/kg bw/event). Chronic exposure estimates are much lower than for the corresponding acute exposure scenarios.

NP9E (Sources: FS WS ver. 2.02; USDA/FS 2003b)

Central and upper estimates for general worker exposure are higher for broadcast spray application (0.037 and 1.01 mg/kg bw/day respectively) than for direct foliar applications (0.53 and 0.01 mg/kg bw/day). The highest accidental/incidental exposure estimate for workers relates to individuals wearing a contaminated glove for one hour, and resulted in a central estimate of 0.01 mg/kg bw/event, with a range of 0.0019 to 0.066 mg/kg bw/event.

For the general public, most exposure estimates were lower than the general worker exposures, with the exception of accidental exposures involving the public. The accidental scenario that lead to the highest exposure involved a child consuming contaminated water from a small pond, which had a typical exposure of 0.46 mg/kg bw/event, with exposures ranging from 0.14 to 1.71 mg/kg bw/event Beyond the contaminated water scenario, other accidental event estimates ranged from 1.25 mg/kg bw/day for short-term consumption of contaminated fruit, to 3.6×10^{-6} mg/kg bw/day for a woman making dermal contact with contaminated vegetation. As with other chemicals, accidental exposure scenarios should be regarded as extreme, but to some extent plausible. Chronic exposure scenarios for the general public led to a wide range of upper limits, from 2.0×10^{-6} to 0.02 mg/kg bw/day.

Sulfometuron methyl (Sources: FS WSM v. 6.00.10; SERA 2004c)

While both direct foliar and broadcast application methods are assessed for worker exposure in this document, it is acknowledged that broadcast application is not likely with sulfometuron methyl. Exposure estimates for workers are highest for broadcast application, with central and upper bounds of 0.001 and 0.007 mg/kg bw/day at the typical Forest Service rate of application of 0.045 lb/acre. Directed foliar application, by contrast, leads to central and upper exposure estimates of 0.0006 and 0.004 mg/kg bw/day. Exposure estimates for accidental exposures related to workers fell within the ranges of the general exposures for workers.

There is variation as to whether exposure estimates for the general public were higher or lower than those for general worker exposures. The highest short-term accidental exposure involves a small child consuming water from a small pond that has been contaminated (upper bound of 0.094 mg/kg bw/day). As with other chemicals, this scenario is particularly implausible and arbitrary. The highest estimates for acute and chronic non-accidental exposure to members of the public were substantially lower and related to the consumption of contaminated broadleaf vegetation (upper bounds of 0.06 mg/kg bw/event and 0.0097 mg/kg bw/day, respectively). By contrast, the lowest estimates for acute and chronic non-accidental exposure involved an adult female swimming in contaminated water for 1 hour (1.4×10^{-12} mg/kg bw/event) and an adult male consuming contaminated fish (2.3×10^{-10} mg/kg bw/day).

Triclopyr (Sources: FS WSM v. 6.00.10; SERA 2011d)

As discussed in the USDA/FS risk assessment, the standard worker exposure rates (mg/kg bw/lb/acre) that are typically used to evaluate general occupational exposure are not applicable to all forms of triclopyr. Current evidence regarding dermal absorption suggest that no exposure rate adjustments are needed for the TEA form of triclopyr, though the BEE form of triclopyr was found to have a much higher exposure rate than the standard (Table 5.17.25). Thus, the USDA/FS adopted rates established in a particular study for backpack spraying (Middendorf 1992b as referenced in SERA 2011d) and to use this information to adjust the rates for broadcast foliar application methods. SERA (2011d) contains details of studies and the rationale used by the Forest Service to adapt the exposure rates of BEE. Substantial differences were found in the risk characterization of TEA and BEE for workers.

For worker exposure, BEE form had a higher dose rate than the TEA form regardless of application method. That said, broadcast application led to higher exposure estimates than direct foliar application for both TEA and BEE. For example, the upper bound for broadcast application of BEE was 0.588 mg/kg/day, whereas the same exposure for TEA was 0.15 mg/kg/day, at an application rate of 1 lb. a.e./acre. The upper bound accidental/incidental exposure estimates for TEA involving workers were below the upper bound for general exposures (i.e., <0.15 mg/kg/day) likely during broadcast application of TEA. This was also true for BEE applications, except for BEE exposure from wearing contaminated gloves, which led to an exposure of 7.49 mg/kg/event at an application rate of 1 lb a.e./acre.

When considering public exposure scenarios, the consumption of water by a child shortly after a spill led to the greatest exposure rate for both BEE and TEA (upper bound of 2.05 mg/kg/day). Consumption of broadleaf vegetation shortly after spraying led to the next highest exposure rate for both forms of triclopyr (upper bound of 1.35 mg/kg/day). Other scenarios involving skin contact and consumption of contaminated water, fish, vegetation and fruit resulted in substantially lower exposures, with upper bounds ranging from 6.0×10^{-10} to 0.07 mg/kg/day. Whether considering occupational or public exposure, triclopyr TEA may cause moderate to severe ocular damage if splashed into the eye, though this potential effect is only qualitatively considered in the most recent USDA/FS risk assessment.

The metabolite 3,5,6-trichloro-2-pyridinol (TCP) is known to be more toxic than triclopyr, particularly to some aquatic organisms, and thus the potential exposure was quantitatively assessed for the USDA/FS risk assessment using all available information. The accidental spill scenario led to a peak concentration of triclopyr in water of about 1.8 (0.23 to 18.2) mg a.e./L. While no such direct comparative data exists for TCP, the concentrations after aquatic triclopyr application have been determined in several studies, and this information has was used to approximate spill information as discussed in SERA (2011d). After aquatic applications, triclopyr was several magnitudes higher than TCP in concentration. In the Forest Service risk assessments, studies evaluating concentrations of triclopyr and TCP were used to approximate “the concentrations of TCP in a pond following an accidental spill are estimated at about 0.0077 (0.0004 to 0.13) mg/L” (see SERA 2011d). Scenarios involving direct spraying or drift of triclopyr into ponds and streams would lead to exposure levels much lower than those for similar direct spill scenarios, and as a result TCP levels would also be much less. Calculations of pond and stream contamination vary depending on several environmental and application factors, as modeled in Gleams-Drivers (SERA 2007a).

Given the toxicity of TCP, the Forest Service risk assessment evaluated the contamination of fruits, vegetable, and water using models with what limited information was available. TCP was found to be “somewhat more persistent in soil when compared to triclopyr, but less persistent than triclopyr in water.” Acute and chronic exposure to triclopyr is greater through consumption of vegetation than compared to fruit (e.g. acute upper bounds: 1.35 and 0.19 mg/kg/event respectively). Exposure to TCP through consumption of vegetation and fruit also follows this pattern (e.g. acute upper bounds 0.38 and 0.053 mg/kg/event respectively), though overall exposure to TCP is less than for triclopyr.

D.3.1.4 Dose-Response Assessment

In addition to understanding the likelihood of human exposure from chemical applications, it is important to consider how the amount, or dose, of a chemical affects the degree or severity of risk (SERA 2012). In USDA/FS assessments, this is quantified in terms of Reference Doses (RfD) or Reference Concentrations (RfC) for each chemical. The units for oral doses (RfD values) are mg/kg/day, whereas inhalation doses are measured as RfC values, in mg/m^3. These values are most often taken directly or derived from U.S. EPA studies, as the U.S. EPA is better equipped to provide analysis and review that is outside of the scope of USDA/FS risk assessments. Beyond clear budgetary benefits, this approach promotes information sharing between federal and state agencies and other organizations, rather than a duplication of efforts. In the SERA (2012) report reference doses are described as "point estimates (single numbers rather than ranges) of doses that are not believed to be associated with any adverse effect and that are not directly related to a dose-response model." Using a reference dose methodology ensures a conservative approach to dose-response assessment.

Both chronic and acute RfDs are used to characterize risk in USDA/FS risk assessments. According to SERA (2012) "[c]hronic RfD values are intended to estimate dose levels associated with a negligible or at least defined level of risk over a lifetime of exposure." Chronic No-Observed-Adverse-Effect-Level (NOAEL) values used are typically based on long-term (chronic or subchronic) toxicity studies, or multigenerational studies (SERA 2012). When there is no NOAEL available, a Lowest-Observed-Adverse-Effect-Level (LOAEL) may be used in conjunction with an uncertainty factor (UF). RfD values result from experimental toxicity values (NOAEL or LOAEL) divided by uncertainty factors. Uncertainty factors are typically established in factors of 10. If several factors are applicable to the data of a particular NOAEL used for establishing a chemical RfD, the factors are multiplied to determine an overall uncertainty value. For example, several of the chemicals under consideration were assigned an uncertainty factor of 100, which in some cases represents a factor of 10 for differences between species multiplied by a factor of 10 for within species uncertainty.

While comparable to chronic RfDs conceptually, acute RfD values are intended to only assess risks associated with one day or less of exposure to a chemical (SERA 2012). Acute RfDs have only recently been determined for U.S. EPA risk assessments, and are determined differently, depending on the chemical, for Forest Service assessments (*ibid*). There seems to be little difference, however, between acute and chronic toxicity of chemical agents that appear to have weak dose-duration relationships, and in such cases the chronic RfDs are used (*ibid*). When risks are apparent, further attempts should be made to categorize these risks. Table D.3-16 displays RfD values used in the most current USDA/FS risk assessments for chemicals that will potentially be used in the VTP and Alternatives.

Table D.3-16

Reference Doses (RfD) Values Used By the USDA/FS for Proposed Chemicals

Active Ingredient	ACUTE mg/kg bw/event	CHRONIC mg/kg bw/day	References
Borax	chronic used	0.200	SERA 2006a, p. 3-21
Clopyralid	0.750	0.150	SERA 2004a, p. 3-27
Glyphosate	chronic used	2.000	SERA 2011b, p. 102
Hexazinone	4.000	0.050	SERA 2005, p. 3-35
Imazapyr	chronic used	2.500	SERA 2011c, p. 47
Sulfometuron methyl	0.870 [1]	0.020	SERA 2004c, p. 3-23
Triclopyr	1.000	0.050 [2]	SERA 2011d, p. 71
TCP - Triclopyr metabolite	0.025	0.012	SERA 2011d, p. 71
NP9E	0.1	0.100 [1]	USDA/FS 2003b, p. 29

[1] While the USDA/FS usually uses the RfD determined by the U.S. EPA, additional data was used to establish this value. [2] Also the acute RfD value for women of childbearing age.

Dose-severity relationships are important to consider only when plausible exposures are above a level of concern (LOC). Given the conservative nature of exposure and dose-response assessments done by the USDA/FS, no elaboration was needed in cases where upper ranges of plausible exposure are below the LOC. However, when risks were apparent, the Forest Service would compare any, often sparse data, such as LOAELs and NOAELs, though explicit dose-response models were not used. The intention for doing this type of dose-response assessment allowed for estimates when explicit data is lacking, which can then be discussed in the risk characterization section for each chemical.

Chemicals potentially used under the VTP and Alternatives are not classified as carcinogens, although some impurities and/or metabolites in technical grade active ingredients or surfactants have the potential to be carcinogens. Hexachlorobenzene, for example, is a manufacturing by-product of clopyralid that is a known carcinogen. The U.S. EPA determines values, known as the cancer potency factors, to approximate the cancer risk of chemicals. These values are adopted from the U.S. EPA for use in Forest Service risk assessments.

Borax (Sources: FS WSM ver. 6.00.10; SERA 2006a)

The U.S. EPA used two developmental studies on boric acid and borates to establish a chronic RfD of 0.2 mg B/kg/day for boron. Decreased fetal weights observed during these studies on rats served as the most sensitive endpoints. This was calculated using a benchmark response (BMR) level, divided by an uncertainty factor of 66, which considers both interspecies and sensitive individual variability. No acute RfD has been established for boron at the time the Forest Service risk assessment was written, and thus, the chronic RfD was also used for one-day exposures.

Clopyralid (Sources: FS WSM ver. 6.00.07 & 6.00.10; SERA 2004a)

The Forest Service used acute and chronic RfD values of 0.75 and 0.15 mg/kg bw/day for clopyralid, as derived by the U.S. EPA. An acute NOAEL of 75 mg/kg bw/day was the basis for the short-term RfD. A NOAEL of 15 mg/kg bw/day from a 2-year dietary study was used to establish the chronic RfD. An uncertainty factor of 100 was used to obtain both acute and chronic RfD values. As is commonly observed in chronic toxicity studies, changes in body, liver and kidney weights were noted in several additional studies with clopyralid. It was also indicated that some mammals developed thickening in some epithelial tissue. The importance of this less common effect is not well understood. The majority of the anticipated exposures were below the RfD and those that were above the RfD only marginally exceeded this dose. Thus, there was no need for further modeling to complete the risk characterization.

Technical grade clopyralid is contaminated with hexachlorobenzene and pentachlorobenzene. The presence of these contaminants was quantitatively evaluated in the Forest Service risk assessment, to a limited extent. Due to the low abundance of these contaminants in technical grade clopyralid and the low potency of each contaminant relative to clopyralid, these contaminants were not anticipated to substantially influence any systemic-toxic effects associated with clopyralid. The carcinogenicity of hexachlorobenzene, however, was considered separately using the U.S. EPA's cancer potency parameter.

Glyphosate (Sources: FS WSM v. 6.00.10; SERA 2011b)

The chronic RfD of 2 mg/kg bw currently used in Forest Service risk assessments was derived by the U.S. EPA Office of Pesticide Programs, based on a chronic developmental study using rabbits that defined both an NOAEL of 175 mg/kg bw/day and definitive LOAEL of 350 mg/kg bw/day. Two uncertainty factors of 10 (one for sensitive individuals and one for species extrapolation) were multiplied, for a total uncertainty factor of 100. There is no acute RfD defined by the U.S. EPA, so the chronic RfD of 2 mg/kg bw/day was used for both acute and chronic exposure characterizations in the USDA/FS assessment.

Some reservations regarding the use of this RfD are discussed in detail in the Forest Service assessment. Moreover, this RfD was established using technical grade glyphosate, though some surfactants, such as POEA, are known to have comparable or greater toxicity than glyphosate. Thus, the RfD equivalency of technical grade glyphosate and mixtures containing POEA surfactants may be questioned. The NOAEL was then divided by the UF, and in the case of glyphosate, the result was rounded. As discussed in the USDA/FS risk assessment, surfactants in glyphosate formulations have the potential to be more toxic in some circumstances, however, currently there is not compelling evidence that would suggest an alternative RfD is necessary for formulations used in the U.S. The margin between the NOAEL and LOAEL is narrow when considering that some dam mortality was observed at the LOAEL, which indicates that the NOAEL may be viewed as a frank effect level. Concern should be given for any doses that exceed the RfD of 2 mg/kg bw/day, especially in terms of sensitive individuals, though defining a clear threshold for adverse effects is difficult for glyphosate.

Hexazinone (Sources: FS WSM v. 6.00.10; SERA 2005)

The USDA/FS adopted the acute and chronic RfD values of 4 mg/kg bw/event and 0.05 mg/kg bw/day, as derived by the U.S. EPA. The acute RfD was based on reproductive/ developmental studies using rabbits and rats that resulted in NOAELs of 400 mg/kg bw/day. This dosage was then divided by an uncertainty factor of 100. The chronic RfD, by contrast, was developed from a study that resulted in a NOAEL of 5 mg/kg bw/day using dogs. Again an uncertainty factor of 100 was used, which in this case consisted of two factors of 10 to account for species-to-species extrapolation and sensitive subgroups.

Imazapyr (Sources: FS WSM v. 6.00.10; SERA 2011c)

A chronic RfD of 2.5 mg/kg bw/day was established by the U.S. EPA and used in the USDA/FS risk assessment, based primarily on a dog study with a NOAEL of 250 mg/kg bw/day, which is reinforced by additional rat and mice studies. Uncertainty factors of 10 for sensitive individuals in the human population and 10 for species extrapolation were multiplied, for an overall uncertainty factor of 100. There is no acute RfD defined by the U.S. EPA, so the chronic RfD of 2.5 mg/kg bw/day was used for both acute and chronic exposure characterizations in the USDA/FS assessment. Dose-severity relationships could not be made, in part because doses could not be associated with any adverse effects and none of the HQs exceed the LOC. Thus far, data does not show that young animals are more susceptible to adverse effects from imazapyr exposure.

NP9E (Sources: FS WS ver. 2.02; USDA/FS 2003b)

The U.S. EPA has not derived an RfD for this surfactant active ingredient. A NOEL of 10 mg/kg bw/day for NP, however, was used by the USDA/FS to establish a chronic RfD, by dividing by an uncertainty factor of 100 to account for interspecies and intraspecies differences. Using an RfD based on NP is protective of both NP and the less toxic NP9E, and is specifically protective of estrogenic or reproductive effects. Acute exposures of NP9E are not anticipated to be associated with any adverse health effects at doses of 0.1 and 0.4 mg/kg bw/day. These RfD values are based on NP, but in reality only a portion of NP9E would degrade into the more toxic NP compound.

Sulfometuron methyl (Sources: FS WSM v. 6.00.10; SERA 2004c)

Contrary to the approach taken in most Forests Service risk assessments, acute and chronic RfD values were not adopted from the U.S. EPA. No acute RfD has been established by the U.S. EPA for sulfometuron methyl. One developmental study using rats, however, established a NOAEL of 86.6 mg/kg bw/day based on observed decreases in maternal and fetal body weights after 10 days of gestational exposure. The Forest Service uses this study to establish a provisional acute RfD of 0.87 mg/kg/day that was calculated using the NOAEL of 86.6 mg/kg/day and an uncertainty factor of 100. Although the U.S. EPA uses a chronic RfD of 0.24 mg/kg/day, the more conservative provisional RfD of 0.02 mg/kg bw/day was derived by the Forest Service from a chronic feeding study using rats. This study had a NOAEL of 2 mg/kg bw/day as a result of hematological effects in male rats. An uncertainty factor of 100 was used, which represents two factors of 10 to account for species to species extrapolation and sensitive subgroups.

Triclopyr (Sources: FS WSM v. 6.00.10; SERA 2011d)

The U.S. EPA established acute and chronic RfDs for triclopyr, and separate RfD values for the metabolite 3,5,6-4 trichloro-2-pyridinol (TCP), which are used in USDA/FS risk assessments without adaptations. The RfD values for triclopyr are 1.0 and 0.05 mg/kg bw/day for acute and chronic exposure respectively. Each of these RfD values was derived from NOAEL findings from studies using rats. The UF used to calculate both RfD values was 100.

The acute RfD of 1 mg/kg bw/day was intended to be used for the general population. This RfD was established because marked maternal toxicity in rats was not seen until a dose of 300 mg/kg bw/day was administered, although fetal toxicity was observed with a dose of 100 mg/kg bw/day. However, the RfD of 1 mg/kg bw/day was not acceptable for human females of reproductive age (13 to 50 years) due to maternal toxicity being observed at 30 mg/kg bw/day with a NOAEL of 5 mg/kg bw/day for the developmental study. Thus, the more conservative RfD of 0.05 mg/kg bw/day for both acute and chronic exposure is most appropriate for women in this age group (SERA 2011d, p. 72).

Triclopyr contains the metabolite/degradate 3,5,6-trichloro-2-pyridinol (TCP), which has the potential to be toxic, so this compound is quantitatively assessed. Acute and chronic RfDs, of 0.025 and 0.012 mg/kg bw/day respectively, were derived by the U.S. EPA and adopted by the Forest Service. Both of these RfDs were derived using a UF of 1000, because, as with triclopyr, there were uncertainties relating to species to species extrapolations and sensitive individuals. In addition to these a third factor was added to account for the potential for children having a higher sensitivity to TCP than adults.

The acute RfD originated from a developmental study of triclopyr resulting in a NOAEL of 25 mg/kg bw/day that was then divided by a UF of 1000 for TCP. This resulted in an RfD of 0.025 mg/kg bw/day. By contrast, the data that was used to establish the chronic RfD for TCP was derived from a chronic study on dogs. A NOAEL of 12 mg/kg/day resulted from this study as well as a LOAEL of 48 mg/kg/day. Once divided by 1000, as done for the acute RfD, the resultant RfD that remains for chronic exposure is 0.012 mg/TCP/kg bw/day.

D.3.1.5 Risk Characterization

In Forest Service risk assessments, the exposure and the dose-response assessments are used to quantitatively characterize risks. Hazard quotients (HQ) are values used to categorize risk for systemic toxicity effects (SERA 2012). All HQ values are directly proportional to the chemical application rate (i.e., an HQ value of 2 at an application rate of 1 lb a.e./acre would be 6 at an application rate of 3 lb a.e./acre). For acute exposures, HQs are in units of mg/kg bw/event whereas chronic exposures are in units of mg/kg bw/day. The HQ is usually calculated by dividing a projected level of exposure by an acceptable level of exposure, such as an RfD (*ibid*). Generally, an HQ greater than 1 indicates that risk is above the Level of Concern (LOC), or unacceptably high for the situation being considered, and that adverse health outcomes may be plausible. By contrast, an HQ less than or equal to 1 indicates that exposures are below the LOC and adverse effects are not expected. Still, when HQ values are 1 or greater, the plausibility of scenarios and assumptions made for each scenario should be considered before conclusions regarding risk levels are drawn. For example, the parameters set for the scenario relating consumption of contaminated water after a pond spill is designed to show varying consequences of spilling different amounts of the chemical under consideration (USDA/FS 2006a). The amounts of a chemical spilled are set at the amounts needed to treat from 1 to 100 acres. Such assumptions in this scenario are arbitrary and may be unrealistic. Given its arbitrary nature, this scenario can usually be used only to quantitatively assess risk to a limited extent.

When characterizing risk, it is important to consider the severity of the toxicological effects used to establish effect levels. Distinctions between adverse effect levels (AELs) and frank effect levels (FEL, defined as “gross and immediately observable signs of toxicity”) are important. These levels are subject to misinterpretation, so judgments should be made with caution (SERA 2012). When no FELs are found, this implies that no overt effects are anticipated, though this does not mean that all HQs are acceptable or comparably acceptable. In some cases, hazard levels of exposure may be greatly exceeded and humans may be asymptomatic. This does not mean, however, that subclinical changes have not occurred that should justify rational people to minimize exposure to chemicals. It needs to be emphasized that for the risk characterizations that follow, regardless of studies and findings, "***[a]bsolute safety cannot be proven and the absence of risk can never be demonstrated***" (*ibid*). There are always uncertainties, such as those associated with using data from surrogate mammals to represent human health risk. Thus, individuals should remain prudent and minimize chemical exposure when possible.

Biologically sensitive individuals also need particular consideration as part of chemical risk characterization. Certain individuals have severe sensitivities when exposed to chemicals, often even when the chemical is below levels of concern (*ibid*). Individuals who are biologically sensitive to chemicals are those who are significantly more sensitive than the general population. Factors such as age (young or old), lifestyle and behavior, as well as the presence of genetic conditions or pre-existing disease states, may increase susceptibility to chemicals (*ibid*). Individuals who are at a high risk due to a high level of exposure, however, are not included in this group. There is also a condition referred to as multiple chemical sensitivities (MCS), which is where individuals report having multiple sensitivities to different types of chemicals, including pesticides (SERA 2011b). These individuals notice effects at very low doses relative to folks without MCS. To date, there is debate about whether this condition is psychosomatic, but regardless, the condition exists (*ibid*). This condition has been particularly noted in the case of glyphosate.

In the risk characterization section of each USDA/FS risk assessment, "connected actions" are also evaluated in terms of adverse effect risks. The Council on Environmental Quality (CEQ) defines connected actions as actions that are closely related, and they are connected if they:

> *(i) Automatically trigger other actions which may require environmental impact statements. (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously. (iii) Are interdependent parts of a larger action and depend on the larger action for their justification (40 CFR 1508.5).*

In terms of USDA/FS risk assessments and pesticide use, connected actions most commonly refer to adverse effects associated with inert ingredients, metabolites, impurities, and synergism. As applicable, these actions are summarized below for each chemical being proposed for use.

In Forest Service risk assessments on specific chemicals, risk is characterized in terms of cumulative effects, when appropriate. The USDA/FS described the cumulative effects section of a chemical-specific risk assessment as considering "known chemical interactions or actions, which taken in consideration with the proposed pesticide use, would affect the quality of human health and the environment (i.e., modify risks to human health and ecological receptors within the context of the risk assessment)" (USDA/FS 2006a). Given the scope of the chemical risk assessment, the Forest Service makes no attempt to identify and consider all agents that could potentially interact with a specific chemical. When applicable, the USDA/FS and the risk assessment in this Program EIR make an attempt to discuss interactions and associated effects in terms of the most current information.

Borax (Sources: FS WSM ver. 6.00.10; SERA 2006a)

Only some of the standard worker and public exposure scenarios usually used by the USDA/FS are applicable to the use of borax, as it is only applied directly as a dry substance to freshly cut stumps of trees. Of general and accidental worker exposure scenarios, only the ones that involve wearing contaminated gloves for a minute or one hour were applicable, and even at the upper application rate (5 lbs a.i./acre) none of the HQ values indicated that toxic effects were plausible. When considering scenarios pertaining to general public exposure, the standard direct spray scenario was adapted to assess the hazards of a child consuming dry borax from a stump. The HQ values for this scenario indicated that adverse effects are plausible at typical and upper application rates. At the typical rate (1 lb a.i./acre) the central, lower and upper HQ values were 4.2, 2.1, and 16.2 respectively, whereas HQ values were 21.2, 10.6 and 80.9 at the upper application rate (5 lbs a.i./acre) for the direct consumption scenario. According to SERA 2006a, such “estimated levels of exposure are below levels of exposure associated with nonlethal effects such as diarrhea and vomiting…”. Thus, if a child consumes borax from a stump, the child would likely experience vomiting and diarrhea as symptoms of toxicity. The only other applicable standard scenarios included acute and chronic consumption of borax contaminated water. Of these scenarios, HQ values are only above levels of concern for central and upper bounds at an application rate of 5 lbs a.i./acre for a child consuming water contaminated by borax shortly after a spill (HQ values = 1.2 and 3.6 respectively).

Certain precautions should be used when handling boron products. Borax is known to be an eye irritant (sometimes severe), and be absorbed more rapidly through damaged skin compared to intact skin. While no scenarios specifically evaluate these factors, borax usually only comes in contact with eyes and damaged skin when the chemical is mishandled. Individuals with large areas of damaged skin should avoid using boron products such as Sporax®. Moreover, prudence should be taken to ensure that proper pesticide application procedures be followed, such as wearing appropriate personal protection equipment, implementing sound hygiene practices and using proper pesticide handling procedures.

Other factors important to risk characterization of borax include sensitive subgroups, connected actions, and cumulative effects. Developing fetuses are a primary target of boron exposure. Since the RfD is based on the adverse fetal effect of weight loss, the reproduction related subgroups are accounted for throughout the entire Forest Service risk assessment. Testes are also targeted in male mammals and thus, while data is currently lacking, males with underlying testicular dysfunction may be at an increased risk of testicular issues induced by boron exposure. Connected action consideration is not a concern since borax is not mixed with other chemicals. In terms of cumulative effects, multiple exposures are not concerns given that the chronic RfD was used to calculate risk through the entire boron assessment. The concern is also lessened by the fact that boron is ubiquitous in nature. Exposures occur naturally at rates of 0.14 to 0.36 mg/kg/day and the Forest Service application rates do not substantially contribute to the already existent background levels.

Clopyralid (Sources: FS WSM ver. 6.00.07 & 6.00.10; SERA 2004a)

The application rate of clopyralid is restricted to a maximum of 0.25 lb a.e./acre in California, and this rate is used as the typical and central rate of application for evaluation in this Program EIR, given that it is lower than the typical rate used by the USDA/FS.

Empirical evidence does not indicate that use of clopyralid poses unreasonable risk to workers and member of the public. At an application rate of 0.25 lb a.e./acre, none of the general or incidental exposures to workers lead to HQ values above the level of concern. Similarly, none of the short or long-term exposure scenarios relating to the general public approach a level of concern based on central estimates. Only the upper bounds of scenarios involving a child drinking water after a spill, and chronic consumption of contaminated vegetation, resulted HQ values just over the level of concern (1.7 and 1.2 respectively). The exposure scenarios for the consumption of contaminated water and vegetation are arbitrary scenarios: scenarios that are more or less severe, all of which may be equally probable or improbable, easily could be constructed. Nonetheless, these acute scenarios help to identify the types of scenarios that are of greatest concern and may warrant the greatest steps to mitigate. For clopyralid, as with most other chemicals, spills of relatively large amounts into a small body of standing water and clopyralid applications on or near vegetation that might be collected for food would require remedial action to limit public exposure.

Though not assessed quantitatively, evidence suggests that dermal and ocular damage may occur when in direct contact with high levels of clopyralid acid, so precautions should be taken, such as wearing personal protection equipment to avoid direct contact while handling clopyralid.

Current evidence does not clearly indicate that there are subgroups sensitive to or connected actions affiliated with clopyralid exposure. In toxicity studies clopyralid has been implicated in causing decreased body weight, increased kidney and liver weight, deceased red blood cell counts, as well as hyperplasia in gastric epithelial tissue. However, the likely critical effect in humans cannot be identified and effects are not consistent among test species or even between different studies on the same species Thus, it is unclear if individuals with pre-existing kidney, liver, or blood diseases would be particularly sensitive to clopyralid exposures (SERA 2004a, p. 3-35). Regarding potential connected actions, although clopyralid may be applied in combination with 2,4-D or other herbicides, “there are no data in the literature suggesting that clopyralid will interact, either synergistically or antagonistically with these or other compounds” (SERA 2004a, p. 3-36).

Using the assumptions and methods typically applied in Forest Service risk assessments, there is no plausible basis for asserting that the contamination of clopyralid with hexachlorobenzene or pentachlorobenzene will result in any substantial risk of cancer in workers applying clopyralid under normal circumstances. According to the clopyralid risk assessment, the Forest Service has adopted a cancer risk level of one in one-million (1÷1,000,000) as a trigger that would require special steps to mitigate exposure or restrict and possibly eliminate use. In the case of hexachlorobenzene that contaminates clopyralid, the highest risk level is at about 3 in 100,000,000. The scenario that leads to this highest estimate involved a subsistence population consuming contaminated fish. This was the primary scenario for exposure to hexachlorobenzene because of the tendency for the chemical to bioconcentrate from water into fish tissue. The prolonged use of clopyralid at the highest plausible application rate, 0.25 lb. a.e./acre, could approach a level of concern in areas with small ponds or lakes used for fishing and in areas with local conditions that favor runoff. In such cases, site-specific exposure assessments and/or monitoring of hexachlorobenzene concentrations in water could be considered.

Glyphosate (Sources: FS WSM v. 6.00.10; SERA 2011b)

When using the HQ approach to assessing risk from exposure to glyphosate, values indicate that concern for workers is minimal. The highest HQ for worker exposure is the upper bound for general broadcast spraying (HQ of 0.2 at typical application rate of 2 lb a.e./acre). Similarly, at the highest rate of application used by the USDA/FS of 8 lbs a.e./acre, the highest upper bound associated with workers participating in broadcast foliar application (HQ of 0.6).

In terms of general public exposure, only two of the public exposure scenarios indicate the potential for adverse effects related to glyphosate exposure (HQ values greater than 1). The accidental acute exposure scenario involving contaminated water after a spill, for example, has an upper bound HQ of 2.1 at the typical application rate (2 lbs a.e./acre), and 8.1 at the upper application rate (8 lbs a.e./acre). The only non-accidental exposure of potential concern involves consumption of contaminated vegetation shortly after application, with an upper bound HQ of 1.4 for the typical application rate (2 lb a.e./acre) and 5.4 at the upper application rate (8 lb a.e./acre). An HQ of 5 may raise concerns regarding adverse health effects to pregnant women and fetotoxicity. Chronic exposure scenarios never resulted in levels of concern, even when the maximum application of 8 lbs a.e./acre was used, as 0.9 was the highest HQ, which was for the chronic scenario involving consumption of contaminated vegetation. South American formulations that contain surfactants have been associated with genotoxicity, though it is currently unclear if this finding is applicable to the U.S. formulations.

There are some glyphosate specific issues, such as sensitive subgroups, connected actions, and cumulative effects, which can only be qualitatively discussed. Sensitive subgroups include women and fetuses, but these are accounted for since a developmental study was used to establish the NOAEL and subsequent RfD. While not well understood, MCS may be a potential concern for glyphosate, as with other chemicals. For glyphosate use, the most important connected action is associated with surfactants. Given that glyphosate functions to inhibit some mixed-function oxidases, this is a plausible mechanism of interaction for other chemicals that function similarly. There has been no evidence of such effects, however, and this is only likely to be a potential when glyphosate is applied at much higher rates than done by the Forest Service or likely under the VTP and Alternatives. Individuals may be exposed to glyphosate applied by the USDA/FS though several routes (e.g. contaminated water and fruit), though this is thought to be inconsequential, particularly since the consumption of contaminated vegetation is the only substantial exposure scenario. The Food Quality Protection Act requires chemicals that have the same mode of action relating to toxicity be assessed, but currently the U.S. EPA has not determined if glyphosate shares toxicity mechanisms with other chemicals.

Some glyphosate formulations may pose the risk of skin and eye irritation. As stated in SERA 2011b, the original Roundup formulation is about as irritating to the skin as standard dish washing detergents, all-purpose cleaners, and baby shampoos. This risk characterization, however, may not be applicable to all formulations of glyphosate that contain a surfactant. Some surfactant containing formulations of glyphosate appear to be greater irritants to the skin and eyes compared with other nominally similar formulations. Because formulations may change over time, care should be taken to read and understand the MSDS for any formulation of glyphosate which may contain a surfactant.

Hexazinone (Sources: FS WSM v. 6.00.10; SERA 2005)

Risks to workers are the dominant element in the risk characterization for potential effects in humans. The highest HQ associated with accidental/incidental exposure of worker is well below the LOC (HQ values ≤ 0.2) for all scenarios at the upper application rate of 4 lbs/acre, regardless of application method. The upper bounds of general exposure for workers is above the LOC at a typical rate of 2 lbs/acre, regardless of whether liquid and granular formulations of hexazinone are applied by broadcast (HQ of 6) or directed foliar (HQ of 3) methods. Since HQ values are proportional to the application rate, HQ values double when considered at the upper application rate of 4 lbs/acre. It should be noted, however, the lower bounds of hazard quotients for general worker exposure do not exceed a level of concern at typical or upper application rates. The simple interpretation of these hazard quotients is that worker exposures to hexazinone during application are likely to exceed exposures that would generally be regarded as acceptable unless workers follow prudent handling practices that minimize exposure.

In addition to hazards associated with systemic toxicity, hexazinone can cause eye irritation. Quantitative risk assessments for irritation are not derived; however, from a practical perspective, eye irritation is probably the overt effect that is most likely to be observed as a consequence of mishandling hexazinone. This effect can be minimized or avoided by using sound industrial hygiene practices during handling of the chemical.

For the general public, few of the scenarios led to HQ values above the LOC. One such scenario of acute accidental exposure involves consumption of contaminated water after a spill into a small pond, which results in an upper bound HQ of 2, for the highest application rate (4 lbs a.e./acre). While no acute non-accidental scenarios resulted in HQ values that substantially exceed the level of concern at the upper application rate, the highest value is associated with consumption of contaminated vegetation (i.e., upper bound HQ of 1.4 for liquid formulations). Chronic scenarios with the highest upper HQ values are those associated with consumption of contaminated vegetation (HQ of 45 at 4 lbs/acre) and fruit (HQ of 6 at 4 lbs/acre) after the application of liquid formulations. Remaining chronic scenarios, other than those relating to vegetation and fruit consumption, resulted in upper bound HQ values ≤ 0.2 for liquid formulations at the upper application rate. The risk of exposure is much lower for granular formulations of hexazinone. Upper HQ values, for example, associated with consumption of contaminated broadleaf vegetation and fruit are 1.8 and 0.3 respectively for granular formulations.

As discussed in SERA 2005, the chronic RfD is based on a NOAEL of 5 mg/kg/day. The corresponding LOAEL was about 40 mg/kg/day based on minor body weight changes and changes in blood chemistry indicative of liver toxicity. This LOAEL is a factor of 8 above the NOAEL. At the highest dose tested, about 160 mg/kg/day and a factor of 32 above the NOAEL, effects included decreased body weight gain, more pronounced changes in blood chemistry indicative of liver damage, and some changes in the liver. The relationship of the experimental NOAEL to the LOAEL or higher doses cannot be used as a direct measure of plausible effects in humans at doses above the chronic RfD. Nonetheless, the hazard quotient of 6 at the lowest application rate (0.5 lb a.i./acre) is a concern. The hazard quotient of 23 at the application rate of 2 lbs a.i./acre and the hazard quotient of 45 at an application rate of 4 lbs a.i./acre are clearly a serious concern. Given that granular application methods result in less residue on plants, particularly on the leaves of broadleaf vegetation and other plant parts that might collect similar levels of residue, this method should be favored over liquid hexazinone applications where public consumption of contaminated vegetation is probable.

Other factors that should be considered include sensitive subgroups, connected actions and cumulative effects. Hexazinone can induce fetal resorptions and other adverse developmental effects, so pregnant women and developing offspring may be sensitive subgroups particularly vulnerable to adverse effects of hexazinone. This potential has been explicitly accounted for given that the developmental endpoint was used in the risk assessment. The literature does not report any other subgroups that may be sensitive to hexazinone and there is no indication that it causes allergic responses or sensitization. In terms of connected actions, while there is almost no information available on the interaction of hexazinone with other compounds, there is no indication that the inerts and adjuvants in its formulations will increase the toxicity of hexazinone in humans or mammals. It is not unreasonable, however, to suspect hexazinone would interact additively, synergistically or antagonistically with chemicals that share similar metabolic pathways. Such potential connected actions are beyond the scope of the risk assessment in this Program EIR and are not evaluated by the Forest Service or the U.S. EPA. Cumulative effects may result from repeated exposures, multiple routes of exposure (i.e., oral and dermal), or exposures to chemicals that have connected modes of action. Forest Service risk assessments consider the effects of multiple, long-term exposures, evaluating risk in terms of both acute and chronic exposures to workers and the general public.

Imazapyr (Sources: FS WSM v. 6.00.10; SERA 2011c)

No hazards have been identified for this chemical other than the potential for eye irritation. None of the scenarios result in an HQ that exceeds 1 when calculated at an application rate of 1 lb a.e./acre. When using the maximum application rate of 1.5 lb a.e./acre the only exposure scenario that exceeded an HQ of 1 was from the upper exposure limit on drinking water from a pond immediately after a spill (HQ 1.2). Given the lack of adverse effects detected, HQ values that do exceed 1 are difficult to interpret. Currently, no evidence suggests that systemic effects are likely to occur among workers and the general public as a result of imazapyr exposure. Eye irritation is the only clear risk to humans and is most pertinent to workers. Injury to the eye is most likely to occur with occupational mishandling of imazapyr, and thus workers would be prudent to follow personal protection measures, such as wearing goggles.

Given the low toxicity of imazapyr, effects on sensitive subpopulations, the occurrence of connected actions, and cumulative effects are thought to be minimal. Because imazapyr is a weak acid it would most likely be affected by other weak acids that are similarly excreted by the kidneys, though only at unrealistically high doses that nearly saturate kidneys. In terms of connected actions, both the low HQ values and conservative assumptions support that impacts of inerts, impurities and metabolites are minimal to imazapyr risk characterization. Potential adjuvant interactions, however, are a potential but were beyond the scope of the USDA/FS risk assessment for imazapyr (as with other chemicals). When characterizing risk of chemical use, cumulative effects may result if humans experience multiple exposures to imazapyr via multiple routes and/or events, or if humans are exposed to additional chemicals with the same toxicity mechanisms at the same time as exposure to imazapyr. At present, common mechanisms of toxicity have not been found between imazapyr and any other chemicals (similar or otherwise). Given this, the USDA/FS found no evidence to suspect cumulative effects should occur with the use of imazapyr, particularly in lieu of the low chemical toxicity to humans.

NP9E (Sources: FS WS ver. 2.02; USDA/FS 2003b)

No evidence indicates that typical acute and chronic exposures for workers would lead to doses that exceed the level of concern, though some of the upper bounds did exceed it. Accidental exposure is not anticipated to cause adverse health effects, with the highest HQ of 0.7 from wearing a contaminated glove for one hour. The upper bounds of general worker exposure resulted in levels above concern, with the level of concern being double for broadcast application (HQ of 10) than directed ground spray (HQ of 5). Despite the high levels of concern at the upper bounds, there is not a high likelihood that workers will use such high levels (the upper application rate of 6.68 lb a.i./acre or 40 gallons per acre of a 2.5% solution) of surfactants containing NP9E on a chronic basis. Additionally, workers are expected to use industrial hygiene practices while handling chemicals, which are not accounted for in worker exposures.

For members of the public, chronic exposure leads to levels below concern, though some accidental exposure scenarios lead to exposures of concern. According to the USDA/FS risk assessment, there should not be any substantial risk of long-term exposure to NP9E-based surfactants to the public. Only the scenarios for consumption of contaminated water (spill or ambient/drift) and/or fish (the latter for subsistence populations), as well as contaminated fruit exposures lead to acute or accidental exposures with unacceptable risk. The scenario relating to consumption of water by a child after a spill leads to the highest risk at typical, lower and upper exposures levels (HQ values of 5, 1.4 and 17 respectively). Beyond water consumption after a spill, only the upper bounds of other scenarios were above the level of concern. As discussed in USDA/FS 2003b, an HQ of 5 represents a risk of subclinical effects to the liver and kidney. The upper HQ of 17 represents an increasing risk of clinical effects to the kidney, liver, and other organ systems. These finding indicate that oral, rather than dermal, exposures are of the greatest concern for NP9E, and help determine where the greatest mitigations may be necessary to minimize exposures to the public.

NP9E exposures directly to the eye may lead to irritation and damage when at relatively high levels, and undiluted NP9E may lead to skin sensitization. Such exposures, however, are only likely to occur in cases where the chemical is mishandled, and thus the use of personal protective equipment and industrial hygiene procedures are imperative.

There are several groups of people that have the potential to be part of sensitive subgroups. There is some indication that some sensitive individuals are prone to develop contact allergies related to NP9E exposures. In addition, there is evidence that NP9E targets the kidneys and liver in mammals, so sensitive subgroups may consist of those individuals that have pre-existing impairment of the liver or kidneys. According to the Forest Service risk assessment, the likelihood of NP9E inducing reproductive effects should be low, though acute exposures may occur that are within the range where fetal effects may occur, therefore pregnant women could be considered a sensitive subgroup.

Potential connected actions and cumulative effects of NP9E are important to consider. NP9E has not been connected to any antagonistic or synergistic interactions relating to human health effects when mixed with other chemicals. This group of surfactants is not known to increase dermal absorption of herbicides and synergistic effects are not expected with repeated exposures of NP related compounds. Toxicological response appears to be dependent on daily doses rather than the duration of exposures. Additionally, any repeated-exposure effects should have been counted for through use of the chronic RfD. That said, there is the potential for additive estrogenic effects to arise if NP related compounds or chemicals that act via similar estrogen-like (xenoestrogen) pathways cumulatively reach a high enough concentration. NP9E exposure may result from a number of non-forestry related sources (e.g. personal care products, industrial and institutional detergents and cleaners, and the environment), and the amount of human exposure to NP9E as a result of forestry use may be negligible in comparison.

Sulfometuron methyl (Sources: FS WSM v. 6.00.10; SERA 2004c)

At the typical application rate used by the Forest Service (0.045 lb a.e./acre), none of the upper limit HQ values for workers or the general public are at or above levels of concern. The highest general worker exposure is the upper bound for broadcast application, with an HQ of 0.34 for at the typical application rate. At the higher application rate of 0.38 lb a.i./acre, however, the upper bounds for both broadcast and direct foliar application are above the level of concern (HQ values of 2.9 and 1.5 respectively). None of the scenarios for the general public resulted in levels of concern at the typical application rate (0.045 lb a.i./acre) At the highest application rate, however, the upper bounds for the scenario involving chronic consumption of contaminated broadleaf vegetation indicated that adverse effects are plausible (HQ of 4.1).

The interpretation by the Forest Service is that an unacceptable level of risk could be expected for workers if the maximum application rates are used, the maximum acreage is treated per day, and the workers are not prudent in using sound hygiene practices and personal protection equipment. Given the low likelihood that all these factors would occur, and the conservative provisionary RfDs used by the Forest Service, it is unlikely that workers or the public alike would experience observable adverse effects. Proper chemical handling and hygiene practices should minimize potential irritation or damage to eyes and skin. Similarly, the risk of adverse effects to the public would be reduced or eliminated if lower application rates and fewer acres were treated.

No adverse effects associated sensitive subgroups, connected actions, or repeated exposures, were identified in the 2004 risk assessment for sulfometuron methyl conducted for the Forest Service. Given hematology and thyroid effects observed in mammalian studies, it was suggested that individuals with pre-existing anemia or thyroid function issues may be more susceptible to adverse effects. According to the Forest Service risk assessment, sulfometuron methyl formulations have not been connected to synergistic or antagonistic effects related to the mixing of sulfometuron methyl with other active ingredients and surfactants. Cumulative effects are not anticipated given that repeated exposures were explicitly considered through using a chronic RfD to evaluate the level of concern with repeated exposure.

Triclopyr (Sources: FS WSM v. 6.00.10; SERA 2011d)

The acute RfD for general worker exposures is 1) less conservative than using the chronic RfD, 2) only applicable to sporadic applications of triclopyr, and is 2) only applicable to men, so these results will not be summarized here (see SERA 2011d for acute details). Overall, triclopyr TEA had a higher HQ values than BEE for ground application methods. Based on the chronic RfD of 1.0 mg/kg bw, central HQ values for workers applying the typical application arte of 1 lb. a.e./acre are below the level of concern for both triclopyr TEA and triclopyr BEE, for all ground application methods. The upper bound HQ values for all ground application methods at this rate, however, were above the level of concern for both TEA and BEE forms of triclopyr. When considering these upper bounds, HQ values of TEA range from 1.6 to 3, and BEE values 6 to 12 with the typical application rate (1 lb/acre). At the expected upper application rate (6.6 lbs/acre), upper HQ values for all ground application methods range from 11 to 20 for TEA; whereas equivalent values range from 41 to 78 for BEE.

Whether the HQ values exceed for public exposure scenarios depends on if the acute or chronic RfD is used, the application rate and the form of triclopyr being evaluated. The chronic RfD used for females (0.05 mg a.e./kg bw/day) results in HQ values 20 times higher than those for males calculated using the acute RfD value (1 mg a.e./kg bw/day). When based on the acute RfD of 1 mg/kg/day, accidental exposures of workers to formulations containing triclopyr TEA do not lead to HQs that exceed a level of concern. When using the chronic RfD of 0.05 mg/kg bw for women, none of the HQs for accidental scenarios for triclopyr TEA formulations exceed a level of concern at an application rate of 1 lb a.e./acre either. The highest HQ at 1 lb a.e./acre is 0.02 for male and 0.3 for female workers, which is associated with wearing contaminated gloves for 1 hour.

When the maximum application rate of 6.6 lbs a.e./acre is used, none of the accidental HQs reach a level of concern for male workers. The accidental scenarios for wearing contaminated gloves for 1 hour as well as 1-hour exposures resulting from spills onto the lower legs reach upper bound HQs of 0.1 for both scenarios, using the acute RfD of 1 mg a.e./kg bw/day. Using the RfD of 0.05 mg/kg bw/day for female workers results in an HQ of about 3 for both scenarios. For triclopyr BEE, the accidental exposure from wearing a contaminated glove for an hour results levels above concern when considered for male workers (acute RfD of 1 mg a.e./kg bw/day), with an upper HQ of about 8 at the typical rate, and an upper HQ of 50 at the 6.6 lbs a.e./acre. Based on triclopyr toxicology, HQs that approach or exceed a factor of 5 could be regarded as clearly unacceptable and possibly hazardous. The development of subclinical adverse effects cannot be ruled out.

Beyond quantitative levels of concern, one of the most likely exposures and risks for workers is from chemicals being splashed into eyes, as the chemical is moderately to severely damaging. This is an avoidable hazard, as long as workers wear eye protection while handling triclopyr.

Risks to the public associated with terrestrial applications of triclopyr TEA and triclopyr BEE are identical for many exposure scenarios. For exposure scenarios involving dermal absorption, the risks associated with triclopyr BEE formulations are only modestly greater than those for triclopyr TEA formulations. The only exposure scenarios of substantial concern involve the consumption of contaminated vegetation, and these risks do not differ between TEA and BEE formulations of triclopyr. Scenarios of concern involving exposures to TCP are also limited to the consumption of contaminated vegetation. The upper bound of the acute exposure scenario for the consumption of contaminated vegetation by a young woman is 27, exceeding the corresponding upper bounds for general exposures in workers applying triclopyr BEE based on the chronic RfD - i.e., HQs of 11 to 22.

Potential exposures to the TCP metabolite of triclopyr also exceed the level of concern at the upper bound of the HQs for both the acute and longer-term consumption of contaminated vegetation and fruit. For TCP, the upper bound of HQs for acute exposures is less than the upper bound of the HQs for longer-term exposures. For the central estimates and the lower bounds, the opposite pattern is apparent. While this may seem incongruous, the calculations are correct and reflect the interplay of the lower chronic RfD and the different half-lives used to estimate the longer-term time-weighted average doses.

The qualitative interpretation of the HQs for TCP is similar to that of the HQs for triclopyr. For TCP, the LOAEL associated with the acute RfD is a factor of 4 higher than the NOAEL on which the RfD is based. As with the discussion of the reproductive NOAELs and LOAELs for triclopyr, this ratio does not indicate that adverse reproductive effects would be predicted in humans at an acute HQ of 4; however, the relationship of the NOAELs to LOAELs in the animal studies does enhance concern for HQs in the range of 4. For TCP, the upper bound acute HQs range from 2 to 15.

As discussed above, exposure to triclopyr has resulted in adverse developmental effects in female mammals, which leads to concerns regarding reproduction and development in female humans. Such effects were only found with doses that also caused frank maternal toxicity in mammals. Concern is lessened because evidence of frank maternal toxicity or reproductive effects in humans was not found associated with the use of triclopyr.

The primary sensitive subgroups thought to be most susceptible to adverse effects from exposure to triclopyr include women of childbearing age and individuals with kidney disease. Women of child bearing age are thought to be of concern due to reproductive and developmental effects found in exposure studies using mammals. Despite the lack of epidemiological evidence, there is a certain level of uncertainty, regarding the possibility of triclopyr causing adverse reproductive effects. One Forest Service study demonstrated a marginal relationship between herbicide use and miscarriages in woman, which creates a level of uncertainty even though triclopyr was not specifically named as one of the herbicides. Current evidence suggests, however, that toxicity to a fetus would only occur at doses that also caused frank signs of maternal toxicity. Despite the years triclopyr has been used, this chemical has never been implicated in causing frank signals of toxicity in male or female humans. Regardless, the current Forest Service risk assessment interprets findings to mean that some woman may be exposed to triclopyr at levels that are of concern. Individuals with kidney disease may also be at greater susceptibility to adverse effects, since the kidneys are the target organ for triclopyr. Despite this concern, however, no evidence associates adverse effects towards people with kidney disease from exposure to triclopyr.

Connected actions of triclopyr are associated with exposure to the triclopyr metabolite 3,5,6-trichloro-2-pyridinol (TCP). Exposure to TCP is quantitatively considered throughout the human and ecological health sections of the Forest Service risk assessment. The U.S. EPA assessments consider all exposures to this compound as below the level of concern, although the Agency does not consider all oral exposures assessed in the Forest Service risk assessments, as discussed previously. Like many herbicides, adjuvants are commonly used with triclopyr and some may be hazardous, however, evaluation of each surfactant is beyond the scope of Forest Service risk assessments.

The cumulative effects associated with triclopyr may include those associated with any additive effects that could potentially result from mixing of triclopyr with other chemicals, as well as effects resulting from repeated exposures. The additive effects associated with mixing particular adjuvants with triclopyr are beyond the scope of the USDA/FS risk assessments. It should be noted, however, that triclopyr is a weak-acid auxin herbicide, and thus, when mixed with other similar weak acids that function by the same mechanisms, such as clopyralid, additive risks would result. Repeated exposure is a cumulative effect accounted for by the use of chronic exposure information in each Forest Service risk assessment.

D.3.2 ECOLOGICAL EFFECTS

D.3.2.1 Introduction

This ecological effects analysis mirrors the protocol used in SERA Risk Assessments (RAs) (SERA 1996a & b, 1997a & b, 1998a & b, 1999, 2003a & b, 2004a, b, & c, 2005, 2006i, 2010c, 2011d, e, & f) and is adapted primarily from those RAs. Information from SERA RAs is supplemented by other sources, including a U.S. Forest Service RA for NPE (USDA/FS 2003b) and for 2,4-D (USDA/FS 2006a), U.S. EPA RAs for NPE (U.S. EPA. 2010e & f), the U.S. EPA risk assessments for the California red-legged frog (U.S. EPA 2007b, 2008b & c, 2009d & e), the Alameda whipsnake (U.S. EPA 2009d), and endangered and threatened salmon and steelhead (U.S. EPA 2004).

As discussed above, the chemical active ingredients and formulations and surfactants likely to be used in the VTP and Alternatives and the parameters under which they will be used are well within the USFS programs for which the RAs were developed. To reiterate, chemicals will not be applied directly to water or riparian areas under the VTP and Alternatives and they will not be applied aerially.

As in the human health assessment, the SERA RAs assess ecological effects in four parts, as follow:

1. First, the hazards of specific chemical active ingredient formulations to terrestrial organisms (mammals, birds, invertebrates, microorganisms, and plants) and aquatic organisms (fish, amphibians and reptiles, invertebrates, and plants) are identified. Hazards are based on toxicities to surrogate species tested under controlled conditions. Testing on certain species groups, notably amphibians and reptiles, is generally inadequate or non-existent. For these species groups, tests are done on surrogate species, namely freshwater fish as a substitute for amphibians and birds as a substitute for reptiles.
2. Next, the potential for exposure to chemicals by terrestrial organisms (from direct spray, indirect contact, ingestion of contaminated vegetation or prey, and ingestion of contaminated water) and by aquatic organisms (from direct spray, off-site drift, runoff, contaminated irrigation water, and wind erosion) are assessed.
3. Then the effects (responses) on terrestrial and aquatic organisms (those tested for hazard identification) from potential doses of chemicals are assessed.
4. Finally, the risk of adverse effects is determined for the terrestrial and aquatic organisms tested for hazard identification.

For an in-depth discussion of how Syracuse Environmental Research Associates, Inc. (SERA) conducts ecological risk assessments, refer to “Preparation of Environmental Documentation and Risk Assessments for the USDA/Forest Service” (SERA 2012). The exposure assessments for ecological effects are conceptually similar to those conducted in the human health risk assessment, and for many terrestrial organisms the exposure assessments are parallel to those used in the human health risk assessment. Similarly, exposures of aquatic species are typically based on the same estimates of concentrations of the chemical in water that are used in the human health risk assessment.

The following from the SERA RA for hexazinone (SERA 2005, p. xviii) illustrates the uncertainty of ecological risk assessments in general, including the one in this Program EIR:

> *As with most ecological risk assessments, the characterization of risk for hexazinone is limited by the comparison of the available data to the number of species that might be exposed and the interactions that could occur among these species. Hexazinone has been tested in only a limited number of species and under conditions that may not well-represent natural populations of nontarget organisms. This leads to uncertainties that may result in underestimates or overestimates of risk. The methods and assumptions used in both the exposure and dose-response assessments are intended to consider these uncertainties by using protective assumptions in developing both the exposure and dose-response assessments which form the basis of the risk characterization.*

As is true for the human health risk assessment, it needs to be reiterated that absence of risk can never be demonstrated and absolute safety cannot be proven. Available data does not, however, indicate that significant adverse effects to populations of terrestrial and most aquatic sentient organisms are likely from most of the chemicals potentially used under the VTP and Alternatives.

D.3.2.2 Hazard (Toxicity) Identification

D.3.2.2.1 Introduction

As in the human health risk assessment, the results of various types of acute toxicity bioassays may be used to classify chemicals into various levels of toxicity, namely highly toxic to virtually nontoxic. As with the corresponding classification scheme for human health effects, acute toxicity is only used in the hazard identification to categorize chemicals and is not directly used in the risk characterization. To support pesticide registration, longer-term studies in most organisms are also required, typically for the active ingredient but not for chemical formulations.

D.3.2.2.2 Terrestrial Organisms

Toxicity data for terrestrial species from the most recent SERA RAs (SERA 2003a & b, 2004a, b, & c, 2005, 2006a, 2011b, c, d), U.S. Forest Service RA for NPE (USDA/FS 2003b) and for 2,4-D (USDA/FS 2006a), U.S. EPA RAs for NPE (U.S. EPA. 2010e & f), and/or U.S. EPA risk assessments for the Alameda whipsnake (U.S. EPA 2009d) is summarized in Table D.3-17. Detailed toxicity data for each terrestrial species group is included below in *Chemical-Specific Hazard (Toxicity) Identification* for each chemical analyzed in this Program EIR.

Mammals - As stated in the "Hazard Identification Overview" in SERA 2012, p. 76):

> *The hazard identification for wildlife mammals is usually based on the same information considered in the human health risk assessment, and this information is typically much more detailed than the information available on other groups because studies are often available on both lethal and sublethal effects. Data on the other groups is typically much less detailed. While information on sublethal effects is often available for some groups, much of the information consists of acute bioassays for lethality. This reflects a major conceptual difference between human health and ecological risk assessment. Human health risk assessment focuses on preventing the occurrence of any effect in any individual. Ecological risk assessment tends to focus on preventing adverse effects at the population level.*

Many of the pesticides used by the Forest Service, particularly the herbicides, are weak acids. Weak acids are often removed from the blood by the kidney, with eventual secretion in the urine. Part of this process involves active transport from the blood into kidney cells. This active transport process in dogs is much less active than the active transport process in primates and other mammals. Consequently, dogs are less able to eliminate weak acids and may be substantially more sensitive to weak acids than other mammals. Thus, in risk assessments on weak acids, any available information on the pharmacokinetics or toxicity of the compound in dogs relative to other mammalian species will be emphasized. If dogs appear to be more sensitive than other mammals, this may be considered further in the dose-response assessment and separate NOAEL or NOEC values may be derived for dogs and other canids. These values may then be used to characterize risks for other canid species that may be covered in the risk assessment – e.g., the consumption of a small mammal by a predator such as a coyote or wolf.

Birds - Information on the toxicity of pesticides to birds is typically much more limited than that for mammals. While some toxicity studies on birds may be available in the open literature, most of the information is usually from studies required specifically by the U.S. EPA for the registration of pesticides.

The acute studies, both oral and dietary, most commonly involve tests on mallard ducks and northern bobwhite quail. The acute oral study involves administration of a single dose and is observed for 14 days, although this period can be extended to 21days if mortality is seen. As with the mammalian oral study a limit test may be conducted at a single dose of 2,000 mg/kg. If no mortality occurs, the LD_{50} value may be expressed as >2,000 mg/kg and no additional testing is required. As with the mammalian studies, the risk assessment will distinguish this type of information from studies in which some, but less than 50%, mortality occurred at the maximum dose.

The avian acute dietary toxicity study is similar to the acute oral study in general design and test species. Occasionally, however, other species may be used such as pigeon, Japanese quail, ring-necked pheasant, and red-legged partridge. The chemical is administered in the standard diet for a period of 5-days, and is sometimes referred to as a 5-day dietary or 8-day dietary study, which can lead to some confusion if the duration of exposure is not clearly distinguished from the duration of observation. As with the acute oral study, the duration of observation can be increased up to 21 days if signs of toxicity are noted during the standard 3-day post-exposure observation period. Either the acute oral study or acute dietary study will often serve as the basis for an acute NOAEL or NOEC that is used in the dose-response assessment for birds.

Chronic studies in birds analogous to those conducted in mammals – i.e., studies that span a full or significant fraction of the life span of the animal – are almost never available. Typically, the consequences of longer-term exposure scenarios for birds are evaluated using the avian reproductive toxicity study. These studies are generally conducted on mallard ducks or bobwhite quail. After egg laying begins, the study is continued for an additional 8 to 10 weeks. During all three periods, dietary exposure is maintained and thus the total period of exposure is 16to 21 weeks.

Reptiles and Amphibians (Terrestrial-Phase) - Data on terrestrial phase amphibians and reptiles are typically sparse to non-existent. When data are available, the studies are assessed in a manner similar to that used for mammals and birds. Typically avian toxicity studies are substituted for those on amphibians. As stated in the U.S. EPA "Risks of 2,4-D Use to the Federally Threatened California Red-legged Frog (*Rana aurora draytonii*) and Alameda Whipsnake (*Masticophis lateralis euryxanthus*)" (U.S. EPA 2009d, p. 110): "[a]s *specified in the Overview Document, the Agency uses birds as a surrogate for reptiles and terrestrial-phase amphibians when toxicity data for each specific taxon are not available (U.S. EPA, 2004).*"

Terrestrial Invertebrates - There is substantial variability in the types of information that are available on terrestrial invertebrates. The U.S. EPA assumes that herbicides are generally not directly toxic to insects, so only requires relatively simple and standard bioassays: the honeybee acute contact toxicity, the honeybee toxicity of residues on foliage, and the earthworm subchronic toxicity test. Earthworms and honeybees comprise only a very small fraction of the terrestrial invertebrates. The acute contact toxicity study in honeybees is often the only kind of invertebrate toxicity study available on herbicides. This acute study is similar in design to acute toxicity studies conducted on mammals and birds, but involves direct application.

The earthworm toxicity test (OPPTS 850.6200) involves exposing a species of earthworm, typically *Eiseniafetida*, to various concentrations of the test compound in soil for a period of 28-days. The use of limit tests is not discussed in the OPPTS protocol. Range-finding studies are conducted as 0.1, 1.0, 10, 100, 1,000 mg/kg dry weight artificial soil.

Terrestrial Plants (Macrophytes) - The testing requirements for the effects of herbicides on terrestrial plants are relatively rigorous, since terrestrial vegetation is the usual target of herbicides. Studies on seedling emergence and vegetative vigor are the two basic types of bioassays that are covered and used in Forest Service risk assessments. Seedling emergence studies typically involve soil exposure and vegetative vigor studies typically involve direct spray. The former are used to characterize risk associated with soil contamination by runoff, and the latter are used to characterize risks associated with direct spray or spray drift.

Terrestrial Microorganisms - Studies on terrestrial microorganisms are not required for pesticide registration in the United States. Nevertheless, assays on microbial toxicity submitted directly to U.S. EPA for registration involve soil exposures, as these are directly relevant to the risk assessment. Many microbial toxicity studies in the open literature involve pure cultures of microorganisms in artificial media, such as agar or liquid culture. These types of assays are less directly relevant and are clearly distinguished from soil assays in the risk assessment.

Table D.3-17

Terrestrial Wildlife Acute Toxicity Summary

Herbicide	Sources	Mammals	Birds	Invertebrates
Boric Acid	SERA 2006a	moderately toxic	practically nontoxic	practically nontoxic
Borax (STD)	SERA 2006a	moderately toxic	practically nontoxic	practically nontoxic
Clopyralid	SERA 2004a; U.S. U.S. EPA 2009b	relatively nontoxic	slightly toxic	particularly nontoxic
Glyphosate	SERA 2011b	slightly toxic	practically nontoxic	practically nontoxic
Diammonium Salt	SERA 2011b	slightly toxic	practically nontoxic	practically nontoxic
Isoproplyamine Salt	SERA 2011b	slightly toxic	practically nontoxic	practically nontoxic
Potassium Salt	SERA 2011b	slightly toxic	practically nontoxic	practically nontoxic
Hexazinone	SERA 2005	slightly toxic	practically nontoxic	slightly to practically nontoxic (bees)
Imazapyr	SERA 2011c.	slightly toxic	slightly toxic	practically nontoxic (bees)
Sulfometuron-Methyl	SERA 2004c, U.S. EPA 2008a	slightly to practically nontoxic	slightly to practically nontoxic	practically nontoxic (bees)
Triclopyr Acid	SERA 2011d	slightly toxic	slightly to practically nontoxic	practically nontoxic (bees)
BEE	SERA 2011d	slightly toxic	practically nontoxic	practically nontoxic (bees)
TEA	SERA 2011d	slightly toxic	practically nontoxic	practically nontoxic (bees)
NP9E	USDA/FS 2003b; U.S. EPA 2010e & f	slightly to practically nontoxic	NA	NA

[1/] Toxicity ranges (from the most recent SERA, USDA Forest Service, and U.S. EPA RAs) are due to variable toxicities to different species in the same class. NA = no published data and/or no reliable data

D.3.2.2.3 Aquatic Organisms

Acute toxicity data for aquatic species from the most recent SERA RAs (SERA 2003a & b, 2004a, b, & c, 2005, 2006a, 2011b, c, d), U.S. Forest Service RA for NPE (USDA/FS 2003b) and for U.S. EPA RAs for NPE (U.S. EPA. 2010 e & f), and/or U.S. EPA risk assessments for the California red-legged frog (U.S. EPA 2007, 2008b & c, 2009d & e) and endangered and threatened salmon and steelhead (U.S. EPA 2004) is summarized in Table D.3-18. Detailed toxicity data for each aquatic species group is included below in *Chemical-Specific Hazard (Toxicity) Identification* for each chemical analyzed in this Program EIR.

Fish - Three general types of relatively standardized studies may be available on fish: acute toxicity studies; egg-and-fry studies, also referred to as early life-stage studies and full life cycle studies. To support pesticide registration, longer-term studies in fish and most other organisms are typically required for the active ingredient but are not required on pesticide formulations.

Freshwater species that are commonly used in acute assays preferred by the U.S. EPA include rainbow trout and bluegill sunfish. A large number of other freshwater and saltwater species may be used. The design of the acute toxicity bioassays is similar to the design of other acute toxicity bioassays. Range-finding studies as well as limit assays may be used. The common limit concentration is 1000 mg/L – if less than half of the fish die at a concentration of 1000 mg/L, further testing may not be required and the LC_{50} value may be reported as >1000 mg/L. In Forest Service risk assessments, NOEC and LOEC values are reported if available. The U.S. EPA will typically use an LC_{50} value for risk characterization while the Forest Service prefers to use an NOEC for sublethal effects.

Early life-stage studies in fish are analogous to mammalian teratology studies. The test involves exposing fertilized eggs to various concentrations of the chemical and maintaining the exposure until the fish are free-feeding. Freshwater species commonly used in this assay include rainbow trout, fathead minnow, zebra fish, and rice fish. The sheepshead minnow is the only saltwater species that is typically used. Results are typically reported as NOEC and LOEC values. While these studies are not true chronic studies, they are often the only longer-term study available on a presumably sensitive life-stage, and these studies often serve as the basis for the longer-term dose response assessment in fish.

Fish life cycle toxicity studies involve essentially egg-to-egg exposures. As with the early life-stage study, the life cycle study starts with fertilized eggs and continues throughout the life of the initial generation and continues until this generation produces eggs. This type of test is almost always conducted on either the fathead minnow (freshwater) or the sheepshead minnow (estuarine). When available, these tests are used for assessing the consequences of longer-term exposures unless egg-and-fry studies on other species appear to be more sensitive indicators of risk –i.e., have lower NOEC values.

Field studies that include observations on fish are occasionally available as well as mesocosm (e.g., littoral enclosure) studies. These studies are used to the extent possible as a check on the available laboratory toxicity studies. The general limitations on field studies apply to observations from field studies that involve fish. Better controlled mesocosm studies are generally more useful in assessing the relevance of standard laboratory studies to potential hazards in the field.

Amphibians (Aquatic-Phase) – The documented decline of amphibian populations worldwide has raised concerns that these species are being impacted by pesticides. Californians for Alternatives to Toxics has published a database (“Reptile, Amphibian and Pesticides”, aka RAP) (CATS 2006) of the most recent international research on the effects of pesticide use on amphibians and reptiles. The list includes over 320 scientific papers published since 1999 on the effects of pesticides on amphibians, as well as almost 130 research papers on the impacts of pesticides on reptiles. This list was reviewed and 11 citations were found specifically addressing three of the chemicals analyzed in this Program EIR (nine on glyphosate, one on sulfometuron methyl, and one on triclopyr). Some findings from these studies follow.

Amphibians appear to be especially vulnerable to pesticides as they readily absorb chemicals and are cutaneous breathers, breathing through their skin, as well as through a developed pair of lungs. It has been found that low levels of pesticides can cause fatal immune system suppression in amphibians (Davidson 2002). Field studies show that there are toxicological effects at much lower doses than in laboratory studies (Davidson 2004).

The “Complaint for Declaratory and Injunctive Relief” filed against the U.S. EPA and the U.S. FWS by the Center for Biological Diversity on October 19, 2011 in the U.S. District Court, Northern District of California, San Francisco Division (CBD v. U.S. EPA & U.S. FWS. 2011), asserts that the California red-legged frog (*Rana aurora draytonii*), California’s largest native frog, has lost more than 70 percent of its historic range. It is believed that the use of pesticides has significantly contributed to the decline of this federally threatened subspecies and continues to pose a hazard to it:

> *Because amphibians like the California red-legged frog respire through their permeable skin, [so] they are especially vulnerable to chemical contamination. Additionally, the California red-legged frog’s eggs float exposed on the water surface, where pesticides tend to concentrate. Once hatched, larvae live solely in aquatic environments for five to seven months before they metamorphose, making agricultural pesticides introduced into wetlands, ponds, and streams particularly harmful. (CBD v. U.S. EPA & U.S. FWS. 2011, p. 9)*

The “Complaint for Declaratory and Injunctive Relief” further states that

Pesticide contamination may cause deformities, depressed immune system functions, endocrine disruption, and death to the California red-legged frog, as well as impairment to the frog's swimming, predator avoidance, reproduction, or other key behaviors. Pesticides can also adversely affect the frog by impacting its food supplies and habitat. (ibid, p. 10)

Due to their sensitivity to chemical contaminants, California red-legged frogs are a strong barometer for the health of California's human residents. Ultimately, the pesticides found in the frogs' habitat also migrate into Californians' drinking water, food, homes, and schools, posing a disturbing health risk. (ibid)

The "Complaint for Declaratory and Injunctive Relief" requests the court to order the completion of interagency consultations between the U.S. EPA and the U.S. FWS on the effects of 64 pesticides on the federally listed California red-legged frog, including five of the herbicides proposed for use in the VTP and Alternatives (2,4-D, glyphosate, hexazinone, imazapyr, and triclopyr) and one (atrazine) that might be used off-Program. Until the consultation process has been completed, it requests the Court to order restrictions on, or prohibit use of, the 64 identified pesticides where they may affect the California red-legged frog or its habitats.

Battaglin and Fairchild (2002) found that:

There has been relatively little research directed at determining the risk of environmental mixtures of pesticides to non-target aquatic organisms. This research gap is due to several factors: (1) the difficulties arising from weather and the timing and rate of application in estimating exposures of organisms to various chemicals; and (2) the expense of conducting toxicity tests on the myriad of potential pesticides (and nutrient) mixtures found in the environment.

"Environmental mixtures", as used in the above quote, are the combinations of pesticide(s) and chemicals in the environment, including nutrients.

Amphibians (e.g., frogs, salamanders, and toads) are cold-blooded animals that spend time both on land and in water, but breeding and development typically occur in water. Although the amount of information on the toxicity of pesticides to amphibians is increasing, very little toxicity data are generally available on amphibians compared to other aquatic species. The most commonly available study is the Frog Embryo Teratogenesis Assay – Xenopus (FETAX) bioassay. This study typically involves exposing frog embryos to the test chemical for a 96 hour period. The study is similar in design to acute toxicity study in fish in terms of the number of concentrations and reporting of results. The endpoints include observations of mortality as well as malformations.

Testing of certain species groups, notably amphibians (especially terrestrial adults) and reptiles, is inadequate or non-existent for most chemicals. As stated in the U.S. EPA "Risks of 2,4-D Use to the Federally Threatened California Red-legged Frog (*Rana aurora draytonii*) and Alameda Whipsnake (*Masticophis lateralis euryxanthus*)" (U.S. EPA 2009d, p. 104):

> *Although several registrant-submitted and ECOTOX studies evaluating the acute toxicity to aquatic-phase amphibians were reviewed, EFED [Environmental Fate and Effects Division] determined that the use of freshwater fish data is preferable to the use of aquatic-phase amphibian data because it is unknown where the CRLF would fall on a species sensitivity distribution. Because amphibian data is not required from the registrant, it is EFED's standard approach to use freshwater fish as a surrogate for aquatic-phase amphibians. In addition, because acute amphibian data were less sensitive than acute freshwater fish data, the use of freshwater fish as a surrogate provides a more conservative estimation of risk to the aquatic-phase CRLF. Chronic aquatic-phase amphibian toxicity data were not available.*

Because of the relative scarcity of data available on toxic effects to amphibians and the high level of concern with effects on amphibians, any available information on effects to amphibians are typically reviewed in some detail. If the data are sufficient, these data are used in the dose-response assessment.

Aquatic Invertebrates - Many aquatic invertebrates are relatively simple organisms to culture and test in aquatic toxicity studies, and standard acute toxicity protocols from U.S. EPA are available on a number of invertebrate species. These tests are similar in design to acute toxicity studies in fish, although some may involve somewhat shorter periods of exposure – e.g., the daphnid study typically only lasts for 48 hours. Acute toxicity studies will often be available in the open literature as well and may be conducted on a large number of different species, although the overall designs of most studies are similar to those (and often follow) standard protocols from either the U.S. EPA. Chronic studies on invertebrates are generally limited to daphnids or mysid shrimp. These are true chronic studies. The chronic daphnid study is typically the only study available on the chronic toxicity of a pesticide to freshwater invertebrates.

Aquatic Plants - Aquatic plants comprise both macrophytes (large multicelluar plants) and algae (microscopic plants). Bioassays in aquatic algae typically involve freshwater green alga, a freshwater diatom, amarine diatom, and a blue-green alga or cyanobacterium. The duration of exposure for algae is typically 48-hours. Bioassays on macrophytes typically use a species of duck weed and the duration for duckweed assays is typically 7-days to 14-days. Both types of studies measure growth (either as cell count, gross weight or length, or frond count) and express results as effective concentrations (e.g., EC50) rather than lethal concentrations. As with most other types of bioassays, the studies often report NOEC and

LOEC values, and NOEC values are typically used in the dose-response assessment. Field studies may be relatively abundant for some herbicides, particularly for those that are intended for aquatic weed control. These studies may be directly useful in the dose-response assessment as long as concentrations in water are reported and can be associated with NOAECs or LOAECs.

Table D.3-18

Aquatic Organism Acute Toxicity Summary

Herbicide	Sources	Aquatic Invertebrates	Fish	Amphibians
Boric Acid	SERA 2006a	practically nontoxic	practically nontoxic	practically nontoxic
Borax (STD)	SERA 2006a	practically nontoxic	practically nontoxic	practically nontoxic
Clopyralid	SERA 2004a	practically nontoxic	practically nontoxic	no data
Glyphosate [2/]	SERA 2011b; U.S. EPA 2004, 2008b	practically nontoxic	slightly to practically nontoxic	(slightly to practically nontoxic) [1/] [3/]
Diammonium Salt	SERA 2011b; U.S. EPA 2004, 2008b	practically nontoxic	slightly to practically nontoxic	(slightly to practically nontoxic)
Isoproplyamine Salt	SERA 2011b; U.S. EPA 2004, 2008b	practically nontoxic	slightly to practically nontoxic	(practically nontoxic)
Potassium Salt	SERA 2011b; U.S. EPA 2004, 2008b	practically nontoxic	slightly to practically nontoxic	(slightly to practically nontoxic)
Hexazinone	SERA 2005; U.S. EPA 2008c	practically nontoxic	practically nontoxic	no data
Imazapyr	SERA 2011c; U.S. EPA 2007b	practically nontoxic	practically nontoxic	no data
Sulfometuron-Methyl	SERA 2004c; U.S. EPA 2008a	slightly to practically nontoxic[1/]	slightly to practically nontoxic [1/]	(toxic) [3/]
Triclopyr Acid	SERA 2011d; U.S. EPA 2009e	(toxic) (~90X less than BEE)	(toxic) (~250X less than BEE)	(toxic) (~30X less sensitive than BEE)
BEE	SERA 2011d; U.S. EPA 2009e	highly toxic	highly toxic	(highly toxic)

		(~140X more than TEA)	(~240X more than TEA)	(~4X less sensitive than for fish) [6/]
TEA	SERA 2011d; U.S. EPA 2009e	toxic	(toxic)	(toxic)
NP9E [4/]	USDA/FS 2003b; U.S. EPA 2010e & f	(slightly toxic) [5/]	(slightly toxic) [5/]	(slightly toxic) [5/]

[1/] Toxicity ranges are due to variable toxicities for different species in the same class. [2/] Some formulations contain surfactants that have been shown to be moderately toxic to fish and other aquatic organisms; [3/](toxic) Toxicity characterizations in parentheses are based upon limited data; [4/] Toxicity is variable, depending on species; [5/] Toxicity is 100X less than for NP, one of the "highly toxic" parent compounds. [6/]This is for triclopyr BEE formulations. No data are available on the toxicity of unformulated triclopyr BEE in amphibians.

D.3.2.2.4 Chemical-Specific Hazard (Toxicity) Identification

D.3.2.2.4.1 Borax (Sources: FS WSM ver. 6.00.10; SERA 2006a)

Under conditions typically found in the environment, borate salts are rapidly converted to boric acid. Since organisms are primarily exposed to boric acid in most surface waters and at physiologic pHs, information on boric acid is used as surrogate data in this risk assessment and data are expressed in terms of the dose or concentration of borate compound (borax or boric acid) and in terms of boron equivalents (B), to facilitate comparisons between borax and boric acid.

Mammals - Although the mode of action of borax and other borate salts in mammals is not well understood, based on the results of acute exposure studies, borax is classified as *moderately toxic* to mammals. However, the Sporax® form of borax can cause severe, irreversible eye damage to the eyes of terrestrial organisms.

Developmental studies show that the developing fetus is the primary target for borate-induced toxicity. Gestational exposure of rats, mice, and rabbits to boric acid resulted in increased fetal deaths and malformations and decreased fetal weight.

Subchronic and chronic dietary exposure studies in adult rats and dogs show that at higher exposure levels adverse testicular effects and infertility can persist for at least 8 months, although at lower exposure levels testicular effects and infertility may be reversed.

Birds - Although acute single and dietary exposure studies have been conducted on borax and boric acid in standard avian test species, only limited information is available on either acute or chronic effects.

Acute exposure studies of borax show that it is *practically non-toxic* to birds, with no significant clinical signs of toxicity at dietary concentrations up to 5000 ppm borax (567 ppm B equivalent to 567 mg B/kg diet). No chronic exposure studies (21-week studies) on borax or boric acid using standard test avian species were identified. It appears that longer-term dietary exposure to boron compounds results in adverse reproductive effects in avian species.

Reptiles and Amphibians (Terrestrial-Phase) - No acute or chronic toxicity studies were found for reptiles or terrestrial-phase amphibians.

Terrestrial Invertebrates - No studies on the acute or chronic effects of borax in terrestrial invertebrates were identified in the available literature. A single study on the effects of acute topical exposure of honeybees to boric acid showed that boric acid is *practically non-toxic* to honey bees. However, borax is used in the control of termites, ants and house flies, so toxic effects may occur in other insects.

Terrestrial Plants (Macrophytes) - Although boron is an essential trace element for terrestrial plants, the amount of boron required for optimal growth and development varies widely between species and even between strains of the same species. Excess boron can lead to the development of phytotoxicity and the amount of boron required for optimal growth and the amount that is phytotoxic can be within a narrow range for some species.

There are many studies evaluating the phytotoxicity of boron compounds, but few provide data that are useful in a quantitative assessment of the risk of boron toxicity. Data are available for only a limited number of domestic plants. According to the product label for

Sporax (Wilbur-Ellis Company, no date), borax spilled or applied to crops may retard plant growth or kill plants. The label does not specify which plants species are at greatest risk for borax-induced phytotoxicity.

Terrestrial Microorganisms - Boron is apparently not an essential nutrient for soil microorganisms. A study of soil treated with borax showed no effect on total soil counts of actinomyces, fungi, protozoa and bacteria involved in nitrification. Although data needed to provide an adequate assessment of the effects of borax in nontarget microorganisms is unavailable, given the effectiveness of borax in the control of annosum root disease, it is likely that borax will have effects on nontarget microorganisms.

Fish - There is limited information available on the effects of acute borax exposure in fish. However, since borax is converted to boric acid in water, studies on boric acid can be used. Based on these studies, the U.S. EPA classifies borax as *practically nontoxic* to fish.

Acute exposure studies on borax using rainbow trout and western mosquito fish resulted in 48-hour LC_{50} values for rainbow trout of LC_{50} = 387 mg B/L and for mosquito fish LC_{50} = 930 mg B/L. Data is also available for acute exposure to boric acid in bluegill sunfish, rainbow trout, Colorado squawfish, razorback sucker, bonytail, and young salmon fry. Razorback sucker fry appear to be the most sensitive to acute boron exposure (96-hour LC_{50} of 233 mg B/L) and rainbow trout appear to be the most tolerant species (96-hour LC_{50} >1100 mg B/L).

A single open literature publication reported longer-term toxicity studies on borax that were conducted using rainbow trout, channel catfish, and goldfish. The studies show a similar degree of sensitivity for the three species tested, with the lowest estimated NOAEC (for mortality) of 0.5 ppm B for goldfish and the highest estimated NOAEC (for mortality) of 1.0 ppm B for rainbow trout and channel catfish. The relative tolerance to borax of the different species cannot be determined, as different exposure times were used for each of the three species tested (up to 28 days for trout, 9 days for catfish, and 7 days for goldfish).

Amphibians (Aquatic Phase) - Although very little information is available on the effects of borax to amphibians, boric acid and borax appear to be *practically nontoxic* to amphibians.

As stated in SERA 2006a (p. 4-6):

> *A single study in larval leopard frogs exposed to borax for 7.5 days reports an LC_{50} of 47 ppm B, with an estimated NOAEC (for mortality) of 1.0 ppm B and an estimated LOAEC (for mortality) of 5.0 ppm B (Birge and Black 1977). Thus, toxicity of borax to leopard frogs appears to be relatively low. Results of a study in wood frog, Jefferson salamander, spotted salamander, and American toad show that boron concentrations of 50 and 100 mg B/L caused a dose-related decrease in proportion of eggs hatching in American toad, while hatching was unaffected in the other three species (Laposata and Dunson 1998). In this same study, a dose-dependent increase in proportion of deformed larvae was observed in wood frog, Jefferson salamander, and spotted salamander (not assessed in American toad)*

Aquatic Invertebrates - Although the “confidential business information” literature did not include standard bioassays of the acute or chronic toxicity of borax or boric acid to aquatic invertebrates, some studies are available in the open literature.

Results of acute toxicity studies in *Daphnia magna* to borax and boric acid show similar LC_{50} values for borax (48-hour LC_{50} = 141 mg B/L) and boric acid (48-hour LC_{50} = 133 mg B/L). Another study indicates that the larval freshwater midge *Chironomus decorus* is more tolerant than daphnids to acute boron exposure, with a 48-hour LC_{50} value of 1376 mg B/L

Two chronic toxicity studies in daphnids conducted with boric acid reported similar results. The lowest 21-day LC_{50} value reported is 52.2 mg B/L. The lowest NOAEC value reported for reproductive parameters is 6 mg B/L, with a LOAEC for reproductive parameters of 13 mg B/L.

Aquatic Plants - Although no studies on the effects of borax in aquatic macrophytes were identified in the available literature, there are a few studies on the effects of boric acid. Short-term exposure studies were conducted with boric acid in water milfoil, water buttercup, and waterweed, with similar LC_{50} values reported for all three plant species (water milfoil and waterweed: 5 mg B/L; water buttercup 10 mg B/L).

A chronic exposure study of boric acid in common reed *(Phragmites australis*) reported a 2-3 month NOAEC of 8 mg B/L and a 2-year NOAEC of 4 mg B/L.

In algae, the 72-hour LC_{50} values for exposure to boron reported for *Scenedesmus subpicatus* range from 34 mg B/L to 52 mg B/L and the 72-hour NOAEC values range from 10 mg B/L to 24 mg B/L, with similar NOAEC values reported for *Scenedesmus quadricauda* and *Microcystis aeruginosa*.

Data reviewed by the WHO on the effects of boron exposure to several species of non-algal aquatic microorganisms reported 72-hour NOAEC values ranging from 0.3 mg B/L in *Entosiphon sulfacum*, a flagellate, to 291 mg B/L in *Pseudomonas putida*.

D.3.2.2.4.2 Clopyralid (Sources: FS WSM ver. 6.00.07 & 6.00.10; SERA 2004a)

As stated in SERA 2004a:

> *The toxicity of clopyralid is relatively well characterized in experimental mammals but few wildlife species have been assayed relative to the large number of non-target species that might be potentially affected by the use of clopyralid. Within this admittedly substantial reservation, clopyralid appears to be relatively non-toxic to aquatic animals. Thus, the potential for substantial effects on non-target species appears to be remote.*

As with terrestrial species, the available data on aquatic species, both plants and animals, suggest that clopyralid is relatively non-toxic.

Mammals - How clopyralid causes toxicity in mammals has not been determined. No consistent toxic effect or set of toxic effects to an organ or an organ system has been attributed to clopyralid.

The toxicity of clopyralid is relatively well characterized in experimental mammals (rats, mice, rabbits, and dogs) and appears to be relatively non-toxic, although it is likely to be more toxic to dogs. Although few wildlife species have been assayed relative to the large number of non-target species that might be potentially affected, the potential for substantial effects on non-target species appears to be remote.

Birds - Most of the acute toxicity studies of clopyralid involve dietary administration over short periods of time (i.e., 5 days) using mallard ducks and bobwhite quail. These studies suggest that the dietary LC_{50} values for both clopyralid and the monoethanolamine salt of clopyralid are above 6000 ppm.

A study of direct spray of bobwhite quail eggs at up to 0.56 kg a.e./ha (0.50 lb a.e./acre) caused no gross effects (i.e., viability, hatchability, body weight) and no effects on immune function (humoral or cell-mediated) in chicks. In California the maximum allowable application rate for clopyralid is 0.25 lb a.e./acre, well under the quantity applied in the study. Clopyralid is considered only slightly toxic to birds.

Reptiles and Amphibians (Terrestrial-Phase) - No acute or chronic toxicity studies were found for reptiles or terrestrial-phase amphibians.

Terrestrial Invertebrates - Clopyralid is *practically nontoxic* to bees and other invertebrates tested.

In several studies involving oral and direct contact exposure to honeybees, no significant increase in mortality was noted at doses of up to 0.1 mg/bee.

Based on a large series of bioassays and field trials of Lontrel 100, a formulation of clopyralid that is no longer marketed commercially, clopyralid was classified as *harmless* (less than 30% mortality) to 14 insect parasites and 17 predatory mites in contact bioassays. It was classified as *slightly harmful* (25-50% mortality) to *Semiadalia 11-notata* (Coccinellidae), *Anthocoris nemoralis* (Anthocoridae), and *Chryosperla carnea* (Chrysopidae). A 2002 study of direct application effects of Lontrel on spiders reported an acute (96-hour) mortality of less than 10%.

Based on the results of a static bioassay on earthworms, the soil LC_{50} of clopyralid to earthworms is greater than 1000 ppm soil.

Terrestrial Plants (Macrophytes) - The toxicity of clopyralid to terrestrial plants has been examined in substantial detail. Because clopyralid is rapidly absorbed across leaf surfaces but much less readily absorbed by roots, it is much more toxic in post-emergent treatments (i.e., foliar applications) than in pre-emergent treatments (i.e., application to soil). Clopyralid appears to be highly selective in its toxicity to terrestrial plants, being highly toxic to broadleaf plants but relatively non-toxic to grasses or grains. The potential for substantial effects on non-target species appears to be remote.

An 8-year follow-up study of plots treated with Stinger, which like Transline contains the monoethanolamine salt of clopyralid, at a rate of 0.28 kg a.e./ha (0.25 lb a.e./acre) (by backpack sprayer for the control of spotted knapweed (*Centaurea maculosa*) showed no substantial or statistically significant effect on species diversity or species richness in plants. Some plant families, such as *Asteraceae* and *Fabaceae*, were impacted. Clopyralid was not detected in soil below 25 cm (9.8 inches). In California the maximum allowable application rate for clopyralid is 0.25 lb a.e./acre, the same as applied in the study.

Terrestrial Microorganisms - What little information is available on the toxicity of clopyralid to terrestrial microorganisms appears to support that there are little to no toxic effects.

Fish - Only standard 96-hour acute toxicity bioassays are available for fish. The lowest reported LC_{50} for clopyralid is 103 mg a.e./L in trout. The monoethanolamine salt of clopyralid appears to be substantially less toxic than technical clopyralid, with 96-hour LC_{50} values in the range of 2000 mg a.i./L to 4700 mg a.i./L (equivalent to 700–1645 mg a.e./L).

No chronic toxicity studies on the toxicity of clopyralid to fish eggs or fry have been done for clopyralid, but such studies done for daphnids indicate that clopyralid is *practically nontoxic* to fish.

Amphibians (Aquatic Phase) - No acute or chronic toxicity data for amphibians was found in either U.S. EPA files or published literature.

Aquatic Invertebrates - *Daphnia magna* (water flea) is the only species of aquatic invertebrate on which toxicity data are available. The lowest reported acute toxicity LC_{50} for technical clopyralid is 225 mg/L (208–245 mg/L), about 2 times higher than the lowest reported LC_{50} in fish. Unlike with fish, the monoethanolamine salt appears to only marginally reduce the toxicity of clopyralid (LC_{50} of 350 mg a.e./L for the salt and 225 mg a.e./L for the acid).

A standard chronic reproduction bioassay conducted in *Daphnia magna* using the monoethanolamine salt resulted in a NOEC of 66 mg a.i./L (equivalent to 23.1 mg a.e./L).

Aquatic Plants - The available data on aquatic plants suggest that clopyralid is relatively non-toxic.

As might be expected, aquatic macrophytes are more sensitive to clopyralid than fish or aquatic invertebrates. The EC_{50} for growth inhibition in duckweed is 89 mg/L. At lower concentrations, in the range of 0.01 to 0.1 mg/L, growth of other aquatic macrophytes is stimulated. The lowest reported EC_{50} for growth inhibition of green algae is 6.9 mg/L.

There are no published or unpublished data regarding the toxicity of clopyralid to aquatic bacteria or fungi.

D.3.2.2.4.3 Glyphosate (Sources: FS WSM v. 6.00.10; SERA 2003a, 2011b; U.S. EPA. 2009c)

Relatively complete sets of studies are available in birds, terrestrial-phase amphibians, and terrestrial invertebrates, plants, and microorganisms for technical grade glyphosate and some formulations (Roundup and Rodeo) used in the United States.

The U.S. EPA has done an extensive review of toxicity of glyphosate to aquatic organisms. Relatively complete sets of studies are available aquatic organisms for technical grade glyphosate and some formulations (Roundup and Rodeo) used in the United States. The toxicity of the original Roundup and other formulations containing the surfactant POEA is far greater than technical grade glyphosate, Rodeo, and other formulations that do not contain POEA. Fish, amphibians, and aquatic invertebrates are about equally sensitive to technical grade glyphosate and some formulations.

Mammals - There is a large body of studies, including those published and those required by the U.S. EPA for pesticide registration, on the effects in test mammals of glyphosate and its formulations. There is less information on the toxicity of glyphosate or its formulations to wildlife and domestic mammals. Glyphosate is considered *slightly toxic* to mammals.

In terms of acute toxicity, there seems to be little difference in toxicity between tested species. Studies have resulted in intrperitoneal LD_{50} values for deer mice, chipmunks, shrews, and voles for glyphosate IPA in the range of 800 to 1370 mg/ kw bw and 1100 mg/ kw bw for lab mice. The LD_{50} for Roundup in rats is approximately 5400 mg/ kw bw, similar to that for humans.

Based on two developmental studies of 2-week sublethal dosing of rabbits and rats with glyphosate and glyphosate formulations, it is thought that larger mammals may be more sensitive than small mammals, as the NOAEL for rabbits (100 mg/kg bw/day) was a factor of 10 less than that for rats (1000 mg/kg bw/day).

An unpublished repeated-dose study (over 7 days) indicates that cattle may be more susceptible to Roundup than rats, as some cattle died at doses of 790 mg/kg bw/day and others exhibited additional signs of toxicity (including diarrhea and decreased food intake) at doses of 500, 630, and 790 mg/kg bw/day. No adverse effects were noted at 400 mg/kg bw/day, equivalent to 160 mg a.e./kg bw.

Decreased food consumption and body weight gain in experimental mammals, including three wildlife species, exposed to high dietary concentrations of glyphosate indicates toxicity, taste aversion, or a combination of these two. However, studies of exposure by dermal, gavage, or drinking water support that toxicity may be the dominant factor.

Most field studies on the effects of applications of glyphosate formulations show no adverse effects to populations of mammalian species. Following application of about 2.7 lb a.e./acre of Roundup, reproduction of deer mice and voles was comparable or better over a 3-year period on the treated site than on the untreated control site.

Birds - The U.S. EPA classifies technical grade glyphosate as *practically nontoxic* to birds. This is based on an acute gavage study in bobwhite quail that determined an LD_{50} of >2000 mg/kg bw. Additional gavage LD_{50} values range from 1130 mg/kg bw for the monoammonium salt of glyphosate to >3190 mg/kg bw for an unspecified salt. No adverse effects were seen in reproduction studies on mallard ducks or bobwhite quail at dietary concentrations up to 833 ppm.

Two acute dietary studies of Roundup PRO (41% glyphosate IPA and 14.5% POEA) determined NOAELs of 1760 ppm a.e., which is not considered highly toxic to birds.

In two open literature dietary studies on Roundup, one 7-day and one 21-day, at doses of 5000 mg a.e. zebra finches experienced substantial weight loss (20-60% over controls) and all died after 7 days and chickens lost 45% of their weight compared to controls at doses of 4500 mg a.e. No adverse effects were noted at lower doses in either study.

There are no standard reproduction tests for Roundup formulations. Two studies where eggs were immersed in a solution of Roundup for 5-30 seconds suggest that it is not likely to cause developmental effects in chicks.

Reptiles and Amphibians (Terrestrial-Phase) - No acute or chronic toxicity studies were found for reptiles.

There is little information on the toxicity of technical grade glyphosate to terrestrial-phase amphibians. Based on intraperitoneal studies on several species of amphibians, LD_{50} values for glyphosate IPA range from 790 to 925 mg a.e./kg bw. This is similar to several species of small mammals.

Direct spray of amphibians is of concern, as frog skin is 26 times as permeable as pig skin to glyphosate acid. The results of two direct spray studies are inconsistent. In one study, species of tree and wood frogs and a toad were sprayed with Roundup Weed and Grass Killer at a rate of about 0.011 lb a.e./acre, with >50% mortality after 24 hours. This is inconsistent with the findings of all of the following studies. In the other study, three glyphosate formulations (one being Roundup WeatherMax) were applied to two toad species at a rate of 15 lbs a.e./acre, with no significant mortality.

In a lab bioassay of newly metamorphosed frogs misted with Vision (41% glyphosate IPA and a POEA surfactant) at a rate of 1.6 lbs a.e./acre, there was no mortality.

In a series of mesocosm studies in which Glyphos (with the adjuvant Cosmo-Flux) was applied at a rate of about 1.7-26 lbs a.e./acre, functional NOEC values ranged from ~0.3-6.3 lb a.e./acre. Substantial mortality would not be expected with application rates in the range of about 1-2 lb a.e./acre and some species would be tolerant of much higher application rates.

A study involving aerial application of glyphosate (formulation and units unspecified) to clearcuts at a rate of 1.2 lbs/acre resulted in no adverse effects (based on capture rates) on six species of amphibians (rough-skin newt, ensatina, Pacific giant salamander, Dunn's salamander, western redback salamander, and red-legged frog), as compared with controls.

In a study where newts were given an introperitoneal dose of glyphosate IPA at a rate of 50mg/kg bw and then released, the movements of the dosed animals did not differ substantially from that of the controls.

Terrestrial Invertebrates - There is a standard set of tests of glyphosate on the honeybee, as well as studies on earthworms, isopods, snails, spiders, butterflies, and other arthropods. Glyphosate appears to be *practically nontoxic* to bees and other invertebrates tested.

Standard oral and contact bioassays have determined a LD_{50} for honeybees of >100 µg/bee. The NOEC for Roundup PRO is also 100 µg.

Glyphosate IPA was ineffective as an insecticide in controlling spider mites at application rates of 0.593-4.74 mg a.i./leaf, based on mortality to eggs, larva, nymphs, and adults. A series of lab and field studies of the effects of glyphosate on the spider *Lepthyphantes tenuis* resulted in low mortality rates.

Two acute dietary studies of an Argentinean formulation of glyphosate IPA (Glifoglex 48), one with spiders and one with lacewings, at a rate of 192 mg a.e./L resulted in adverse effects in the spiders in food consumption, web building, and reproductive capacity. In the lacewings there was increased mortality, reduced reproductive capacity, and malformed offspring.

While data on other arthropods is less detailed, it appears to indicate that there is a low potential for direct adverse effects from exposure to glyphosate. The soil LC_{50} of glyphosate for a common Libyan earthworm is 177-246 mg/kg soil dry weight over 8-37 days of exposure. In a 14-day dietary study, there was no mortality to the Brown garden snail (*Helix aspersa*) exposed to glyphosate at a rate of 1500 mg/kg bw.

Terrestrial Plants (Macrophytes) - There are toxicity studies on vegetative vigor for both technical grade glyphosate IPA and glyphosate formulations and on seedling emergence for glyphosate formulations.

Glyphosate is much less toxic to plants when they are exposed through soil than when exposed through foliage, probably because glyphosate binds tightly to some types of soil. Soil application rates of 4-5 lbs a.e./acre for three formulations of glyphosate were relatively nontoxic to seedlings. Foliar applications of glyphosate IPA resulted in NOAEC values for monocots of 0.56-0.70 lb a.e./acre and values for dicots of 0.035-0.46 lb a.e./acre. Studies on a wetable powder formulation of glyphosate gave a similar relationship between NOAEC values (monocots 0.07-0.45 lb a.e./acre, dicots 0.02-0.45lb a.e./acre).

Several spray drift studies have been conducted. In one, transient (30-day) damage to soybeans occurred at a spray deposition concentration of 0.03 lb/acre (1/33 of the application rate of 1.121 kg/ha), but did not affect yield at harvest time. Grapes only experienced damage at deposition concentrations of 1/3 the application rate. A grass and a dicot experienced substantial damage at a spray deposition concentration of 1.8 lbs/acre. Canola, smartweed, soybeans, and sunflowers experienced no marked effects at a deposition concentration of 0.003 lb/acre (1/125 of the application rate).

A study determined that some bryophytes and fungi may be sensitive to long-term exposure to glyphosate. The EC_{50} value for a decrease in abundance two years after exposure was 0.7 lb/acre and the decrease was apparent six weeks after the application.

Terrestrial Microorganisms - A substantial body of information indicates that glyphosate is likely to enhance or have no effect on soil microorganisms, with little information indicating adverse effects under field conditions. However, under laboratory conditions, a number of studies indicate adverse effects. At high concentrations (845-3380 mg/L) glyphosate might inhibit growth in soil algae and cyanobacteria, although other studies show no inhibitory effects on fungi and only slight effects on some species of bacteria at more realistic concentrations (2-20 ppm). Another study resulted in direct toxicity to soil fungi in a culture medium at concentrations of 10 ppm or greater. Apparently glyphosate acid is the least inhibitory, followed by glyphosate IPA and Roundup.

Field applications of glyphosate resulted in only a short-term (2 month) decrease in fungal and bacterial counts at an application rate of 0.54 kg/ha, no effect on soil fungi or bacteria after 10-14 months after an application of 3.23 kg/ha, and only a transient decrease in soil microbial activity after an application of 5 kg/ha.

Fish - The U.S. EPA classifies glyphosate acid and glyphosate IPA as *slightly toxic* (LC_{50} >10-100 mg/L) to *practically nontoxic* (LC_{50} >100 mg/L) to fish. One study found two LC_{50} values of 10 mg a.e./L, but these appear to be related to the pH of the water, with LC_{50} values decreasing (toxicity increases) as water pH decreases (becomes more acidic). Although this acute toxicity study in five species of fish in five different types of water spans a range from 24 to 96 hours, in many of the bioassays most of the fish died on the first day, so 24-hour and 96-hour LC_{50} values are the same, or only marginally different.

The same study found that the acidity of water has a much greater effect on the toxicity of glyphosate to fish than does the variability of sensitivity between species (relatively minor at the same pH). Coho salmon were the least sensitive species to pH variance, with LC_{50s} of 27 mg a.e./L at a pH of 6.3 and 174 mg a.e./L at a pH of 8.2, differing by a factor of 6. Rainbow trout were the most sensitive species, with LC_{50s} of 10 mg a.e./L at a pH of 6.3 and 197 mg a.e./L at a pH of 8.2, differing by a factor of 20.

As the temperature of water increases there is a corresponding increase in the toxicity of Roundup. An increase of 10° C resulted in a decrease in the LC_{50} by a factor of 2 in rainbow trout and bluegill sunfish. As might be expected, smaller fingerlings and fry were more susceptible to changes in temperature than larger fingerlings or eggs.

Most acute toxicity studies require fish not to be fed (i.e., fasted) before (for 48 hours) and during the bioassay. A 96-hour bioassay would require fish to fast for 6 days. In a study of flagfish that were both fasted and fed, fasting increased the toxicity of glyphosate to 8-day old flagfish by a factor of 10 (LC_{50s} of 2.94 mg a.e./L for fed fish and 29.6 mg a.e./L for fasted fish).

In a 12-hour field simulation study, rainbow trout were exposed to either glyphosate IPA or Roundup at concentrations of 0.02, 0.2, or 2 mg/L, equivalent for IPA salt of 0.015, 0.15, and 1.5 mg a.e./L and for Roundup of 0.006, 0.06, and 0.6 mg a.e./L. Following exposure the trout were held for 30 days in uncontaminated water, showing no adverse effects, based on gonadal weight in males and the number of eggs per female.

Most of the extensive studies on glyphosate formulations have been done on Roundup. Earlier studies were mostly done on Monsanto's Roundup (41% aqueous solution glyphosate IPA, 15% POEA surfactant). For glyphosate formulations with POEA and for POEA itself, toxicity to fish increases with increasing pH (alkalinity), although increases in toxicity are modest. For five species of salmonids, over a range of pHs from 6.3 to 8.2, the range of 96-hour LC_{50s} was about 2 to 3 (6 to 20 for glyphosate). The increase in toxicity of glyphosate formulations with increasing pH is due to the effects on the surfactant POEA, as the glyphosate itself decreases in toxicity.

Various studies have reported a range of LC_{50} values for Roundup formulations (those used in the U.S.), which contain, or appear to contain the POEA surfactant, of 1-10 mg a.e./L. The toxicity of Vision, a glyphosate formulation equivalent to Roundup, varies by a factor of 4 as the concentration of surfactant varies from 7.5% to 15%.

The only clearly documented study on Rodeo reported a LC_{50} of 429 mg a.e./L for trout. However, Rodeo and similar formulations require surfactants (less toxic than POEA), which may increase the toxicity of the formulation by a factor of 4. Roundup Biactive, an Australian formulation that contains a surfactant at a concentration of 10-20%, has an LC_{50} of 800 mg a.e./L for rainbow trout and is less toxic than Rodeo and much less toxic than Roundup with POEA.

The manufacturing process for POEA surfactants and the chemical composition is proprietary, so the variability of the surfactants in different glyphosate formulations is unavailable.

Monsanto's product code for the original Roundup surfactant is MON 0818 (75% POEA). As with Roundup, the toxicity of MON 0818 to fish increases with increasing water pH. Over a pH range of 6.3 to 8.2, the LC_{50} values for five species of salmonids decreased by factors of 1.2 to 3.2. Typical LC_{50} values for trout are 1-3 mg/L, but the upper and lower bounds for MON 0818 are 0.65 mg/L and 7.4 mg/L respectively. It has also been determined that the joint action of Roundup with MON 0818 is less than additive.

Acute toxicity values provided by Monsanto for surfactants mostly used with Rodeo and similar formulations are mostly in the range of 1-10 mg/L, similar to MON 0818. The U.S. EPA classifies Syndets (anionic surfactant), Activator 90, Entry II, Frigate, Induce, No Foam A, R-11, S. Spreader 200,Widespread, X-77 as *moderately toxic* to fish. Liqua-Wet, Passage, and Spreader-Sticker are *slightly toxic* and Agri-Dex, LI 700, and Geronol CF/AR are *practically nontoxic*.

Sub-lethal exposures to Roundup formulations sometimes, but not always, result in a broad spectrum of stress effects in fish. Roundup formulations, most likely the surfactants in the formulations, have been shown to cause damage to the gills of fish. In one study, trout and bluegill sunfish were exposed to technical grade glyphosate at a purity (62%) that is much lower than used in commercial formulations. Damage to gill occurred at concentrations of 5 mg/L over 14 days and damage to both gills and livers at concentrations of 10 mg/L.

Trout can sense but will not avoid Roundup formulations in water until concentrations approach or exceed 96-hour LC_{50} concentrations. At concentrations as low as 25% of this LC_{50} value, trout exhibit one or more of the following behavioral effects: changes in coughing and ventilation rates, swimming, and coloration and loss of equilibrium.

Two acute toxicity studies of Roundup involving short (10 minute) exposures to a high concentration (100 mg/L or 30 mg a.e./L) of a 41% Roundup formulation resulted in adverse effects on fish immune systems.

The only full life-cycle chronic toxicity study for any form of glyphosate is for the fathead minnow. Using 87.3% pure technical grade glyphosate, no effect was apparent on mortality or reproduction at a concentration of 25.7 mg/L. Given that the differences in the acute toxicity of technical grade glyphosate, glyphosate formulations, and glyphosate-surfactant mixtures are substantial, the merit of this finding is questionable. However, since the surfactants used with glyphosate are less persistent under field conditions, it is likely that glyphosate-surfactant mixtures over longer term exposures will not exhibit the toxicity of acute exposures.

Four long-term studies (2-3 months) of various types of exposure to various species of fish using Roundup formulations in a wide range of concentrations found no overt signs of toxicity and only sublethal adverse effects, primarily to livers, but in some cases to gills and kidneys.

Amphibians (Aquatic Phase) - Numerous acute toxicity studies have been done on the effects of technical grade glyphosate and glyphosate formulations to aquatic-phase amphibians, most over a 96-hour period. However, the U.S. EPA “Pesticide Effects Determination” for the risks of glyphosate use to the federally threatened California red-legged frog (U.S. EPA 2008b) listed only one toxicity study using an aquatic-phase amphibian (leopard frog) as a study organism.

Relative to the skin of fish, amphibian skin is highly permeable to glyphosate. However, based on acute toxicity data, there is no indication that amphibians are substantially more sensitive than fish to glyphosate, glyphosate formulations, or the POEA surfactant in Roundup.

Definitive LC_{50} values for glyphosate acid range from 75.2 to 121 mg a.e./L, similar to those for fish (43 to 100 mg a.e./L at neutral pH). Non-definitive LC_{50} values for glyphosate IPA range from >17 to >466 mg a.e./L, indicating that it is much less toxic than the acid. Based on intraperitoneal studies on several species of amphibians, LD_{50} values for glyphosate IPA range from 790 to 925 mg a.e./kg bw. This is similar to several species of small mammals.

The formulation Rodeo is essentially an aqueous solution of glyphosate IPA, with an LC_{50} of 7297 mg a.e./L in African clawed frogs (*Xenopus laevis*) embryos. It may be that frog embryos are less sensitive to glyphosate and surfactants than larvae, as in fish.

Studies on the effect of water pH on the toxicity of glyphosate and a surfactant to *Xenopus laevis* larvae indicate that as pH increases (decreasing acidity) the toxicity of Rodeo, Roundup, and the surfactant MON 0818 increases. For Rodeo, the 96-hour LC_{50} was 7-11 times more toxic at a pH of 8.0 than at 6.5. The stage of frog development also affects sensitivity, with the embryos of four species being less sensitive than the larvae. Sensitivity also varies between species, ranging from factors of 2 to 3 in *Bufo americanus* to a factor of 7 in *Xenopus laevis* and *Rana pipiens*.

Another study (Chen 2003) found that “multiple stress interactions may exacerbate chemical effects on aquatic biota in natural systems”. For two common wetland species, zooplankton and Ranid tadpoles, significant effects of the herbicide Vision® (glyphosate) were measured at concentrations lower than the calculated worst-case value for the expected environmental concentration ([EEC], 1.40 mg a.e./L). High pH (7.5) increased the toxic effects of the herbicide on all response variables for both species. This finding corroborates those from other studies and supports the premise that laboratory studies are inadequate to assess the hazard of chemicals to wild species in their natural environment. It should be noted that although Vison® is not registered for use in California, it is similar to Roundup® (Vison® = 41% glyphosate, 59% other ingredients; Roundup® = 41% glyphosate, 15% polyethoxylated-tallowamine surfactant, and 44% water).

A study on *Ranidella signifera* tadpoles exposed to glyphosate IPA, with the surfactant Geronol CF/AR (classified as *practically nontoxic* to fish by the U.S. EPA) at concentrations of 10-45%, resulted in indefinite LC_{50} values ranging from >100 to >450 mg a.e./L, which are considered NOAELs. Amphibians appear to be less sensitive to this formulation than trout. It is postulated that more toxic surfactants will increase the toxicity of glyphosate IPA, Rodeo, and similar formulations to amphibians.

Roundup Biactive, an Australian formulation that contains a surfactant at a concentration of 10-20%, has a range of non-definitive LC_{50} values of >17.9 to >494 mg a.e./L. Glyfos BIO, a formulation containing 3-7% POEA surfactant, has a LC_{50} of 17.9 mg a.e./L and is less toxic than typical Roundup formulations. It is unclear whether this is due to a less toxic form of POEA, to a smaller quantity of POEA, or to a combination of the two. Glyfos AU, which also contains 3-7% POEA, has a LC_{50} of 8.9 mg a.e./L, in the range of the upper bounds of more toxic Roundup formulations. An unspecified Glyphos formulation containing 15% POEA has a LC_{50} of 0.93 mg a.e./L, in the range of the lower bounds for Roundup formulations

More toxic formulations of glyphosate include various Roundup, Vision, and Glyphos formulations. Roundup Original Max has a LC_{50} value of 3.2 mg a.e./L. The upper bound for other formulations of Roundup and Vision range from 8.0 to 51.8 mg a.e./L. Absence matched bioassays, it cannot be determined whether higher LC_{50} values reported in other studies are due to species sensitivity, experimental conditions, or random variability.

Rick Relyea found through his research (Relyea 2005) that Roundup®, "the most commonly used herbicide in the world, is deadly to tadpoles at lower concentrations than previously tested; that the presence of soil (in water) does not mitigate the chemical's effects; and that the product kills frogs in addition to tadpoles." Relyea wrote that "The most striking result from the experiments was that a chemical designed to kill plants killed 98 percent of all tadpoles within three weeks and 79 percent of all frogs within one day." Previous studies (Howe 2003) have determined that the surfactant polyethoxylatedtallowamine (POEA), an inert ingredient added to enhance herbicide penetration into plant leaves, and not the active ingredient (glyphosate) is lethal to amphibians.

A study (Howe 2003) in California on the effects of glyphosate formulations to four Ranid frog species in the Sierra found that "acute toxicity values in order of decreasing toxicity were POEA > Roundup Original > Roundup Transorb® >Glyfos AU®; no significant acute toxicity was observed with glyphosate technical material or the glyphosate formulations Roundup Biactive®, Touchdown®, or Glyfos BIO®." Data from this study indicated that the composition of surfactants must be considered when the toxicity of glyphosate-based herbicides are evaluated.

Differences in the toxicity of the more toxic formulations of Roundup and similar formulations to amphibians and fish appear to be negligible, with 96-hour LC_{50} values for amphibians ranging from 8.0 to 51.8 mg a.e./L and for fish from 0.96 to 11.26 mg a.e./L.

Studies on the toxicity to amphibians of the surfactant POEA (MON 0818) report a range of 96-hour LC_{50s} of 1.1 mg/L in the green frog (*Rana clamitans*) to 6.8 mg/L in the African clawed frog (*Xenopus laevis*). These values are comparable to those in fish (1-3 mg/L).

Studies by Relyea on green frog tadpoles indicate that growth is sometimes a more sensitive endpoint than mortality, but that the difference in glyphosate concentration that causes these effects is only ~1 ppm (~1 ppm for adverse growth effects and ~2 ppm for mortality).

A frog (*Xenopus laevis*) embryo teratogenesis assay for malformations after exposure for 96 hours to glyphosate IPA, Roundup, and the surfactant POEA found no statistically significant increases in abnormalities between embryos exposed to nonlethal concentrations and the control group.

Another study tested Kleeraway Grass and Weed Killer RTU (Monsanto) (0.75% glyphosate IPA and an ethoxylated tallowamine surfactant) exposure to tadpoles of the western chorus frog (*Pseudacris triseriata*) and the plains leopard frog (*Rana blairi*). Tadpoles were exposed to concentrations of 0.56, 5.6, 56, or 560 mg a.e./L for 24 hours. At a concentration of 0.56 mg a.e./L, 55% of the western chorus frog tadpoles died and at greater concentrations, all died. In an initial experiment, all plains leopard frog tadpoles died at all concentrations, but in a repeat experiment on older tadpoles, all tadpoles survived when exposed to a concentration of 0.56 mg a.e./L. In both species, normal growth and development occurred in survivors.

Some data indicate that frogs will avoid laying eggs in pools contaminated with Roundup at a concentration of 2.4 mg a.e./L, within the 96-hour LC_{50} range for frogs. Similar to fish, frogs appear to avoid waters contaminated with acutely toxic concentrations of glyphosate-surfactant mixtures, but avoidance of waters contaminated at sub-toxic concentrations has not been demonstrated.

A study of the effect on the immune function of green frog tadpoles (*Rana clamitans*) of exposure to a concentration of 3.7 mg a.e./L technical grade glyphosate found no adverse effects.

In a chronic study (42-day) on *Rana pipiens* larvae of exposure to glyphosate IPA at a concentration of 1.8 mg a.e./L, no adverse effects were noted. Tadpoles were also exposed to Roundup Original and Roundup Transorb at concentrations of 0.6 and 1.8 mg a.e./L (the surfactant MON 0818 POEA in those formulations was 0.3 and 0.9 mg a.e./L) as well as to MON 0818 by itself. With all exposures adverse effects were noted, including an increase in the length of time for development of tadpoles, a decrease in survival, a decrease in the length of tadpoles, and an increase in the number of tadpoles with intersex gonads. Roundup Transorb appeared to be more toxic than Roundup Original and MON 0818 POEA surfactant alone caused the same effects as the formulations.

Another chronic study (43-days) on *Rana cascadae* larvae of exposure to Roundup at concentrations of 1 or 2 mg a.e./L found a substantial decrease in survival at the lower concentration and no survival to day 43 at the higher concentration.

A 16-day exposure study by Relyea on the interaction of Roundup and predator stress on six species of frogs found LC_{50} values in the absence of predator stress of 1.32 to 2.52 mg a.e./L. Based on other studies, as with fish there does not appear to be a substantial concentration-duration relationship for glyphosate-surfactant formulations.

Several mesocosm studies by Relyea and coworkers with Roundup formulations at concentrations of 1.3 to 2.8 mg a.e./L found decreases in survival (only 21% at the end of day 1) and biomass of three species of frog tadpoles.

Aquatic Invertebrates - Acute toxicity studies on aquatic invertebrates are typically done for 48 hours and results are expressed in terms of EC_{50} (immobility) rather than LC_{50} (mortality), as an immobilized invertebrate in an aquatic ecosystem is considered to be functionally dead.

As with fish and amphibians, most Roundup and similar formulations are much more toxic to invertebrates than glyphosate or glyphosate salts, with EC_{50} values for the former formulations of 1 to 50 mg a.e./L and for the latter of 100 to 650 mg a.e./L. Studies that show the joint action of glyphosate and POEA indicate a less than additive effect. For some Accord formulations that contain POEA the EC_{50} values range from 20 to 25 mg a.e./L. EC_{50} values for Rodeo, Roundup formulations with other surfactants, and other non-USA formulations range from 50 to >500 mg a.e./L. As there are few acute toxicity studies on Accord formulations with surfactants, it is unclear whether it is less toxic than most Roundup formulations.

Although for technical grade glyphosate there is a relationship between duration of exposure and response, there does not appear to be a substantial relationship for glyphosate formulations.

Acute toxicity studies are available on two species of daphnid, a copepod, midge larvae, and a bivalve. Studies on *Daphnia magna* report EC_{50} values for glyphosate acid of 128 to 647 mg a.e./L. Studies of copepods and *Ceriodaphnia* found that glyphosate acid is somewhat more toxic than glyphosate IPA. Sensitivity to glyphosate acid is about equal for midges (LD_{50} = 55 mg/L), *Ceriodaphnia* (LD_{50} = 147 mg/L), and copepods (LD_{50} = 35.3 mg/L).

An acute toxicity study of freshwater mussels (*Lampsilis siliquoidia*) exposed to glyphosate acid, glyphosate IPA, and isopropanol amine found that glyphosate acid was relatively non toxic (LC_{50} = >200 mg a.e./L) to larvae and juvenile mussels and that glyphosate IPA and isopropanol amine were much more toxic (LC_{50} = 5 to 7 mg a.e./L).

Formulations of Roundup are much more toxic (LC_{50} = 1.5 to 62 mg a.e./L) than Rodeo (essentially an aqueous solution of the IPA salt of glyphosate) and similar formulations (LC_{50} = 200 to >4,000 mg a.e./L) to aquatic invertebrates. This is attributable to the POEA surfactant in Roundup formulations, which is lacking in Rodeo and similar formulations.

Studies specifically on the toxicity of the POEA surfactant MON 0818 to aquatic invertebrates indicates an LC_{50} of 0.5 to 13 mg/L. Studies on the effect of water pH on the toxicity of MON 0818 have not been done (as they have for fish), so the lower LC_{50} value may be a reflection of a higher water pH (8.2) rather than a greater sensitivity to POEA of invertebrates relative to fish. The surfactants Activator 90, Entry II, and X-77 appear to be as toxic as MON 0818. Geronol CF/AR surfactant is much less toxic than MON 0818, with an EC_{50} for *Daphnia magna* of 48 mg/L, and the EC_{50} values for most other surfactants range from 10 to 100 mg/L. The surfactant Agri-Dex is virtually non toxic to aquatic invertebrates.

Based on studies of the joint action of glyphosate and the POEA surfactant used in Roundup (MON 0818), there was an additive toxic effect in two species of fish and in midge larvae and a less-than additive effect in a daphnid and copepod.

It appears that as the concentration of clay suspended in water increases the acute toxicity of Roundup to *Daphnia pulex* increases. In one 48-hour study the LC_{50} when there was no suspended clay was 7.9 (7.2-8.6) mg a.i./L while the LC_{50} when there was 50 mg/L of suspended clay was 3.2 (3.0-3.4) mg a.i./L. Another study found a decrease in the LC_{50} of *Ceriodaphnia dubia* from 5.38 mg a.e./L when there was no suspended clay to 0.59 mg a.e./L when there was 200mg/L of suspended clay. It is speculated that since daphnids are efficient filter feeders, they may intake and absorb greater quantities of Roundup and POEA attached to suspended clay particles.

Comparative sediment assays with *Ceriodaphnia dubia* of Roundup and Roundup Biactive found the latter formulation much less acutely toxic. The surfactant in Roundup Biactive evidently has a lesser affinity to sediment than POEA.

A study on the impact of glyphosate and Roundup on the acute toxicity of heavy metals to *Ceriodaphnia dubia* found that with most metals (Cd, Cu, Cr, Ni, Pb, Se, and Zn) there was an antagonistic effect.

A sublethal study on the effects of glyphosate to mosquito larvae found that pre-exposure to nonlethal concentrations resulted in a significant increase in cytochrome P450 levels after 72 hours, a positive outcome. Sublethal exposure of a freshwater annelid to glyphosate and Roundup Ultra resulted in oxidative stress.

Longer term toxicity studies indicate a duration-response relationship to glyphosate IPA salt in daphnids. A standard chronic bioassay study in *Daphnia magna* found a NOEC of 37 mg a.e./L and a corresponding LOEC of 74 mg a.e./L. However, a study on Roundup showed only a transient duration-response in *Daphnia pulex*. A study of glyphosate acid and the IPA salt of glyphosate in mussels showed no duration-response relationship, nor did a study of POEA or Roundup Ultramax. There was a relationship with Aqua Star. The effects of long-term exposure of the aquatic snail *Pseudosuccinea columella* to technical grade glyphosate found mixed effects, with egg-hatching being inhibited while egg-laying was enhanced, resulting in negligible effects on reproductive capacity.

Various field studies have found no adverse effects on aquatic invertebrates from applications of Rodeo or Roundup. Following applications of Roundup at rates of 2.2, 22, and 220 kg/ha to a forest pond mesocosms, there were no differences in survival rates of aquatic invertebrates. Following Roundup applications that resulted in concentrations of ~3 mg a.e./L in water, Relyea reported no effect on predatory insects or snails, although there were significant reductions in some species of dragonfly and backswimmers. An artificial stream mesocosms treated with Vision had an increase in periphyton populations.

Aquatic Plants - Acute toxicity is determined for algae and macrophytes, with EC_{50} endpoints determined for growth inhibition. Most EC_{50} values for algae are for 48-hour exposures and for macrophytes are for 7-14 days. Duration-response relationships for macrophytes are not pronounced.

Sensitivity (EC_{50}) to glyphosate acid and glyphosate IPA varies widely between species of algae, from 2 to 600 mg a.e./L, spanning a factor of 260. The acid appears to be more toxic than the IPA salt by a factor of 2. Although there is variability in inter and intraspecies duration-response data for algae, it is apparent that for 2- and 4-day exposure durations there are substantial duration-response relationships.

The pattern of toxicity of glyphosate formulations to algae is similar to that for animals, with most glyphosate-surfactant formulations being more toxic than Rodeo without a surfactant and technical grade glyphosate. A Glyphos (IPA) formulation appears to be the most toxic, with EC_{50} values ranging from 0.12 to 0.68 mg a.e./L. The most toxic formulation (Glyphos IPA) and the least toxic (technical grade glyphosate) differ by a factor of 20.

A study exposed two species of algae to the POEA surfactant used in some formulations of Roundup for 96 hours. The EC_{50} values ranged from 3.35 to 4.1 mg/L. Tests of several surfactants, including MON 0818 (POEA), on giant salvinia, found no toxicity at concentration of 2500 mg/L. Optima was the only surfactant that enhanced the toxicity of glyphosate to salvinia.

Field studies have shown growth inhibition of algae by Roundup at concentrations of 44.4-69.7 mg/L. But growth stimulation has been observed at 10 mg a.e./L. Other studies have shown no or equivocal effects at application rates ranging from 0.4 to 2 lbs/acre. A study of the effect of Roundup on phytoplankton found a decrease in abundance on day one at concentrations of 6 and 12 mg a.e./L, but an increase after that up to the end of the experiment, on day eleven.

There is little data available on the toxicity of glyphosate acid and salts on aquatic macrophytes. EC_{50} values span a range of 10 to 200 mg a.e./L between species of macrophytes. In two species of duckweed, EC_{50} values for 7- to 10-day exposure to glyphosate acid ranged from 10 mg a.e./L for *Lemna gibba* to 47 mg a.e./L for *Lemna minor*.

For glyphosate IPA exposure to *Lemna paucicostata*, the 7-day EC_{50} value was 42 mg a.e./L.

Two 14-day exposure studies (to glyphosate acid) are available for submerged macrophytes. In the watermilfoil study, the EC_{50} for reduction in root length was 1.56 mg a.e./L. For eelgrass, the NOAEC for growth inhibition was 170 mg a.e./L, with a stimulation of growth at 17 mg a.e./L.

Data on the toxicity of Rodeo, Roundup, and Glyphos on *Lemna* show 7-day EC_{50} values differing by only a factor of 2 for Roundup (3.4 mg a.e./L) and Glyphos (7.7 mg a.e./L). Based on 14-day EC_{50} values, Roundup and Rodeo differ by a factor of only 1.5 for watermilfoil and 1.7 for *Lemna gibba*. These differences are insubstantial. Other studies show only a modest duration-response relationship over 7- to 14-day exposures of *Lemna* to Roundup.

In a study of the influence of suspended clay (50 mg/L) on the toxicity of Roundup to macrophytes, a NOEC of 10 mg a.i./L was determined, as opposed to a NOEC of 2 mg a.i./L for water without clay. Evidently Roundup and the surfactant POEA bind with the clay particles, making them less available to macrophytes.

Aquatic Microorganisms - Most studies on aquatic microorganisms indicate that they are not very sensitive to glyphosate. Short-term (15-30 minutes) studies on the aquatic ciliate *Vibrio fischeri* determined EC_{50} values ranging from 17.5-44.2 mg a.e./L for glyphosate acid and 24.9-36.4 mg a.e./L for Roundup. The differences in toxicity between glyphosate acid and Roundup were slight.

A 48-hour bioassay of two other aquatic ciliates, *Euplotes vannu* (a freshwater protozoan) and *Tetrahymena pyriformis* (a marine protozoan) found large differences in sensitivity to glyphosate acid (10.1 mg a.e./L for the former and 648 mg a.e./L for the latter) and similar toxicity results for glyphosate IPA. Sensitivity to Roundup was similar (23.5 mg a.e./L for *Euplotes vannu* and 29.5 mg a.e./L for *Tetrahymena pyriformis*. The sensitivity of aquatic microorganisms to glyphosate acid appears to be similar to that of algae but less than algae for Roundup.

An aquatic mesocosm study of the effect of Roundup on cyanobacteria found an increase in abundance by a factor of up to 40, at concentrations of 6 and 12 mg a.e./L. Other bacteria were not substantially affected.

D.3.2.2.4.4 Hexazinone (Sources: FS WSM v. 6.00.10; SERA 2005)

As stated in SERA 2005, p. 4-1: *Most of the information on the toxicity of hexazinone to mammals as well as other species comes from unpublished bioassays submitted to the U.S. EPA for the registration of hexazinone. These studies as well as other studies submitted for* *registration are conducted using methods specified by the U.S. EPA (e.g., U.S. EPA/OPP 2005). While some studies may be conducted directly by the registrant, most toxicity studies are performed by commercial testing laboratories. All studies submitted for registration are independently reviewed by U.S. EPA*. All toxicity studies on mammals and other species that are cited in the Forest Service risk assessment for hexazinone were obtained and reviewed.

Mammals - Although the mode of action of hexazinone in mammals is unclear, the toxicity of hexazinone to mammals is relatively well-characterized in a large number of standard acute, subchronic, and chronic toxicity studies on mice, rats, rabbits, and dogs, an acute toxicity study in guinea pigs, and a number of standard skin sensitization studies in guinea pigs. (SERA 2005, p. 4-2)

The acute oral toxicity to mammals is classified by the U.S. EPA as Category III, the second lowest oral toxicity category. Assays for chronic toxicity indicate that dogs may be somewhat more sensitive than rats and mice. However, it is not clear whether patterns in sensitivity among different species are true differences or an artifact of differences in experimental design.

Hexazinone is considered to be slightly toxic to mammals, although it can cause severe, irreversible damage to the eyes of terrestrial organisms.

Birds - The available toxicity studies in birds include acute gavage studies, avian acute oral dietary studies, and two avian reproductive toxicity studies. Based on the U.S. EPA classification system, hexazinone is practically nontoxic to birds. Based on an acute gavage LD50 in quail of 2258 (1628-3130) mg/kg, birds appear to be somewhat less sensitive than mammals to hexazinone.

Reptiles and Amphibians (Terrestrial-Phase) - No acute or chronic toxicity studies were found for reptiles or terrestrial phase amphibians.

Terrestrial Invertebrates - Relatively little information is available on the toxicity of hexazinone to terrestrial invertebrates. The U.S. EPA assumes that herbicides are generally not directly toxic to insects, so only required one direct contact bioassay using honeybees. No clear dose response relationship was apparent and the highest observed mortality was only marginally significant.

In a field study conducted in northern California, hexazinone was applied to pine plantations at a rate of 2.7 lb a.i./acre (Busse et al., 2001). No significant differences were found between treated and control plots in the numbers of mites, spiders, beetles, or springtails (SERA 2005, p. 4-4). Hexazinone is considered to be *slightly to practically* nontoxic to invertebrates.

Terrestrial Plants (Macrophytes) - The toxicity to and mode of action of hexazinone are well characterized. Hexazinone is readily absorbed by plant roots and is readily translocated in most species. Differences in sensitivity to hexazinone among different types of plants is related to differences in absorption and rates of metabolism. The metabolites of hexazinone are much less toxic then hexazinone itself.

Based on standard pre-emergence and post-emergence bioassays in sensitive species, soil treatments are more toxic than direct spray treatments. Hexazinone has relatively little effect on seed germination, with Pronone 10 perhaps having more effect than Velpar L.

A large number of field studies on terrestrial vegetation are available. These studies are typically conducted at or above the recommended application rates and tend to focus on efficacy rather than unintended adverse effects. Hexazinone is used effectively in management of pine stands to control hardwoods and shrubs, as it causes only minor mortality in pines.

Terrestrial Microorganisms - Standard laboratory culture bioassays indicate that hexazinone can inhibit microbial growth at both low and relatively high concentrations, depending on the species. However, field studies have demonstrated no effects on mixed fungal and bacterial populations following application rates of up to 8 kg/ha (about 7 lbs/acre).

Fish - The U.S. EPA classifies technical grade hexazinone as *practically nontoxic* to fish. This is based specifically on acute LC_{50} values reported for rainbow trout (>320 mg/L), fathead minnow (274 mg/L) and bluegill sunfish (>370 mg/L and 505 mg/L). It also classifies Velpar L as *practically nontoxic* to fish, with acute LC_{50} values of >1000 mg/L in bluegills and >585.6 mg/L in trout.

Although the U.S. EPA does not discuss studies on Pronone, Pronone 10G appears to be less toxic than Velpar L and both Velpar L and Pronone 10G are less toxic than technical grade hexazinone. This is true even when comparisons are made on an mg a.i./L basis. The inerts in both Velpar L and Pronone 10G appear to lower the toxicity of hexazinone to fish. The Pronone 10G carrier and the Velpar L carrier (mainly ethanol) are essentially nontoxic to fish.

The only longer term toxicity study of hexazinone in fish is an egg-and-fry study that defined a clear NOEC of 17 mg/L and an LOEC of 35.5 mg/L. Consistent with this finding is a 4-week assay for bioconcentration in bluegill sunfish that found no signs of toxicity at concentrations of 0.1 or 1 mg/L.

Amphibians (Aquatic Phase) - Very little information is available on the toxicity of hexazinone to amphibians. The U.S. EPA Pesticide Effects Determinations for the risks of hexazinone use to the federally threatened California red-legged frog (U.S. EPA 2008c) did not list any toxicity studies using aquatic-phase amphibians as study organisms.

In one study, a hexazinone concentration of 100 mg/L over an 8-day exposure period was associated with transient reduced avoidance behavior in newly hatched tadpoles. These exposure levels had no effect on hatching success.

Aquatic Invertebrates - Toxicity information is limited to studies submitted to the U.S. EPA for pesticide registration. Based on acute toxicity studies on *Daphnia magna*, the 48-hour LC_{50} for technical grade hexazinone was 151.6 (125.2-172.8) mg/L and for Velpar L it was 110 (83-130) mg a.i./L. The U.S. EPA classifies both hexazinone and Velpar L as *practically nontoxic* to freshwater invertebrates. There is no indication that the inerts in Velpar L reduce the toxicity of hexazinone to daphnids.

The U.S. EPA classifies hexazinone as moderately toxic to saltwater crustaceans, based on the sensitivity of grass shrimp, which appear to be about equally sensitive as daphnids to hexazinone (48-hour LC_{50} value of 94 [50-176] mg/L). The fiddler crab is much less sensitive, with a NOEC for mortality of over 1000 mg/L. The only data available on mollusks, for embryos of the eastern oyster, indicate a NOEC of 320 mg/L, substantially above the LC_{50} values for small crustaceans.

Although there were reporting deficiencies in the only available reproduction studies, in *Daphnia magna*, the U.S. EPA did accept those studies. The NOEC discussed by the U.S. EPA is 29 mg/L, however a NOEC of 10 mg/L may be a more appropriate for this risk assessment.

As stated in SERA 2005 (p. 4-9):

> *Additional information on the effects of hexazinone on aquatic invertebrates is also available in field or field simulation assays (Appendix 10). In one such study, 13 species of stream macroinvertebrates were exposed to very high concentrations of hexazinone, 70 mg/L to 80 mg/L, for one hour in an artificial stream followed by a 48-hour observation period. The most sensitive species were two species of Ephemeroptera, an Isonychia sp and Epeorus vitrea, both of which exhibited 14% mortality. Mortality in all other species ranged from 0% to 4% (Kreutzweiser et al., 1992). In a subsequent study (Kreutzweiser et al., 1995), no effects were noted on invertebrate drift in five stream channels over a 14 day period of observation after 12 hour exposures to hexazinone at concentrations that ranged from 3.1 to 4.1 mg/L. At the end of the 14-day observation period, no significant pair-wise differences between treated and control channels were noted for 14 taxa of macroinvertebrates. Overall, however, there was a significant increase in abundance of invertebrate taxa in treated versus control channels (Kreutzweiser et al., 1995). In a similarly designed study, no effects on stream invertebrates were observed after the application of*

> *Velpar L at a level that resulted in hexazinone levels of 0.145-0.432 mg/L over a 24-hour exposure period (Schneider et al., 1995). In addition, Mayack et al., (1982) reported no effects on stream macroinvertebrates at water concentrations of 0.008 mg/L to 0.044 mg/L. These concentrations were the result of the application of hexazinone pellets (formulation not specified but consistent with Pronone 10G) at a rate of 16.8 kg/ha in four small watersheds located in mixed hardwood-pine stands. One additional watershed served as an untreated control.*

Aquatic Plants - Based on the standard bioassays submitted to the U.S. EPA for registration and published studies, there are relatively substantial differences in sensitivity to hexazinone among species of freshwater algae. The differences span a factor of approximately 24 based on the EC_{25} values and 38 based on the NOEC values, with *Selenastrum capricornutum* (a freshwater green alga) being the most sensitive (5-day EC_{50} = 0.0068 [0.0063-0.0072] mg/L; NOEC of 0.004 mg/L) and the least sensitive species being *Anabaena flos-aquae* (a freshwater blue-green alga) (5-day EC_{25} = 0.16 [0.02-0.24] mg/L; NOEC 0.15 mg/L).

In one study on the toxicity of hexazinone to macrophytes (i.e., duckweed - *Lemna* sp.), adverse effects (a reduction in frond count and reduced biomass) were noted at the lowest concentration tested (0.026 mg/L), with exposures over a 14-day period. The EC_{25} for the most sensitive endpoint (frond count) was estimated at 0.027 mg/L. In another study the NOEC is estimated to be 0.012 mg/L.

The carriers and/or inerts in formulations of Velpar L do not appear to reduce the toxicity of hexazinone to aquatic plants.

It appears that in two of the field trials (Kreutzweiser et al 1995 and Schneider et al., 1995) described under *Aquatic Invertebrates*, reductions in algal photosynthesis were temporary and recovery was rapid following clearing of hexazinone from stream channels.

D.3.2.2.4.5 Imazapyr (Sources: FS WSM v. 6.00.10; SERA 2011c; U.S. EPA 2006d)

Mammals - Although acute, subchronic, and chronic toxicity studies on imazapyr do not demonstrate adverse effects that are unequivocally attributable to exposure, *this uncertainty or a lack of knowledge has a relatively minor impact on this risk assessment, because the available toxicity studies are relatively complete—chronic studies in three mammalian species (dogs, rats, and mice) and several reproduction studies in two mammalian species (rats and rabbits)—and indicate that imazapyr is not likely to be associated with adverse effects at relatively high-dose levels* (SERA 2011c, p. 54). Imazapyr is considered *slightly toxic* to mammals.

Birds - The available avian studies on imazapyr (acute gavage, acute dietary, and reproduction studies in both bobwhite quail and mallard ducks), all of which were conducted up to limit doses, do not report any signs of toxicity. Imazapyr is considered *slightly toxic* to birds.

Reptiles and Amphibians (Terrestrial-Phase) - No acute or chronic toxicity studies were found in open literature or in studies submitted to the U.S. EPA for reptiles or terrestrial-phase amphibians.

Terrestrial Invertebrates - Two studies (oral and contact) on honeybees suggest that imazapyr is *practically nontoxic* to honeybees. Whether this is true for all of the diverse species of invertebrates found in the environment is unknown.

Terrestrial Plants (Macrophytes) - After foliar application, imazapyr is transported via the phloem and inhibits acetolactate synthase, an enzyme that catalyzes the biosynthesis of three branched-chain amino acids, which are essential for protein synthesis and plant growth. Imazapyr does not appear to be extensively metabolized by plants.

Imazapyr has been shown to translocate to plant roots and exude from the roots into the surrounding soil, posing a risk to nearby plants (SERA 2011c, p. 58), in a process known as allelopathy. However, given that imazapyr moves relatively rapidly in soil, the potential for allelopathic effects may not have a practical or substantial impact on potential risk to non-target plants.

Imazapyr formulations are labeled for both post-emergence and pre-emergence control of both broadleaf vegetation (dicots) and grasses (monocots). Based on standard toxicity studies of foliar applications of technical grade imazapyr, dicots appear to be substantially more sensitive than monocots in assays for both vegetative vigor and seedling emergence

Terrestrial Microorganisms - What little information is available on the toxicity of imazapyr to terrestrial microorganisms indicates that it is highly species specific, with variations in sensitivity of up to a factor of 100. It is not clear whether these effects, which are based on laboratory cell culture studies at very high concentrations of imazapyr, would occur in field populations of microorganisms.

As stated in SERA 2011c, p 61:

> *In peak soil concentrations, imazapyr inhibited cellulose decomposition and carboxymethyl cellulase activity when applied at 0.25 to 1 kg/ha, equivalent to about 0.22 to 0.9 lb/acre, to a predominantly peat soil (Ismail and Wong 1994). These investigators speculate that "the reduction in cellulose degradation is likely to be only a temporary effect" (Ismail and Wong 1994, p. 122) and that the activity of imazapyr on terrestrial microorganisms may decline as the herbicide is adsorbed to soil and thereby becomes less bioavailable to microorganisms. On the other hand, imazapyr may persist in soil for a prolonged period of time, particularly in relatively arid regions,*

> *and will not bind tightly to alkaline soils with low organic matter. Thus, in at least some areas, a potential for longer-term effects on soil microorganisms seems possible. This effect, however, has not been demonstrated in field studies. In a greenhouse study, Busse et al., (2004) noted no effects on the infectivity of mycorrhizal fungi to pine seedlings following application of imazapyr at rates of 0.82 to 1.6 lb a.e./acre (i.e.,, rates that caused clear signs of toxicity in the pine seedlings).*

Fish - The U.S. EPA classifies both imazapyr acid and isopropylamine salt as *practically non-toxic* to fish. One commonly used formulation of imazapyr, Arsenal Herbicide (27.8% a.i, 22.6% a.e. isopropylamine salt and 72.2% inerts, which include an unspecified solvent), appears to be substantially more toxic to trout relative to imazapyr and isopropylamine salt of imazapyr. This is evidently due to one or more of the inerts in the formulation. The 96-hour LC_{50} of Arsenal Herbicide is about 41 mg a.e./L in bluegills and 21 mg a.e./L in trout.

Longer-term toxicity studies have been done on imazapyr but not on its formulations. This is problematic, as the acute NOAEC of the isopropylamine salt of imazapyr in rainbow trout is 110 mg a.e./L while for the Arsenal Herbicide formulation it is 10.4 mg a.e./L. The acute NOAEC for the Arsenal Herbicide formulation in rainbow trout is below the longer-term NOAEC for imazapyr acid by a factor of about 4.

The longer-term toxicity of imazapyr acid to fathead minnows has been assayed in an early life-stage study and a full life cycle study. Neither study detected adverse effects at concentrations of up to about 120 mg a.e./L. Rainbow trout appear to be the most sensitive species, as at a concentration of 92.4 mg a.e./L in an early life-stage study there was a reduction in hatch and fry survival, judged by the researcher as a "…*nearly significant effect on hatching.*" No effects, however, were noted at a concentration of 43.1 mg a.e./L. The U.S. EPA determined that the 92.4 mg a.e./L concentration is a LOAEC (lowest observed adverse effect concentration) rather than a NOAEC.

Amphibians (Aquatic Phase) - No acute or chronic toxicity testing on aquatic-phase amphibians was found for imazapyr.

The U.S. EPA Pesticide Effects Determinations for the risks of imazapyr use to the federally threatened California red-legged frog (U.S. EPA 2007b) did not list any toxicity studies using aquatic-phase amphibians as study organisms.

Aquatic Invertebrates - The U.S. EPA classifies both imazapyr acid and isopropylamine salt of imazapyr as *practically non-toxic* to *Daphnia magna* and saltwater invertebrates (oysters and pink shrimp). The Arsenal Herbicide formulation of imazapyr is more toxic than either imazapyr acid or the isopropylamine salt. In *Daphnia magna* the EC_{50} for Arsenal Herbicide is 79 mg a.e./L while the EC_{50} for isopropylamine salt of imazapyr is 614 mg a.e./L, lower by a factor of about 8.

The only longer-term toxicity study on imazapyr, a standard life cycle study in *Daphnia magna*, resulted in no effects at concentrations of up to 97.1 mg a.e./L. This chronic NOAEC is above the acute NOAEC of 59.3 mg a.e./L for Arsenal Herbicide.

As stated in SERA 2011c (p. 64):

> *Concern for longer-term effects of exposures of aquatic invertebrates is at least somewhat diminished by the mesocosm study by Fowlkes et al., (2003). As summarized in Appendix 5 (Table 4), the study involved exposures of mixed macroinvertebrates to mesocosms treated with Arsenal Applicators Concentrate at concentrations of 0.184, 1.84, or 18.4 mg a.e./L. No impacts were noted on species richness or abundance after a 2-week exposure period, which is comparable to the exposure period in chronic daphnid studies. The apparent NOAEC of 18.4 mg a.e./L is consistent with the acute NOAEC of 59.3 mg a.e./L for Arsenal Herbicide (Forbis et al., 1984b) as well as the chronic NOAEC of 97.1 mg a.e./L in daphnids (Manning 1989c).*

Aquatic Plants - Based on the geometric means of the EC_{50} values in algae (37.2 mg a.e./L) and aquatic macrophytes (0.023 mg a.e./L), imazapyr is more toxic to aquatic macrophytes than to algae by a factor of over 1600. The differences in 7-day EC_{50} values for imazapyr acid among different species of algae span a factor of about 8, ranging from 12.2 to 92 mg a.e./L. The isopropylamine salt of imazapyr (EC_{50} = 11.5 mg a.e./L) is more toxic than imazapyr acid (EC_{50} = 71 mg a.e./L) by a factor of about 6.

Three standard bioassays in aquatic macrophytes (duckweed [*Lemna gibba*] and water milfoil [*Myriophyllum sibiricum*]) suggest little variability in the sensitivity of aquatic macrophytes to imazapyr acid and Arsenal (isopropylamine salt of imazapyr). These bioassays resulted in similar EC_{50} values for growth inhibition, ranging from 0.018 mg a.e./L for the salt of imazapyr in duckweed to 0.029 mg a.e./L for the Arsenal formulation in water milfoil. However, efficacy studies suggest variability in the tolerance of species to imazapyr.

D.3.2.2.4.6 NP9E (Sources: FS WS ver. 2.02; USDA/FS 2003b; U.S. EPA 2010e)

NP (nonylphenol) is one of the parent chemicals of NPE (nonylphenolpolyethyoxylate), a chemical group that is part of many herbicide surfactants. NPs are used widely in the U.S. About 80% of this use is for industrial and institutional surfactants and liquid detergents (USDA/FS 2003b). As stated in U.S. EPA.2010e:

> *NP and certain oligomeric NPEs are highly toxic to aquatic organisms, are moderately bioaccumulative in mollusks, are persistent in the aquatic environment, and accumulate in soils and sediments (EPA, 2005). (ibid, p. 1)*

Many herbicide surfactants used by the USFS, analyzed in USDA/FS 2003b (p. v), and likely to be used under the VTP and Alternatives, contain from 20-80% NPE. The chemical group of NPEs that are used in herbicide surfactants, NP9E, are of relative low acute toxicity to fish, as are the metabolites (the NPECs) likely to be found in water. As stated in USDA/FS 2003b (p. 43), "The NPECs would appear to be slightly more acutely toxic to fish than NP9E. NP is an order of magnitude more toxic to fish than the NP9E or NPECs." NP9E surfactants are generally mixed with herbicides and water carriers at dilution rates of 0.25% to 2.5% (USDA/FS 2003b, p. 1). The percentage of NP9E in a tank mix would therefore range from 0.0005% to 0.02%.

Mammals - NP9E is classified by the U.S EPA as *slightly toxic to practically non-toxic* to mammals (toxicity category III or IV). Although the acute toxicity of NP, the parent compound of NP9E, is somewhat higher, it is also classified in category III or IV.

NP9E is minimally to severely irritating to rabbit skin and moderately to severely irritating to rabbit eyes. It can cause severe, irreversible eye damage to the eyes of terrestrial organisms.

The liver and kidney are the organs most likely to be affected by chronic and subchronic exposures to NPE and NP. These compounds have been determined to be weakly estrogenic in both *in vitro* and *in vivo* tests involving aquatic and terrestrial organisms. Non-reproductive effects appear to be the more sensitive endpoint.

No evidence of carcinogenicity was reported in 2-year chronic oral toxicity studies of NP9E with rats and dogs. However, ethylene oxide and 1, 4-dioxane, sometimes found as impurities in NP9E at low levels, are classified as carcinogens. Ethylene oxide is also a mutagen.

NP9E appears to be rapidly metabolized and excreted, based on one study. It does not appear to be immunotoxic or neurotoxic at doses considered protective of kidney or liver effects.

Birds - Published literature has no data on the effects of NP or NPEs to birds.

Reptiles and Amphibians (Terrestrial-Phase) - No acute or chronic toxicity studies were found for reptiles.

Terrestrial Invertebrates - The only study found in the literature on the effects of NPE on terrestrial insects (honeybees) does not provide sufficient data to characterize the risk to terrestrial invertebrates.

Terrestrial Plants (Macrophytes) - There is no data in the published literature on the toxicity of NPEs to plants. Since NP9E surfactants would be mixed with herbicides, any potential toxic effects would be masked by the effects of the herbicides.

There is only limited data on the toxicity of NP to plants. It appears that NP is quickly mineralized by soil microorganisms, uptake of NP from soil is slow to non-existent, and there is little to no toxic effect on plants.

Terrestrial Microorganisms - There is no toxicity of NPE and NP to soil microorganisms at application rates of NP in soil up to 250 mg/kg.

Fish - As stated in U.S. EPA.2010e:

> *The available acute and chronic toxicity data of NP to aquatic organisms indicates NP is highly toxic to fish, aquatic invertebrates, and aquatic plants. (ibid, p. 4)*
>
> *However, For NPEs, toxicity to aquatic organisms tends to decrease with increasing degree of ethoxylation. For example, acute toxicity to killifish was 1.4 mg/L, 3 mg/L, 5.4 mg/L, 12 mg/L and 110 mg/L for NP, NP1EO (i.e., NPE with one ethoxylate group), NP6.4EO (i.e., NPE mixture with an average of 6.4 ethoxylate groups), NP9EO and NP16.6EO, respectively (Canada, 2002). Environment Canada, based on a comprehensive analysis of available toxicity data for NP and NPEs, developed Toxic Equivalency Factors (TEFs) for NP and NPEs, as follows: NP =1; NP1EO and NP2EO =0.5 (i.e., half as toxic as NP); NP3EO to NP8EO also = 0.5 (a conservative estimate because of inadequate data); NP9EO and greater = 0.005 (i.e., 100 times less toxic than NP) (Canada 2002). (ibid)*

As stated above, acute toxicity varies with the degree of ethoxylaytion. For NP8E, 96-hour LC_{50} values for juvenile rainbow trout range from 4,100 to 5,400 ppb. For NP8.9E, 48-hour LC_{50} values for the Japanese medaka (*Oryzias latipes*) range from 11,200 to 14,000 ppb. For NP9E, 96-hour LC_{50} values for fathead minnows (*Pimephales promelas*) range from 4,000 to 6,600 ppb. These acute toxicity values for NP8-9E are at least 1 order of magnitude less than NP. For NP10E, 96-hour LC_{50} values for adult cod (*Gadus moorhua*) and flounder (*Pleuronectes flesus*) range from 2,500 to 6,000 ppb, depending upon water temperature.

Most 96-hour LC_{50} values for acute toxicity of NP to tested fish species range from 100 to 460 ppb. The lowest tested 96-hour LC_{50} was for the salt-water species flounder (*Pleuronectes americanus*), with a value of 17 ppb. Other species tested were the fathead minnow (128 to 320 ppb), rainbow trout (190 to 270 ppb), Atlantic salmon (130 to 900 ppb), and sheepshead minnow (460 ppb). In the Japanese medaka, the 48-hour LC_{50} for NP is 1,400 ppb.

A study comparing the acute toxicity of NP in surrogate fish species against threatened or endangered species found that the Apache trout, greenback cutthroat trout, and Lahontan trout were all similar to the rainbow trout surrogate (96-hour LC_{50} values of 150 to 180 ppb as compared to the rainbow trout 190 ppb). Correlations were less good between warm water threatened or endangered fish (bonytail chub, Colorado pikeminnow, and razorback sucker) and the fathead minnow surrogate (96-hour LC_{50} values of 170 to 290 ppb as compared to 270 ppb). The authors of the study concluded that a safety factor of 2X should be sufficient to provide a conservative estimate for listed cold and warm freshwater fish species.

The acute toxicity of the environmental metabolite NP1EC to fathead minnows indicates a 96-hour EC_{50} of 2,000 ppb while in Japanese medaka or killifish, a 48-hour EC_{50} for NP1EC was determined to be 9,600 ppb and for NP2EC, 8,900 ppb.

As stated in USDA/FS 2003b (p. 43):

> *It would appear that in terms of acute toxicity to fish, NP9E is of relatively low acute toxicity, as are the likely environmental metabolites that would be found in water (the NPECs). The NPECs would appear to be slightly more acutely toxic to fish than NP9E. NP is an order of magnitude more toxic to fish than the NP9E or NPECs.*

There is little data on NPEs in regard to sub-chronic and chronic toxicity. In a 7-day study of NP9E on fathead minnows, a NOEC of 1,000 ppb was determined, based on growth. In a 42-day study where fathead minnows were exposed to NP9E at rates up to 5.5 ppb, there was no mortality and no effects to secondary sex characteristics. A 14-day study of rainbow trout exposed to NP8E resulted in a LC_{50} of 4,250 ppb. Sublethal effects (impaired locomotor activity and breathing rate) from exposure to NP10E in codfish (*Gadus morhua*) have been demonstrated at rates of >1 mg/L (1,000 ppb), with the effects remaining reversible over a long period of time. This exposure rate was three orders of magnitude higher than needed to elicit the same response from NP (2 µg/L or 2 ppb) in the same species.

For NP, the subchronic NOEC varies with species, with lab-determined 28- to 90-day values ranging from 1-23 ppb.

Exposure to the environmental metabolite NP1EC at rates up to 50 ppb for 35 days after hatch in rainbow trout had no dose-dependent effects on growth or ovosomatic index, as measured after 108 or 466 days. In an unpublished study with fathead minnows, a NOEC of 1000 ppb was established for NP1EC.

Further, as stated in USDA/FS 2003b (p. 45):

Bioconcentration potential of the short-chain ethoxylates (NP, NP1E, NP2E) in freshwater fish and other aquatic biota appears to be low to moderate ranging up to about 740 (Ahel et al 1993; Liber et al 1999b;Snyder et al 2001; US EPA 1996). Little data exists on the bioconcentration of longer chain NPEs, but based on their structure they are not expected to bioaccumulate (Environment Canada 2001a, Servos 1999)

Amphibians (Aquatic Phase) - No acute or chronic toxicity studies on adult amphibians were found for NP9E. Acute toxicity studies on amphibians were found for NP/NPE. These studies are generally of a limited nature and are limited to frog or toad embryos or tadpoles.

Two studies on NP8E tested embryos of three species and tadpoles of six species. In the embryo study, 96- to 140- hour LC_{50} values ranged from 3.9 to 9.2 ppm, comparable to values for freshwater fish. Developmental EC_{50} values ranged from 2.8 to 8.8 ppm. The minimum NP8E concentration inhibiting growth (an LOEC) ranged from 1 to 4 ppm. In the tadpole study, mild narcosis EC_{50} values ranged from 2.3 to <10.6 ppm. Water temperature increases did not affect EC_{50} values, but reduced dissolved oxygen in water reduced EC_{50} values by about half, as compared to normal levels of oxygen. Tadpoles recovered from narcosis during the life of the test.

For NP, acute toxicity 96-hour to 14-day LC_{50} values for amphibians ranged from 75 to 120 ppb in water and 10 to 30 day LC_{50} values of 260 mg/kg for dosed sediments. When *Xenopus laevis* was exposed to NP, there was a 14-day NOEC for tail resorption of 25 ppb. NP exposure for 12 weeks to *X. laevis* tadpoles at 22 ppb caused a significant increase in the percentage of female frogs, but this effect was not seen at 2.2 ppb.

Aquatic Invertebrates - NP9E toxicity to aquatic invertebrates is less than for NP, demonstrating the same relationship as is found in fish and amphibians. The 48-hour EC_{50} for *Daphnia magna*, is 14,000. In two subchronic studies, a *Daphnia* 7-day NOEC (growth) value of 10,000 ppb was determined. For mysid shrimp, the 48-hour LC_{50} value ranges from 900 – 2,000 ppb.

After exposure to NP10E, sublethal effects to mussels, cockles, and barnacles were seen at 2-5 mg/L (ppm) while effects to locomotion of a decapod, hermit crab and shore crab were seen at 20-40 mg/L (ppm).

To determine the toxic effects to invertebrates of a tank mix of X-77, an NPE-based surfactant, mixed with the Rodeo formulation of glyphosate, in-lab toxicity tests were done as well as field applications to freshwater wetlands. For four species of invertebrates, 48- and 96-hour LC_{50} values for X-77 ranged from 2.0 to 14.1 mg/L, about two orders of magnitude greater than the acute toxicity of Rodeo alone. However, mortality patterns were similar between the treated and untreated wetlands, indicating a lack of acute toxicity of the tank mix at the application rate. But potential chronic effects of such applications are unknown.

One study of the exposure of *Daphnia* to the metabolites NP2E and NP2EC derived a 48-hour LC_{50} of 115 to 198 ppb for NP2E and 770 to 1,295 ppb for NP2EC.

Tests of NP on various species of freshwater and marine invertebrates have resulted in 96-hour LC_{50} values ranging from about 20 to about 775 ppb. For *Daphnia*, the LC_{50} for NP and NP2E are similar.

For mysid shrimp after exposure to NP, the 28-day chronic NOEC (growth) is 4 ppb. *Daphnia* have a slightly higher 21-day NOEC (reproduction) of 24 and 116 ppb while the NOEC (embryotoxicity) occurs at 44 ppb. The marine copepod *Tisbe battagliai* had a 53-day NOEC of 20 ppb. In littoral enclosure studies, no effects were seen on macroinvertebrates at levels of NP up to 23 ppb and no effects to zooplankton at levels of 5 ppb.

In a study of NP applied to outdoor microcosms at average concentrations of 5, 23, 76, and 243 µg/L, only the highest concentration caused significant declines in zooplankton abundance and insect emergence, although there were sensitive taxa affected at 23 µg/L. However, in terms of abundance, the overall zooplankton community structure was relatively unaffected.

Aquatic Plants - For NP9E exposure to green algae, the NOEC (growth) value is 8,000 ppb and the 96-hour EC_{50} (growth) value is 12,000 ppb.

For NP, a marine alga has been the most sensitive aquatic plant species tested, with a 96-hour EC_{50} (growth) of 27 ppb and a NOEC of 10 ppb. Green algae and duckweed have 96-hour NOEC (growth) values ranging from 90 to 900 ppb. Duckweed seems to be more tolerant than the algae. In a littoral enclosure study there were no effects to aquatic macrophytes (*Chara* and *Potamogeton*) while there was a small increase in periphyton biomass at the highest mean average concentration of 243 µg/L over 20 days.

D.3.2.2.4.7 Sulfometuron methyl (Sources: FS WSM v. 6.00.10; SERA 2004c; U.S. EPA 2008a, 2009g)

Mammals - Sulfometuron methyl has low acute and chronic oral toxicity to mammals. Although there is relatively little information on the effects in non-target wildlife species, it is reasonable to assume that the effects will mirror those in experimental mammals.

Birds - Based on acute exposure studies, birds appear to be somewhat less sensitive than experimental mammals to the toxic effects of sulfometuron methyl. No chronic exposure studies were identified in the available literature.

Reptiles and Amphibians (Terrestrial-Phase) - No acute or chronic toxicity studies were found for reptiles.

Terrestrial Invertebrates - Sulfometuron methyl is *practically nontoxic* to bees. It is not clear from available data whether this low level of toxicity is true for other invertebrates.

Terrestrial Plants (Macrophytes) - Non-target plants are sensitive to sulfometuron methyl. Based on pre-emergence applications, rape, tomato, sorghum, wheat, and corn were the most sensitive species (onion, pea, cucumber, and soybean were the least sensitive). Based on post-emergence applications, corn was the most sensitive species. Adverse effects were observed in most broadleaved plants and grasses tested. Field reports indicate "substantial and prolonged damage to crops or ornamentals after the application of sulfometuron methyl in both an arid region, presumably due to the transport of soil contaminated with sulfometuron methyl by wind, and in a region with heavy rainfall, presumably due to the wash-off of sulfometuron methyl contaminated soil" (SERA 2004c, p. 4-5).

Terrestrial Microorganisms - Sulfometuron methyl appears to inhibit the growth of several soil microorganisms at low concentrations.

Fish - Studies on acute toxic effects of sulfometuron methyl in fish suggest that effects are not likely to be observed at concentrations less than or equal to 150 mg/L (SERA 2004c). Available acute toxicity data for freshwater fish and invertebrates indicate that sulfometuron methyl is *practically non-toxic* on an acute exposure basis, with all EC_{50}s / LC_{50}s >100 mg/L. For marine and estuarine fish, available acute toxicity data indicate that sulfometuron is at most *slightly toxic* on an acute exposure basis (EC_{50}s / LC_{50}s range from >38 to >45 mg a.i./L) (U.S. EPA 2008a).

Based on 30-day chronic exposure assays of fathead minnow embryo hatch, larval survival, or larval growth, no adverse effects would be expected at concentrations of up to 1.17 mg/L.

Amphibians (Aquatic Phase) - In acute and chronic exposure studies, the most sensitive aquatic species tested appears to be the African clawed frog, with exposure to sulfometuron methyl producing alterations in limb development, organogensis, and metamorphosis, with the lowest NOEL of 0.001 mg/L for metamorphosis.

Aquatic Invertebrates - Based on acute bioassays in daphnids, crayfish, and field-collected species of other aquatic invertebrates, sulfometuron methyl appears to be relatively non-toxic to aquatic invertebrates. As stated in SERA 2004c (p. 4-8):

> *One daphnid reproduction study noted a decrease in the number of neonates at 24 mg/L but not at 97 mg/L or any of the lower concentrations tested. The authors report the NOEL as 6.1 mg a.i./L. Although the effect observed at 24 mg/L may have been a random variation, it is treated as an LOAEL for the purpose of this risk assessment. While this approach may be regarded as conservative, in the absence of additional studies regarding reproductive effects in aquatic invertebrates, the approach seems prudent.*

Available acute toxicity data for invertebrates indicate that sulfometuron methyl is *practically non-toxic* on an acute exposure basis, with all EC_{50}s / LC_{50}s >100 mg/L. For marine and estuarine invertebrates, available acute toxicity data indicate that sulfometuron is at most *slightly toxic* on an acute exposure basis (EC_{50}s / LC_{50}s range from >38 to >45 mg ai/L) (U.S. EPA 2008a).

Aquatic Plants - As might be expected, aquatic plants are much more sensitive than aquatic animals to the effects of sulfometuron methyl, although the effects on aquatic plants have not been extensively studied. EC_{50} values for growth inhibition range from 0.462 g/L in duckweed to 10 g/L in hydilla. EC_{50} values in algae for growth inhibition range from 4.6 g/L in *Selenastrum capricornutum* to > 370 g/L (the NOEC value) in *Navicula pelliculosa*. Macrophytes appear to be generally more sensitive than unicellular algae.

As stated in SERA 2004c (p. 4-2):

> *There are no published or unpublished data regarding the toxicity of sulfometuron methyl to aquatic bacteria or fungi. By analogy to the effects on terrestrial bacteria and aquatic algae, it seems plausible that aquatic bacteria and fungi will be sensitive to the effects of sulfometuron methyl.*

D.3.2.2.4.8 Triclopyr (Sources: FS WSM v. 6.00.10; SERA 2011d)

The hazard identification for nontarget organisms is concerned with triclopyr acid, triclopyr TEA, triclopyr BEE, and 3,5,6-trichloro-2-pyridinol (TCP) a metabolite of triclopyr. In terrestrial animals, triclopyr TEA and triclopyr BEE appear to be bioequivalent to triclopyr. Few systematic differences in species sensitivity in terrestrial animals are apparent. In aquatic organisms, triclopyr BEE is much more toxic than triclopyr TEA or triclopyr acid.

Mammals - Triclopyr is only *slightly toxic* to mammals. Triclopyr is a weak acid and is therefore likely to be more toxic to dogs than to most other mammals. Based on very clear and consistent patterns in both subchronic and chronic studies involving dietary exposures, sensitivity to triclopyr is greater in larger mammals.

The primary target tissue for triclopyr toxicity in mammals is the kidney. Triclopyr causes developmental effects only at doses that cause maternal toxicity. Triclopyr will not accumulate in mammals on repeated dosing. Available studies on wildlife do not report adverse effects attributable to the toxicity of triclopyr.

Triclopyr TEA can cause severe, irreversible eye damage to the eyes of terrestrial organisms.

Birds - Based on studies in mallard ducks and bobwhite quail, triclopyr is only slightly toxic to birds (triclopyr acid *practically non-toxic* to *slightly toxic* and triclopyr TEA and BEE [Garlon 4] *practically non-toxic*). In ducks, the acute oral toxicity of triclopyr acid and triclopyr

TEA are substantially similar. In quail, the toxicity of triclopyr BEE is lower than the toxicity of triclopyr acid and triclopyr TEA to ducks by a factor of about 2.5.

In two field studies using triclopyr applications in the range of application rates that may potentially be used under the Program EIR or Alternatives, no adverse effects were observed in birds.

TCP is less toxic to birds than triclopyr BEE, triclopyr TEA, and triclopyr acid (SERA 2011d, p. 90).

Reptiles and Amphibians (Terrestrial-Phase) - The toxicity of triclopyr or TCP to reptiles or terrestrial phase amphibians is not included in “either the recent EPA ecological risk assessment on triclopyr (U.S. EPA/OPP 2009a) or in the database on amphibian and reptile toxicity data maintained by the Canadian National Wildlife Research Centre (Pauli et al., 2000)” (SERA 2011d, p. 90).

No acute or chronic toxicity studies were found for reptiles.

Terrestrial Invertebrates - Triclopyr acid and triclopyr TEA are *practically nontoxic* to bees while triclopyr BEE is *slightly more toxic*.

One study on earthworms suggests that triclopyr TEA may be moderately toxic to earthworms relative to triclopyr acid. However, the toxic concentrations in this study were far higher than soil concentrations of triclopyr that would occur in the environment. A chronic effects study indicated no adverse effects from exposure to Garlon 4 on earthworm reproduction or growth. A field study of the effects of Garlon 3A to earthworms and other invertebrates resulted in no significant reduction in mixed earthworm populations, mites, springtails, or ants in turf and soil core samples.

A series of field studies suggest that effects to invertebrates were attributable to changes in vegetation rather than direct toxic effects of triclopyr.

Terrestrial Plants (Macrophytes) - Triclopyr BEE is bioequivalent to triclopyr TEA in foliar applications to terrestrial plants. With foliar applications, triclopyr is effective for controlling dicots and relatively ineffective in controlling monocots. Pines tend to be tolerant to triclopyr exposures after fall dormancy but more sensitive during the spring and summer.

In seedling emergence studies, triclopyr BEE is much more toxic than triclopyr TEA, at least in some species, such as alfalfa.

One study suggests that some bryophytes and lichens may be sensitive to long-term effects after triclopyr exposure, which raises a concern that exposure to substantial triclopyr drift may have long- term impacts on bryophyte and lichen communities. Since triclopyr BEE is much more volatile than triclopyr TEA, it can cause damage to nontarget plants through vapor transport. Although none of the field studies involving triclopyr BEE document damage to nontarget plant species through volatilization, anecdotal reports from the Forest Service suggest that volatilization of triclopyr may damage nontarget plants if triclopyr BEE is applied under a poorly ventilated canopy and high temperatures.

Terrestrial Microorganisms - Diverse studies on the toxicity of triclopyr to terrestrial microorganisms suggest that it is not likely to have an impact on soil microorganisms.

Fish - Based on acute toxicity studies, triclopyr TEA is much less toxic to fish than either triclopyr BEE or TCP. The median of the LC_{50} values for triclopyr TEA is about 131 mg a.e./L while the median for corresponding values of TCP is 3.19 mg/L. Triclopyr TEA is less toxic than TCP by a factor of about 40. The median for corresponding values of triclopyr BEE is 0.539 mg a.e./L. Triclopyr TEA is less toxic than triclopyr BEE by a factor of about 240 and TCP is less toxic than triclopyr BEE by a factor of about 6.

Based on chronic studies, the NOAEC for triclopyr TEA is about 32.4 mg a.e./L and the NOAEC for TCP is 0.178 mg/L. TCP is more toxic than triclopyr TEA by a factor of about 180. Based on a standard egg-to-fry study in trout, the NOAEC for triclopyr BEE is 0.017 mg a.e./L. Based on chronic exposures, triclopyr BEE is more toxic than TCP to fish by a factor of about 10.

To summarize, triclopyr BEE is more toxic to fish than triclopyr TEA by a factor of about 240, based on acute toxicity. TCP is more toxic to fish than triclopyr TEA by a factor of about 40, based on acute toxicity, and by a factor of 180, based on chronic toxicity. TCP is less toxic to fish than triclopyr BEE by a factor of 6, based on acute toxicity, and less toxic to fish than triclopyr BEE by a factor of 10, based on chronic toxicity. There do not seem to be any significant differences among fish species in terms of sensitivity to the forms or formulations of triclopyr covered in this risk assessment

TCP is of concern in applications of triclopyr TEA, although this concern is somewhat lessened by the lower concentrations of TCP relative to triclopyr. However, for fish exposures, the risks associated with TCP are assessed quantitatively in U.S. Forest Service risk assessments.

Studies on the sublethal effects of Garlon 4 on rainbow trout showed that at concentrations of 0.32-0.43 mg/L, about a factor of 2 below the 96-hour LC_{50} determined in this study, fish were lethargic. At levels ≤0.1 mg/L, fish were hypersensitive over 4-day periods of exposure. This is reasonably consistent with the threshold for behavioral changes in rainbow trout for Garlon 4 of 0.6 mg/L found in another study, which also found a corresponding threshold for behavioral changes to Garlon 3A of 200 mg/L, consistent with the relative acute lethal potencies of these two agents.

Amphibians (Aquatic Phase) - There is only one acute toxicity value for triclopyr TEA, the 96-hour LC_{50} of 84 mg a.e./L in *Xenopus laevis* exposed to Garlon 3A. This is lower than the median LC_{50} in fish (~130 mg a.e./L) but well within the range of LC_{50} values (~40 to 420 mg a.e./L).

The only acute toxicity values for triclopyr BEE are for the Release or Garlon 4 formulations. Tadpoles are more sensitive than embryos, with differences in sensitivity spanning about an order of magnitude (median LC_{50} values of about 2 mg a.e./L in tadpoles and 20 mg a.e./L in embryos). Based on the LC_{50} value for tadpoles, the most sensitive stage, amphibians appear to be less sensitive than fish by a factor of about 4.

A large body of literature on reproductive toxicity in mammals indicates that triclopyr is not likely to cause reproductive or teratogenic effects at sublethal concentrations. 96-hour teratogenesis assays of Garlon 3A and Garlon 4 for malformations in frog (*Xenopus laevis*) embryos found no statistically significant increases in abnormalities in any groups exposed to Garlon 3A or Garlon 4 at levels that were not lethal.

As stated in SERA 2011d (p. 99):

> *Berrill et al., (1994) also assayed the toxicity of Garlon 4 using embryos and tadpoles of Rana pipiens (leopard frog), Rana clamitans (green frog), and Rana catesbeiana (bullfrog) in a static assay with aeration, which was conducted in darkness to prevent hydrolysis of triclopyr BEE. Exposures to 0.6, 1.2, and 4.6 mg a.e./L had no effect on hatching success, malformations, or subsequent avoidance behavior of embryos. Newly hatched tadpoles died or became immobile after exposure to the two higher concentrations. The approximate EC_{50} values for response to prodding were between 1.2 and 4.6 mg a.e./L after a 24-hour exposure period. As summarized in Table 34, these EC_{50} values for response to stimuli are very close to the LC_{50} values for frog larvae and probably reflect signs of nearly lethal exposures rather than sublethal effects on behavior.*

Data on the toxicity of TCP to aquatic phase amphibians were not identified in the conduct of the current risk assessment.

Aquatic Invertebrates - Based on the median acute 48-hour LC_{50} values, triclopyr BEE is more toxic than triclopyr TEA to aquatic invertebrates, by a factor of about 140, which is less than the difference in toxicity to fish (240X) between these two chemical forms. This difference in sensitivity is due almost entirely to the greater tolerance of aquatic invertebrates to triclopyr TEA. For triclopyr TEA, aquatic invertebrates are more tolerant than fish by a factor of about 3while for triclopyr BEE, aquatic invertebrates are more tolerant than fish by a factor of about 5. Based on acute bioassays of aquatic invertebrates exposed to triclopyr BEE, daphnids appear to be more sensitive than aquatic insects, with other aquatic arthropods displaying intermediate sensitivity. Snails may be more tolerant to triclopyr than aquatic arthropods.

In a standard 48-hour LC_{50} determination in *Daphnia magna*, TCP appears to be more toxic than triclopyr TEA but less toxic than triclopyr BEE.

As stated in SERA 2011d (p. 99):

> *Kreutzweiser et al., (1992) conducted a series of 1-hour bioassays of triclopyr BEE in several species of stream invertebrates. Based on these bioassays (Kreutzweiser et al., 1992, Table 4), LC_{50} values for these aquatic invertebrates were greater than 290 mg/L (≈200 mg a.e./L). These LC_{50s} are higher than the standard 48-hour LC_{50}s for triclopyr BEE by about 2 orders of magnitude. While 1-hour LC_{50} values are not typically available and are not routinely used in Forest Service risk assessments, these data from Kreutzweiser et al., (1992) are considered further in the risk characterization for aquatic invertebrates (Section 4.4.3.4).*

Aquatic Plants - In aquatic plants, triclopyr TEA is more toxic to dicots than monocots, while the differences in the toxicity of triclopyr BEE is less pronounced. Triclopyr TEA appears to be more toxic than triclopyr BEE to aquatic macrophytes while triclopyr BEE appears to be about equally toxic to both monocots and dicots.

Of the six species of algae that have been assayed with triclopyr TEA, it appears that the filamentous or rod shaped algae (species of *Ankistrodesmus*, *Anabaena*, and *Skeletonema*) may be somewhat more sensitive than more spherical species of algae (*Chlorella* species). Triclopyr BEE is more toxic than triclopyr TEA to algae by a factor of about 10 and appears to be as toxic if not slightly more toxic to fish than to algae. Investigations into the effects of triclopyr acid on carbon fixation in algae noted no or relatively little inhibition in carbon fixation at concentrations of 2.6 mg/L.

The only two bioassays on the toxicity of TCP to algae report EC_{50s} of 1.8 mg/L. TCP appears to be more toxic to algae than triclopyr TEA. Data also suggest that TCP may be as phytotoxic as triclopyr BEE as to aquatic macrophytes.

D.3.2.3 Exposure Assessment

D.3.2.3.1 Introduction

Non-target organisms could be affected by chemicals if they are exposed to them. To assess exposure the SERA and USDA/FS RAs use both plausible and highly conservative exposure scenarios unique to each chemical and non-target species and based upon available data. The exposure scenarios used in this risk assessment to determine the amount of chemical an organism could be exposed to are determined by the application method and the chemical and toxicological properties of the compound being applied. Scenarios for foliar applications include acute and chronic oral exposure (food or drinking water) and dermal exposure, soil contamination, direct spray, and spray drift. Scenarios for other application methods, such as soil treatment or cut surface applications, use only a subset of the standard exposure scenarios for foliar applications. As stated in SERA 2012 p. 85, "*The exposure assessment for aquatic species typically relies on the estimated peak and longer-term concentrations in water that are used in the human health risk assessment, as well as the exposure assessments for terrestrial wildlife from the consumption of contaminated water.*" As with the human health exposure assessment, the computational details for each exposure assessment are presented in the 2012 EXCEL "F series" workbooks created by WorksheetMaker and summaries are in "G series" workbooks. Rather than showing these in detail here, the reader is referred to the specific SERA or USDA/FS RAs for each chemical. These RAs can be downloaded from the USFS, Forest Health Protection website (http://www.fs.fed.us/foresthealth/pesticide/risk.shtml). The most current version of WorksheetMaker can be downloaded directly from the SERA website (www.sera-inc.com).

As stated in SERA 2012 p. 86,

> *Given the large number of species that could be exposed to pesticides and the varied diets in each of these species, a very large number of different exposure scenarios could be generated. For the generic risk assessments, an attempt is made to limit the number of exposure scenarios. The* specific exposure scenarios presented in the general risk assessments are designed as conservative *screening scenarios that may serve as guides for more detailed site-specific assessments by identifying the groups of organisms and routes of exposure that are of greatest concern.*

In order for chemicals to adversely affect offsite, non-target organisms they must be transported from the treatment site in sufficient quantities to expose those organisms to doses that could harm them. Chemicals are mobile to varying degrees, in both similar and different ways, and for different lengths of time.

It needs to be emphasized that in order to minimize risks to non-target, off-site organisms, the U.S. EPA requires language on chemical product labels to minimize drift or runoff. The following language for sulfometuron methyl is illustrative of that found on other chemical product labels (U.S. EPA 2009g, pp. 15 &17):

> *For terrestrial uses, except for under the forest canopy: Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate.*

Exposure to (Brand Name) can injure or kill plants. Damage to susceptible plants can occur when soil particles are blown or washed off target onto cropland. Applications may not be made to soil that is subject to wind erosion when less than a 60% chance of rainfall is predicted to occur in the treatment area within 48 hours. Soils that are subject to wind erosion usually have a high silt and/or fine to very fine sand fractions. Soils with low organic matter also tend to be prone to wind erosion.

Applications must be made using extremely coarse or coarser droplet size spectrum according to ASABE (S572) definition.

Do not apply when wind speed is greater than 10 mph.

Do not make aerial or ground applications into temperature inversions.

Inversions are characterized by stable air and increasing temperatures with height above the ground. Mist or fog may indicate the presence of an inversion in humid areas. The applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.

For ground boom applications, apply spray at lowest height that is consistent with pest control objectives to minimize drift.

D.3.2.3.2 Terrestrial Organisms

Terrestrial organisms could be exposed to chemicals from direct spray, ingestion of contaminated materials (vegetation, prey species, soil, or water), grooming activities, or by indirect contact with contaminated vegetation. The greatest exposure to chemicals for terrestrial vertebrates is most likely to occur from consumption of contaminated vegetation or insects. The greatest exposure for terrestrial invertebrates is by direct spray or by indirect contact with contaminated vegetation.

The highest exposure level for non-target terrestrial plants will be from direct spraying within the treatment area. Direct spraying will result in an exposure level equivalent to the application rate. Off-site drift is also a significant route of exposure, but spray drift will decrease with increasing distance from the boundaries of treatment areas.

Exposures of soil organisms to a pesticide are typically based on the Gleams-Driver modeling and/or available monitoring data. Exposures to terrestrial plants are estimated both as concentrations in soil and direct foliar contamination either from direct spray or drift. For some species of terrestrial animals (typically insects), standard toxicity studies may report units that are not readily converted to mg agent/kg body weight. For example, some contact toxicity studies express exposure only in mass of agent per unit surface area – e.g., lb/acre or mg/m^2. In such a case, some dose-response assessments may be based on units of mass of agent per unit surface area and the exposure assessment is simply expressed as the application rate, or some fraction of the application rate to account for drift. In other cases, such as honeybees, body weight data may be used to convert exposures in mg/organism to mg/kg bw.

As stated in SERA 2012 (p. 85):

> *Estimates of oral exposure are expressed in the same units as the available toxicity data. As in the human health risk assessment, these units are usually expressed as mg of agent per kg of body weight and abbreviated as mg/kg for terrestrial animals. For dermal exposures to terrestrial animals, the units of measure usually are expressed in mg of agent per cm^2 of surface area of the organism and abbreviated as mg/cm^2. In estimating dose, however, a distinction is made between the exposure dose and the absorbed dose. The exposure dose is the amount of material on the organism (i.e., the product of the residue level in mg/cm^2 and the amount of surface area exposed), which can be expressed either as mg/organism or mg/kg body weight. The absorbed dose is the proportion of the exposure dose that is actually taken in or absorbed by the animal.*

For any given type of exposure, small animals (and insects) will generally receive a higher dose (mg/kg body weight) relative to larger animals due to the relationship between body weight to surface area and to the amount of food and water consumed relative to size. Mammals of five sizes are considered: small- (20 g) and medium-sized (400 g) omnivores, a 5 kg canid, a 70 kg herbivore, and a 70 kg carnivore while birds of four standard sizes are considered: a 10 g passerine, a 640 g predatory bird, a 2.4 kg piscivorous bird, and a 4 kg herbivorous bird. Because of dietary differences, all of the mammals and birds are not considered in all of the exposure scenarios, since, for instance, predatory birds don’t eat vegetation.

As toxicity data are not generally available on reptiles or terrestrial-phase amphibians, exposure assessments are typically not developed. When toxicity data are available, custom exposure scenarios are developed.

D.3.2.3.2.1 Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

Exposure assessments for terrestrial mammals, birds, reptiles, and amphibians (terrestrial phase) are typically done for direct spray, dermal contact with contaminated vegetation, ingestion of contaminated vegetation or prey, ingestion of contaminated water, and ingestion of contaminated fish.

Direct Spray - This scenario is similar to the accidental exposure scenarios for the general public, involving exposure to direct spray. The amount of chemical absorbed depends on the application rate, the surface area of the organism, and the rate of absorption.

For foliar applications, two direct spray scenarios are conducted. The first scenario is the direct spray of half of the body surface of a 20 g mammal. This exposure assessment assumes first-order dermal absorption. The second scenario assumes complete absorption during the first day of exposure. This assessment is included so as to encompass increased exposures due to grooming.

There are substantial uncertainties associated with all direct spray scenarios. For example, first-order dermal absorption estimates do not consider losses of applied herbicides from the surface of the animal and may overestimate the absorbed dose. Birds, mammals, and other animals may groom frequently and such grooming may contribute to the total absorbed dose by direct ingestion of any herbicide on fur or feathers. Amphibians and some other vertebrates may have skin that is much more permeable than the skin of most mammals. When data are available on dermal absorption and toxicity in amphibians, direct spray scenarios may be developed in risk assessments involving foliar applications.

Direct spray scenarios are not generally given for large mammals as allometric relationships dictate that they will be exposed to lesser amounts of a herbicide than smaller mammals. Direct spray scenarios may be given when toxicity data indicate that large mammals are more sensitive than small mammals.

Dermal Contact with Contaminated Vegetation - To estimate the potential effect of indirect dermal contact with an herbicide, a relationship is assumed between the application rate and dislodgeable foliar residue. However, rates of transfer of herbicides from foliage to organisms are unavailable for wildlife species. Wildlife are likely to be in contact with contaminated vegetation for longer periods than humans, so it is reasonable to assume that an equilibrium is reached between levels on the skin, rates of absorption, and levels on contaminated vegetation. Assuming this, the absorbed dose resulting from contact with contaminated vegetation might be on the order of one-tenth (10%) that associated with comparable direct spray scenarios. Because this assumption is speculative, it is not generally used to quantify exposures in the risk assessments. The potential for effects from contact with contaminated vegetation is only addressed qualitatively. For most herbicides this adds relatively little uncertainty to the risk assessment, because the dominant route of exposure will be the consumption of contaminated vegetation, which is addressed in the following scenario. Therefore, dermal contact with contaminated vegetation will not be addressed in the chemical-specific section below.

Ingestion of Contaminated Vegetation or Prey - Exposure assessments for the consumption of contaminated vegetation are developed for small- and medium-sized omnivores, a canid, a herbivore, a passerine bird, a piscivorous bird, and a herbivorous bird, but not for a large carnivorous mammal or a predatory bird, as they are primarily meat eaters. Both acute and chronic exposure scenarios are developed for the consumption of contaminated fruit and the consumption of short grass. Fruit and short grass are selected so as to encompass the range of plausible concentrations of herbicide residues in vegetation, with fruit having the lowest concentration and short grass the highest.

For both the acute and chronic exposure scenarios it is assumed that 100% of the diet is contaminated. For some acute exposures this may not be a realistic assumption and is probably unlikely in chronic exposures, as animals may feed only sporadically in treated areas. Rather than incorporating into the exposure assessment arbitrary adjustments in the proportion of the diet that is contaminated, the impact of variations is discussed further in the risk characterization section, because the proportion of the diet that is contaminated is linearly related to the resulting Hazard Quotients (HQs).

Allometric relationships of the estimated food consumption rates by various species of mammals and birds are based on field metabolic rates (kcal/day) and account for much of the variability in food consumption among mammals and birds. Estimates of field metabolic rates are used to calculate food consumption based on the caloric value (kcal/day dry weight) of the food items considered in risk assessments and estimates of the water content of the various foods. Residual variability is remarkably constant among different groups of organism. Estimates from the allometric relationships may differ from actual field metabolic rates by approximately ±70%. In all worksheets involving the use of the allometric equations for field metabolic rates, the lower bound is taken as 30% of the estimate and the upper bound is taken as 170% of the estimate.

Exposure scenarios similar to those for the consumption of contaminated vegetation are provided for the consumption of small mammals by either a predatory mammal or a predatory bird as well as for the consumption of contaminated insects by a small mammal, a medium-sized mammal, and a small bird.

As stated in SERA 2012 (p. 89), "For aquatic applications, the consumption of contaminated vegetation is not typically considered. For soil treatments, the consumption of contaminated vegetation may be considered if compound-specific data are available on the relationship between concentrations of the pesticide in soil and the resulting concentration of the pesticide in plants."

Ingestion of Contaminated Water - Both the human health and the ecological effects risk assessments use the same methods for estimating concentrations of herbicides in water, with a major difference that the estimates of exposure for the ecological effects risk assessment involves the weight of the animal and the amount of water consumed. Water consumption rates are well characterized in terrestrial vertebrates and are based on allometric relationships in mammals and birds. Based on these estimates, exposure scenarios involving the consumption of contaminated water are developed for mammals and birds for accidental spills, expected peak concentrations, and expected longer-term concentrations. For both acute and chronic exposures, for the chemicals analyzed in this

Program EIR, ingestion of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This is a common pattern following terrestrial application of many herbicides and reflects the direct application of the herbicides to vegetation.

Along with many other factors, water consumption in birds and mammals varies substantially with diet and season, but there are no well-documented quantitative estimates of this variability. Therefore, the variability in water consumption rates is not considered in the exposure assessments. For both acute and chronic exposures to herbicides, the upper and lower bound estimates of concentrations in surface water typically vary substantially. Therefore, quantitative consideration of the variability in water consumption rates would not typically have a substantial impact on the risk characterization.

As stated in (USDA/FS 2006a, p. 4-17):

> *Unlike the human health risk assessment, estimates of the variability of water consumption are not available. Thus, for the acute scenario, the only factors affecting the estimate of the ingested dose include the field dilution rates (i.e., the concentration of the chemical in the solution that is spilled) and the amount of solution that is spilled. As in the acute exposure scenario for the human health risk assessment, the amount of the spilled solution is taken as 200 gallons for liquid formulations. In the exposure scenario involving contaminated ponds or streams due to contamination by runoff or percolation, the factors that affect the variability are the water contamination rate, (see Section 3.2.3.4.2) and the application rate.*

Ingestion of Contaminated Fish - Since the consumption of contaminated fish by species that eat fish is a viable route of exposure to herbicides, sets of exposure scenarios are developed for an accidental spill, expected peak exposures, and estimated longer-term concentrations. These exposure scenarios are applied to a 5 kg canid, a 70 kg carnivorous mammal (typified by a black bear), and a piscivorous bird.

Herbicides exposures from the consumption of contaminated fish are dependent on both the concentration of the herbicide in water and the bioconcentration factor for the herbicide. The concentrations of herbicides in water are the same as used in the scenarios for ingestion of contaminated water. Bioconcentration factors for wildlife are usually based on whole-body bioconcentration factors in fish, under the assumption that mammalian or avian predators will typically consume the entire fish. If chemical and species-specific data indicate that this is not the case, alternative custom exposure scenarios may be developed.

D.3.2.3.2.2 Terrestrial Invertebrates

Exposure assessments for terrestrial invertebrates are typically done for direct spray and drift, ingestion of contaminated vegetation or prey, contact with contaminated soil, and honeybees foraging for nectar.

Direct Spray and Drift - Honeybees are typically used as a surrogate for other terrestrial insects. Exposure levels from broadcast applications are modeled based on the herbicide application rate and the surface area of the bee (1.42 cm^2 for a bee with a body length of 1.44 cm). Doses in units of mg/bee are converted to units of mg/kg bw, with a typical mean body weight for worker bees of 116 mg.

Honeybee exposure to an herbicide during or shortly after application depends on how close the bee is to the application site and how much of the herbicide is intercepted by foliage prior to deposition on the bee. AgDRIFT is used to estimate the proportion of the nominal application rate deposited at various distances (0 to 900 feet) downwind from the treated site. The impact of foliar interception varies according to the nature of the vegetative canopy. Foliar interception rates of 0% (no interception), 50%, and 90% are used in the exposure assessment.

Broadcast applications of a herbicide will most likely expose other terrestrial invertebrates to direct spray. If toxicity data on other terrestrial invertebrates is available and supports a dose-response assessment, an exposure scenario may be elaborated.

Ingestion of Contaminated Vegetation or Prey - Terrestrial invertebrates may be exposed to foliar applications of herbicides by consuming contaminated vegetation or prey. Estimated residue rates (mg/kg residues per lb applied) are calculated for contaminated vegetation or prey.

An estimate of food consumption by a foraging herbivorous insect is required to calculate a dose level. But since food consumption varies greatly, depending on the caloric requirements in a given life stage or activity and the caloric value of the food to be consumed, the derivation of consumption values for specific species, life stages, activities, and food items is beyond the scope of the current analysis. However, based on studies on food consumption patterns of various insects, the risk assessments will typically use food consumption factors of 1.3 (0.6 to 2.2) kg food /kg bw.

Contact with Contaminated Soil - Some herbicides may be broadcast applied to soil, in which case soil concentrations from Gleams-Driver and/or monitoring data are used directly in the exposure assessment. For some herbicides, earthworm subchronic toxicity tests are available. There may also be field studies or other studies that provide toxicity data on terrestrial invertebrates that are based on soil exposures.

Honeybees Foraging for Nectar – U.S. Forest Service risk assessments develop an exposure assessment on honeybees foraging for nectar, if sufficient data are available. This is generally done only when information on the concentration of the pesticide in nectar is available or can be reasonably estimated. Exposure assessments are generally limited only to nectar foragers, because this is the subgroup estimated to be exposed to the highest doses. None of the chemicals analyzed in this Program EIR have sufficient data on the concentration of the chemical in pollen or nectar to support the development of an exposure assessment.

The basis of the exposure assessments is the sugar demand of the honeybee. Studies have found that the concentration of pesticides per unit of sugar in nectar are sometimes greater than in honey, despite honey having more sugar than nectar. If this is generally true, exposure assessments based on nectar consumption could overestimate pesticide exposure from honey residue.

D.3.2.3.2.3 Terrestrial Plants

Exposure assessments for terrestrial plants are typically done for direct spray, spray drift, runoff, wind erosion and the use of contaminated irrigation water.

Direct Spray - Direct spray will result in an exposure level equivalent to the application rate. Direct spray of non-target plants immediately adjacent to the application site is modeled in the worksheets that assess off-site drift.

Off-Site Drift - Off-site drift depends primarily on spray droplet size and meteorological conditions rather than specific properties of the compound being sprayed. Estimates of off-site drift are modeled using AgDRIFT and are summarized for foliar applications. Custom worksheets may be used to assess ground broadcast and backpack applications.

As stated in SERA 2012 (p. 94):

> *The drift estimates used in the current risk assessment are based on AgDRIFT (Teske et al., 2002) using Tier 1 analyses for aerial and ground broadcast applications. The term Tier 1 is used to designate relatively generic and simple assessments that may be viewed as plausible upper limits of drift. Aerial drift estimates are based on Tier 1 using ASAE Fine to Medium drop size distributions. Tier 1 estimates of drift for ground broadcast applications are modeled using both low boom and high boom options in AgDRIFT. For both types of applications, the values are based on Very Fine to Fine drop size distributions and the 90th percentile values from AgDRIFT.*
>
> *Drift associated with backpack applications (directed foliar applications) are likely to be much less than drift from ground broadcast applications. Few studies, however,*

are available for quantitatively assessing drift after backpack applications. For the current risk assessment, estimates of drift from backpack applications are based on an AgDRIFT Tier 1 run of a low boom ground application using Fine to Medium/Coarse drop size distributions (rather than very fine to fine) as well as 50th percentile estimates of drift (rather than the 90th percentile used for ground broadcast applications).

The values for drift used in generic (i.e.,, not site-specific) risk assessments should be regarded as little more than generic estimates similar to the water concentrations modeled using GLEAMS (Section 3.2.3.4.3). Actual drift will vary according to a number of conditions—e.g., the topography, soils, weather, and the pesticide formulation. All of these factors cannot be considered in generic risk assessments.

Typical backpack ground spray droplet sizes are greater than 100 μ and the distance from the spray nozzle to the ground is 3 feet or less. Mechanical sprays may use raindrop nozzles that generate droplets that are usually greater than 400 μ, with a maximum distance above the ground of about 6 feet. In both cases, the sprays are directed downward.

For most applications, the wind velocity will be no more than 5 mph (~7.5 feet/second). Assuming a wind direction perpendicular to the line of application, 100 μ particles falling from 3 feet above the surface could drift as far as 23 feet. A raindrop or 400 μ particle applied at 6 feet above the surface could drift about 3 feet.

For backpack applications, wind speeds of up to 15 mph are allowed in U.S. Forest Service programs. The VTP and Alternatives are limited to windspeeds of no more than 7 mph (SPR HAZ-9). At a 15 mph wind speed, a 100 μ droplet can drift as far as 68 feet. Smaller droplets will drift further, so the proportion of this size particle in the spray as well as the wind speed and turbulence will affect the proportion of the applied herbicide that drifts off-site.

Runoff and Soil Mobility - Herbicides can be transported off-site from the soil by runoff, sediment loss, or percolation, so these are considered in estimating contamination of ambient water. Only runoff and sediment loss are considered in assessing contamination of off-site soil that might affect plants. Percolation is not considered in this case as it represents the amount of herbicide that is transported below the root zone. While it may impact water quality, it will likely not affect off-site vegetation. Runoff estimates are modeled using GLEAMS for clay, loam, and sand at nine sites that are representative of different temperatures and rainfall patterns.

When results from a runoff study of sulfometuron methyl were compared with GLEAMS modeling predictions, GLEAMS under-predicted runoff, in some cases by a factor of more than 30. The greatest discrepancies were apparent for heavy rainfall events. These discrepancies are likely attributable to the 1-day time step used by GLEAMS, which fails to account for rapid water and herbicide movement during short-term but intense rainfall events. In any case, if herbicides are applied during or shortly before heavy rainfall events, concentrations in runoff of some herbicides could reach levels toxic to sensitive plant species.

Contaminated Irrigation Water - This scenario is unlikely to occur with potential herbicide application under this Program EIR and the Alternatives, as applications will primarily be to non-irrigated rangelands and forests. Levels of exposure will depend on the amount of irrigation water used and the herbicide concentration in the ambient water used for irrigation, based on the peak concentrations modeled in the human health risk assessment.

The selection of an irrigation rate is somewhat arbitrary and depends on the climate, soil type, topography, and plant species under cultivation. The application of 1 inch of irrigation water with a range of 0.25 to 2 inches is used in U.S. Forest Service risk assessments.

The product labels for some herbicides may note that water contaminated with the herbicide should not be used for irrigation. In these cases the standard exposure scenario is included in the risk assessment with a comment indicating that it is not relevant except to evaluate the consequences of disregarding the labeled use restrictions.

Wind Erosion - Wind erosion can be a major mechanism for off-site movement of herbicides and is highly site-specific. The amount of herbicide that might be transported depends on several factors, including application rate, depth of incorporation into the soil, persistence in the soil, wind speed, and topographical and surface conditions of the soil. It is unlikely that herbicide transport would be substantial with relatively deep (4 inches) soil incorporation, low wind speed, and surface conditions which inhibit wind erosion.

As stated in SERA 2012 (p. 94):

> *For Forest Service risk assessments, the potential effects of wind erosion are estimated in Worksheet G06b. In this worksheet, it is assumed that the pesticide is incorporated at a depth that is identical to the depth of incorporation used in Gleams-Driver modeling, typically 1 cm. Average soil losses are estimated to range from 1 to 10 tons/ha/year with a typical value of 5 tons/ha/year. These estimates are based on the results of agricultural field studies which found that wind erosion may account for annual soil losses ranging from 2 to 6.5 metric tons/ha (Allen and Fryrear 1977).*
>
> *As noted in Worksheet G07b, the use of the above values typically results in estimates of offsite losses at about 0.014% of the application rate. Larney et al., (1999), however, report that wind erosion of other herbicides could be associated with losses up to 1.5% of the nominal application rate following soil incorporation or 4.5% following surface application. This difference appears to be a due to the much higher soil losses noted by Larney et al., (1999)—i.e., up to 56.6 metric tons/ha from*

a fallow field. The losses reflected in Worksheet G06b may be somewhat more realistic for forest or rangeland applications, because herbicide applications are rarely made to fallow areas. In any event, the higher offsite losses reported by Larney et al., (1999) are generally comparable to exposures associated with offsite drift at distances of about 50 feet from the application site following low boom (0.017) and high boom (0.05) ground broadcast applications (Worksheet G05). All of the estimates for wind erosion and offsite drift are likely to vary dramatically according to site conditions and weather conditions.

Volatilization - Volatilization may be an important route of exposure to some herbicides for off-site, non-target plants. As general methods for estimating exposures from volatilization have not been developed, this section is included only when the chemical-specific information is adequate to support both an exposure assessment and a dose-response assessment. None of the chemicals analyzed in this Program EIR have such chemical-specific information, so no exposure scenarios have been developed.

D.3.2.3.3 Aquatic Organisms

Aquatic organisms could be exposed from direct spray, ingestion of contaminated materials (aquatic vegetation, prey species, or water), or by indirect contact with contaminated vegetation or water.

The greatest exposure for aquatic organisms is most likely to occur following an accidental chemical spill directly into a water body. The exposure assessment is based on the concentrations of the pesticide in surface water that are used in the exposure assessment for terrestrial vertebrates, which is in turn equivalent to the concentrations used in the human health risk assessment.

D.3.2.3.4 Chemical-Specific Exposure Assessments

D.3.2.3.4.1 Borax (Sources: FS WSM ver. 6.00.10; SERA 2006a)

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

As stated in the Overview in SERA 2006a, p 4-8:

As discussed in Section 3.2, Sporax is applied directly to the surfaces of freshly cut tree stumps. Sporax is not applied using backpack, broadcast or aerial spray methods and it is not applied directly to vegetation. Therefore, many of the standard exposure scenarios that are typically considered for Forest Service risk assessments, such as direct spray, oral exposure via ingestion of contaminated prey or vegetation, are not applicable for this risk assessment. The exposure scenarios used in this risk assessment are those expected to result in substantial exposure considering the atypical application method for Sporax.

For terrestrial vertebrates, two exposure scenarios are considered for this risk assessment: acute exposure via consumption of Sporax applied to tree stumps, and acute as well as chronic exposure via exposure to contaminated pond water.

Ingestion of Sporax from Tree Stumps – A field study found that deer licked borax (Sporax) applied to the surface of tree stumps, but also licked the surface of untreated stumps. Therefore, it is unclear whether Sporax attracts deer. But the study suggests that the consumption of Sporax from treated stumps is a plausible exposure scenario for deer and perhaps other species.

As little information is available to estimate the amount of Sporax that terrestrial mammals or birds are likely to consume from tree stumps, exposures developed for this scenario are highly uncertain. For large (70 kg) mammals, such as a deer, exposure is based on the underlying assumption that a deer might consume all of the Sporax applied to a tree stump that is 1 foot in diameter, with amounts consumed estimated as 40 mg (lower bound), 242 mg (central bound), and 807 mg (upper bound). Although direct consumption of Sporax from a stump by a large (4 kg) bird, such as a goose or heron, is implausible, as they typically consume either vegetation or fish, a similar scenario is developed for a Canada goose. For smaller species, it seems less plausible that the animal would consume all of the Sporax on a treated stump. The body weights that are used are 20 grams for a small mammal and 10 grams for a small bird.

For small mammals and birds, exposure values for acute exposure via consumption of Sporax applied to a tree stump are essentially identical, as follow: 0.0056 mg B/kg/event (lower bound), 0.011 mg B/kg/event (central bound), and 0.011 mg B/kg/event (upper bound). For large mammals and birds, exposure values for the same scenario are also essentially identical, as follow: 0.575 mg B/kg/event (lower bound), 3.43 mg B/kg/event (central bound), and 11.5 mg B/kg/event (upper bound). A summary of exposure assessments for terrestrial animals is displayed in Worksheet G01 in FS WSM ver. 6.00.10.

Ingestion of Contaminated Water – After application of granular Sporax to tree stumps, runoff from rainfall could contaminate standing water or streams. Accidental spills of Sporax could also contaminate a small body of water. Exposure assessments are developed for terrestrial animals for both of these scenarios. However, the use of Sporax in stump treatments is not likely to have a substantial affect on concentrations of boron in ambient water, so this is not considered a relevant scenario (Worksheet G01 in FS WSM ver. 6.00.10). For chronic exposures of a small mammal by consuming water contaminated by runoff, exposure values are 0.00146 mg B/kg/day (lower bound), 0.0102 mg B/kg/day (central bound), and 0.0512 mg B/kg/day (upper bound).

Terrestrial Invertebrates

There is no information in SERA or USDA/FS risk assessments on exposure of terrestrial invertebrates to borax. Since Sporax is not applied as a spray, wide-spread exposure of insects is not expected.

Terrestrial Plants (Macrophytes)

As stated in the Overview in SERA 2006a, p 4-8: "*Since Sporax is not applied to vegetation, the only exposure scenario considered for terrestrial macrophytes is exposure to boron that reaches soil via runoff. Based on the results of GLEAMS modeling, peak concentrations of boron in soil range from 0.0026 ppm for the lowest value associated with an application rate of 0.1 lb Sporax/acre to 2.29 ppm in soil for the highest value associated with an application rate of 5 lbs Sporax/acre.*"

Aquatic Organisms

As stated in SERA 2006a, p. 4-11: "The potential for effects on aquatic species is based on estimated concentrations of borax (as boron equivalent) in water that are identical to those used in the human health risk assessment. For this risk assessment, contamination of water is considered for two scenarios – accidental spill of a bag of Sporax (containing an amount ranging from 6.25 to 25 pounds Sporax) into a small pond and contamination of pond water and contamination of a small pond by runoff. For an accidental spill of Sporax into a small pond, the peak estimated concentration of boron in ambient water is 0.64 mg B/L (0.32 - 1.28) mg B/L (ppm). Details of this calculation are provided in Worksheet F05.

Contamination of a small pond by runoff, the peak estimated concentration of boron in ambient water is 30 (6 to 100) μg boron/L after a single application of 1 lb Sporax/acre (0.11 lb boron/acre). For longer-term exposures, the corresponding longer term concentrations in ambient water are estimated at about 14 (2 to 70) μg boron/L. (ibid)

D.3.2.3.4.2 Clopyralid (Sources: FS WSM ver. 6.00.07 & 6.00.10; SERA 2004a)

Exposure values for the scenarios displayed below are summarized in the "G" series Worksheets in FS WSM ver. 6.00.10: for mammals (G01a) and birds (G01b). For the analysis in this Program EIR, all exposure values for clopyralid have been computed for the typical application rate of 0.25 lb. a.e./acre, which is also the highest application rate that is legal in California.

By far the highest short-term acute exposures to clopyralid are associated with the consumption of contaminated grass by a small mammal (173 mg/kg bw/event) and a small bird (427 mg a.e./kg bw/event). The corresponding maximum chronic exposures are 90.9 mg/kg bw/day for a small mammal and 225 mg a.e./kg bw/day for a small bird. For both acute and chronic exposures, consumption of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This pattern is common in many herbicide exposure assessments, reflecting the consequences of direct applications to vegetation.

Hexachlorobenzene is a contaminant of clopyralid that may be of concern to terrestrial and aquatic animals. According to the SERA risk assessment for clopyralid (SERA 2004a, p. 3-23), hexachlorobenzene is: "*…. ubiquitous and persistent in the environment. The major sources of general exposure for the public to hexachlorobenzene involve industrial emissions, proximity to hazardous waste sites, and the consumption of contaminated food. Virtually all individuals are exposed to hexachlorobenzene and virtually all individuals have detectable concentrations of hexachlorobenzene in their bodies (ATSDR 2002).*"

Hexachlorobenzene is found at average concentrations of less than 2.5 ppm in technical grade clopyralid. It has a higher potential for human exposure than clopyralid itself, because the body is better able to absorb it. Hexachlorobenzene will bioconcentrate in fish and has a BCF that ranges from 2,000 to 20,000. For the Forest Service RA a BCF of 2,000 was used for acute exposure and a BCF of 20,000 for chronic exposure (SERA 2004a, p. 3-22).

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

Direct Spray – At the typical application rate, accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.435 mg/kg/event (first-order absorption of direct spray by a small mammal) to 12.1 mg/kg/event (100% absorption of direct spray by a small mammal). For birds, no exposure scenarios for direct spray are developed, as it is assumed that most birds will fly away during herbicide applications.

Dermal Contact with Contaminated Vegetation - Based on data for clopyralid, dislodgeable residue from the surface of contaminated vegetation will be approximately 10 times less than the highest application rate of 0.25 lb. a.e./acre. Since direct spray scenarios result in exposure levels below the estimated NOAEL, details of the exposure scenarios for contaminated vegetation are not elaborated. This adds relatively little uncertainty to the risk assessment, because the dominant route of exposure will be the consumption of contaminated vegetation.

Ingestion of Contaminated Vegetation or Prey - At the typical application rate, non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 1.15 mg/kg/event (consumption of a small mammal by a canid) to 173 mg/kg/event (consumption of grass by a small mammal). For birds, estimates of exposure range from 1.37 mg/kg/event (consumption of a small mammal by a carnivorous bird) to 427 mg/kg/event (consumption of short grass by a small bird).

Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.99 mg/kg/day (consumption of fruit by a large mammal) to 90.9 mg/kg/day (consumption of short grass by a small mammal). For birds, estimates of exposure range from 1.90 mg/kg/day (consumption of fruit by a large bird) to 225 mg/kg/day (consumption of short grass by a small bird).

Ingestion of Contaminated Water - At the typical application rate, accidental acute exposure scenarios for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.735 mg/kg/event (large mammal) to 1.66 mg/kg/event (small mammal). For birds, estimates of exposure range from 0.424 mg/kg/event (large bird) to 3.06mg/kg/event (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(latter values in parentheses) for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.00113 (0.00021) mg/kg/event(day) (large mammal) to 0.00256 (0.000476) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.000653 (0.000121) mg/kg/event(day) (large bird) to 0.00472 (0.000876) mg/kg/event(day) (small bird).

Ingestion of Contaminated Fish - Ambient water and fish are exposure pathways for clopyralid. As clopyralid has a low potential to bioconcentrate in fish, the bioconcentration factor for fish is taken as 1.0 L/kg for chronic exposure scenarios. For the scenario of accidental acute exposure from a spill into a pond, the upper bound estimates of exposure are 1.9 mg/kg/event (large mammalian carnivore), 2.74 mg/kg/event (canid), and 3.18 (fish-eating bird). The non-accidental acute exposure scenario for a large mammalian carnivore or a canid (value for canid in parentheses) consuming contaminated fish results in doses of 0.00293 (0.00422) mg/kg/event at the upper bound at the highest application rate. The corresponding value for a fish-eating bird is 0.0049 mg/kg/event. Chronic exposure values at the upper bound at the highest application rate are 0.000545 mg/kg/day (large mammalian carnivore) and 0.000784 mg/kg/day (canid). The corresponding value for a fish-eating bird is 0.000911 mg/kg/day.

Terrestrial Invertebrates

Concentrations of clopyralid in clay, loam, and sand over a wide range of rainfall rates are summarized in Table 4-2 in SERA 2004a (p. Tables-12). At the highest application rate of 0.25 lb a.e./acre, the estimated maximum concentrations of clopyralid in clay soil would range from about 0.066 lb. a.e./acre at an annual rainfall of 10 inches to 0.07 lb. a.e./acre at an annual rainfall of 100 inches. Due to percolation, concentrations in loam and sand soils would be less.

Only limited data is available on the toxicity of clopyralid to soil invertebrates and soil microorganisms. Since there is no information regarding the dermal absorption rate of clopyralid by bees or other invertebrates, an exposure scenario (100% absorption over one day) for a honeybee with a body weight of 0.093 g is used.

Terrestrial Plants (Macrophytes)

Direct Spray and Off-Site Drift - Unintended direct spray will result in an exposure level equivalent to the application rate. Estimates of off-site drift for ground applications of clopyralid, which is typically applied by low boom ground spray, are used in the SERA risk assessment. At the typical and maximum application rate of 0.25 lb. a.e./acre, drift is estimated to result in concentrations of clopyralid of 0.00875 lb. a.e./acre 25 feet from the application site to 0.00237 lb. a.e./acre 100 feet from the application site, the furthest distance away where there is still a concern for toxicity to non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from direct spray and off-site drift is in Worksheet G05 in FS WSM ver. 6.00.10.

Runoff and Soil Mobility – Runoff of minor amounts of clopyralid following broadcast applications, at the typical and highest application rate of 0.25 lb. a.e./acre, is estimated to begin occurring on clay soils at an annual rainfall rate of 15 inches (50 inches on loams and >250 inches on sand). Runoff is estimated to result in concentrations of clopyralid of 0.01075 lb. a.e./acre at 15 inches of rain to 0.09125 lb. a.e./acre at 100 inches, the annual rainfall rate where toxicity to non-target, sensitive plant species becomes problematic. A summary of both the exposure assessment and risk characterization for terrestrial plants from runoff is in Worksheet G04 in FS WSM ver. 6.00.10.

Based on the GLEAMS modeling, clopyralid may penetrate to about 18 inches in clay. In loam or sand, detectable residues are modeled to occur at 60 inches. Because the GLEAMS modeling used a 60-inch root zone, the actual penetration in loam or sand could be greater than 60 inches.

Contaminated Irrigation Water - Clopyralid is relatively mobile and contamination of ambient water is plausible. Based on the estimated concentrations of clopyralid in ambient water at the typical and highest application rate of 0.25 lb. a.e./acre, the estimated functional application rate of clopyralid to the irrigated area is 0.0011 lb. a.e./acre at an irrigation rate of 1 inch per day and 0.0079 lb. a.e./acre at an irrigation rate of 2 inches per day. Relative to off-site drift and runoff, this level of exposure is inconsequential. A summary of both the exposure assessment and risk characterization for terrestrial plants from contaminated irrigation water is in Worksheet G06a in FS WSM ver. 6.00.10.

Wind Erosion - Although no specific incidents of non-target damage from wind erosion have been encountered in the literature for clopyralid, this mechanism has been associated with the environmental transport of other herbicides. Wind erosion of minor amounts of clopyralid following broadcast applications, at the typical and highest application rate of 0.25 lb. a.e./acre, is estimated to result in concentrations of clopyralid of 0.000017 lb. a.e./acre at the central bound to 0.000034 lb. a.e./acre at the upper bound. Relative to off-site drift and runoff, this level of exposure is inconsequential and well below a LOC for non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from wind erosion is in Worksheet G06b in FS WSM ver. 6.00.10.

Aquatic Organisms

At the typical (and highest) application rate of 0.25 lb a.e./acre the peak estimated rate of contamination of ambient water associated with the normal application of clopyralid is 0.005 (0.00125 to 0.0175) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.00175 (0.00025 to 0.00325) mg a.e./L.

D.3.2.3.4.3 Glyphosate (Sources: FS WSM v. 6.00.10; SERA 2011b; U.S. EPA. 2009c)

The SERA risk assessment for glyphosate (SERA 2011b) displays a standard set of exposure assessments. All workbooks use a unit application rate of 1 lb. a.e./acre, but the exposure assessment in this Program EIR uses a typical application rate of 2 lbs. a.e./acre. Values displayed in SERA 2011b can be easily converted by multiplying them by whatever application rate is anticipated. Summaries of the exposure assessments are in Worksheet G01a (mammals), G01b (birds), and G08a (insects) in FS WSM ver. 6.00.10.

By far the highest short-term acute exposures to glyphosate are associated with the consumption of contaminated grass by a small mammal (1,380 mg/kg bw/event) and a small bird (3,420 mg a.e./kg bw/event). The corresponding maximum chronic exposures are 221 mg/kg bw/day for a small mammal and 547 mg a.e./kg bw/day for a small bird. For both acute and chronic exposures, consumption of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This pattern is common in many herbicide exposure assessments, reflecting the consequences of direct applications to vegetation.

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

The SERA risk assessment for terrestrial mammals and birds displays a standard set of exposure assessments (accidental, acute non-accidental, and chronic) for foliar applications of glyphosate, in Attachment 1a for backpack applications and in Attachment 1b for ground broadcast applications. As stated above, values displayed in those attachments can be easily converted by multiplying by 2, to reflect the typical rate of application.

The exposure assessments for terrestrial mammals, birds, reptiles, and amphibians (terrestrial phase) do not distinguish between the more or less toxic forms of glyphosate. Apparently, glyphosate becomes more toxic to aquatic species when certain surfactants are added to the formulation, most notably POEA. In this analysis, “more toxic” glyphosate includes such formulations.

Direct Spray – At the typical application rate, accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 1.15 mg/kg/event (first-order absorption of direct spray by a small mammal) to 97 mg/kg/event (100% absorption of direct spray by a small mammal). For birds, no exposure scenarios for direct spray are developed, as it is assumed that most birds will fly away during herbicide applications.

Ingestion of Contaminated Vegetation or Prey - At the typical application rate, non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 9.23 mg/kg/event (consumption of a small mammal by a canid) to 1,380 mg/kg/event (consumption of grass by a small mammal). For birds, estimates of exposure range from 11 mg/kg/event (consumption of a small mammal by a carnivorous bird) to 3,420 mg/kg/event (consumption of short grass by a small bird).

Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 2.41 mg/kg/day (consumption of fruit by a large mammal) to 221 mg/kg/day (consumption of short grass by a small mammal). For birds, estimates of exposure range from 4.61 mg/kg/day (consumption of fruit by a large bird) to 547 mg/kg/day (consumption of short grass by a small bird).

Ingestion of Contaminated Water - At the typical application rate, accidental acute exposure scenarios for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 2.35 mg/kg/event (large mammal) to 5.32 mg/kg/event (small mammal). For birds, estimates of exposure range from 1.36 mg/kg/event (large bird) to 9.8 mg/kg/event (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(values in parentheses) for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.0107 (0.000751) mg/kg/event(day) (large mammal) to 0.0243 (0.0017) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.0062 (0.000433) mg/kg/event(day) (large bird) to 0.0448 (0.00313) mg/kg/event(day) (small bird).

Ingestion of Contaminated Fish - Ambient water and fish are exposure pathways for glyphosate. As glyphosate has a low potential to bioconcentrate in fish, the bioconcentration factor for fish is taken as 0.52 L/kg for chronic exposure scenarios.

At the typical application rate, accidental acute exposure scenarios for consumption of contaminated fish lead to upper bound estimates of exposure for mammals ranging from 3.17 mg/kg/event (large mammalian carnivore) to 4.56 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 5.29 mg/kg/event. Non-accidental acute exposures lead to upper bound estimates of exposure for mammals ranging from 0.0145 mg/kg/event (large mammalian carnivore) to 0.0208 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.0242 mg/kg/event. Chronic exposures lead to upper bound estimates of exposure for mammals ranging from 0.0010 mg/kg/event (large mammalian carnivore) to 0.0015 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.00169 mg/kg/event.

Terrestrial Invertebrates

The exposure assessments for terrestrial invertebrates do not distinguish between the more or less toxic forms of glyphosate. Honeybees are used as a surrogate for other terrestrial insects as available toxicity data on terrestrial invertebrates do not support the derivation of separate toxicity values for different groups of terrestrial insects.

Direct Spray and Off-Site Drift – A summary of the exposure assessments and risk characterization for the honeybee for the scenarios of direct spray and drift is in G09 in FS WSM ver. 6.00.10. Exposure from direct spray is shown for three scenarios (0%, 50%, and 90% foliar interception), none of which lead to a HQ above the LOC. The absorbed doses are 137.2, 68.6, and 13.7 mg/kg bw/event, respectively. The absorbed doses from spray drift 25 feet from the application site are 4.8, 2.4, and 0.5 mg/kg bw/event, respectively.

Ingestion of Contaminated Vegetation or Prey - Four non-accidental acute exposure scenarios of a herbivorous insect consuming vegetation were developed. For a large insect consuming fruit, the estimated dose at the typical application rate of 2 lbs. a.e./acre, is 18.2 mg/kg bw/event (central bound) and 66 mg/kg bw/event (upper bound). For a small insect consuming broadleaf foliage, the estimated dose is 117 mg/kg bw/event (central) and 594 mg/kg bw/event (upper). For an insect consuming tall and short grass (the latter value in parentheses), the estimated dose is 93.6 (221) mg/kg bw/event (central) and 484 (1,056) mg/kg bw/event (upper).

Contact with Contaminated Soil - Concentrations of glyphosate in clay, loam, and sand over a wide range of site conditions are summarized in Table 4-2 in SERA 2004a (p. Tables-12). At the typical application rate of 2 lb a.e./acre, the estimated maximum concentrations of glyphosate in the top 12 inches of clay soil would range from about 0.283 lb. a.e./acre in dry, warm locations to 0.243 lb. a.e./acre in wet, cool locations. Due to percolation, concentrations in loam and sand soils would be less; 0.176 lb. a.e./acre in dry, warm locations to 0.172 lb. a.e./acre in wet, cool locations.

Terrestrial Plants (Macrophytes)

Direct Spray and Off-Site Drift - Unintended direct spray will result in an exposure level equivalent to the application rate. Estimates of off-site drift for broadcast ground applications of glyphosate are calculated in the SERA risk assessment. At the typical application rate of 2 lb. a.e./acre, drift is estimated to result in concentrations of clopyralid of 0.01664 lb./acre 25 feet from the application site to 0.00482 lb./acre 100 feet from the application site, the furthest distance away where there is still a concern for toxicity to non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from direct spray and off-site drift is in Worksheet G05 in FS WSM ver. 6.00.10.

Runoff and Soil Mobility – For glyphosate, there is no rainfall-specific information for runoff displayed in Worksheet G04 in FS WSM ver. 6.00.10. Information on the relationship between site conditions and runoff rates is displayed in SERA 2011b, Appendix 10, Table 1, p. 116. The effective off-site application rate from runoff in clay soils ranges from 0.000104 lb a.e./acre in dry and warm locations to 0.036 lb a.e./acre in wet and cool locations. In loam and sand soils (values for sand in parentheses) these values range from 0.0 lb a.e./acre in dry and warm locations to 0.0058 (0.00057) lb a.e./acre in wet and cool locations.

Based on the GLEAMS modeling, detectable residues of glyphosate may penetrate to a depth of about 4-12 inches in clay soils, resulting in concentrations in the top 12 inches of soil of 0.283 ppm in dry and warm locations to 0.243 ppm in wet and cool locations. In loam soils, detectable residues may penetrate to about 4-12 inches (4-18 inches for sandy soils), resulting in concentrations of 0.176 ppm in dry and warm locations to 0.172 ppm in wet and cool locations.

Contaminated Irrigation Water - Glyphosate is not likely to contaminate ambient water. Based on the estimated concentrations of glyphosate in ambient water at the typical application rate of 2 lb. a.e./acre, the estimated functional application rate of glyphosate to the irrigated area is 0.0050 lb. a.e./acre at an irrigation rate of 1 inch per day and 0.075 lb. a.e./acre at an irrigation rate of 2 inches per day. Relative to off-site drift and runoff, this level of exposure is inconsequential. A summary of both the exposure assessment and risk characterization for terrestrial plants from contaminated irrigation water is in Worksheet G06a in FS WSM ver. 6.00.10.

Wind Erosion - Although no specific incidents of non-target damage from wind erosion have been encountered in the literature for glyphosate, this mechanism has been associated with the environmental transport of other herbicides. Wind erosion of minor amounts of glyphosate following broadcast applications, at the typical application rate of 2 lb. a.e./acre, is estimated to result in concentrations of glyphosate of 0.000137lb. a.e./acre at the central bound to 0.000274 lb. a.e./acre at the upper bound. Relative to off-site drift and runoff, this level of exposure is inconsequential and well below a LOC for non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from wind erosion is in Worksheet G06b in FS WSM ver. 6.00.10.

Aquatic Organisms

The plausibility of effects on aquatic species is assessed based on estimated concentrations of glyphosate in water that are identical to those used in the human health risk assessment. At the typical application rate of 2 lb a.e./acre, the peak estimated rate of contamination of ambient water associated with the normal application of glyphosate is 0.042 (0.0013 to 0.083) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.0029 (0.000088 to 0.0058) mg a.e./L.

D.3.2.3.4.4 Hexazinone (Sources: FS WSM v. 6.00.10; SERA 2005)

Exposure values for the scenarios displayed below are summarized in the "G" series Worksheets in FS WSM ver. 6.00.10: for mammals (G01a) and birds (G01b). For the analysis in this Program EIR, all exposure values for liquid and granular hexazinone have been computed for the typical application rate of 2 lb. a.i./acre.

In the SERA 2005 risk assessment, no exposure scenarios were developed for granular formulations of hexazinone, as the clay pellets were thought not to stick to mammals or other ecological receptors. Also, data for adjusting estimates of pellet deposition were not available. It was thought that risks were far below a LOC and any overestimate of exposure would have no impact on the characterization of risk.

However, two sets of exposure scenarios are provided in the 2012 version of the EXCEL workbooks. One workbook covers Velpar L, the only liquid formulation considered in this risk assessment, and the other covers the granular formulations. Although these assessments are generally similar in nature, some of the computational details differ in ways that are mandated by differences between granular and liquid formulations. There is also a substantial difference in the amount of residue on contaminated vegetation, with much higher residues expected after the application of Velpar L compared to the granular formulations.

By far the highest short-term acute exposures to liquid and granular (the latter values in parentheses) formulations of hexazinone are associated with the consumption of grass, 1,380 (55.3) mg/kg bw/event (small mammal) and 3,420 (137) mg a.e./kg bw/event (small bird). The corresponding maximum chronic exposures are 581 (23.3) mg/kg bw/day for a small mammal and 1,440 (57.5) mg a.e./kg bw/day for a small bird. For both acute and chronic exposures, consumption of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This pattern is common in many herbicide exposure assessments, reflecting the consequences of direct applications to vegetation.

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

Direct Spray – At the typical application rate, accidental acute exposure scenarios for liquid and granular (values in parentheses) formulations of hexazinone lead to upper bound estimates of exposure for mammals ranging from 5.28 (0.0109) mg/kg/event (first-order absorption of direct spray by a small mammal) to 97 (3.0) mg/kg/event (100% absorption of direct spray by a small mammal). For birds, no exposure scenarios for direct spray are developed, as it is assumed that most birds will fly away during herbicide applications.

Ingestion of Contaminated Vegetation or Prey – Residues on vegetation are likely to be much greater after applications of Velpar L compared to applications of the granular formulations. Standard residue rates are used directly in the Velpar L worksheets but are divided by a factor of 25 for applications of granular formulations.

At the typical application rate, non-accidental acute exposure scenarios for liquid and granular (values in parentheses) formulations of hexazinone lead to upper bound estimates of exposure for mammals ranging from 9.23 mg/kg/event (consumption of a small mammal by a canid) to 1,380 (55.3) mg/kg/event (consumption of grass by a small mammal). The lower estimate for the granular formulation is 0.602 mg/kg/event (consumption of fruit by a large mammal). For birds, estimates of exposure range from 11 mg/kg/event (consumption of a small mammal by a carnivorous bird) to 3,420 (137) mg/kg/event (consumption of short grass by a small bird). The lower estimate for the granular formulation is 1.15 mg/kg/event (consumption of fruit by a large bird).

Chronic exposure scenarios for liquid and granular (values in parentheses) formulations of hexazinone lead to upper bound estimates of exposure for mammals ranging from 6.33 (0.253) mg/kg/day (consumption of fruit by a large mammal) to 581 (23.3) mg/kg/day (consumption of short grass by a small mammal). For birds, estimates of exposure range from 12.1 (0.485) mg/kg/day (consumption of fruit by a large bird) to 1,440 (57.5) mg/kg/day (consumption of short grass by a small bird).

Ingestion of Contaminated Water – Since estimates of the variability of water consumption by mammals, birds, reptiles, and terrestrial amphibians are not available, for the acute scenario, the only factors affecting the estimate of the ingested dose include the amount of solution that is spilled and the field dilution rates. For liquid formulations (Velpar L), the amount of the spilled solution is the standard amount used for exposure assessments, 200 gallons. For granular formulations, the amount spilled is calculated in pounds based on the number of acres that would be treated with the corresponding liquid formulation(s) and the range of application rates covered by this risk assessment. Variability in the exposure scenario involving ponds or streams contaminated by runoff or percolation is affected by the water contamination rate and the herbicide application rate.

At the typical application rate, accidental acute exposure scenarios for both formulations of hexazinone for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 2.35 mg/kg/event (large mammal) to 5.32 mg/kg/event (small mammal). For birds, estimates of exposure range from 1.36 mg/kg/event (large bird) to 9.8 mg/kg/event (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(values in parentheses) for both formulations of hexazinone for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.0518 (0.0205) mg/kg/event(day) (large mammal) to 0.117 (0.00906) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.0299 (0.00523) mg/kg/event(day) (large bird) to 0.216 (0.0378) mg/kg/event(day) (small bird).

Ingestion of Contaminated Fish - Ambient water and fish are exposure pathways for hexazinone. As hexazinone has a low potential to bioconcentrate in fish, the bioconcentration factor for fish is taken as 2 L/kg for chronic exposure scenarios.

At the typical application rate, accidental acute exposure scenarios for both formulations of hexazinone for consumption of contaminated fish lead to upper bound estimates of exposure for mammals ranging from 12.2 mg/kg/event (large mammalian carnivore) to 17.5 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 20.4 mg/kg/event. Non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.268 mg/kg/event (large mammalian carnivore) to 0.386 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.0448 mg/kg/event. Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.0469 mg/kg/event (large mammalian carnivore) to 0.0676 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.0785 mg/kg/event.

Terrestrial Invertebrates

Direct Spray and Drift – No specific information on exposure to terrestrial invertebrates from direct spray or off-site drift of hexazinone is available in the SERA 2005 risk assessment. The application rate and the amount of drift will be the same as for plants (see below) and will determine the maximum dose that terrestrial invertebrates could be exposed to.

Ingestion of Contaminated Vegetation or Prey - No specific information on exposure to terrestrial invertebrates from ingestion of contaminated vegetation or prey of hexazinone is available in the SERA 2004c risk assessment. It seems likely that the routes of exposure modeled for some other herbicides analyzed in this Program EIR would be similar, with similar exposure levels. For those herbicides, four non-accidental acute exposure scenarios were developed for herbivorous insects consuming vegetation contaminated by herbicide residues. The highest anticipated dose was to a small insect consuming broadleaf vegetation, followed by an insect consuming tall or short grass, and lastly, by a large insect consuming fruit.

Contact with Contaminated Soil - Only limited data are available on the toxicity of hexazinone to soil invertebrates and microorganisms. The data on soil invertebrates are only semi-quantitative and the effects reported are not associated with soil concentrations of hexazinone.

Concentrations of hexazinone in clay, loam, and sand over a wide range of site conditions are summarized in Table 4-3 in SERA 2005 (p. Tables 1-25). At the typical application rate of 2 lb a.i./acre, the estimated maximum concentrations of hexazinone in the top 12 inches of clay soil would range from about 0.147 ppm at 10 inches of annual rainfall to 0.0752 ppm at 100 inches. Due to percolation, concentrations in loam and sand soils would be less; 0.139 (0.119) ppm at 10 inches of annual rainfall and 0.215 (0.168) ppm at 100 inches.

Terrestrial Plants (Macrophytes)

Direct Spray and Off-Site Drift - Unintended direct spray will result in an exposure level equivalent to the application rate. Estimates of off-site drift for ground applications of the liquid formulation hexazinone, which is typically applied by low boom ground spray, are used in the SERA risk assessment. At the typical application rate of 2 lb. a.i./acre, drift is estimated to result in concentrations of hexazinone of 0.07 lb./acre 25 feet from the application site to 0.01896 lb./acre 100 feet from the application site, the furthest distance away where there is still a concern for toxicity to non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from direct spray and off-site drift is in Worksheet G05 in FS WSM ver. 6.00.10 for the liquid formulation (but not granular) of hexazinone.

Runoff and Soil Mobility – Runoff of minor amounts of both the liquid and granular formulations of hexazinone following broadcast applications, at the typical application rate of 2 lb. a.i./acre, is estimated to begin occurring on clay soils at an annual rainfall rate of 15 inches (50 inches on loams and >250 inches on sand). Runoff is estimated to result in concentrations of hexazinone of 0.10 lb. a.e./acre at 15 inches of rain to 0.894 lb. a.e./acre at 100 inches. Toxicity to non-target, sensitive plant species from runoff from clay soils becomes problematic at an annual rainfall rate of 15 inches and severe at 100 inches. Even for tolerant species, exposures become problematic at an annual rainfall rate of 15 inches, but are much less severe. A summary of both the exposure assessment and risk characterization for terrestrial plants from runoff is in Worksheet G04 in FS WSM ver. 6.00.10.

Based on the GLEAMS modeling, detectable residues of hexazinone may penetrate to a depth of about 18-36 inches in clay soils, 42->60 inches in loam soils, and >60 inches in sand at annual rainfall rates of 15-100 inches (SERA 2005, Table 4-5). The detectable concentrations of hexazinone in the top 12 inches of clay soil average from 0.274 ppm (rainfall 15") to 0.1504 ppm (rainfall 100"). In loam soil, concentrations average 0.25 ppm (rainfall 15") and 0.0836 ppm (rainfall 100") and in sandy soils, concentrations average

0.1924 ppm (rainfall 15”) and 0.0248 ppm (rainfall 100”) (SERA 2005, Table 4-3). These estimates are consistent with the field monitoring studies reporting soil penetration.

Contaminated Irrigation Water - Hexazinone is highly mobile and contamination of ambient water may be anticipated. Based on the estimated concentrations of hexazinone in ambient water at the typical application rate of 2 lb. a.i./acre, the estimated functional application rate of hexazinone to the irrigated area is 0.0453 lb. a.e./acre at an irrigation rate of 1 inch per day and 0.3625 lb. a.e./acre at an irrigation rate of 2 inches per day. A summary of both the exposure assessment and risk characterization for terrestrial plants from contaminated irrigation water is in Worksheet G06a in FS WSM ver. 6.00.10.

Wind Erosion - Although no specific incidents of non-target damage from wind erosion have been encountered in the literature for hexazinone, this mechanism has been associated with the environmental transport of other herbicides. While somewhat speculative, it seems plausible that granular formulations would be more susceptible to wind erosion than liquid formulations. Since no data have been located that would permit a quantitative adjustment in estimates of off-site transport, the worksheets for the two formulations are identical.

Wind erosion of minor amounts of hexazinone following broadcast applications, at the typical application rate of 2 lb. a.i./acre, is estimated to result in concentrations of hexazinone of 0.000137 lb. a.e./acre at the central bound to 0.000274 lb. a.e./acre at the upper bound. Relative to off-site drift and runoff, this level of exposure is inconsequential and well below a LOC for non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from wind erosion is in Worksheet G06b in FS WSM ver. 6.00.10.

Aquatic Organisms

The plausibility of effects on aquatic species is based on estimated concentrations of hexazinone in water that are identical to those used in the human health risk assessment. At the typical application rate of 2 lb a.i./acre, the peak estimated rate of contamination of ambient water associated with the normal application of hexazinone is 0.200 (0.0005 to 0.4) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.035 (0.00001 to 0.07) mg a.e./L.

D.3.2.3.4.5 Imazapyr (Sources: FS WSM v. 6.00.10; SERA 2011c; U.S. EPA 2006d)

Exposure values for the scenarios displayed below are summarized in the “G” series Worksheets in FS WSM ver. 6.00.10: for mammals (G01a), birds (G01b), and insects (G08a). For the analysis in this Program EIR, all exposure values for imazapyr have been computed for the typical application rate of 0.30 lb. a.e./acre.

By far the highest short-term acute exposures to imazapyr are associated with the consumption of contaminated grass by a small mammal (207 mg/kg bw/event) and a small bird (513 mg a.e./kg bw/event). The corresponding maximum chronic exposures are 100 mg/kg bw/day for a small mammal and 248 mg a.e./kg bw/day for a small bird. For both acute and chronic exposures, consumption of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This pattern is common in many herbicide exposure assessments, reflecting the consequences of direct applications to vegetation.

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

Direct Spray – At the typical application rate, accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.489 mg/kg/event (first-order absorption of direct spray by a small mammal) to 14.5 mg/kg/event (100% absorption of direct spray by a small mammal). For birds, no exposure scenarios for direct spray are developed, as it is assumed that most birds will fly away during herbicide applications.

Ingestion of Contaminated Vegetation or Prey - At the typical application rate, non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 1.38 mg/kg/event (consumption of a small mammal by a canid) to 207 mg/kg/event (consumption of grass by a small mammal). For birds, estimates of exposure range from 1.65 mg/kg/event (consumption of a small mammal by a carnivorous bird) to 513 mg/kg/event (consumption of short grass by a small bird).

Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 1.09 mg/kg/day (consumption of fruit by a large mammal) to 100 mg/kg/day (consumption of short grass by a small mammal). For birds, estimates of exposure range from 2.09 mg/kg/day (consumption of fruit by a large bird) to 248 mg/kg/day (consumption of short grass by a small bird).

Ingestion of Contaminated Water - At the typical application rate, accidental acute exposure scenarios for consumption of contaminated water from a spill lead to upper bound estimates of exposure for mammals ranging from 0.353 mg/kg/event (large mammal) to 0.798 mg/kg/event (small mammal). For birds, estimates of exposure range from 0.204 mg/kg/event (large bird) to 1.47 mg/kg/event (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(values in parentheses) for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.00505 (0.00233) mg/kg/event(day) (large mammal) to 0.0114 (0.00527) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.00291 (0.00134) mg/kg/event(day) (large bird) to 0.0210 (0.00971) mg/kg/event(day) (small bird).

Ingestion of Contaminated Fish - Ambient water and fish are exposure pathways for imazapyr. As imazapyr has a low potential to bioconcentrate in fish, the bioconcentration factor for fish is taken as 0.5 L/kg f for chronic exposure scenarios.

At the typical application rate, accidental acute exposure scenarios for consumption of contaminated fish lead to upper bound estimates of exposure for mammals ranging from 0.457 mg/kg/event (large mammalian carnivore) to 0.658 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.764 mg/kg/event. Non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.00654 mg/kg/event (large mammalian carnivore) to 0.00941 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.0109 mg/kg/event. Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.00302 mg/kg/day (large mammalian carnivore) to 0.00434 mg/kg/day (canid). For birds, the estimated exposure of a fish-eating bird is 0.00504 mg/kg/day.

Terrestrial Invertebrates

Direct Spray and Drift - A summary of the exposure assessments and risk characterization for the honeybee for the scenarios of direct spray and drift of imazapyr is in G09 in FS WSM ver. 6.00.10. Exposure from direct spray is shown for three scenarios (0%, 50%, and 90% foliar interception), none of which lead to a HQ above the LOC. The absorbed doses are 20.6, 10.3, and 2.1 mg/kg bw/event, respectively. The absorbed doses from spray drift 25 feet from the application site are0.72, 0.36, and 0.07 mg/kg bw/event, respectively.

Ingestion of Contaminated Vegetation or Prey - Four non-accidental acute exposure scenarios were developed for herbivorous insects consuming vegetation contaminated by residues of imazapyr. For a large insect consuming fruit, the estimated dose at the typical application rate of 0.30 lbs. a.e./acre, is 2.73 mg/kg bw/event (central bound) and 9.9 mg/kg bw/event (upper bound). For a small insect consuming broadleaf foliage, the estimated dose is 17.6 mg/kg bw/event (central) and 89.1 mg/kg bw/event (upper). For an insect consuming tall and short grass (the latter value in parentheses), the estimated dose is 14.04 (33.2) mg/kg bw/event (central) and 72.6 (158) mg/kg bw/event (upper).

Contact with Contaminated Soil - Based on the GLEAMS modeling, imazapyr may penetrate to 36 inches in clay, loam, and sand soils. Because the GLEAMS modeling used a 36-inch root zone, the actual penetration of imazapyr could be greater than 36 inches.

Terrestrial Plants (Macrophytes)

Direct Spray and Off-Site Drift - Unintended direct spray will result in an exposure level equivalent to the application rate. Estimates of off-site drift for broadcast ground applications of imazapyr are used in the SERA risk assessment. At the typical application rate of 0.30 lb. a.e./acre, drift is estimated to result in concentrations of imazapyr of 0.0105 lb./acre 25 feet from the application site to 0.000327 lb./acre 900 feet from the application site, where adverse effects to non-target, sensitive plant species are still plausible. There are no concerns for tolerant species, even at the application site. A summary of both the exposure assessment and risk characterization for terrestrial plants from direct spray and off-site drift is in Worksheet G05 in FS WSM ver. 6.00.10.

Runoff and Soil Mobility – For imazapyr, there is no rainfall-specific information for runoff displayed in Worksheet G04 in FS WSM ver. 6.00.10. Information on the relationship between site conditions and runoff rates is displayed in SERA 2011c, Appendix 7, Table 1, p. 196. The effective off-site application rate from runoff in clay soils ranges from 0.00106 lb a.e./acre in dry and warm locations to 0.12 lb a.e./acre in wet and cool locations. In loam and sand soils (values for sand in parentheses) these values range from 0.0 (0.0) lb a.e./acre in dry and warm locations to 0.0093 (0.0) lb a.e./acre in wet and cool locations.

Based on the GLEAMS modeling, detectable residues of imazapyr may penetrate to a depth of about 4-36 inches in clay soils, resulting in concentrations in the top 12 inches of soil of 0.27 ppm in dry and warm locations and 0.211 ppm in wet and cool locations. In loam and sand soils (values for sand in parentheses), detectable residues may penetrate to about 4-36 inches, resulting in concentrations of 0.241 (0.209) ppm in dry and warm locations to 0.198 (0.17) ppm in wet and cool locations.

Contaminated Irrigation Water - Imazapyr is relatively mobile and contamination of ambient water may be anticipated. Based on the estimated concentrations of imazapyr in ambient water at the typical application rate of 0.30 lb. a.e./acre, the estimated functional application rate of imazapyr to the irrigated area is 0.00136 lb. a.e./acre at an irrigation rate of 1 inch per day and 0.0353 lb. a.e./acre at an irrigation rate of 2 inches per day. Relative to off-site drift and runoff, this level of exposure is inconsequential. A summary of both the exposure assessment and risk characterization for terrestrial plants from contaminated irrigation water is in Worksheet G06a in FS WSM ver. 6.00.10.

The Re-registration Eligibility Decision for imazapyr notes that water that contains imazapyr residues should not be used for irrigation. Product labels for the formulations listed in SERA 2011c (Table 2) include restrictions to limit the use of water for crop irrigation that may contain imazapyr residues. While perhaps not relevant to imazapyr, the exposure assessment in this Program EIR is included for consistency with other herbicide risk assessments and to enable assessment of the consequences of disregarding the labeled use restrictions.

Wind Erosion - Although no specific incidents of non-target damage from wind erosion have been encountered in the literature for clopyralid, this mechanism has been associated with the environmental transport of other herbicides. Wind erosion of minor amounts of imazapyr following broadcast applications, at the typical application rate of 0.30 lb. a.e./acre, is estimated to result in concentrations of imazapyr of 0.000055 lb. a.e./acre at the central bound to 0.000041 lb. a.e./acre at the upper bound. Relative to off-site drift and runoff, this level of exposure is inconsequential and well below a LOC for non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from wind erosion is in Worksheet G06b in FS WSM ver. 6.00.10.

Aquatic Organisms

At the typical application rate of 0.30 lb a.e./acre, the peak estimated rate of contamination of ambient water associated with the normal application of imazapyr is 0.13 (0.000009 to 0.26) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.06 (0.000003 to 0.12) mg a.e./L.

D.3.2.3.4.6 NP9E (Sources: FS WS ver. 2.02; USDA/FS 2003b; U.S. EPA 2010e)

Exposure values for the scenarios displayed below are summarized in the Worksheet in FS WSM ver. 6.00.10: for mammals and birds (WL Ex1). For the analysis in this Program EIR, all exposure values for NP9E have been computed for the typical application rate of 1.67 lb. a.i./acre.

By far the highest short-term acute exposures to NP9E are associated with the consumption of contaminated vegetation by a large mammal (324 mg/kg bw/event) and a large bird (508 mg a.e./kg bw/event). The corresponding maximum chronic exposures are 0.0822 (off-site), 520 (on-site) mg/kg bw/day for a large mammal and 0.129 (off-site), 8.14 (on-site) mg a.e./kg bw/day for a large bird. For both acute and chronic exposures, consumption of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This pattern is common in many herbicide exposure assessments, reflecting the consequences of direct applications to vegetation. Because of the apparently low toxicity of NP9E to animals, the rather substantial variations in the different exposure assessments have little impact on the assessment of risk to terrestrial animals.

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

Direct Spray – At the typical application rate, accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.00107 mg/kg/event (100% absorption by a honeybee) to 3.46 mg/kg/event (first-order absorption of direct spray by a small mammal) to 162 mg/kg/event (100% absorption of direct spray by a small mammal). For birds, no exposure scenarios for direct spray are developed, as it is assumed that most birds will fly away during herbicide applications.

Dermal Contact with Contaminated Vegetation - Neither the bioconcentration data on NP9E or the estimated rates of dermal absorption in humans indicate that NP9E is likely to preferentially partition from the surface of contaminated vegetation to the surface of skin, feathers, or fur, which supports a plausible partition coefficient of unity (i.e., the concentration of the chemical on the surface of the animal will be equal to the dislodgeable residue on the vegetation).

Ingestion of Contaminated Vegetation or Prey – As stated in USDA/FS 2003b, p. 50: "*For estimating the effects of longer-term exposures, time-weighted average concentrations are used, which is similar to the approach taken in the human health risk assessment and using the same estimates of foliar halftime as were used in the corresponding human health risk assessment. Also, the longer term exposure scenario is based on a 90-day post-spray period and uses the geometric mean over this period as the central estimate of the exposed dose, as in the human health risk assessment. Like the acute exposure scenario, this exposure scenario assumes that 100% of the diet is contaminated.*"

At the typical application rate, non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 17.9 mg/kg/event (consumption of vegetation by a small mammal) to 324 mg/kg/event (consumption of vegetation by a large mammal). For birds, the estimated exposure for consumption of vegetation by a large bird is 508 mg/kg/event.

Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.000906 (off-site), 0.0574 (on-site) mg/kg/day (consumption of vegetation by a small mammal) to 0.0822 (off-site), 520 (on-site) mg/kg/day (consumption of vegetation by a large mammal). For birds, the estimated exposure is 0.129 (off-site), 8.14 (on-site) mg/kg/event (consumption of vegetation by a large bird).

Ingestion of Contaminated Water - At the typical application rate, the accidental acute exposure scenario for a small mammal drinking from a pond after a spill leads to an estimated dose of 2.22 mg/kg/event. The non-accidental scenario of a small mammal drinking from a stream contaminated by runoff or percolation through the soil leads to an upper bound estimate of exposure of 0.00457 mg/kg/event. For chronic exposure, for a small mammal, the dose is 0.00205 mg/kg/day.

Ingestion of Contaminated Fish - Ambient water and fish are exposure pathways for NP9E. As NP9E has a low potential to bioconcentrate in fish, the bioconcentration factor for fish is taken as 1 L/kg for chronic exposure scenarios. The only scenario for ingestion of contaminated fish involves a predatory bird. The acute accidental dose is 2.27 mg/kg/event and the chronic dose is 0.0021 mg/kg/day.

Terrestrial Invertebrates

Direct Spray and Drift – There is no information for NP9E in the Worksheet or in USDA/FS 2003b specific to these scenarios. For other herbicides analyzed in this Program EIR, exposure from direct spray and off-site drift is shown for three scenarios (0%, 50%, and 90% foliar interception). In the case of imazapyr, none of these scenarios leads to absorbed doses above the LOC at the application site. At a distance of 25 feet from the application site, absorbed doses are close to 30 times lower. It is plausible that NP9E would follow a similar pattern.

Ingestion of Contaminated Vegetation or Prey - There is no information for NP9E in the Worksheet or in USDA/FS 2003b specific to these scenarios. For other herbicides analyzed in this Program EIR, four non-accidental acute exposure scenarios were developed for herbivorous insects consuming contaminated fruit, broadleaf vegetation, and grass.

Contact with Contaminated Soil - There is some concern that surfactants might increase the movement of herbicides into soils. In one study, levels of nonionic NPE-based surfactants at concentrations below 1000 mg/L caused little or no decrease in sorption of a fungicide, but at 10,000 mg/L, an increase in sorption was seen.

Terrestrial Plants (Macrophytes)

Direct Spray and Off-Site Drift - Unintended direct spray will result in an exposure level equivalent to the application rate of 1.67 lb. a.i./acre. There is no information for NP9E in the Worksheet or in USDA/FS 2003b specific to off-site drift or to the toxicity of NP9E to terrestrial plants. Since NP9E-based surfactants would not be applied alone, but would be applied in a mix with an herbicide, the herbicide would determine the effects to terrestrial plants.

Runoff and Soil Mobility – The dose-response assessment in USDA/FS 2003b did not support a quantitative assessment and no GLEAMS modeling was conducted, so no information is available for an assessment of NP9E. Since NP9E-based surfactants would not be applied alone, but would be applied in a mix with an herbicide, the herbicide would determine the effects to terrestrial plants.

Contaminated Irrigation Water - There is no information for NP9E in the Worksheet or in USDA/FS 2003b specific to the effects of contaminated irrigation water. Since NP9E-based surfactants would not be applied alone, but would be applied in a mix with an herbicide, the herbicide would determine the effects to terrestrial plants.

Wind Erosion - There is no information for NP9E in the Worksheet or in USDA/FS 2003b specific to the effects from wind erosion. Since NP9E-based surfactants would not be applied alone, but would be applied in a mix with an herbicide, the herbicide would determine the effects to terrestrial plants.

Aquatic Organisms

As stated in USDA/FS 2003b, p. 51:

The potential for effects on aquatic species are based on estimated concentrations of NP9E or NP1-2EC in water that are identical to those used in the human health risk assessment. The estimated rate of contamination of ambient water associated with the normal application of NP9E is 0.0125 mg a.e./L (12.5 ppb). For acute exposure scenarios, the highest estimated concentration of NP9E in water after an accidental spill is about 6.1 mg a.e./L (ppm) with a range of about 3.0 to 15.1 mg a.e./L. As another exposure scenario, if the Forest Service were to overspray an herbicide mixture with an 80% NPE-based surfactant into a small pond or stagnant stream reach, with no foliar interception, instantaneous levels of NP9E could approach 1.5 mg/L (1,500 ppb) and the concentration of NP and the short-chain ethoxylates (NP1E and NP2E) could approach (0.075 mg/L (75 ppb) (refer to worksheet 1 in Appendix 1). Assuming a more realistic live stream, these levels would be quickly lowered as water is mixed through stream flow.

As discussed in section 3.2.3.3, the breakdown of NPE would likely not liberate NP, and any free NP in the surfactant would be broken down in the forested environment or bound to soil particles. Therefore, it is very unlikely that NP would be found in forest streams above the level that might be found in the NP9E mixture originally. As stated in section 4.3, the acute toxicity of NP9E includes this small percentage of NP and short-chain NPEs, so no adjustment for acute exposures is necessary.

Based on environmental fate, the toxicological compound of interest is more likely to be the short chain NPECs (NP1EC, NP2EC), as they will be formed in the forested environment and their persistence would make them more available for aquatic wildlife exposure and for exposure to terrestrial wildlife through water consumption. As stated in section 3.2.3.3.2, the assumed levels of NP1-2EC in water will be based on water monitoring and set at 0.007 mg/L (with a range of 0 to 0.014 mg/L).

D.3.2.3.4.7 Sulfometuron methyl (Sources: FS WSM v. 6.00.10; SERA 2004c; U.S. EPA 2008a, 2009g)

Exposure values for the scenarios displayed below are summarized in the “G” series Worksheets in FS WSM ver. 6.00.10: for mammals (G01a) and birds (G01b). For the analysis in this Program EIR, all exposure values for sulfometuron methyl have been computed for the typical application rate of 0.045 lb. a.e./acre.

By far the highest short-term acute exposures to sulfometuron methyl are associated with the consumption of contaminated grass by a small mammal (31.1 mg/kg bw/event) and a small bird (76.9 mg a.e./kg bw/event). The corresponding maximum chronic exposures are 4.97mg/kg bw/day for a small mammal and 12.3 mg a.e./kg bw/day for a small bird. For both acute and chronic exposures, consumption of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This pattern is common in many herbicide exposure assessments, reflecting the consequences of direct applications to vegetation.

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

Direct Spray – At the typical application rate, accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.0254 mg/kg/event (first-order absorption of direct spray by a small mammal) to 2.18 mg/kg/event (100% absorption of direct spray by a small mammal). For birds, no exposure scenarios for direct spray are developed, as it is assumed that most birds will fly away during herbicide applications.

Ingestion of Contaminated Vegetation or Prey - At the typical application rate, non-accidental acute exposure scenarios for sulfometuron methyl lead to upper bound estimates of exposure for mammals ranging from 0.208 mg/kg/event (consumption of a small mammal by a canid) to 31.1 mg/kg/event (consumption of grass by a small mammal). For birds, estimates of exposure range from 0.247 mg/kg/event (consumption of a small mammal by a carnivorous bird) to 76.9 mg/kg/event (consumption of short grass by a small bird).

Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.0542 mg/kg/day (consumption of fruit by a large mammal) to 4.97 mg/kg/ day (consumption of short grass by a small mammal). For birds, estimates of exposure range from 0.104 mg/kg/ day (consumption of fruit by a large bird) to 12.3 mg/kg/ day (consumption of short grass by a small bird).

Ingestion of Contaminated Water - At the typical application rate, accidental acute exposure scenarios for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.0539 mg/kg/event (large mammal) to 0.122 mg/kg/event (small mammal). For birds, estimates of exposure range from 0.0311 mg/kg/event (large bird) to 0.225 mg/kg/event (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(values in parentheses) for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.0000583 (0.000000204) mg/kg/event(day) (large mammal) to 0.000132 (0.000000461) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.0000336 (0.000000118) mg/kg/event(day) (large bird) to 0.000243 (0.000000849) mg/kg/event(day) (small bird).

Ingestion of Contaminated Fish - Ambient water and fish are exposure pathways for sulfometuron methyl. Sulfometuron methyl may bioconcentrate to a small degree in the muscle and viscera of fish. The bioconcentration factor for fish is taken as 7 L/kg for chronic exposure scenarios.

At the typical application rate, accidental acute exposure scenarios for consumption of contaminated fish lead to upper bound estimates of exposure for mammals ranging from 0.977 mg/kg/event (large mammalian carnivore) to 1.41 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 1.63 mg/kg/event. Non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.00106 mg/kg/event (large mammalian carnivore) to 0.00152 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.00177 mg/kg/event. Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.0000037 mg/kg/day (large mammalian carnivore) to 0.00000532 mg/kg/day (canid). For birds, the estimated exposure of a fish-eating bird is 0.00000618 mg/kg/day.

Terrestrial Invertebrates

Direct Spray and Drift – No specific information on exposure to terrestrial invertebrates from direct spray or off-site drift of sulfometuron methyl is available in the SERA 2004c risk assessment. The application rate and the amount of drift will be the same as for plants (see below) and will determine the maximum dose that terrestrial invertebrates could be exposed to.

Ingestion of Contaminated Vegetation or Prey - No specific information on exposure to terrestrial invertebrates from ingestion of contaminated vegetation or prey of sulfometuron methyl is available in the SERA 2004c risk assessment. It seems likely that the routes of exposure modeled for some other herbicides analyzed in this Program EIR would be similar, with similar exposure levels. For those herbicides, four non-accidental acute exposure scenarios were developed for herbivorous insects consuming vegetation contaminated by herbicide residues. The highest anticipated dose was to a small insect consuming broadleaf vegetation, followed by an insect consuming tall or short grass, and lastly, by a large insect consuming fruit.

Contact with Contaminated Soil - Only limited data are available on the toxicity of sulfometuron methyl to microorganisms. The maximum detectable concentrations of sulfometuron methyl in clay soil averages from 0.27 ppm (mg/kg) (rainfall 10”) to 0.05 ppm (rainfall 100”). In loam soil, concentrations average 0.387 ppm (rainfall 10”) and 0.23 ppm (rainfall 100”) and in sandy soils, concentrations average 0.287 ppm (rainfall 10”) and 0.014 ppm (rainfall 100”) (SERA 2004c, Table 4-2).

Terrestrial Plants (Macrophytes)

Direct Spray and Off-Site Drift - Unintended direct spray will result in an exposure level equivalent to the application rate. Estimates of off-site drift for broadcast and backpack applications of sulfometuron methyl are used in the SERA risk assessment. At the typical application rate of 0.045 lb. a.e./acre in a broadcast application, drift is estimated to result in concentrations of sulfometuron methyl of 0.001575 lb./acre 25 feet from the application site to 0.000094 lb./acre 500 feet from the application site, the furthest distance away where there is still a concern for toxicity to non-target, sensitive plant species. There is only minor concern for tolerant plants at up to 25 feet from the application site. A summary of both the exposure assessment and risk characterization for terrestrial plants from direct spray and off-site drift is in Worksheet G05 in FS WSM ver. 6.00.10.

Runoff and Soil Mobility – Runoff of minor amounts of sulfometuron methyl following broadcast applications, at the typical application rate of 0.045 lb. a.i./acre, is estimated to begin occurring on clay soils at an annual rainfall rate of 15 inches (50 inches on loams and >250 inches on sand). Runoff is estimated to result in concentrations of sulfometuron methyl of 0.000756 lb. a.e./acre at 15 inches of rain to 0.01494 lb. a.e./acre at 100 inches. Adverse effects in sensitive species are plausible at an annual rainfall rate of 15 inches (100 inches for loam soils, with concentrations of 0.00039 lb. a.e./acre) and severe effects are likely at a rate of 100 inches. Runoff becomes problematic for tolerant species at a rainfall rate of 20 inches. A summary of both the exposure assessment and risk characterization for terrestrial plants from runoff is in Worksheet G04 in FS WSM ver. 6.00.10.

Various studies on runoff losses of sulfometuron methyl generally support the supposition that at least 1% could run off from the application site to adjoining areas after a moderate rain and up to 50% could run off in the case of a heavy rain (200 inches), especially in an extremely heavy rain on a steep slope. Runoff will be negligible in relatively arid environments (5-20 inches annual rainfall) as well as in sandy or loam soils, but in regions of California with very high rainfall rates (100 inches), in clay soils, off-site loss may reach up to about 35% of the applied amount.

Contaminated Irrigation Water - There are no studies in the literature addressing the impact of sulfometuron methyl in contaminated irrigation water, but since it is relatively mobile, contamination of ambient water may be anticipated. Based on the estimated concentrations of sulfometuron methyl in ambient water at the typical application rate of 0.045 lb. a.i./acre, the estimated functional application rate of sulfometuron methyl to the irrigated area is 0.0000102 lb. a.e./acre at an irrigation rate of 1 inch per day and 0.000408 lb. a.e./acre at an irrigation rate of 2 inches per day. Relative to off-site drift and runoff, this level of exposure is inconsequential. A summary of both the exposure assessment and risk characterization for terrestrial plants from contaminated irrigation water is in Worksheet G06a in FS WSM ver. 6.00.10.

Wind Erosion - Although no specific incidents of non-target damage from wind erosion have been encountered in the literature for sulfometuron methyl, this mechanism has been associated with the environmental transport of other herbicides. Wind erosion of minor amounts of sulfometuron methyl following broadcast applications, at the typical application rate of 0.045 lb. a.i./acre, is estimated to result in concentrations of sulfometuron methyl of 0.00000308 lb. a.e./acre at the central bound to 0.00000606 lb. a.e./acre at the upper bound. Relative to off-site drift and runoff, this level of exposure is inconsequential and well below a LOC for non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from wind erosion is in Worksheet G06b in FS WSM ver. 6.00.10.

Aquatic Organisms

At the typical application rate of 0.045 lb a.i./acre, the peak estimated rate of contamination of ambient water associated with the normal application of sulfometuron methyl is 0.010 (0.00006 to 0.02) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.00004 (0.00001 to 0.00007) mg a.e./L. sulfometuron methyl is highly soluble in water and is likely to dilute quickly.

D.3.2.3.4.8 Triclopyr (Sources: FS WSM v. 6.00.10; SERA 2011d)

Exposure values for the scenarios displayed below are summarized in the "G" series Worksheets in FS WSM ver. 6.00.10: for mammals (G01a), birds (G01b), honeybee (G09), and insects (G08a). For the analysis in this Program EIR, exposure values for triclopyr have been computed for the typical application rate of 1 lb. a.e./acre. Triclopyr TEA and BEE appear to have similar effects on terrestrial organisms.

By far the highest short-term acute exposures to triclopyr are associated with the consumption of contaminated grass by a small mammal (691 mg/kg bw/event) and a small bird (1,710 mg a.e./kg bw/event). The corresponding maximum chronic exposures are 164 mg/kg bw/day for a small mammal and 404 mg a.e./kg bw/day for a small bird. For both acute and chronic exposures, consumption of contaminated water leads to dose estimates far below those associated with consumption of contaminated vegetation. This pattern is common in many herbicide exposure assessments, reflecting the consequences of direct applications to vegetation.

Terrestrial Mammals, Birds, Reptiles, and Amphibians (Terrestrial Phase)

The highest exposures are associated with the consumption of contaminated grasses, and the lowest exposures are associated with the consumption of contaminated water. The exposure assessment for mammals is somewhat more detailed to encompass more diverse body weights. Larger mammals appear to be substantially more sensitive than smaller mammals to triclopyr, experiencing adverse effects at lower doses. As toxicity data on terrestrial phase amphibians are unavailable, exposure assessments for these organisms are not developed.

Direct Spray – At the typical application rate for triclopyr TEA and BEE (values in parentheses), accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 1.47 (4.28) mg/kg/event (first-order absorption of direct spray by a small mammal) to 48.5 (48.5) mg/kg/event (100% absorption of direct spray by a small mammal). For birds, no exposure scenarios for direct spray are developed, as it is assumed that most birds will fly away during herbicide applications.

Ingestion of Contaminated Vegetation or Prey - At the typical application rate for both formulations of triclopyr and TCP, non-accidental acute exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 4.62 mg/kg/event (consumption of a small mammal by a canid) to 691 mg/kg/event (consumption of grass by a small mammal). For birds, estimates of exposure range from 5.49 mg/kg/event (consumption of a small mammal by a carnivorous bird) to 1,710 mg/kg/event (consumption of short grass by a small bird).

Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from5.06 mg/kg/day (consumption of fruit by a large mammal) to 164 mg/kg/day (consumption of short grass by a small mammal). For birds, estimates of exposure range from 9.69 mg/kg/day (consumption of fruit by a large bird) to 404 mg/kg/day (consumption of short grass by a small bird).

Fruit and short grass are the food items that define the upper and lower bounds of residue rates. They are not necessarily intended to be interpreted literally, but do encompass the range of triclopyr and TCP concentrations in food items likely to be consumed by a variety of mammals and birds.

Ingestion of Contaminated Water – At the typical application rate, accidental acute exposure scenarios for both formulations of triclopyr and TCP for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from1.18 mg/kg/event (large mammal) to 2.66 mg/kg/event (small mammal). For birds, estimates of exposure range from 0.678mg/kg/event (large bird) to 4.90 mg/kg/event (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(values in parentheses) for triclopyr TEA for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.0155 (0.00388) mg/kg/event(day) (large mammal) to 0.0351 (0.00878) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.00896 (0.00224) mg/kg/event(day) (large bird) to 0.0647 (0.0162) mg/kg/event(day) (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(values in parentheses) for triclopyr BEE for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.00194 (0.00000453) mg/kg/event(day) (large mammal) to 0.00439 (0.0000102) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.00112 (0.00000261) mg/kg/event(day) (large bird) to 0.00809 (0.0000189) mg/kg/event(day) (small bird).

Scenarios of non-accidental acute exposure and chronic exposure(values in parentheses) for TCP for consumption of contaminated water lead to upper bound estimates of exposure for mammals ranging from 0.00181 (0.000129) mg/kg/event(day) (large mammal) to 0.00410 (0.000293) mg/kg/event(day) (small mammal). For birds, estimates of exposure range from 0.00105 (0.0000747) mg/kg/event(day) (large bird) to 0.00755 (0.000539) mg/kg/event(day) (small bird).

For both acute and chronic exposures, contaminated water leads to dose estimates far below those associated with contaminated vegetation. The upper and lower bounds of the estimated concentrations of both triclopyr and TCP in surface water vary by several orders of magnitude (see Table 26 in SERA 2011d). Given this variability, it seems likely that a quantitative consideration of the variability in water consumption rates of birds and mammals would not have a substantial impact on the risk characterization.

Ingestion of Contaminated Fish - Ambient water and fish are exposure pathways for triclopyr. As triclopyr has a low potential to bioconcentrate in fish, the bioconcentration factor for fish is taken as 0.83 L/kg for chronic exposure scenarios.

At the typical application rate for both formulations of triclopyr and TCP, accidental acute exposure scenarios for consumption of contaminated fish lead to upper bound estimates of exposure for mammals ranging from 2.53 mg/kg/event (large mammalian carnivore) to 3.64 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 4.23 mg/kg/event.

Non-accidental acute exposure scenarios for triclopyr TEA and BEE (values in parentheses), lead to upper bound estimates of exposure for mammals ranging from 0.0334 (0.00418) mg/kg/event (large mammalian carnivore) to 0.0481 (0.00601) mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.0558 (0.00698) mg/kg/event. Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.00835 (0.00000974) mg/kg/day (large mammalian carnivore) to 0.012 (0.000014) mg/kg/day (canid). For birds, the estimated exposure of a fish-eating bird is 0.0000163 mg/kg/day.

Non-accidental acute exposure scenarios for TCP lead to upper bound estimates of exposure for mammals ranging from 0.0039 mg/kg/event (large mammalian carnivore) to 0.00561 mg/kg/event (canid). For birds, the estimated exposure of a fish-eating bird is 0.00651 mg/kg/event. Chronic exposure scenarios lead to upper bound estimates of exposure for mammals ranging from 0.000278 mg/kg/day (large mammalian carnivore) to 0.000401 mg/kg/day (canid). For birds, the estimated exposure of a fish-eating bird is 0.000465 mg/kg/day.

Terrestrial Invertebrates

Direct Spray and Drift - A summary of the exposure assessments and risk characterization for the honeybee for the scenarios of direct spray and drift of both formulations of triclopyr is in worksheet G09 in FS WSM ver. 6.00.10. Exposure from direct spray is shown for three scenarios (0%, 50%, and 90% foliar interception), none of which lead to a HQ above the LOC. The absorbed doses are 68.6, 34.3, and 6.9 mg/kg bw/event, respectively. The absorbed doses from spray drift 25 feet from the application site are2.4, 1.2, and 0.24 mg/kg bw/event, respectively.

Ingestion of Contaminated Vegetation or Prey - Four non-accidental acute exposure scenarios were developed for herbivorous insects consuming vegetation contaminated by residues of both formulations of triclopyr. For a large insect consuming fruit, the estimated dose at the typical application rate of 1.0 lb. a.e./acre, is 9.1 mg/kg bw/event (central bound) and 33 mg/kg bw/event (upper bound). For a small insect consuming broadleaf foliage, the estimated dose is 58.5 mg/kg bw/event (central) and 297 mg/kg bw/event (upper). For an insect consuming tall and short grass (the latter value in parentheses), the estimated dose is 46.8 (111) mg/kg bw/event (central) and 242 (528) mg/kg bw/event (upper).

Contact with Contaminated Soil - Only limited data are available on the toxicity of triclopyr to microorganisms. No GLEAMS information was found in SERA 2011d specific to soil concentrations. Based on the GLEAMS modeling, triclopyr TEA may penetrate to about 36 inches in clay, loam, and sand. Because a 36-inch root zone was used in the GLEAMS modeling, the actual penetration in loam or sand could be greater than 60 inches. Triclopyr BEE is much less likely to penetrate into the soil column, with a maximum penetration of 24 inches occurring only in sandy soils, cool temperatures, and heavy rainfall. In relatively arid locations, the maximum penetration is estimated at 4-8 inches.

Terrestrial Plants (Macrophytes)

Direct Spray and Off-Site Drift - Unintended direct spray will result in an exposure level equivalent to the application rate. Estimates of off-site drift from broadcast ground applications of triclopyr TEA and BEE are calculated in the SERA 2011d risk assessment. At the typical application rate of 1 lb. a.e./acre, drift is estimated to result in concentrations of triclopyr of 0.035 lb./acre 25 feet from the application site to 0.0177 lb./acre 50 feet from the application site, the furthest distance away where there is still a concern for toxicity to non-target, sensitive plant species. The modeled concentrations of off-site drift are not problematic for tolerant plants at any distance from the application site. A summary of both the exposure assessment and risk characterization for terrestrial plants from direct spray and off-site drift is in Worksheet G05 in FS WSM ver. 6.00.10.

Runoff and Soil Mobility – As stated in SERA 2011d, p. 110: “The runoff for triclopyr TEA as a proportion of the application rate is taken as 0.00266 (0.00001 to 0.108) rounded to 0.0027 to 0.11. The central estimate and upper bound is taken directly from the Gleams-

Driver modeling—i.e., the median and empirical upper 95% bound. The lower limit is the approximate lower bound for clay soils in areas with moderate to heavy rain. Although lower loss rates of 1x10-6 to 1x10-8 are plausible, they have no impact on the risk characterization. For triclopyr BEE, the rates, which are similarly derived, are much lower due to the binding of triclopyr BEE to soil—i.e., rates of 0.0006 (2x10-7 to 0.046)." A summary of both the exposure assessment and risk characterization for terrestrial plants from runoff is in Worksheet G04 in FS WSM ver. 6.00.10.

Based on the GLEAMS modeling, triclopyr TEA may penetrate to about 36 inches in clay, loam, and sand. Because a 36-inch root zone was used in the GLEAMS modeling, the actual penetration in loam or sand could be greater than 60 inches. Triclopyr BEE is much less likely to penetrate into the soil column, with a maximum penetration of 24 inches occurring only in sandy soils, cool temperatures, and heavy rainfall. In relatively arid locations, the maximum penetration is estimated at 4-8 inches.

Contaminated Irrigation Water - Triclopyr is slightly mobile and contamination of ambient water is plausible. Based on the estimated concentrations of triclopyr in ambient water at the typical application rate of 1 lb. a.e./acre, the estimated functional application rate of triclopyr TEA, BEE, and TCP (values for BEE and TCP in parentheses) to the irrigated area is 0.00068 (BEE - 0.0000906, TCP – 0.000204) lb. a.e./acre at an irrigation rate of 1 inch per day and 0.1087 (BEE - 0.0136, TCP – 0.0127) lb. a.e./acre at an irrigation rate of 2 inches per day. Relative to off-site drift and runoff, this level of exposure is inconsequential, although at the highest rate of irrigation, adverse effects are plausible to sensitive plants. A summary of both the exposure assessment and risk characterization for terrestrial plants from contaminated irrigation water is in Worksheet G06a in FS WSM ver. 6.00.10.

Wind Erosion - Although no specific incidents of non-target damage from wind erosion have been encountered in the literature for triclopyr, this mechanism has been associated with the environmental transport of other herbicides. Wind erosion of minor amounts of both triclopyr TEA and BEE following broadcast applications, at the typical application rate of 1 lb. a.e./acre, is estimated to result in concentrations of triclopyr of 0.0000685 lb. a.e./acre at the central bound to 0.000137 lb. a.e./acre at the upper bound. Relative to off-site drift and runoff, this level of exposure is inconsequential and well below a LOC for non-target, sensitive plant species. A summary of both the exposure assessment and risk characterization for terrestrial plants from wind erosion is in Worksheet G06b in FS WSM ver. 6.00.10.

Aquatic Organisms

The plausibility of effects on aquatic species is assessed based on estimated concentrations of triclopyr and TCP in water that are identical to those used in the human health risk assessment. At the typical application rate of 1 lb a.e./acre, the peak estimated rate of contamination of ambient water associated with the normal application of triclopyr TEA is 0.12 (0.000001 to 0.24) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.03 (0.0000000002 to 0.06) mg a.e./L. Corresponding values for triclopyr BEE are 0.015 (0.00000015 to 0.03) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.000035 (0.00000000002 to 0.00007) mg a.e./L. Corresponding values for TCP are 0.014 (0.00000001 to 0.028) mg a.e./L, while the average estimated rate of contamination for longer-term exposures is 0.001 (0.0000000000012 to 0.002) mg a.e./L.

D.3.2.4 Dose-Response Assessment

U.S. Forest Service risk assessments attempt to define dose-response relationships for all classes of organisms discussed in the hazard identification section, such as mammals, birds, reptiles, amphibians (terrestrial and aquatic phases), terrestrial and aquatic invertebrates and macrophytes, microorganisms, fish, and algae (SERA 2012). When there is enough acceptable data to permit doing so, sensitivity differences between species within each class are also considered in USDA/FS risk assessments for each chemical. Additional relationships are also evaluated, as specified below.

Studies report toxicological effect results in several ways. For example, some studies are designed to identify acute hazards while determining the dose or concentration of a chemical that will cause death in an “X” percentage (i.e., most commonly 25% or 50%) of a defined experimental animal population over a specific observation period. When doses for such a study are administered through gavage, diet, or dermal methods, results are expressed as a “Lethal Dose” or LD. When aquatic organisms are exposed to chemically treated water, or terrestrial organisms are dosed through inhalation of chemically treated air for such a study, the results are recorded as “Lethal Concentration” or LC. The LD or LC is then followed by a subscripted percentage of lethality. Thus, if 1,500 milligrams of a chemical (i.e., per kilogram of body weight) had been fed to a population of experimental rats and proved fatal to 50% of that population, the lethal dose would be LD_{50} = 1500 mg/kg bw. However, if 1500 mg was the maximum dose tested in the study and the dose was not lethal to any rats, then the infinite lethal dose, LD_{50} >1500 mg/kg bw, would be assigned. Similarly, sublethal effects may be recorded as “effect dose” or “effect concentration”, with a subscript percent to indicate the dose causing “X”% inhibition of a process.

Results may also be recorded in terms of *lowest-observed-adverse-effect-level* or *concentration* (LOAEL or LOAEC), as well as by *no-observed-adverse-effect-level* or *concentration* (NOAEL or NOAEC). As implied, LOAEL values indicate the lowest dose an adverse effect occurred and, by contrast, the NOAEL is the lowest dose administered that did not result in an adverse effect. It should be noted that in some studies both the *no-observed-effect-level* or *concentration* (NOEL/NOEC) and associated LOEL and LOEC values are recorded. These values indicate *any* effect, though for all practical purposes these terms may be considered synonymous with respective NOAEL and NOAEC or LOAEL and LOAEC terms. In reference to wildlife, results reported using the terms “dose” and “level” generally refer to studies on terrestrial organisms, whereas results expressed as “concentration” are usually reserved for aquatic organisms. All such results that function to define the occurrence of toxicological effects, or lack thereof, are collectively referred to as endpoints.

The USDA/FS predominantly utilizes five different methods to assess dose-response relationships. In order of increasing complexity, these methods include 1) Point Estimates and 2) Extreme Values (SERA 2012). Point estimates involve making use of only values that specifically evaluate for sublethal effects rather than just for lethality. Ideally, to establish point estimates, “the study should define both a NOAEL and a LOAEL and there should be reasonable confidence that the NOAEL involves endpoints that would not impair the ability of the organism to function normally over a short-term period” (SERA 2012, p. 98). In cases where LD_{50} or LC_{50} values are the only ones available, an LD_{50} is divided by 10 to estimate an NOAEL for mammals and birds, whereas an LC_{50} is divided by 20 to estimate an NOAEL for aquatic organisms. The extreme value method involves making use of a range of values that include a central estimate, with upper and lower bounds, for toxicity and exposures. This approach also applies when evaluating studies of the same taxonomic group to decide if the highest and lowest NOAEL values represent, respectively, the most tolerant and sensitive species.

The next three methods commonly utilized in U.S. Forest Service risk assessments include: 3) Relative Potency, 4) Species Sensitivity Distributions, and 5) Allometric Relationships (SERA 2012). The relative potency method makes use of ratios for toxicity to calculate values for missing data. If a data set is complete for a tolerant species, for example including both acute and chronic endpoints, but only acute information is available for the sensitive species, the ratio of acute to chronic data for the sensitive species can be used to calculate an estimated chronic endpoint. Species sensitivity distributions are utilized when data are occasionally available to suggest more refined estimates in gradations of sensitivity within and among species. It should be noted that the dose differences between tolerant and sensitive species within the same class of organisms are often limited by how many species have been tested. Allometric relationships are those that relate body size or mass to any number of characteristics (i.e., anatomical, physiological, or pharmacological). One example of an allometric relationship applicable to this risk assessment is that larger mammals are more sensitive to adverse effects associated with triclopyr exposure than their smaller counterparts (SERA 2011d).

Most toxicological endpoints applied in U.S. Forest Service risk assessments are typically those used by the U.S. EPA, which are obtained from registrant-submitted studies. These endpoints, however, are altered, supplemented or replaced in USDA/FS risk assessments when evidence warrants that changes are necessary. The USDA/FS apply endpoints used by the U.S. EPA whenever possible, though there are some distinct differences in how values are used, as discussed in SERA 2012 (p. 97): "*As in the human health risk assessment, the Forest Service will consider, discuss, and sometimes defer to dose-response assessments developed in ecological risk assessments developed by the U.S. EPA/OPP. Also as in the human health risk assessment, this approach avoids a duplication of effort, capitalizes on the substantial expertise of U.S. EPA/OPP, and decreases the size, complexity, and cost of Forest Service risk assessments. There are, however, important differences between the approach taken by U.S. EPA/OPP and the approach preferred by the Forest Service. The Forest Service prefers to use NOEC values for both acute and chronic exposures. This differs from the U.S. EPA/OPP which will base dose-response assessments for acute exposures on LC_{50} or EC_{50} values. Nonetheless, the Forest Service assessment will adapt (slightly modify) the methods used by U.S. EPA/OPP, as detailed further below, for data sets in which only LC_{50} or EC_{50} values are available.*"

As briefly mentioned above when discussing the five methods (relationships) utilized by the U.S. Forest Service, there are several ways that values reported by the U.S. EPA may be adapted in U.S. Forest Service risk assessments. The risk assessment for triclopyr (SERA 2011d) describes some examples of how these adaptations may be done with aquatic organism data. These modifications are also applicable to terrestrial organism results that are reported as NOAEL, LD_{50}, and ED_{50} values:

> *If NOAECs are not available, LC_{50} or EC_{50} values may be multiplied by 0.05 to approximate an NOAEC. This procedure is based on the U.S. EPA/OPP general approach of using LC_{50} or EC_{50} values with levels of concern (LOC) of 0.05 for the ratio of exposure to the LC_{50} or EC_{50} for endangered species (e.g., U.S. EPA/OPP 2009a, Appendix C). It should be noted that this is a very conservative approach, equivalent to treating all aquatic species as endangered species.*
>
> *As noted in several instances below, an intermediate approach can be taken to estimate NOAECs for sensitive and tolerant species. When there is not an NOAEC for the most sensitive or most tolerant species within a group of organisms, but there is either an LC_{50} or EC_{50} with a corresponding NOAEC for one or more other species in the group, the ratio of the available NOAEC to the available LC_{50} or EC_{50} can be used to estimate an NOAEC for the most sensitive or tolerant species.*
>
> *Few chronic NOAECs are available for any group of aquatic organisms. For some groups (e.g., algae), the lack of a chronic NOAEC is not a concern, because chronic is not meaningful in the context of exposure for organisms with very short lifespans. For fish and invertebrates, however, attempts are made to incorporate the very well-documented variability in acute data into the chronic dose-response assessment. Consequently, acute-to-chronic ratios are developed for the species on which both acute and chronic toxicity data are available; furthermore, these ratios are used to*

> *estimate chronic NOAECs for sensitive and tolerant species. As detailed below, this approach is used only when it appears to be sensible given the available species-specific data. (SERA 2011d, p. 118)*

Endpoints are established in U.S. Forest Service dose-response assessments using a few more approaches. Values from one organism class may be applied to an organism from a different class, as a surrogate endpoint. If acute data for mammals and birds, for example, indicate that a chemical is equally toxic to each class of organism, but there is no chronic NOAEL established for birds, a rat NOAEL may be used as a surrogate endpoint, if all other data supports the assumption of equivalency. Additionally, in limited instances LOAEL or LOAEC may also be used in the absence of other, more conservative data. In cases when there is not enough data to support a dose response assessment using U.S. Forest Service methods, or data is limited for a class of organisms, qualitative information from available studies will be discussed in depth in the risk characterization section of the applicable risk assessment.

This section functions to summarize the endpoint values for class of organisms, by chemical. Endpoints for terrestrial organisms including mammals, birds, invertebrates, and plants (macrophytes) are disclosed in tables for each chemical when data is available (Tables 5.17.30 – 5.17.42). Likewise, each table also includes values for aquatic organisms, such as fish, amphibians, invertebrates, plants (macrophytes) and algae (microphytes). When information is available from U.S. Forest Service risk assessments, these tables also summarize test species (aka receptor), the form of active ingredient used in a study, and how the endpoints were derived or adapted. Any additional information particularly pertinent to dose-response values will be briefly paraphrased from U.S. Forest Service overviews in the dose-response section of each chemical. For information regarding studies evaluated, explanations regarding the choice of particular endpoints, or details regarding how chosen values were adjusted for USDA/FS risk assessments, consult the appropriate SERA risk assessments. For background information regarding SERA risk assessment methodology, refer to SERA 2012. For this Program EIR, dose response values determined to be appropriate by the U.S. Forest Service are adopted without reservation, for similar reasons that the U.S. Forest Service opts to rely on information released by the U.S. EPA.

After exposures are calculated in the exposure assessment and maximum doses that lack adverse effects are determined for each chemical in the dose-response assessment, risk will be evaluated in the risk characterization section, in part through the use of Hazard Quotient (HQ) values. A HQ is the ratio of an exposure level to a toxicity value and is analogous to the Risk Quotient (RQ) values used to assess risk to human health in U.S. EPA risk assessments. Both HQ and RQ values function to quantitatively express risk characterization. As with human risk studies, ecological risk studies used by the U.S. EPA are acceptable under specific guidelines and protocols for each organism being assessed for risk. For the human health assessment, NOEL, NOEC, or other toxicity values are divided by an uncertainty factor to derive a reference dose for each endpoint. By contrast, uncertainly factors are not used for ecological risk assessment. Instead, values are often used directly, or in some instances divided by factors to account for a level of concern (LOC) or an endangered species.

D.3.2.4.1 Terrestrial Organisms

For terrestrial organisms, the dose-response assessment is most complete for mammals and terrestrial plants. This is likely due to the direct applicability of mammal studies to human health risks, and to the chemicals evaluated in this Program EIR being predominately used to alter terrestrial plant growth. Other terrestrial organisms often have little to no dose-response information available relative to plants and mammals. Acceptable lifetime or chronic studies are seldom available for these other classes of terrestrial organism. Details regarding each class and the assumptions used by the U.S. Forest Service are summarized from each applicable chemical risk assessment, as well as SERA (2012). The latter document provides details of USDA/FS methodology.

Mammals and Birds – The dose-response assessment for mammals is generally based on the same values used to derive reference doses (RfDs) in the human health dose response section. Typically, these data are on non-canine mammals, such as rats and rabbits, since dogs are unable to excrete weak acids to the same extent and thus are often more severely affected than most other mammals. When considering the comparability of different types of mammalian and avian studies, gavage application methods tend to produce greater toxicological effects compared to dietary ingestion of a chemical. When available, results from dietary studies are usually preferred over those involving gavage applications. This is in part because gradual intake through consumption of food is most ecologically relevant in most cases.

Reptiles and Amphibians (Terrestrial Phase) – The U.S. EPA does not require standard toxicity studies on reptiles or terrestrial-phase amphibians. Currently, no information is available regarding toxicity to reptiles for any of the chemicals proposed in the Program EIR. If no acceptable studies are available for risk characterization for terrestrial-phase amphibians, no formal dose-response assessment is developed. Information regarding terrestrial phase amphibians is very limited and contributes most to dose-response assessment of aquatic phase amphibians. Thus, all information regarding amphibian exposure is discussed under the aquatic section for each chemical in this Program EIR.

Terrestrial Invertebrates – Acute toxicity values from honey bees are often used as surrogate values for other terrestrial insects. Given the numerous species of terrestrial invertebrates, the use of this single acute toxicity value on a single species obviously leads to uncertainty in the risk assessment. U.S. Forest Service risk assessments also attempt to characterize risks to terrestrial invertebrates from the consumption of contaminated vegetation following broadcast applications (i.e., direct spray). The results of oral toxicity studies in honeybees are typically used to assess risks associated with this scenario (SERA 2011c). Results of contact toxicity studies in honeybees are often used as surrogate toxicity values to characterize risks to herbivorous insects from the consumption of contaminated vegetation (SERA 2011c). Most honeybee results are reported in units of µg chemical/bee, and in USDA/FS risk assessments that value is divided by the average honeybee body weight (bw) of 116 mg to convert the result into units of mg/kg bw for risk characterization.

Terrestrial Plants (Macrophytes) – The assessment of potential effects in plants is based on standard toxicity studies required for pesticide registration, involving pre-emergence and post-emergence exposures. All of the herbicides are designed to adversely affect specific plant physiological processes in specific ways. Each herbicide is targeted to specific plant groups, as specified on the herbicide labels. Non-targeted plant groups will generally experience fewer adverse effects than those that are targeted. To assess the potential consequences of exposures to nontarget plants via transport of runoff or sediment or through direct soil treatment, the values reported from seedling emergence (pre-emergence application) bioassays are used (USDA/FS 2006a). To assess the impact of drift (accidental direct spray) on nontarget terrestrial vegetation, the values reported from the post-emergent (vegetative vigor) bioassays are used (USDA/FS 2006a).

Terrestrial Microorganisms - For the purposes of this risk assessment, terrestrial microorganism refers to terrestrial bacteria, fungi and in some cases heterotrophic algae and green algae. Given the limited testing done to evaluate toxicological effect of proposed chemicals on such organisms, little specific endpoint data will be presented in tables, but instead a brief summary will be included in this subsection for each chemical, when information is available.

D.3.2.4.2 Aquatic Organisms

For some aquatic species, as well as other groups of organisms, sensitive life-stage studies are often available. Such studies include egg-and-fry studies in fish and life-cycle toxicity studies in Daphnia magna, both of which are typically required by the U.S. EPA for the registration of herbicides. U.S. EPA toxicity categories assigned to aquatic species have the same caveats regarding the limitations of applying data from surrogate species tested in controlled situations to wild populations (see SERA 2005, p. xviii). Note that variation in toxicity values for aquatic species may be based more on the conditions of exposure, particularly the pH of water, than on differences between species (SERA 2011b).

Fish - The three general types of relatively standardized studies most commonly used by the U.S. Forest Service, which follow standard U.S. EPA study protocols, include acute toxicity studies, egg-and-fry studies, also referred to as early lifestage studies, and full life cycle studies (SERA 2012, p. 4-8). There is also extensive open source literature available on fish species that is consulted as needed for U.S. Forest Service risk assessments.

Amphibians (Aquatic Phase) –While studies are not required by the U.S. EPA at this time, the U.S. Forest Service uses the following approach to evaluating risks of chemical exposure to amphibians: *Because of the relative sparsity of data available on toxic effects to amphibians and the high level of concern with effects on amphibians because they may be good indicator species, any available information on effects to amphibians are typically reviewed in some detail. If the data are sufficient, these data are used in the dose-response assessment* (SERA 2012, p. 4-8). See also the "Reptiles and Amphibians" section above.

Aquatic Invertebrates – As stated in SERA (2012 p. 4-8): *Many aquatic invertebrates are relatively simple organisms to culture and test in aquatic toxicity studies, and standard acute toxicity protocols from U.S. EPA/OPPTS (2005) are available on a number of invertebrate species: daphnids (OPTTS 850.1010), gammarids (OPTTS 850.1020), oysters (OPTTS 850.1025), mysid shrimp (OPTTS 850.1035), penaeid shrimp (OPTTS 850.1045), and several species of bivalves (OPTTS 850.1055). These tests are similar in design to acute toxicity studies in fish (Section 4.1.3.1), although some may involve somewhat shorter periods of exposure – e.g., the daphnid study typically only lasts for 48 hours.*

Aquatic Plants (Algae and Macrophytes) – As stated in SERA (2012 p. 4-9): Aquatic plants comprise both macrophytes (large multicellular plants) and algae (small microscopic plants). Bioassays in aquatic algae typically involve freshwater green alga (Selenastrum capricornutum or Raphidocelis subcapitata), a freshwater diatom (Navicula pelliculosa), a marine diatom (Skeletonema costatum), and a blue-green alga or cyanobacterium (Anabaena flos-aquae). Bioassays on macrophytes typically use a species of duck weed (e.g., Lemna gibba). The duration of exposure for algae is typically 48-hours and the duration for duckweed is typically about 7-days. Both types of studies measure growth (either as cell count or gross weight) and express results as effective concentrations (e.g., EC_{50}) rather than lethal concentrations (e.g., LC_{50}). As with most other types of bioassays, the studies often report NOEC and LOEC values, and NOEC values are typically used in the dose-response assessment.

Aquatic Microorganisms – The assessment of aquatic microorganisms is the same as for terrestrial microorganisms, except that algae are included in the assessment for aquatic plants.

D.3.2.4.3 Chemical-Specific Dose-Response Assessment

D.3.2.4.3.1 Borax (Sources: FS WSM ver. 6.00.10; SERA 2006a)

Dose-response endpoints for borax are summarized in Table D.3-19. Dose response assessments are supported for ten classes of organisms in the U.S. Forest Service risk assessment for borax: terrestrial mammals, birds, non-target terrestrial invertebrates, terrestrial macrophytes, fish, aquatic invertebrates, amphibians, aquatic macrophytes, algae, and aquatic microorganisms.

There is relatively little difference in acute toxicity values between fish and aquatic invertebrates. For chronic exposures, however, fish appear more sensitive than aquatic invertebrates to boron exposure.

Mammals and Birds - Borate compounds are relatively non-toxic to mammals and birds. For mammals, the toxicity values used in the ecological risk assessment are identical to those used in the human health risk assessments: the 95% lower bound on the dose corresponding to the benchmark response (BMR) level, i.e., the $BMDL_{05}$, of 10.3 mg B/kg/day (the *critical dose*) for decreased fetal body weight. The acute NOAEL for birds was taken at the highest dose given during a 5-day dietary study, as no clinical signs of toxicity occurred. For chronic exposure of birds, the limited data available suggest that longer-term exposure to boron compounds can cause testicular toxicity in avian species. However, the available studies did not rigorously investigate the potential for boron compounds to produce testicular toxicity. Therefore, the mammalian *critical dose* of 10.3 mg B/kg/day will be used to characterize the risk of chronic exposure to boron compounds in birds.

Terrestrial Invertebrates – A honey bee study that evaluated mortality relative to a single contact was used as a NOAEL for this class of organism.

Terrestrial Plants (Macrophytes) - Boron is known to be an essential element for plants, though data specifically evaluating the effects of borax on seedling emergence and vegetative vigor are limited. It is likely that a wider range of plant sensitivity exists.

Terrestrial and Aquatic Microorganisms – *No formal dose-response assessment was completed for terrestrial microbes due to a lack of acceptable studies. Available microbe studies will be used to qualitatively assess these organisms in the risk characterization section.* In terms of terrestrial organisms, borax is used as an anti-fungal treatment, so some soil microbes could be affected by borax exposure, though such data is limited. For aquatic microorganisms, the NOAEC values of 0.3 mg B/L and 291 mg B/L are used to assess the consequences of both acute and longer-term exposures for sensitive and tolerant species of aquatic microorganisms.

Fish - In fish the range of NOAEC values is relatively narrow, with the difference between sensitive and tolerant species being only 0.05 ppm (1.0 - 0.5 ppm).

Table D.3-19

Ecological Endpoints for Borax

			Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute		***N/A***	No data available
	Chronic		***N/A***	
Medium mammals	Acute		***NOAEL = 10.3 mg B/kg bw***	chronic endpoint is surrogate
	Chronic		***adjusted NOAEL = 10.3 mg B/kg bw/day***	rat, borates
Small mammals	Acute		***N/A***	No data available
	Chronic		***N/A***	
Large herbivore mammals	Acute		***N/A***	
	Chronic		***N/A***	
Birds	Acute		***NOAEL = 136 mg B/kg bw***	bobwhite quail, borax
	Chronic		***surrogate NOAEL = 10.3 mg B/kg bw/day***	rats, borates; based on a benchmark response (BMR) level and used as the critical dose.
Terrestrial Invertebrates	Acute		***single contact NOAEL = 677 mg B/kg bw***	honey bees, boric acid, for mortality; also used as a surrogate for herbivorous insects
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOAEC = 5 B/kg soil***	potato, boric acid
		tolerant spp.	***NOAEC = 20 B/kg soil***	sugar beet, boric acid
	Vegetative vigor	sensitive spp.	***N/A***	seedling emergence values are equivalent, as the only method of application is direct stump application for borax
		tolerant spp.	***N/A***	
Aquatic Microorganism	sensitive spp.		***NOEC =0.3 mg/L***	*Entosiphon sulfacum*, a flagellate
	tolerant spp.		***NOEC =291 mg/L***	*Pseudomonas putida*
Fish	Acute	sensitive spp.	***LC50 = 233 mg B/L***	razorback sucker swimup fry, boric acid
		tolerant spp.	***LC50 > 1,100 mg B/L***	rainbow trout, boric acid
	Chronic	sensitive spp.	***NOAEC = 0.5 mg B/L***	goldfish, borax
		tolerant spp.	***NOAEC = 1 mg B/L***	rainbow trout /channel catfish, borax

Amphibians	Acute	sensitive spp.	***NOAEC = 1.0 mg B/L***	leopard frog larvae, borax, NOAEC = 1.0, sensitive vs. tolerant species not identified
		tolerant spp.		
	Chronic	sensitive spp.	***N/A***	No chronic exposure studies were identified or surrogate values in the risk assessment; chronic NOAEC values were listed in FS WSM
		tolerant spp.	***N/A***	
Aquatic invertebrate	Acute	sensitive spp.	***LC50 = 133 mg B/L***	*Daphnia magna,* boric acid
		tolerant spp.	***LC50 = 1,376 mg B/L***	*Chironomas decorus*, freshwater midge, borax
	Chronic	sensitive spp.	***NOEC = 6.0 mg/L***	*Daphnia magna*, boric acid
		tolerant spp.	***surrogate NOEC = 61.8 mg/L***	*Chironomas decorus*, midges are more tolerant than daphnids by a factor of 10.3 (1,376/133) [derived by daphnid NOAEC of 6 mg B/L x 10.3]
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***EC50 = 5 mg/L***	water milfoil and waterweed, boric acid, 21-day study
		tolerant spp.	***EC50 = 10 mg/L***	water buttercup, boric acid, 21-day study
	Chronic	sensitive/ tolerant spp.	***N/A***	No data available
Aquatic Algae (Microphytes)	sensitive spp.		***NOEC = 10 mg/L***	green alga, (*Scenedesmus subpicatus)*, unspecified chemical spp. of boron
	tolerant spp.		***NOEC = 20.3 mg/L***	blue-green alga, (*Microcystis aeruginosa*), unspecified chemical spp. of boron

All endpoints are in terms of a.i. ED/C = Effect Dose/Concentration, LD/C = Lethal Dose/Concentration, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration.

Amphibians – To characterize acute risk in amphibians, only a single study in leopard frog larvae is used. Appropriate chronic data is lacking.

Aquatic Invertebrates – Unlike in fish, the dose range for sensitivity of aquatic invertebrates is much wider, with a difference of about 55 mg B/L (61.8 – 6 mg B/L).

Aquatic Plants (Algae and Macrophytes) – Sensitivity of algae ranged from 10 to 20.3 mg B/L. These sensitive and tolerant concentrations were applied to both short and long-term concentrations due to the short lifespan of individual algal cells. For aquatic macrophytes, 21-day exposure studies yield a range of values from 5 to 10 mg B/L. These values will be used to assess acute exposure risk to sensitive and tolerant aquatic macrophytes.

D.3.2.4.3.2 Clopyralid (Sources: FS WSM ver. 6.00.07 & 6.00.10; SERA 2004a)

Dose-response endpoints for clopyralid are summarized in Table D.3-20. Dose response assessments are fully supported for a few classes of organisms in the U.S. Forest Service risk assessment for clopyralid: terrestrial mammals, terrestrial macrophytes, fish, aquatic invertebrates, amphibians, aquatic macrophytes, algae, and aquatic microorganisms. There is only acute data for several classes, such as birds, bees, fish, aquatic macrophytes and algae. Currently, there is a lack of data regarding toxicological effects of clopyralid on amphibians.

Mammals and Birds – A comparison of gavage studies between mammals and birds suggest that birds may be more sensitive than mammals by a factor of about 3. However, based on a comparison of short-term dietary NOAELs, birds appear to be somewhat less sensitive, with an acute dietary NOAEL of about 670 mg/kg/day, a factor of about 9 above the acute NOEL of 75 mg/kg/day for mammals. These more ecologically relevant dietary NOAEL values are those chosen for dose response. No chronic toxicity studies have been completed in birds at dosages as high as the chronic NOAEL of 15 mg/kg/day for rats, which are used as a surrogate for chronic exposure of birds.

Terrestrial Invertebrates – Values relating to honey bee exposure are used to represent the effects clopyralid may have on terrestrial invertebrates.

Terrestrial Plants (Macrophytes) - Clopyralid is more toxic to broadleaf plants than to grains or grasses and is more toxic in post-emergence applications (i.e., foliar spray) than pre-emergence applications (i.e., soil treatment). For assessing the potential consequences of exposures to nontarget plants via runoff, the NOEC values for seed emergence are used for sensitive species (0.025 lb a.e./acre) and tolerant species (0.5 lb a.e./acre). For assessing the impact of drift, bioassays on vegetative vigor are used, with NOEC values of 0.0005 lb/acre for sensitive species and 0.5 lb/acre for tolerant species.

Terrestrial and Aquatic Microorganisms – No formal dose-response assessment was completed for terrestrial or aquatic microbes due to a lack of acceptable studies. Available terrestrial microbe studies will be used to qualitatively assess these organisms in the risk characterization section. A NOEC for soil microorganisms was established for clopyralid at concentrations of 10 ppm, based on effects relating to nitrification, nitrogen fixation, and degradation of carbonaceous material. As discussed further in Section 4.4, this NOEC is much higher than anticipated for concentrations of clopyralid in soil.

Fish - No chronic studies, or even long-term studies, on fish egg- and-fry have been encountered. The dose-response assessment uses admittedly limited data, suggesting that at least some fish species may be more sensitive to clopyralid than daphnids. The chronic value for tolerant species was adopted directly from the daphnid study.

Amphibians – Neither the published literature nor the U.S. EPA files include data regarding the toxicity of clopyralid to amphibian species. No formal dose-response assessment was completed for amphibians due to a lack of acceptable studies.

Aquatic Invertebrates – A limited dataset may indicate that daphnia may be more tolerant than some fish species.

Aquatic Plants (Algae and Macrophytes) - For sensitive aquatic plants, risk is characterized using the lowest reported EC_{50} of 6.9 mg a.e./L. Conversely, for tolerant aquatic plants, the highest reported EC_{50} of 449 mg/L is used. The available data on aquatic plants are not sufficient to support separate dose-response assessments for macrophytes and algae.

Table D.3-20

Ecological Endpoints For Clopyralid

			Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute		***N/A***	Dog studies resulted in inconsistent results; no canine endpoints established
	Chronic		***N/A***	
Medium mammals	Acute		***NOAEL = 75 mg/kg bw***	rat, 11-day gavage study
	Chronic		***NOAEL = 15 mg/kg bw/day***	rat, 2-year dietary study
Small mammals	Acute		***N/A***	No data available
	Chronic		***N/A***	
Large herbivore mammals	Acute		***N/A***	
	Chronic		***N/A***	
Birds	Acute		***NOAEL = 670 mg/kg bw***	quail and ducks, 5-day dietary studies [NOAEL rounded from 696 mg/kg/day]
	Chronic		***surrogate NOAEL = 15 mg/kg bw/day***	No lifetime toxicity studies in birds, and thus the chronic mammal exposure NOAEL is applied, surrogate is a 2-year dietary study with rats
Terrestrial Invertebrates	Acute		***NOAEL = 909 mg/kg bw***	honey bee (*Apis mellifera)*
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOEC = 0.025 lb/acre***	soy bean
		tolerant spp.	***NOEC = 0.5 lb/acre***	several spp.
	Vegetative vigor	sensitive spp.	***NOEC = 0.0005 lb/acre***	soybean, snap bean, tomato, sunflower
		tolerant spp.	***NOEC = 0.5 lb/acre***	barley, corn, radish, canola

Fish	Acute	sensitive spp.	***LC50 = 103 mg/L***	rainbow trout, (*Salmo gairdneri*) clopyralid acid
		tolerant spp.	***LC50 = 1,645 mg/L***	rainbow trout, bluegill sunfish, and fathead minnows, clopyralid monoethanolamine salt
	Chronic	sensitive spp.	***surrogate NOEC = 10 mg/L***	no fish data [derived from daphnid study: 23.1 mg a.e./L divided by 2, then rounded to 1 significant digit]
		tolerant spp.	***NOEC = 23.1 mg/L***	no chronic fish studies, *Daphnia* value accepted directly
Amphibians	Acute	sensitive spp.	***N/A***	No data available
		tolerant spp.	***N/A***	
	Chronic	sensitive spp.	***N/A***	
		tolerant spp.	***N/A***	
Aquatic invertebrate	Acute	sensitive spp.	***NOEC = 23.1 mg/L***	*Daphnia magna*, used from one existing study, which examined chronic exposure. Sensitivity was not specified
		tolerant spp.		
	Chronic	sensitive spp.	***NOEC = 23.1 mg/L***	
		tolerant spp.		
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***NOEC = 0.1 mg/L***	water milfoil (*Myriophyllum sibiricum)* and sago pondweed, (*Potamogeton pectinatus)*
		tolerant spp.	***NOEC = 0.1 mg/L***	
	Chronic	sensitive/ tolerant spp.	***NOEC = 0.1 mg/L***	available data on aquatic plants are not sufficient to support dose-response assessments for macrophytes
Aquatic Algae (Microphytes)	sensitive spp.		***EC50 = 6.9 mg/L***	green algae (*Selanastrum capricornutum)*
	tolerant spp.		***EC50 = 449 mg/L***	green alga

All endpoints are in terms of a.e. ED/C = Effect Dose/Concentration, LD/C = Lethal Dose/Concentration, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration.

D.3.2.4.3.3 Glyphosate (Sources: FS WSM v. 6.00.10; SERA 2011b; U.S. EPA. 2009c)

As discussed in several sections, there are often substantial differences between the toxicity of some formulations that contain surfactants like POEA and those that do not, such as technical grade glyphosate, Accord, and Rodeo. While the available information does not permit formulation-specific toxicity values, an attempt is made in the U.S. Forest Service risk assessment to discriminate between less toxic and more toxic formulations. For details regarding what and how formulations were categorized, see SERA 2011b. In general, formulations clearly identified as *Low Toxicity* are less toxic, while all other formulations are regarded as more toxic.

For most ecological receptors, with the exception of plants, separate toxicity values can be derived for less and more toxic glyphosate formulations, as indicated in Tables D.3-21 and Table D.3-22. The dose-response assessment for terrestrial plants assumes that the surfactants added to all formulations of glyphosate will result in equal efficacy among formulations. While less toxic formulations typically do not contain surfactants, labels on these formulations specify that surfactants must be added to the field solution prior to application. The surfactants added have the potential to be more toxic than the initial formulation, and thus may become the dominant toxicological concern, especially for aquatic species. The impact of using surfactants with less toxic formulations of glyphosate is discussed in the risk characterization. The dose-response assessments for the less toxic surfactants are based on the toxicity of glyphosate, salts of glyphosate, and the information on the toxicity of the less toxic formulations of glyphosate.

***Mammals and Birds* –** Whether evaluating more or less toxic formulations, chronic exposure to glyphosate appears to be somewhat more toxic to mammals than birds. For chronic toxicity, the difference between more and less toxic formulations is narrower for mammals (325 mg/kg bw/day) than for birds (960 mg/kg bw/day).

Terrestrial Invertebrates – Studies indicate that more toxic formulations have a greater oral and contact exposure toxicity to honey bees than less toxic formulations, by factors of >3 and 2 respectively.

***Terrestrial Plants (Macrophytes)* –** The glyphosate formulations are more toxic to plants than technical grade glyphosate. It is reasonable to assume that the increased toxicity is attributable to the surfactants in the formulations. The dose-response assessment for terrestrial plants assumes that the surfactants added to all formulations result in equal efficacy among formulations. No distinction is made between less toxic and more toxic surfactants, and the assessment is based only on the toxicity data involving glyphosate formulations. Foliar exposures in the range of 0.7 lbs/acre may have long-term impacts on bryophyte and lichen communities. Glyphosate is much less toxic and less effective as an herbicide in soil exposures.

Terrestrial and Aquatic Microorganisms – *No formal dose-response assessment was completed for either group of microbes due to a lack of acceptable studies. Available terrestrial microbe studies will be used to qualitatively assess these organisms in the risk characterization section.* For terrestrial organisms, studies show that glyphosate inhibits microbial growth in laboratory cultures, causes transient decreases in populations of soil fungi and bacteria after field applications of ~0.5 lbs/acre), and results in increases in soil microorganisms or microbial activity.

Fish - There is no indication of a pronounced duration-response relationship in fish from glyphosate or glyphosate formulations. Any sublethal effects that were observed from chronic exposure to more toxic formulations were encompassed by the 0.048 and 0.5 mg a.e./L surrogate NOEC values derived for acute toxicity for more toxic formulations. Similarly, chronic exposure to less toxic formulations did not indicate a dose response relationship. Thus, the acute values for both more and less toxic formulations were maintained for respective chronic exposure values.

Amphibians - Based on the acute bioassays with the more toxic formulations of glyphosate, the sensitivities of fish and aquatic-phase amphibians to glyphosate appear to be virtually identical. For the more toxic formulations of glyphosate, the dose-response assessment for amphibians is developed in the same manner as for fish, which involves the LOC approach used by the U.S. EPA (i.e., multiplying by a RQ of 0.05 and rounding the outcome). As with the dose-response assessment for fish, for more toxic formulations the surrogate acute NOAEC values for amphibians are applied to longer-term exposures. The dose-response assessment for acute exposures of amphibians to less toxic formulations is similar to that of fish.

Evidence indicates that glyphosate IPA is less acutely toxic than glyphosate acid to amphibians and that the differences between the toxicity of glyphosate IPA and glyphosate acid relates to the pH of water. Unlike with fish, the above data are sufficiently compelling to assert that the lower toxicity values for glyphosate acid are not appropriate for the dose-response assessment. All of the less toxic formulations of glyphosate likely to be used in U.S. Forest Service programs contain glyphosate IPA as the active ingredient. Consequently, for amphibians the dose-response assessment for less toxic formulations is based on studies using glyphosate IPA. No sublethal toxicity studies have been identified on glyphosate IPA, Rodeo, or equivalent formulations. The lack of more detailed sublethal toxicity studies on glyphosate IPA, Rodeo, and other similar formulations is treated qualitatively as a data gap. The dose-response assessment for longer-term exposures of amphibians to less toxic formulations is extremely simple, in that only one longer-term study (i.e., using glyphosate IPA) is available. Given the limited data, sensitive and tolerant species could not be distinguished for chronic exposure to less toxic formulations.

Aquatic Invertebrates - As with fish and amphibians, for more toxic formulations the first approximation to estimating NOAEC values is made by multiplying the range of acute EC_{50} values by a factor of 0.05. Existing data for more toxic formulations does not indicate a dose-response relationship, and thus the acute values are also applied to chronic exposure for less toxic formulations. As discussed above, the acute toxicity data for glyphosate acid and glyphosate IPA in amphibians indicate that glyphosate IPA is less toxic than glyphosate acid, probably due to variable water pH. For aquatic invertebrates, the studies on the toxicity of glyphosate acid relative to glyphosate IPA are not consistent. While all evidence is evaluated in the U.S. Forest Service risk assessment, some is not used when calculating dose response values, as discussed in depth in the risk assessment. For long-term exposure to less toxic formulations, the NOAEC for sensitive species was maintained for chronic exposure, though a different NOAEC was used for tolerant species.

Aquatic Plants (Algae and Macrophytes) – For exposure of a tolerant algal species to a more toxic formulation of glyphosate, the U.S. Forest Service risk assessment applied an EC_{10} of 3.78 mg a.e./L. While EC_5 values are typically used to approximate a NOAEL value, a conversion was unnecessary because an EC_{10} of 3.78 was considered a reasonable approximation of a minimal effect level. EC_{50} values for algae exposed to less toxic formulations of glyphosate, however, were converted by dividing by a factor of 10 for approximate EC_5 (and estimated NOAEC) values to account for endangered species. For macrophytes, there are no substantial differences between the sensitivity of macrophytes to the formulations of glyphosate that are generally classified as more toxic or less toxic formulations in the current U.S. Forest Service risk assessment. Consequently, and as with terrestrial macrophytes, separate dose-response assessments for more and less toxic formulations of glyphosate are not developed for aquatic macrophytes.

Table D.3-21

Ecological Endpoints for Less Toxic Glyphosate Formulations

		Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute	***N/A***	No data available
	Chronic	***N/A***	
Medium mammals	Acute	***NOAEL = 500 mg/kg bw***	rat, dietary exposure of glyphosate 97.67% a.i., 2-generation reproduction study
	Chronic	***NOAEL = 500 mg/kg bw/day***	
Small mammals	Acute	***N/A***	No data available

	Chronic		***N/A***	
Large herbivore mammals	Acute		***N/A***	
	Chronic		***N/A***	
Birds	Acute		***NOAEL = 1,500 mg/kg bw***	bobwhite quail/mallard duck, technical grade acid [converted from NOAEC = ~5,000 ppm]
	Chronic		***NOAEL = 58 mg/kg bw/day***	bobwhite quail, technical grade acid [converted from NOAEL = 830 ppm]
Terrestrial Invertebrates	Acute		***oral/contact NOEAL = 860 mg/kg bw***	honey bees, technical grade glyphosate [converted oral/contact LD50 values >100 µg/bee] [1]
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOEC = 3.6 lb/acre***	The dose-response assessment for terrestrial plants assumes that the surfactants added to all formulations, resulting in equal efficacy among formulations. For study details, see the more toxic glyphosate formulations table below.
		tolerant spp.	***NOEC = 5 lb/acre***	
	Vegetative vigor	sensitive spp.	***NOEC = 0.0013 lb/acre***	
		tolerant spp.	***NOAEC = 0.445 lb/acre***	
Fish	Acute	sensitive spp.	***surrogate NOAEC of 0.5 mg/L***	several spp. - i.e., chum salmon and rainbow trout, Rodeo at pH 6.3, [derived from an LC50 of 10 mg a.e./L a factor of 0.05]
		tolerant spp.	***surrogate NOAEC = 21 mg/L***	rainbow trout, Rodeo without surfactant at pH 7.8 [derived from an LC50 of 429.2 mg a.e./L * a factor of 0.05]
	Chronic	sensitive spp.	***surrogate NOAEC = 0.5 mg/L***	A duration-response relationship is not evident from the few chronic toxicity studies. As with the more toxic formulations of glyphosate, the surrogate acute NOAECs are applied to longer-term exposure scenarios
		tolerant spp.	***NOAEC = 21 mg/L***	
Amphibians	Acute	sensitive spp.	***NOAEC = 340 mg/L***	glyphosate IPA, tadpoles (*Litoria moorei*) [derived from indefinite LC50 (343 mg a.e./L)]
		tolerant spp.	***NOAEC = 470 mg/L***	tadpole (*Crinia insignifera*), glyphosate IPA [derived from indefinite LC50 (466 mg a.e./L)]
	Chronic	sensitive spp.	***NOAEC = 1.8 mg/L***	glyphosate IPA, leopard frogs. Note:

		tolerant spp.	***NOAEC = 1.8 mg/L***	difference in risk between sensitive and tolerant spp. could not be distinguished
Aquatic invertebrate	Acute	sensitive spp.	***surrogate NOAEC = 2.7 mg/L***	midge larvae (*Chironomous plumosus*), acid (96.7%) [derived from 53.2 mg a.e./L x 0.05 = 2.66 mg a.e./L]
		tolerant spp.	***surrogate NOAEC = 210 mg/L***	midge (*Chironomus riparius*), Rodeo (glyphosate IPA: 53.5% a.i.) [derived from 4140 mg a.e./L x 0.05 = 207 mg a.e./L]
	Chronic	sensitive spp.	***NOAEC = 1.0 mg/L***	No duration-response relationship is evident for glyphosate, Glyphosate acid, 97%, snails (*Pseudosuccinea columella*)
		tolerant spp.	***surrogate NOAEC = 210 mg/L***	No duration-response relationship is evident for glyphosate, so the acute endpoint is maintained for longer-term exposures
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***surrogate NOAEC = 0.082 mg/L***	As with terrestrial plants, there are no substantial differences between the sensitivity of macrophytes to the formulations of glyphosate that are generally classified as more toxic or less toxic formulations. For study details, see the *more toxic glyphosate formulations* table below.
		tolerant spp.	***NOAEC = 170 mg/L***	
	Chronic	sensitive/ tolerant spp.	***N/A***	
Aquatic Algae (Microphytes)	sensitive spp.		***surrogate NOAEC = 0.23 mg/L***	*Skeletonema costatum,* technical grade glyphosate [EC10 derived from EC50 of 2.27 mg a.e./L divided by a factor of 10]
	tolerant spp.		***surrogate NOAEC = 59 mg/L***	*Chlorella pyrenoidosa*, glyphosate acid (96.7%) [EC10 derived from a EC50 of 590 mg a.e./L divided by a factor of 10]

All endpoints are in terms of a.e. ED/C = Effect Dose/Concentration, IPA = isopropyl amine (salt), LD/C = Lethal Dose/Concentration, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration. [1] The oral toxicity values for the honey are used as a surrogate for herbivorous insects.

Table D.3-22

Ecological Endpoints for More Toxic Glyphosate Formulations

		Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute	***N/A***	No data available
	Chronic	***N/A***	

Medium mammals	Acute		***NOAEL = 175 mg/kg bw***	Rabbit, developmental study, dietary exposure of glyphosate acid
	Chronic		***NOAEL = 175 mg/kg bw/day***	
Small mammals	Acute		***N/A***	No data available
	Chronic		***N/A***	
Large herbivore mammals	Acute		***N/A***	
	Chronic		***N/A***	
Birds	Acute		***NOAEL = 540 mg/kg bw***	bobwhite quail/mallard duck, likely RoundUp PRO (a.i. IPA salt) [converted from NOAEC = ~1800 ppm]
	Chronic		***NOAEL = 43 mg/kg bw/day***	broiler chickens, RoundUp (a.i. IPA salt) [converted from NOAEC = 450 ppm]
Terrestrial Invertebrates	Acute		***contact NOAEC = 260 mg/kg bw***	honey bee, MON 77360 (containing POEA) [30µg/bee divided by 0.000116 kg, rounded]
			oral NOAEC = 430 mg/kg bw	honey bee, MON 77360 (containing POEA); also representative of herbaceous insects [15µg/bee divided by 0.000116 kg, rounded]
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOEC = 3.6 lb/acre***	80WDG, 75% a.i., crop monocots and dicots
		tolerant spp.	***NOEC = 5 lb/acre***	oat, rice, sorghum, barnyard grass, soybean, sugar beet, buckwheat, cocklebur, crabgrass, panicum grass, downy brome, velvetleaf, smartweed, morning glory, lambsquarter, hemp, CP-70139, IPA, 50% a.i.
	Vegetative vigor	sensitive spp.	***NOEC = 0.0013 lb/acre***	daisy, Roundup Bio (European formulation)[derived from NOAEC of 0.02 lb/acre x a factor of 15]
		tolerant spp.	***NOAEC = 0.445 lb/acre***	purple nut sedge, formula 80WDG, 48.3% a.i
Fish	Acute	sensitive spp.	***surrogate NOAEC = 0.048 mg/L***	rainbow trout, Roundup formulation with surfactants (i.e., POEA) [derived from an LC50 of 0.96 mg a.e./L x an RQ of 0.05]
		tolerant spp.	***surrogate NOAEC = 0.5 mg/L***	Glyphosate technical from Monsanto [derived from an LD50 of 10 mg a.e./L x an

				RQ of 0.05]
	Chronic	sensitive spp.	***surrogate NOAEC = 0.048 mg/L***	A duration-response relationship is not evident from the few chronic toxicity studies, and significant effects in such studies were within the range of acute LD50 doses (0.96 and 10 mg a.e./L) for acute studies. Thus, the NOAEC range for acute exposure (i.e., 0.048 to 0.5) is used for chronic exposure to more toxic formulations.
		tolerant spp.	***surrogate NOAEC = 0.5 mg/L***	
Amphibians	Acute	sensitive spp.	***surrogate NOAEC = 0.04 mg/L***	American bullfrog larvae, Roundup Original Max [derived from an LC50 of 0.8 mg a.e./L x an RQ of 0.05]
		tolerant spp.	***surrogate NOAEC = 2.6 mg/L***	metamorph (*Crinia insignifera*), Roundup with POEA surfactant (MON 2139), [derived from LC50 of 51.8 mg a.e./L x an RQ of 0.05]
	Chronic	sensitive spp.	***surrogate NOAEC = 0.04 mg/L***	Acute data used for both sensitive and tolerant spp.
		tolerant spp.	***surrogate NOAEC = 2.6 mg/L***	
Aquatic invertebrate	Acute	sensitive spp.	***surrogate NOAEC = 0.075 mg/L***	amphipods, Roundup formulation from Monsanto USA, [derived from LC50 1.5 mg a.e./L x an RQ of 0.05]
		tolerant spp.	***surrogate NOAEC = 2.3 mg/L***	amphipods, original Roundup formulation, [derived from LC50 46 mg a.e./L x an RQ of 0.05]
	Chronic	sensitive spp.	***surrogate NOAEC = 0.075 mg/L***	A duration-response relationship is not indicated for limited data of more toxic glyphosate formulations, so the surrogate acute NOAECs for sensitive and tolerant species are used for chronic exposures.
		tolerant spp.	***surrogate NOAEC = 2.3 mg/L***	
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***NOAEC = 0.082 mg/L***	Macrophytes seem equally sensitive to more and less toxic formulations of glyphosate. The algae endpoint is protective for sensitive species of aquatic macrophytes.
		tolerant spp.	***NOAEC = 170 mg/L***	Macrophytes seem equally sensitive to more and less toxic formulations, marine eelgrass,

				(Zostera marina), acid
	Chronic	sensitive/ tolerant spp.	***N/A***	No data available
Aquatic Algae (Microphytes)	sensitive spp.		***NOAEC = 0.082 mg/L***	*Navicula pelliculosa,* Glyphos
	tolerant spp.		***EC10 = 3.8 mg/L***	*Pseudokirchneriella subcapitata*, Roundup *[an EC5 or NOAEC is not warranted]*

All endpoints are in terms of a.e. ED/C = Effect Dose/Concentration, IPA = isopropyl amine (salt), LD/C = Lethal Dose/Concentration, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration.

D.3.2.4.3.4 Hexazinone (Sources: FS WSM v. 6.00.10; SERA 2005)

Dose-response endpoints for hexazinone are summarized in Table D.3-23. The available toxicity data support separate dose-response assessments in eight classes of organisms: terrestrial mammals, birds, terrestrial invertebrates, terrestrial plants, fish, aquatic invertebrates, aquatic algae, and aquatic macrophytes.

Mammals and Birds - Based on dietary and gavage toxicity studies, mammals appear to be somewhat more sensitive to hexazinone than birds. For example, the acute dietary NOAEL for birds is 550 mg/kg/day, a factor of about 1.4 above the acute NOEL of 400 mg/kg/day that is used for mammals. No lifetime toxicity studies in birds have been encountered. Based on the reproduction study, the chronic NOAEL for birds is set at 150 mg/kg/day. This is about a factor of 30 above the NOAEL of 5 mg/kg/day used for mammals.

Terrestrial Invertebrates* -** Relatively little information is available on terrestrial insects. A contact toxicity value of 1075 mg/kg bw is taken as a marginal LOEC.***

Terrestrial Plants (Macrophytes) - Hexazinone is relatively ineffective in inhibiting seed germination, but is toxic after either direct spray or soil application. Based on toxicity studies in which exposure can be characterized as an application rate, hexazinone is more toxic in pre-emergent soil applications than direct spray (post-emergent application).

Terrestrial and Aquatic Microorganisms – *No formal dose-response assessment was completed for aquatic microbes due to a lack of acceptable studies.* For terrestrial microbes, there is extensive literature regarding toxicity of hexazinone towards soil bacteria and fungi, though most information is from laboratory cultures. However, some field studies have shown hexazinone to have no adverse effects on these organisms at application rates up to about 7 lbs/acre. This information is used directly in the risk characterization for terrestrial microorganisms.

Fish - The acute NOEC values for sensitive and tolerant species of fish cover a very narrow range, 160 mg/L to 370 mg/L. For longer term exposures, the data are not sufficient to identify tolerant and sensitive species, so a single NOEC value of 17 mg/L is used.

Amphibians – *No formal dose-response assessment was completed for amphibians due to a lack of acceptable studies.*

Aquatic Invertebrates - Somewhat greater variability is apparent in aquatic invertebrates compared to fish, with acute NOEC values ranging from 20.5 mg/L to 320 mg/L. However, this may be an artifact of comparisons between freshwater and saltwater species. An NOEC of 10 mg/L from a reproduction study in daphnids is used to assess the effects of longer-term exposures in sensitive aquatic invertebrates. No longer-term NOEC is available for tolerant invertebrates, so the relative potency from acute studies is used to estimate a longer-term NOEC for tolerant species at 160 mg/L.

***Aquatic Plants (Algae and Macrophytes*) -** Aquatic plants are much more sensitive to hexazinone than fish and aquatic invertebrates, with much greater toxicity variability. Aquatic macrophytes appear to fall within the range of algae, so a single NOEC of 0.012 mg/L is used for this group.

Table D.3-23

Ecological Endpoints for Hexazinone

		Endpoint	**Receptor, Study & Endpoint Details**
Canine mammals	Acute	***N/A***	No data available
	Chronic	***NOAEL = 5 mg/kg bw/day***	dog, 1-dietary study for chronic toxicity
Medium mammals	Acute	***NOAEL = 400 mg/kg bw/day***	rat, developmental study, endpoint for offspring; at dose evidence of maternal toxicity
	Chronic	***N/A***	No data available
Small mammals	Acute	***N/A***	
	Chronic	***N/A***	
Large herbivore mammals	Acute	***N/A***	
	Chronic	***N/A***	

Birds	Acute		***surrogate NOAEL = 550 mg/kg bw***	bobwhite quail, (derived from 2,500 ppm * food consumption rate of 22% bw/day), dietary study
	Chronic		***surrogate NOAEL = 150 mg/kg bw/day***	bobwhite quail, derived from 1,000 ppm * food consumption rate of 15% bw/day, reproduction study
Terrestrial Invertebrates	Acute		***LOEC = 1075 mg/kg bw***	honey bee, derived from LD50 > 0.1 mg/bee and functions as a marginal LOEC
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOEC = 0.000348 mg/kg bw***	tomato, for all effects
		tolerant spp.	***NOEC = 0.0234 mg/kg bw***	corn, for all effects
	Vegetative vigor	sensitive spp.	***NOEC = 0.00391 mg/kg bw***	cucumber, for all effects
		tolerant spp.	***NOEC = 0.0625 mg/kg bw***	corn, for all effects
Fish	Acute	sensitive spp.	***NOEC = 160 mg/L***	flathead minnows, for mortality
		tolerant spp.	***NOEC = 370 mg/L***	trout, for mortality
	Chronic	sensitive spp.	***NOEC = 17 mg/L***	flathead minnows, egg-and-fry development, used given the narrow range for acute NOEC and LD50 values and that flatheads appear to be most sensitive.
		tolerant spp.		
Amphibians	Acute	sensitive spp.	***N/A***	Data is not adequate enough to propose an independent toxicity value for amphibians
		tolerant spp.	***N/A***	
	Chronic	sensitive spp.	***N/A***	
		tolerant spp.	***N/A***	
Aquatic invertebrate	Acute	sensitive spp.	***NOEC = 20.5 mg/L***	*Daphnia magna*
		tolerant spp.	***NOEC = 320 mg/L***	Oyster embryos
	Chronic	sensitive spp.	***NOEC = 10 mg/L***	*Daphnia magna*, reproduction study

		tolerant spp.	***NOEC = 160 mg/L***	[derived by multiplying relative potency from acute studies (320 divided by 20.5 mg/L) x 10 mg/L]
Aquatic Plants (Macrophytes)	Acute	sensitive/ tolerant spp.	***NOEC = 0.012 mg/L***	Lemna minor, 7-day growth study
	Chronic			
Aquatic Algae (Microphytes)	sensitive spp.		***NOEC = 0.004 mg/L***	green algae, Selenastrum capricornutum, 5-day growth inhibition study
	tolerant spp.		***NOEC = 0.15 mg/L***	blue-green algae (*Anabaena flos-aquae*), 5-day growth inhibition study

All endpoints are in terms of a.i. LD/C = Lethal Dose/Concentration, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration. LOEC = lowest-observed-effect-level.

D.3.2.4.3.5 Imazapyr (Sources: FS WSM v. 6.00.10; SERA 2011c)

Dose-response endpoints are summarized in Table D.3-24 for imazapyr. Dose response assessments are supported for eight classes of organisms in the U.S. Forest Service risk assessment for imazapyr: terrestrial mammals, birds, terrestrial invertebrates, terrestrial plants, fish, aquatic invertebrates, aquatic algae, and aquatic macrophytes. The dose-response assessments for terrestrial and aquatic animals are limited, primarily because imazapyr is relatively nontoxic to animals and the number of animal species tested is so few. Consequently, sensitive and tolerant species are not defined for either terrestrial animals or for most groups of aquatic animals.

Mammals and Birds - The standard array of studies used to assess the acute, subchronic, and chronic toxicity of pesticides, including effects on reproduction and development, indicate that imazapyr causes adverse effects in mammals only at doses of 1000 mg a.e./kg or more. The use of a NOAEL in dogs to characterize risks for all terrestrial mammals, however, may be overly conservative. Imazapyr is a weak acid, and, like most weak acids, is excreted primarily in the urine. Because dogs have a limited capacity to excrete weak acids, they are more sensitive than other mammals to certain weak acids. Imazapyr has a low order of acute toxicity in birds. Both of the acute and chronic NOAEL values for toxicity of birds are free-standing—i.e., adverse effects may occur at higher, but as yet undetermined, doses.

Terrestrial Invertebrates - The standard contact toxicity study in honeybees is used to represent this class of organisms. Likewise the standard oral toxicity study using honey bees is used as a surrogate toxicity value to characterize risks to herbivorous insects from the consumption of vegetation contaminated with imazapyr.

Terrestrial Plants (Macrophytes) - Like other imidazolinone herbicides, imazapyr appears to be more toxic to terrestrial monocots than to dicots.

Terrestrial and Aquatic Microorganisms *- No formal dose-response assessment was completed for either group of microbes due to a lack of acceptable studies. Available studies will be used to qualitatively assess terrestrial microbes in the risk characterization section.* Liquid culture solutions of imazapyr were toxic to various soil bacteria, with LC_{50} values ranging from about 10 to 1000 μM (2.61 to 261 mg/L - ppm). Because these concentrations involve liquid cultures and because bioavailability of imazapyr is likely to be substantially less in a soil matrix, these values are not appropriate for direct use, analogous to other NOAEL and NOAEC values discussed in this risk assessment. Imazapyr had only a slight effect on the breakdown of cellulose at a concentration in soil of 20 mg/kg but had a substantial impact at a concentration of 150 mg/kg. These values are relevant to the functional effect of imazapyr on soil microorganisms.

Fish **-** Studies consistently indicate that Arsenal, the only formulation on which toxicity data are available, is more toxic than imazapyr acid or the isopropylamine salt of imazapyr.

Amphibians **-** *No formal dose-response assessment was completed for terrestrial phase or aquatic phase amphibians due to a lack of toxicity data.*

Aquatic Invertebrates - studies consistently indicate that, as for fish, the formulation Arsenal is more toxic than imazapyr acid or the isopropylamine salt of imazapyr.

Aquatic Plants (Algae and Macrophytes**) -** Like other imidazolinone herbicides, imazapyr appears to be more toxic to aquatic macrophytes than to algae and more toxic to terrestrial monocots than to dicots.

Table D.3-24

Ecological Endpoints for Imazapyr

Receptor	Exposure		Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute		***NOAEL = 250 mg/kg bw/day***	Chronic endpoint applied
Canine mammals	Chronic		***NOAEL = 250 mg/kg bw/day***	dog, 1-year dietary study
Medium mammals	Acute		***NOAEL = 738 mg/kg bw/day***	Chronic endpoint applied
Medium mammals	Chronic		***NOAEL = 738 mg/kg bw/day***	rat, reproduction (dietary) study
Small mammals	Acute		***N/A***	No data available
Small mammals	Chronic		***N/A***	No data available
Large herbivore mammals	Acute		***N/A***	No data available
Large herbivore mammals	Chronic		***N/A***	No data available
Birds	Acute		***NOAEL = 2,510 mg/kg bw***	Mallard ducks, technical grade (93% a.e.) used in gavage study; Also supported by Northern bobtail quail studies
Birds	Chronic		***NOAEL = ~610 mg/kg bw***	Northern bobwhite quail, acid, based on measured food consumption and body weights, reproductive (dietary) study [derived from 1,670 ppm a.e.]
Terrestrial Invertebrates	Acute		***contact/oral NOAEL > 860 mg/kg bw***	honey bee, oral functionally surrogate for herbivorous insects [derived from an LD50 = 100µg/bee]
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOAEL = 0.00017 lbs/acre***	sugar beet (a dicot), technical grade
Terrestrial Plants (Macrophytes)	Seedling Emergence	tolerant spp.	***NOAEL = 0.0156 lbs/acre***	oat (a monocot), for growth (height)
Terrestrial Plants (Macrophytes)	Vegetative vigor	sensitive spp.	***NOAEL = 0.000064 lb/acre***	cucumber (a dicot)
Terrestrial Plants (Macrophytes)	Vegetative vigor	tolerant spp.	***NOAEL = 0.4 lb/acre***	pumpkin (a dicot)
Fish	Acute	sensitive spp.	***NOAEC = 10.4 mg/L***	trout, formulation
Fish	Acute	tolerant spp.	***N/A***	No data available

	Chronic	sensitive spp.	***surrogate NOAEC = 4.0 mg/L***	formulation, [derived from the chronic NOAEC of 43.1 mg a.e./L from a trout study that is divided by 10 and rounded]
		tolerant spp.	***estimated NOAEC = 12 mg/L***	formulation, [derived from the NOAEC of 118 mg a.e./L in flathead minnows divided by 10 and rounded]
Amphibians	Acute	sensitive spp.	***N/A***	no data available
		tolerant spp.	***N/A***	
	Chronic	sensitive spp.	***N/A***	
		tolerant spp.	***N/A***	
Aquatic invertebrate	Acute	sensitive spp.	***N/A***	No data available
		tolerant spp.	***NOAEC = 41 mg/L***	Daphnia magna, Arsenal formulation
	Chronic	sensitive spp.	***N/A***	No data available
		tolerant spp.	***surrogate NOAEC = 12 mg/L***	Daphnia magna, formulation [derived from NOAEC of 97.1 mg a.e./L divided by 8.0 to account potentially greater long-term toxicity of formulations]
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***NOEC = 0.003 mg/L***	water milfoil *(Myriophyllum sibiricum*), Arsenal formulation
		tolerant spp.	***surrogate NOEC = 0.1 mg/L***	giant salvinia (*Salvinia molesta*)
	Chronic	sensitive/ tolerant spp.	***N/A***	No data available
Aquatic Algae (Microphytes)	sensitive spp.		***NOEC = 7.6 mg/L***	*Selenastrum capricornutum*, acid
	tolerant spp.		***NOEC = 50.9 mg/L***	*Skeletonema costatum*, acid

All endpoints are in terms of a.e. ED/C = Effect Dose/Concentration, LD/C = Lethal Dose/Concentration, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration.

D.3.2.4.3.6 NP9E (Sources: FS WS ver. 2.02; USDA/FS 2003b)

Dose-response endpoints are summarized in Table D.3-25 for NP9E and associated compounds.

Although NP is of higher toxicity to aquatic organisms than NPE or NPEC, there is sufficient information in the literature to make the assumption that in a forested environment, contamination of surface water is more likely to involve NP9E in the short-term and NP1-2EC in the long-term. As such, indicators of risk will be based upon these two compounds, not on NP.

Mammals and Birds - Mammalian toxicity is well characterized for NP, but less so for NP9E and the carboxylate metabolites. The acute NOEL value of 10 mg/kg bw was taken from a 90-day rat feeding study and should be considered a conservative value, as the NOEL values from similar tests range up to 40 mg/kg/day, with LOELs beginning at 50 mg/kg/day. The chronic toxicity value is also 10 mg/kg bw/ day, though it was derived from an NP multigenerational study with rats; it will be used for both NP and NPE. For birds, mammal data is protective of birds and is thus used for surrogate values.

Terrestrial Invertebrates – *No formal dose-response assessment was completed due to a lack of acceptable studies.*

Terrestrial Plants (Macrophytes) - Since NP9E-based surfactants would not be applied alone, but would be applied in a mix with an herbicide, the herbicide would determine the effects to terrestrial plants. Thus, a dose-response assessment is not appropriate.

Terrestrial and Aquatic Microorganisms - *No formal dose-response assessment was completed due to a lack of acceptable studies.*

Fish - For NP9E, the value that will be used to establish the aquatic acute no-effect level is the 7-day NOEC (growth) for minnows of 1,000 ppb. Species that have been tested with the longer chain NPEs all have similar values, so no interspecies factor will be used. It is assumed that acute toxicity tests involving NP9E included a small percentage of the short-chain ethoxylates, as well as small amounts of NP. For NP1EC and NP2EC, the NOEC value of 100 ppb in fathead minnows will be applied.

Amphibians - Frogs seem similar in sensitivity or somewhat less sensitive than fish. Therefore, levels of exposure that result in low levels of risk to fish should be similarly protective of frogs.

Aquatic Invertebrates – For aquatic invertebrates, the 7-day NOEC for NP9E of 10 mg/L for *Daphnia* spp. will be used for acute exposures. For chronic exposures, since no testing has been done using the NP1-2ECs, the 21-day NP NOEC for *Daphnia magna* will be used (0.024 mg/L).

***Aquatic Plants (Algae and* Macrophytes) -** For aquatic plants, the 96-hour NP9E NOEC (growth) of 8 mg/L for green algae will be used for acute exposures. There are no chronic exposure studies for aquatic plants.

Table D.3-25

Ecological Endpoints for NP9E

			Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute		***N/A***	No data available
	Chronic		***N/A***	
Medium mammals	Acute		***NOAEL = 10 mg/kg***	rat, NP9E dietary study
	Chronic		***NOAEL = 10 mg/kg/day***	rat, NP oral gavage multigeneration study
Small mammals	Acute		***N/A***	No data available
	Chronic		***N/A***	
Large herbivore mammals	Acute		***N/A***	
	Chronic		***N/A***	
Birds	Acute		***surrogate NOAEL = 10 mg/kg***	rat data, acute and chronic mammal endpoints are used as surrogate values for avian species
	Chronic		***surrogate NOAEL = 10 mg/kg/day***	
Terrestrial Invertebrates	Acute		***N/A***	No data available
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***N/A***	NP9E-based surfactants would not be applied alone, but applied with an herbicide, and the herbicide would determine effects to plants. Thus, a dose-response assessment is NA.
		tolerant spp.	***N/A***	
	Vegetative vigor	sensitive spp.	***N/A***	
		tolerant spp.	***N/A***	
Fish	Acute	sensitive spp.	***NP9E: NOEC = 1.0 mg/L***	Fathead minnow (*Pimephales promelas*), 7-day growth study (based on growth), [converted from 1,000 ppb]
		tolerant spp.		
	Chronic	sensitive spp.	***NP1EC/NP2EC: NOEC = 0.1 mg/L***	flathead minnow (*Pimephales promelas*), [derived from 1,000 ppb, dividing by an interspecies factor of 10 for NOEC = 100 ppb which is then
		tolerant spp.		

				converted to mg/L]
Amphibians	Acute	sensitive spp.	***surrogate NP9E: NOEC = 1.0 mg/L***	flathead minnow (Pimephales promelas) data, limited amphibian data suggests NP9E is equally or less toxic to amphibians compared to fish.
		tolerant spp.		
	Chronic	sensitive spp.	***surrogate NP1EC/NP2EC: NOEC = 0.1 mg/L***	
		tolerant spp.		
Aquatic invertebrate	Acute	sensitive spp.	***NOEC = 10 mg/L***	sensitive and tolerant spp. not specified; Daphnia spp., 7-day study using NP9E
		tolerant spp.	***NOEC = 10 mg/L***	
	Chronic	sensitive spp.	***NOEC = 0.024 mg/L***	species sensitivity not specified; *Daphnia magna* 21-day study using NP
		tolerant spp.	***NOEC = 0.024 mg/L***	
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***surrogate NOEC = 8 mg/L***	algal values applied: green algae (*Selenastrum capricornutum*), NP9E study
		tolerant spp.	***surrogate NOEC = 8 mg/L***	
	Chronic	sensitive/ tolerant spp.	***N/A***	No data available
Aquatic Algae (Microphytes)	sensitive spp.		***NOEC = 8 mg/L***	sensitive and tolerant species not specified; exposure to NP9E, green algae (*Selenastrum capricornutum*)
	tolerant spp.		***NOEC = 8 mg/L***	

All endpoints are in terms of a.i. N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration.

D.3.2.4.3.7 Sulfometuron methyl (Sources: FS WSM v. 6.00.10; SERA 2004c)

Dose-response endpoints are summarized in Table D.3-26 for sulfometuron methyl.

Mammals and Birds **-** All of the potential longer-term and acute exposures of terrestrial mammals to sulfometuron methyl are substantially below the NOAEL values of 2 mg/kg/day and 87 mg/kg/day respectively. Birds appear to exhibit the same low order of toxicity to sulfometuron methyl as mammals, with an acute NOAEL of 312 mg/kg based on changes in body weight observed following a single gavage administration to mallard ducks. No chronic exposure studies of birds to sulfometuron methyl were identified in the available literature. Since results of acute exposure studies suggest that the sensitivity of birds to sulfometuron methyl is similar to that of mammals, in the absence of chronic exposure data in birds the chronic NOAEL for rats is used for birds.

Terrestrial Invertebrates - For terrestrial invertebrates, based on direct spray studies in honey bees, no mortality would be expected following acute exposure to doses up to 1075 mg/kg.

Terrestrial Plants (Macrophytes) - Sulfometuron methyl is a potent herbicide that causes adverse effects in a variety of target and non-target plant species.

Terrestrial and Aquatic Microorganisms - No formal dose-response assessment was completed for either group of microbes due to a lack of acceptable studies. Available studies will be used to qualitatively assess terrestrial microbes in the risk characterization section. Regarding terrestrial microbes, soil microorganisms appear sensitive to sulfometuron methyl at concentrations of about 70 µg/L. No specific NOEC was determined, though the chemical has been found to inhibit growth in some species (e.g. *Salmonella typhimurium*) and microbe species may develop resistance to the chemical, while other bacteria species (e.g. *Streptomyces griseolus*) metabolize the compound.

Fish - The data on toxicity to fish and aquatic invertebrates was obtained for several species. Fish do not appear to be highly sensitive to sulfometuron methyl toxicity. However, investigations of acute toxicity have been hampered by the limited water solubility of sulfometuron methyl. Both of the acute values were the highest concentration tested in both studies, so identification of a most sensitive and a most tolerant species cannot be made with certainty. Toxicity values for chronic toxicity may be based on the available egg-and-fry/early life stage studies. Only one study of chronic exposure in fish is available, a 30-day exposure of fathead minnow yielding an NOAEC of 1.17 mg a.i./L. This value is used for both the most sensitive and tolerant species for chronic exposure.

Amphibians – The toxicity of acute and chronic exposure to sulfometuron methyl to amphibians has been evaluated in a single study in African Clawed frogs (*Xenopus laevis*). In this report, the author did not state whether data were reported in terms of mg sulfometuron methyl/L or mg Oust/L. Taking the most conservative approach, values are assumed to be expressed in terms of mg a.i./L. Since no studies on other amphibian species were identified in the available literature, it is not possible to identify a most tolerant and most sensitive amphibian species.

***Aquatic Invertebrates* -** For acute exposure of aquatic invertebrates, the most sensitive species appear to be *Alonella* sp. and *Cypria* sp., with *Daphnia* the most tolerant species. *Daphnia* are 32 times more tolerant than *Alonella* and *Cypria* to acute exposure of sulfometuron methyl. For chronic exposure of aquatic invertebrates, data are only available from a single study in Daphnia, with a NOAEC of 6.1 mg/L. This value is used for the most tolerant species for chronic exposure. Although no data are available to determine the most sensitive species for chronic exposures, parallels can be drawn to the acute exposure studies. Using the relative potency factor for acute exposures of 32 and the chronic NOEC in *Daphnia* of 6.1 mg/L, a NOAEC for *Alonella* and *Cypria* is estimated to be 0.19 mg/L. This surrogate NOAEC for chronic exposure in *Alonella* and *Cypria* will be used to estimate the chronic NOAEC for the most sensitive species.

***Aquatic Plants (Algae and Macrophytes*) -** Aquatic plants appear to be much more sensitive to sulfometuron methyl than aquatic animals. A NOAEC for growth inhibition of 0.00021 mg/L in duckweed is used to quantify effects for both acute and chronic exposure in aquatic macrophytes. Based on the limited data available as well as difference in experimental protocols, it is not possible to identify a most sensitive and most tolerant species for aquatic macrophytes. For algae, the most sensitive algal species appears to be *Selenastrum capricornutum* and the most tolerant species appears to be *Navicula pelliculosa*.

Table D.3-26

Ecological Endpoints for Sulfometuron Methyl

		Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute	***N/A***	No data available
	Chronic	***N/A***	
Medium mammals	Acute	***NOAEL = 87 mg/kg bw***	rat, diets containing 1000 ppm convert to ~86.6 mg/kg/day
	Chronic	***NOAEL = 2 mg/kg bw/day***	rats, 2-year feeding study
Small mammals	Acute	***N/A***	No data available
	Chronic	***N/A***	
Large herbivore mammals	Acute	***N/A***	
	Chronic	***N/A***	
Birds	Acute	***NOAEL = 312 mg/kg bw***	mallard duck, technical grade, gavage administration
	Chronic	***NOAEL = 2 mg/kg bw/day***	Acute values for birds and mammals had comparable magnitude. Chronic mammal endpoint applied as surrogate chronic bird endpoint. rats, from a 2-year feeding study.
Terrestrial Invertebrates	Acute	***NOAEL = 1075 mg/kg bw***	honey bee, [derived from an LD50 of 100 µg/bee divided by bee bw of 0.093 g

Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOEC = 0.0000086 lb/acre***	rape, tomato sorghum, wheat and corn
		tolerant spp.	***NOEC = 0.00026 lb/acre***	onion, pea, cucumber and soybean
	Vegetative vigor	sensitive spp.	***NOEC = 0.000024 lb/acre***	corn
		tolerant spp.	***NOEC = 0.00078 lb/acre***	pea
Fish	Acute	sensitive spp.	***NOEC = 7.3 mg/L***	acute LC50 result hampered by limited water solubility of sulfometuron methyl, flathead minnows
		tolerant spp.	***NOEC = 150 mg/L***	acute LC50 result hampered by limited water solubility of sulfometuron methyl, bluegill sunfish and rainbow trout
	Chronic	sensitive spp.	***NOEC = 1.17 mg/L***	flathead minnow larvae; identification of sensitivity by species not possible
		tolerant spp.		
Amphibians	Acute	sensitive spp.	***NOEC = 0.38 mg/L***	African Clawed frogs (*Xenopus laevis*), Oust formulation, sensitivity by spp. is NA for 1 study. This NOAEC and assoc. LOAEC value are for lethality and malformations during metamorphosis
		tolerant spp.		
	Chronic	sensitive spp.	***NOEC = 0.00075 mg/L***	African Clawed frog (*Xenopus laevis*) study, Oust formulation, sensitivity by spp. is NA for 1 study. This NOEC is for changes in tail resorption rates during a 14-day study
		tolerant spp.		
Aquatic invertebrate	Acute	sensitive spp.	***LOEC = 75 mg/L***	Alonella spp. and Cypria spp. [the lowest concentration tested]
		tolerant spp.	***NOEC = 1,800 mg/L***	*Daphnia*
	Chronic	sensitive spp.	***surrogate NOEC = 0.19 mg/L***	[derived from tolerant chronic NOEC of 6.1 mg/L ÷ relative potency of 32 that is based on ratio of Daphnia to Alonella and Cypria acute LOAEC values (2,400/75)]
		tolerant spp.	***NOEC = 6.1 mg/L***	*Daphnia*
Aquatic Plants	Acute	sensitive/	***NOEC = 0.00021 mg/L***	duckweed (Lemna spp.), technical grade,

(Macrophytes)		tolerant spp.		14-day study; most conservative (lowest) NOEC of both acute and chronic values
	Chronic	sensitive/ tolerant spp.	***NOEC = 0.00021 mg/L***	
Aquatic Algae (Microphytes)	sensitive spp.		***NOEC = 0.0025 mg/L***	alga (*Selenastrum capricornutum*), based on cell density
	tolerant spp.		***NOEC = 0.37 mg/L***	alga (*Navicula pelliculosa*), based on growth inhibition

All endpoints are in terms of a.i. LD/C = Lethal Dose/Concentration, LOEC = lowest-observed-effect-level, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration.

D.3.2.4.3.8 Triclopyr (Sources: FS WSM v. 6.00.10; SERA 2011a,d)

Triclopyr acid and salts are considered separately from esters**.** Dose response is also considered for the compound 3,5,6-trichloro-2-pyridinol (TCP) within this section, as TCP is a metabolite of triclopyr of particular concern. Dose-response endpoints are summarized in Table D.3-27 for TCP, Table D.3-28 for acid and triethylamine salt of triclopyr, and Table D.3-29 for butoxyethyl esters of triclopyr.

Data on triclopyr TEA are typically included in the dose-response assessment for triclopyr acid, because these two forms of triclopyr appear to be bioequivalent in most groups of organisms. Data on triclopyr BEE and formulations of triclopyr BEE are discussed separately for some groups of organisms, primarily because the toxicity of triclopyr BEE formulations (expressed in units of triclopyr a.e.) and technical grade triclopyr BEE (also expressed in units of triclopyr a.e.) appears to be the same. In other words, the inerts used in the triclopyr BEE formulations do not have an obvious impact on the toxicity of the triclopyr BEE formulations on which data are available (primarily Garlon 4). The toxicity values for TCP span much narrower ranges than the toxicity values for triclopyr. This difference is almost certainly due to the fewer number of studies available on TCP.

The dose-response assessments for triclopyr acid and triclopyr BEE in terrestrial animals are relatively standard and uncomplicated, except for mammals. For TCP, the available data limit the dose-response assessment for terrestrial organisms to mammals. The dose-response assessment for aquatic species is somewhat detailed, because triclopyr acid and triclopyr BEE are not bioequivalent in aquatic organisms. With the exception of aquatic dicots, triclopyr BEE is much more toxic than triclopyr acid or triclopyr TEA. Within most groups of aquatic organisms, the toxicity values differ substantially for both triclopyr TEA and triclopyr BEE. Typically, this high variability reflects differences among bioassays conducted by different investigators at different times rather than true underlying differences in species sensitivity. A possible exception involves the toxicity of triclopyr BEE to aquatic arthropods.

Mammals and Birds - The available toxicity data on triclopyr indicate that larger mammals are substantially more sensitive than smaller mammals, and this relationship can be characterized quantitatively. Most U.S. Forest Service risk assessments consider only small mammals and canids, however, the dose-response assessment for mammalian wildlife is elaborated to include a large herbivorous mammal, such as a deer. There is no remarkable difference in the toxicity of triclopyr acid, triclopyr TEA, and triclopyr BEE to birds. Similarly, the toxicity data, available only on a few avian species, do not indicate substantial or systematic differences in species sensitivities to triclopyr. The current U.S. Forest Service risk assessment relies on the EPA review of the toxicity of TCP and available open literature. Relatively little information is available on the toxicity of TCP to mammals or birds (U.S. EPA/OPP 2002b as referenced in SERA 2011d).

Terrestrial Invertebrates – For triclopyr, an indefinite LD_{50} was used rather than a well-documented NOAEC for the calculation of hazard quotients, though the risk characterization for insects is based primarily on field studies rather than the HQs. A dose-response assessment of the toxicity of TCP to terrestrial invertebrates cannot be proposed due to the lack of pertinent data.

Terrestrial Plants (Macrophytes) The dose-response assessments in terrestrial plants are also relatively standard for triclopyr acid and the triclopyr ester. Foliar studies do not suggest any remarkable differences in potency between triclopyr TEA and triclopyr BEE formulations. Dicots are more sensitive than monocots to both formulations. A dose-response assessment of the phytotoxicity of TCP is not proposed because no data are available on the toxicity of TCP to terrestrial plants.

Terrestrial and Aquatic Microorganisms – *No formal dose-response assessment was completed for either group of microbes due to a lack of acceptable studies. Available field studies will be used to qualitatively assess terrestrial organisms in the risk characterization section.*

Fish - Acute LC_{50} values for triclopyr TEA range from 40.1 to 422.8 mg a.e./L and encompass the more limited number of LC_{50} values available on triclopyr acid. The acute sublethal toxicity of triclopyr acid and triclopyr TEA is not well documented, either in standard acute toxicity studies or field studies. There are more toxicity data for triclopyr BEE than for triclopyr TEA, including more acute toxicity studies, many of which report both LC_{50} values and NOAECs. Acute LC_{50} values for triclopyr BEE range from 0.2 to 1.5 mg a.e./L. As with triclopyr TEA, there is only one chronic study available. For TCP, there are two sets of studies, which are obviously inconsistent and reflect experimental variability or other unidentified factors rather than any differences in species sensitivity.

Amphibians - Information on the toxicity of triclopyr to amphibians is much less abundant than the information on fish. Since there are no chronic bioassays involving amphibian exposure to triclopyr, explicit longer-term NOAECs are not developed. Nonetheless, a field study involving longer-term observations of amphibian populations following forestry applications of triclopyr BEE is used in the development of acute NOAECs and is discussed further in the risk characterization for amphibians.

***Aquatic Invertebrates* -** There is no apparent basis, given admittedly limited data, for asserting that non-arthropod aquatic invertebrates are substantially different from aquatic arthropods in their sensitivity to triclopyr. Within this group, cladocerans appear to be more sensitive than aquatic insects to triclopyr BEE, though no such species sensitivity is clearly documented for triclopyr TEA or the TCP metabolite.

Aquatic Plants (Algae and Macrophytes) – Data regarding toxicity to algae are available for triclopyr acid, triclopyr BEE, and TCP. As with most other groups of aquatic organisms, algae are more sensitive to triclopyr BEE than to triclopyr TEA. Based on median EC_{50} values, triclopyr BEE is more toxic to algae than triclopyr TEA by a factor of 10. When considering toxicity to aquatic macrophytes, relative sensitivity to triclopyr TEA is assessed based on an analogy to differences in the sensitivity of monocots and dicots, with dicots comprising the sensitive species and monocots comprising the tolerant species. There is not a substantial difference in the toxicity of triclopyr BEE to monocots and dicots. Dicots are the only group of aquatic organisms in which triclopyr TEA is substantially more toxic than triclopyr BEE. A dose-response assessment of the toxicity of TCP to macrophytes is not proposed because no data are available on the toxicity of TCP to aquatic macrophytes.

Table D.3-27

Ecological Endpoints for TCP, a Metabolite of Triclopyr

		Endpoint	Receptor, Study & Endpoint Details
Canine mammals	Acute	***NOAEL = 25 mg/kg bw***	rabbit, LOAEL endpoint: birth defects
	Chronic	***surrogate NOAEL = 12 mg/kg bw***	dog study, chronic NOAEL
Medium mammals [1]	Acute	***surrogate NOAEL = 25 mg/kg bw***	rabbit study, acute NOAEL
	Chronic	***NOAEL = 12 mg/kg bw***	dog, LOAEL endpoint: clinical chemistry
Small mammals	Acute	***N/A***	No data available
	Chronic	***N/A***	

Large herbivore mammals	Acute		***N/A***	
	Chronic		***N/A***	
Birds	Acute		***LOAEL = 116 mg/kg bw***	5-day dietary study
	Chronic		***N/A***	No data available
Terrestrial Invertebrates	Acute		***N/A***	No data available
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***N/A***	No data available
		tolerant spp.	***N/A***	
	Vegetative vigor	sensitive spp.	***N/A***	
		tolerant spp.	***N/A***	
Fish	Acute	sensitive spp.	***surrogate NOAEC = 0.18 mg/L***	rainbow trout, [see chronic NOAEC; conservatively applied]
		tolerant spp.	***estimated NOAEC = 0.63 mg/L***	rainbow trout, [LC50 of 1.26 mg TCP/L x LOC of 0.5]
	Chronic	sensitive spp.	***adjusted NOAEC = 0.18 mg/L***	rainbow trout, fry to egg study, variation for trout (see acute) may be related to environmental and experimental variability (i.e., pH), unidentifiable factors, and/or chance [rounded from 0.178 mg/L].
		tolerant spp.		
Amphibians	Acute	sensitive spp.	***N/A***	No data available
		tolerant spp.	***N/A***	
	Chronic	sensitive spp.	***N/A***	
		tolerant spp.	***N/A***	
Aquatic invertebrate	Acute	sensitive spp.	***estimated NOAEC = 0.55 mg/L***	[LC50 of 10.9 mg/L x 0.05]
		tolerant spp.	***estimated NOAEC = 0.55 mg/L***	
	Chronic	sensitive spp.	***NOAEC = 0.058 mg/L***	*Daphnia magna* study
		tolerant spp.	***NOAEC = 0.058 mg/L***	
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***N/A***	No data available
		tolerant spp.	***N/A***	

	Chronic	sensitive/ tolerant spp.	***N/A***	
Aquatic Algae (Microphytes)	sensitive spp.		***NOAEC = 0.36 mg/L***	*Anabaena flos-aquae*, 5-day study
	tolerant spp.		***NOAEC = 0.65 mg/L***	*Kirchneria subcapitata*, 5-day study

All toxicity values for 3,5,6-trichloro-2-pyridinol (TCP) metabolite of triclopyr are expressed as mg TCP/kg bw or mg TCP/L. LD/C = Lethal Dose/Concentration, LOC = level of concern, LOAEL = lowest-observed-adverse-effect-level, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration. [1] Due to lack of data for species sensitivity of mammals to TCP, the NOAELs of 25 mg/kg bw for acute exposures and 12 mg/kg bw for longer-term term exposures are used to characterize risks of TCP exposure to small mammals.

Table D.3-28

Ecological Endpoints for Triclopyr Acid and TEA

			Endpoint	**Receptor, Study & Endpoint Details**
Canine mammals	Acute		***NOAEL = 20 mg a.e./kg bw***	estimated relative to rat [derived by 100 mg/kg bw ÷ factor of 5]
	Chronic		***NOAEL = 1 mg a.e./kg bw***	estimated relative to rat [derived by 5 mg/kg bw ÷ factor of 5]
Medium mammals	Acute		***NOAEL = 100 mg/kg bw***	rat
	Chronic		***NOAEL = 5 mg/kg bw***	rat
Small mammals	Acute		***NOAEL = 440 mg/kg bw***	estimated relative to rat [derived by 100 mg/kg bw x factor of 4.4]
	Chronic		***NOAEL = 22 mg/kg bw***	estimated relative to rate [derived by 5 mg/kg bw x factor of 4.4]
Large herbivore mammals	Acute		***NOAEL = 8 mg/kg bw***	estimated relative to rat [derived by 100 mg/kg bw ÷ factor of 13 ≈ 7.69]
	Chronic		***NOAEL = 0.4 mg/kg bw***	estimated relative to rat [derived by 5 mg/kg bw ÷ factor of 13 ≈ 0.38]
Birds	Acute		***NOAEL = 126 mg/kg bw***	Northern bobwhite quail, BEE gavage study
	Chronic		***NOAEL =7.5 mg/kg bw/day***	Northern bobwhite quail, reproduction study
Terrestrial Invertebrates	Acute		***indefinite oral LD50 = 620 mg/kg bw***	honey bees, [derived by LD50 of >72 µg (0.072 mg) ÷ 0.000116 kg bee bw ≈ 620.68 mg/kg bw]
Terrestrial Plants	Seedling Emergence	sensitive spp.	***NOEC = 0.0028 lb/acre***	soybean (a dicot), TEA, based on shoot length
		tolerant spp.	***NOEC = 0.23 lb/acre***	barley (a monocot), TEA, based on shoot length

(Macrophytes)	Vegetative vigor	sensitive spp.	***NOEC = 0.0028 lb/acre***	sunflower (a dicot), TEA and BEE
		tolerant spp.	***NOEC = 2.0 lb/acre***	oat (a monocot), BEE [converted from >2242 g a.i./ha]
Fish	Acute	sensitive spp.	***estimated NOAEC = 20 mg/L***	acid [derived from LC50 of 40.1 mg a.e./L x LOC of 0.5]
		tolerant spp.	***estimated NOAEC = 210 mg/L***	acid [LC50 of 210 mg a.e./L x LOC of 0.5]
	Chronic	sensitive spp.	***estimated NOAEC = 7.4 mg/L***	acid, [acute NOAEC 20 mg a.e./L x acute-to chronic ratio 0.37 = 7.4 mg a.e./L]
		tolerant spp.	***estimated NOAEC = 78 mg/L***	acid [acute NOAEC 210 mg a.e./L x acute-to-chronic ratio 0.37 =77.7 mg a.e./L]
Amphibians	Acute	sensitive spp.	***NOAEC = 125 mg/L***	African clawed frog (*Xenopus laevis*), embryos, TEA, for growth (only study)
		tolerant spp.	***NOAEC = 125 mg/L***	
	Chronic	sensitive spp.	***N/A***	No data available
		tolerant spp.	***N/A***	
Aquatic invertebrate	Acute	sensitive spp.	***adjusted NOAEC = 25 mg/L***	[estimated acute NOAEC of 5 mg a.e./L is adjusted upward to 25 mg a.e./L given the chronic NOAEC]
		tolerant spp.	***estimated NOAEC = 320 mg/L***	[LD50 of 6,400 mg/L x LOC factor of 0.05]
	Chronic	sensitive spp.	***NOAEC = 25 mg/L***	daphnid, cannot be classified as sensitive, tolerant, or intermediate
		tolerant spp.		
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***marginal NOAEC = 0.0005 mg/L***	Eurasian water milfoil (*Myriophyllum sibiricum*; a dicot), NOAEL is a biochemical indicator of an adverse effect but no overt effect found.
		tolerant spp.	***NOEC = 5.6 mg/L***	duckweed (*Lemna minor*; a monocot) Garlon 3A (32.3% a.e.)
	Chronic	sensitive/ tolerant spp.	***N/A***	No data available
Aquatic Algae (Microphytes)	sensitive spp.		***NOEC = 0.23 mg+E41/L***	*Ankistrodesmus* spp., 5-day study
	tolerant spp.		***estimated NOEC = 4.0 mg/L***	*Chlorella pyrenoidosa*, 4-day study [upper bound EC50 of 80 mg a.e./L x factor of 0.05]

All endpoints are in terms of a.e. BEE = butoxyethyl ester, LD/C = Lethal Dose/Concentration, LOC = level of concern, NOAEL/C = no-observed-adverse-effect-level/concentration, TEA = triethylamine salt.

Table D.3-29

Ecological Endpoints for Triclopyr BEE

			Endpoint	**Receptor, Study & Endpoint Details**
Canine mammals	Acute		***NOAEL = 20 mg a.e./kg bw***	estimated relative to rat [derived by 100 mg/kg bw ÷ 5]
	Chronic		***NOAEL = 1 mg a.e./kg bw***	estimated relative to rat: [derived by 5 mg/kg bw ÷ 5]
Medium mammals	Acute		***NOAEL = 100 mg/kg bw***	rat
	Chronic		***NOAEL = 5 mg/kg bw***	rat
Small mammals	Acute		***NOAEL = 440 mg/kg bw***	estimated relative to rat [derived by 100 mg/kg bw x 4.4]
	Chronic		***NOAEL = 22 mg/kg bw***	estimated relative to rate [derived by 5 mg/kg bw x 4.4]
Large herbivore mammals	Acute		***NOAEL = 8 mg/kg bw***	estimated relative to rat [derived by 100 mg/kg bw ÷ 40 13 ≈ 7.69]
	Chronic		***NOAEL = 0.4 mg/kg bw***	estimated relative to rat [derived by 5 mg/kg bw ÷ 13 ≈ 0.38]
Birds	Acute		***NOAEL = 126 mg /kg bw***	Northern bobwhite quail, BEE gavage study
	Chronic		***NOAEL =7.5 mg/kg bw/day***	Northern bobwhite quail, reproduction study
Terrestrial Invertebrates	Acute		***indefinite oral LD50 = 620 mg/kg bw***	honey bees [derived by LD50 of >72 µg (0.072 mg) ÷ 0.000116 kg bee bw ≈ 620.68 mg/kg bw]
Terrestrial Plants (Macrophytes)	Seedling Emergence	sensitive spp.	***NOEC = ~0.022 lb/acre***	soybeans (a dicot); BEE, equivalent to 35 g a.i/ha, based on shoot weight
		tolerant spp.	***NOEC = 2.0 lb/acre***	corn, oats, sunflowers, wheat, BEE study, [converted from >2242 g a.i./ha based on shoot weight]
	Vegetative vigor	sensitive spp.	***NOEC = 0.0028 lb/acre***	sunflower (a dicot), TEA and BEE
		tolerant spp.	***NOEC = 2.0 lb/acre***	oat (a monocot), BEE [converted from >2242 g a.i./ha]
Fish	Acute	sensitive spp.	***NOAEC = 0.091 mg/L***	bluegills, BEE [converted from a.i. to a.e.]

		tolerant spp.	***adjusted NOAEC = 0.75 mg/L***	flathead minnows, BEE [LC50 of 1.5 mg a.e./L x LOC of 0.5]
	Chronic	sensitive spp.	***U.S. EPA adjusted NOAEC = 0.019 mg/L***	rainbow trout, BEE [Chronic exposure to BEE are far below this dose, and thus protective of all spp. sensitivity]
		tolerant spp.		
Amphibians	Acute	sensitive spp.	***surrogate NOAEC: sublethal EC10 = 0.1 mg/L,***	*Rana clamitans* larvae, TEA, abnormal avoidance response.
		tolerant spp.	***estimated NOAEL = 4.2 mg/L***	*Rana clamitans* embryos, TEA [LC50 of 24.6 mg a.e./L x 0.17 (factor resulting from ratio of an NOAEC to LC50)]
	Chronic	sensitive spp.	***N/A***	No data available
		tolerant spp.	***N/A***	
Aquatic invertebrate	Acute	sensitive spp.	***estimated NOAEC = 0.045 mg/L***	[LD50 of 0.25 mg a.e./L x a factor of 0.18 (lower bound of mean that resulted from ratios of NOAEC to LC50 values)]
		tolerant spp.	***estimated NOAEC = 3.6 mg/L***	[LD50 of 20.0 mg a.e./L x a factor of 0.18 (lower bound of mean that resulted from ratios of NOAEC to LC50 values)]
	Chronic	sensitive spp.	***LOAEC = 0.25 mg/L***	*Simocephalus vetulus*, concentration-related decreases in reproduction
		tolerant spp.	***estimated LOAEC = 20 mg/L***	[chronic LOAEC of 0.25 mg a.e./L x factor of 80 (ratio of LD50 values for tolerant and sensitive species)]
Aquatic Plants (Macrophytes)	Acute	sensitive spp.	***estimated NOEC = 0.043 mg/L***	[EC50 of 0.86 mg a.e/L x a factor of 0.05]
		tolerant spp.	***estimated NOEC = 0.31 mg/L***	[EC50 of 6.25 mg a.e/L x a factor of 0.05]
	Chronic	sensitive/ tolerant spp.	***N/A***	No data available
Aquatic Algae (Microphytes)	sensitive spp.		***U.S. EPA estimated NOEC = 0.0014 mg/L***	*Navicula pelliculosa,*[~0.002 mg a.i./L]
	tolerant spp.		***NOEC = 1.0 mg/L***	*Skeletonema costatum*

All endpoints are in terms of a.e. BEE = butoxyethyl ester, ED/C = Effect Dose/Concentration, LD/C = Lethal Dose/Concentration, LOEC = lowest-observed-effect-concentration, N/A = Not Applicable, NOAEL/C = no-observed-adverse-effect-level/concentration, TEA = triethylamine salt.

D.3.2.5 Risk Characterization

D.3.2.5.1 Introduction

Conceptually, risk characterization is simply the process of comparing the exposure assessment to the dose-response assessment. In this process, risk is characterized quantitatively as a ratio. Because the risk characterization flows directly from the exposure and dose-response assessments, the complexity and clarity of the risk characterization will be dependent on complexity and clarity of both the exposure and dose-response assessments. In most cases, risk will be quantitatively characterized as a ratio: a level of exposure divided by some defined effect level. In the human health risk assessment, the defined effect level is almost always the reference dose (RfD), and the ratio of the exposure to the reference dose is referred to as the hazard quotient (HQ). In the ecological risk assessments, the defined effect level may be an NOEC or a risk level. The risk level, in turn, may be a lethal dose (e.g., LD_{50} or some other response level such as an LD_{25}) or a dose causing some risk of a non-lethal effect (e.g., an ED_{50} or ED_{25}). For aquatic organisms and for some terrestrial organisms for which exposure is characterized by a concentration rather than a dose, the defined risk levels may be expressed as a lethal concentration (LC_{50} or some other response level) or a sublethal concentration that leads to some effect (e.g., an EC_{50}). In general, the Forest Service prefers to use NOAEL or NOEC values in risk characterizations. If NOAEL or NOEC values are not available, a sublethal effective dose at some response rate may be used to approximate a NOAEL or NOAEL.

The following is a characterization of the risks associated with plausible levels of exposure to the chemicals, and in some cases metabolites and surfactants, likely to be used in the VTP and Alternatives. This is a synthesis of the hazard (toxicity) of each chemical, the likelihood of exposure to non-target organisms, and the likelihood that non-target organisms would be adversely affected by plausible levels (doses) of chemicals. The characterization of risk is substantially from the most recent USDA/FS and SERA risk assessments (RAs) for each chemical analyzed. These RAs can be downloaded from the USFS Forest Health Protection website at (http://www.fs.fed.us/foresthealth/pesticide/risk.shtml). These RAs have been updated using information from the 2012 EXCEL “F” and “G” series workbooks created by WorksheetMaker. The most current version of WorksheetMaker can be downloaded directly from the SERA website (www.sera-inc.com).

As cautioned in the SERA risk assessment for clopyralid (SERA 2004a, p. xviii), when considering the risks portrayed in SERA RAs: “*The risk characterization for both terrestrial and aquatic animals is limited by the relatively few animal and plant species on which data are available compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments*.”

As discussed above in Section D.3.2.2, *Hazard (Toxicity) Identification*, chemicals that are not approved for aquatic use may be inadvertently applied or transported to shallow wetlands or to low volume or intermittent streams that support frogs and their larvae (tadpoles), and/or other amphibians. There is some scientific evidence that chemicals could accumulate to toxic levels in these shallow, low volume waterbodies. D.G. Thompson (Thompson 2003) measured the toxic effects on Ranid frogs of Vision® (glyphosate), which is not registered for use in California, in 51 wetlands in Canada that were 1) buffered from spraying, 2) sprayed adjacent to the wetland, and 3) over sprayed. No significant differences in mortality to Ranid frogs were observed between the treatments. However, "*vegetated buffers significantly mitigated against exposure and thus potential for acute effects. Aqueous concentrations of Vision® (glyphosate) in buffered wetlands were below analytical limits of quantification (0.02 mg acid equivalent [a.e.]/L) in 14 of 16 cases, with mean concentration (0.03 ± 0.02 mg a.e./L) significantly (p< 0.05) less than that of either adjacent (0.18 ± 0.06 mg a.e./L) or over sprayed wetlands (0.33 ± 0.11 mg a.e./L)*" (Thompson 2003).

A study of potential pesticide toxicity (including imazapyr and sulfometuron methyl) in Midwestern streams found that: 1) spring and early summer runoff events can contain pesticides in sufficient quantities to be toxic to non-target aquatic organisms, 2) accounting for herbicide degradates can substantially increase the estimated toxicity of stream water to aquatic plants, and 3) the quality of this analysis is limited by the lack of acute toxicity data for many of the pesticide-organism combinations (Battaglin and Fairchild 2002). Only 10% of the water samples contained acetolactate synthase (ALS) inhibitor herbicides, a class of herbicides that includes imazapyr and sulfometuron methyl. It was thought that the data from this study might underestimate potential effects of pesticides on aquatic systems in smaller streams because peak concentrations of herbicides were generally inversely related to stream size.

With the exception of glyphosate formulations containing POEA, sulfometuron methyl (for amphibians), and triclopyr, the chemicals analyzed in this Program EIR and potentially applied under the VTP and Alternatives are only slightly toxic to practically nontoxic to aquatic organisms. However, there is little to no testing of most of the chemicals for effects on adult amphibians.

Mann et al., 2003 found that: "*Although the relative sensitivity of amphibians to the toxic effects of pesticides and other environmental contaminants has yet to be established, the perceived vulnerability of amphibians to pesticide effects may actually be attributable to their specific habitat requirements. Shallow temporary ponds, essential to the life cycles of many amphibians, are also areas where pollutants may accumulate without substantial dilution. Research in Western Australia has highlighted the potential risk that agricultural chemicals may pose to fauna that inhabit low dilution environments, and indicates that the data* *currently required for pre-registration assessment of pesticides may be inadequate to effectively protect these environments.*"

Raphael 2003, made the following findings in the forested systems of the western Pacific Northwest: "*While not all* [stream-dwelling amphibians] *respond the same way, there is typically a rapid decrease in population after management activity in the riparian zone, and recovery for some species can be quite slow. In some sites, the numbers are still low as much as 60 years after timber harvest.*"

> *"Potential for large-scale reduction in amphibian numbers is high, and indeed the focus on amphibian population decline worldwide is increasing. It seems clear that amphibian numbers should at least be considered as part of the buffer zone assessment and recommendation process." (ibid)*

In light of the sensitivity of amphibians to microsite conditions and some of the herbicides and surfactants likely to be used under the VTP and Alternatives, it is clear that buffer zones are needed, particularly adjacent to shallow wetlands, vernal pools, and ponds and shallow, slow-moving, low-volume, and/or intermittent streams.

Chemicals will be potentially used in the VTP and Alternatives to only treat terrestrial vegetation and only by ground-based application methods. Aquatic environments are buffered during spray projects through specific chemical label requirements and court orders applicable to specific chemicals, areas, and species. Buffers to protect special status aquatic species are required by Project Specific Requirements HAZ-6, HAZ-8, HYD-3, BIO-1, BIO-7, BIO-11, and BIO-13 (see Section 2.6). Such measures will preclude the application of herbicides within watercourse buffer zones as described even when the label allows for use within these buffers.

D.3.2.5.2 Chemical-Specific Risk Characterization

D.3.2.5.2.1 Borax (Sources: FS WSM ver. 6.00.10; SERA 2006a)

Terrestrial and Aquatic Organism Overview

Three exposure scenarios are considered: 1) the direct consumption of Sporax® applied to tree stumps (acute exposure), 2) consumption of water contaminated by an accidental spill (acute exposure), and 3) acute and chronic exposure by consumption of water contaminated by runoff. Other than the direct consumption of Sporax® applied to tree stumps, none of the exposure scenarios for terrestrial organisms are associated with HQs that exceed the LOC.

For terrestrial species, risks associated with the application of Sporax® to tree stumps appear to be very low. At the application rates (lowest 0.1 lb./acre, typical 1 lb./acre, and highest 5 lbs./acre) and methods used in U.S. Forest Service programs and likely to be used under the VTP and Alternatives, Sporax® will not substantially contribute to or increase boron concentrations in water or soil beyond those that are associated with its normal occurrence in the environment. The highest HQ (5.6), for the direct consumption of Sporax® from a tree stump by a large mammal, is at the upper bound at the highest application rate.

Most aquatic animals do not appear to be at risk for any of the exposure scenarios (water contaminated by accidental spill or by runoff). Accidental spill of large quantities of Sporax® into a small pond may result in toxicity in amphibians.

HQs for aquatic plants for the accidental spill scenario and for acute and longer-term exposures to water contaminated by runoff are well below the LOC. Sensitive aquatic microorganisms may be at risk following an accidental spill of a large quantity (25 pounds) of Sporax® into a small pond, but exposure *via* runoff does not present a risk.

Terrestrial Organisms

Mammals and Birds – For the direct consumption scenario, there appears to be very little risk to either mammals or birds. Only a large mammal, such as a deer, consuming Sporax® from a treated stump is at risk, with HQs exceeding the LOC at the upper bound (HQ 1.1) at the typical application rate and at the central (HQ 1.7) and upper bound (HQ 5.6) at the highest rate. However, Sporax® applied to tree stumps does not appear to attract deer and deer allowed free access to Sporax®-treated stumps showed no clinical signs of toxicity.

Risk associated with other exposure scenarios are very low, as Sporax will not substantially contribute to or increase boron concentrations in water or soil beyond those that are associated with its normal occurrence in the environment.

***Terrestrial Invertebrates* –** Exposure assessments were not conducted for insects, so risk of exposure cannot be characterized quantitatively. Borax is used effectively to control insects, so adverse effects of environmental exposures are possible. However, given the atypical application method for Sporax®, widespread exposures are not likely.

Terrestrial Plants (Macrophytes) – Even at the at the maximum application rate potentially used under the VTP and Alternatives, non-target terrestrial plants do not appear to be at risk from exposure to borax, as no HQ values exceed the LOC. However, since this risk assessment is based on data from relatively few terrestrial plant species, more sensitive species may exist and may be at risk for boron-induced toxicity.

Terrestrial and Aquatic Microorganisms – Exposure assessments were not conducted for soil microorganisms, so risk of exposure cannot be characterized quantitatively. Borax is effective as either a fungicide or an insecticide. Sporax® will be used in the VTP and

Alternatives as a fungicide, to control annosum root rot, so adverse effects of environmental exposures are possible. However, given the atypical application method for Sporax®, widespread exposures are unlikely.

Aquatic Organisms

Fish – HQs associated with acute exposure of fish to water contaminated by an accidental spill or runoff are all below the LOC, so there is no indication that adverse effects will occur. For chronic exposure of fish to water contaminated by runoff, HQs for both sensitive (HQ 4) and tolerant (HQ 2) species are above the LOC only at the upper bound at the highest application rate. Adverse effects on non-target fish are plausible for longer-term exposures.

Amphibians – If large amounts (25 pounds) of Sporax® accidentally contaminate surface waters, such as a small pond, amphibians may be at risk. HQs for both sensitive and tolerant species exceed one at the highest application rate and the upper bound at the typical rate.

HQs for acute and chronic exposure of amphibians to water contaminated by runoff are above the LOC for both sensitive and tolerant species at the upper bound at the highest application rate. Although HQs are below the LOC at the lower and central bounds at the highest application rate, adverse effects on amphibians are plausible for either acute or longer-term exposures at the upper bound at the highest application rate.

Aquatic Invertebrates – HQs for acute and chronic exposure of aquatic invertebrates to water contaminated by runoff are all below the LOC. There is no basis for asserting that adverse effects are likely for either acute or longer-term exposures to Sporax®.

Aquatic Plants (Algae and Macrophytes) – HQs for the accidental spill scenario and for acute and longer-term exposures to water contaminated by runoff are well below the LOC. There is no basis for asserting that effects on aquatic macrophytes or algae are likely for either acute or longer-term exposures.

Aquatic Microorganisms – HQs for the most sensitive species (but not tolerant species) of microorganisms exceed the LOC for all accidental spill scenarios. All HQs are below the LOC for both sensitive and tolerant species for acute exposure to water contaminated by runoff. More sensitive microorganisms may be at risk following an accidental spill of large quantities of Sporax® into a small pond, but exposure *via* runoff does not present a risk to aquatic microorganisms.

D.3.2.5.2.2 Clopyralid (Sources: FS WSM ver. 6.00.07 & 6.00.10; SERA 2004a)

Terrestrial and Aquatic Organism Overview

The SERA 2004a risk assessment for clopyralid uses a typical application rate of 0.35 lb a.e./acre and an upper application rate of 0.5 lb a.e./acre. In California the maximum allowable application rate is 0.25 lb a.e./acre. Therefore, information from the SERA 2004a “Risk Characterization” section is adjusted to reflect a lower application rate.

The SERA 2004a risk assessment for clopyralid anticipated no adverse effects in terrestrial or aquatic animals from the use of clopyralid in U.S. Forest Service programs at the typical application rate of 0.35 lb a.e./acre. However, using the 2012 Excel Worksheets, at an application rate of 0.25 lb a.e./acre, HQs are above the LOC at the upper bound for some exposure scenarios for terrestrial organisms.

For aquatic organisms, HQs are only above the LOC at the central and upper bounds for the acute accidental spill exposure scenario for tolerant aquatic macrophytes (no data on sensitive species) and for sensitive algae at the upper bound.

Terrestrial Organisms

Mammals – At an application rate of 0.25 lb a.e./acre, HQs for all terrestrial organisms are above the LOC at the upper bound for all acute and chronic exposure scenarios of small mammals consuming contaminated grass and broadleaf foliage. HQs range from 1.3 to 6, with the highest HQ for a small mammal consuming contaminated short grass. The only scenario where the HQ (1.4) for a larger animal exceeds the LOC is for long-term consumption of contaminated short grass. However, the scenario of a mammal consuming vegetation on-site is essentially used as a very conservative/extreme screening scenario. It assumes that animals stay in treated areas consuming nothing but contaminated vegetation. Since most forms of vegetation would likely die after herbicide applications, or at least be substantially damaged, this exposure scenario is implausible. Still, adverse acute and chronic effects are plausible based on consumption of contaminated vegetation, especially longer term consumption of short grass, by small mammals.

Birds – HQs for small birds are above the LOC at the upper bound for chronic exposure scenarios involving consumption of contaminated fruit, tall and short grass, and vegetation. HQs range from 1.3 to 15, with the highest HQ for a small bird consuming contaminated vegetation. The HQ (1.3) also exceeds the LOC for a small bird consuming contaminated tall grass at the central bound. The only scenario where the HQ (1.7) for a larger bird exceeds the LOC is for consumption of contaminated vegetation. However, the scenario of a bird consuming vegetation on-site is essentially used as a very conservative/extreme screening scenario. It assumes that animals stay in treated areas consuming nothing but contaminated vegetation. Since most forms of vegetation would likely die after herbicide applications, or at least be substantially damaged, this exposure scenario is implausible. Still, adverse chronic effects are plausible based on consumption of contaminated vegetation, especially longer term consumption by small birds.

Terrestrial Invertebrates – As there is a dearth of data available, values relating to honey bee exposure are used to represent the effects clopyralid may have on terrestrial invertebrates.

At the highest application rate of 0.25 lb a.e./acre, the estimated maximum concentrations of clopyralid in clay soil would range from about 0.066 mg/kg at an annual rainfall of 10 inches to 0.07 mg/kg at an annual rainfall of 100 inches. Due to percolation, concentrations in loam and sand soils would be less. Concentrations of clopyralid in clay, loam, and sand over a wide range of rainfall rates are summarized in Table 4-2 in SERA 2004a (p. Tables-12).

While the available toxicity data on soil organisms are limited, these projected maximum concentrations in soil are far below potentially toxic levels. Information on the toxicity of clopyralid to soil organisms is limited, consisting only of an acute LC_{50} value for earthworms reported as >1000 mg/kg soil and a report on soil microorganisms indicating an NOEC of 10 ppm soil for effects on nitrification, nitrogen fixation, and degradation of carbonaceous material. This information does not provide any basis for asserting that adverse effects on soil invertebrates are plausible. (SERA 2004a, p. 4-25)

Terrestrial Plants (Macrophytes) – Clopyralid is an auxin-mimicking herbicide that is formulated to control many annual and perennial broadleaf plants, particularly of the Asteraceae (sunflower), Fabaceae (legume), Polygonaceae (knotweed), and Solanaceae (nightshade) families. It has been used to control non-native invasive species such as Canada thistle, Russian knapweed, yellow star thistle, and English ivy. Like other auxin-mimicking herbicides, clopyralid has little to no effect on grasses and other monocots, plants in the Brassicaceae (mustard) family, and several other groups of broad-leaved plants. (TNC 2001)

Clopyralid is an extremely effective herbicide in trace concentrations. Studies have determined that it will bind to organic matter when treated vegetation is composted and will remain active for some time. If the compost is spread around susceptible non-target plants, they could be damaged or killed. If livestock eat clopyralid-treated vegetation, the chemical will pass through the digestive system and be eliminated in manure, still in an active form. Wherever the manure lands, susceptible non-target plants could be damaged or killed. (TNC 2001)

Drift is likely to cause adverse effects on some non-target plant species under certain application conditions and circumstances. Off-site drift of clopyralid associated with ground applications may cause damage to sensitive plant species at distances of about 300 feet (HQ 2) from the application site. Tolerant plant species would probably not be impacted and might show relatively little damage.

As stated in SERA 2004a, p. 4-25, "*The situational variability in the exposure assessments for runoff, wind erosion, and irrigation water has a substantial impact on the characterization of risk for sensitive non-target plant species. All of these scenarios may overestimate or underestimate risk under certain conditions.*"

The SERA 2004a (p. 4-23) risk assessment for clopyralid states that: "*Because of the tendency for clopyralid to move into soil rather than to be transported by runoff and because of the greater toxicity of clopyralid by foliar deposition compared to soil contamination, off-site movement of clopyralid by soil runoff does not appear to be substantial risk to nontarget plant species.*" Runoff does not appear to present a significant risk to sensitive or tolerant non-target plant species even under conditions in which runoff is favored (clay soil over a very wide range of rainfall rates).

Wind erosion could lead to adverse effects in sensitive plant species. Soil losses by wind erosion are substantially less than off-site losses associated with runoff from clay soils, but similar to off-site losses from drift in the range of about 200-900 feet from the treatment site. Wind erosion of contaminated soil is most plausible in relatively arid environments and if local soil surface and topographic conditions are favorable.

As stated in SERA 2004a, p. 4-25: "*The simple verbal interpretation for this quantitative risk characterization is that sensitive plant species could be adversely affected by the off-site drift of clopyralid under a variety of different scenarios depending on local site-specific conditions that cannot be generically modeled. If clopyralid is applied in the proximity of sensitive crops or other desirable sensitive plant species, site-specific conditions and anticipated weather patterns will need to considered if unintended damage is to be avoided. More tolerant plant species are not likely to be affected unless they are directly sprayed.*"

Terrestrial and Aquatic Microorganisms – At the highest application rate of 0.25 lb a.e./acre, the estimated maximum concentrations of clopyralid in clay soil would range from about 0.066 mg/kg at an annual rainfall of 10 inches to 0.07 mg/kg at an annual rainfall of 100 inches. Due to percolation, concentrations in loam and sand soils would be less. Concentrations of clopyralid in clay, loam, and sand over a wide range of rainfall rates are summarized in Table 4-2 in SERA 2004a (p. Tables-12).

As stated in SERA 2004a, p. 4-26: "While the available toxicity data on soil organisms are limited, these projected maximum concentrations in soil are far below potentially toxic levels. The information on soil organisms is limited, however, consisting only of an acute LC_{50} value for earthworms reported as >1000 mg/kg soil (Section 4.3.2.3) and a report in soil microorganisms indicating an NOEC of 10 ppm soil for effects on nitrification, nitrogen fixation, and degradation of carbonaceous material (Section 4.3.2.5). Nonetheless, this information does not provide any basis for asserting that adverse effects on soil organisms are plausible."

Aquatic Organisms

The SERA 2004a (p. 4-23) risk assessment for clopyralid states that: "*Aquatic plants do not appear to be at any substantial risk from any plausible acute or chronic exposures. In the very extreme case of an accidental spill of a large amount of the herbicide into a relatively small body of water, sensitive aquatic plants could be damaged.*"

Clopyralid appears to have a very low potential to cause any adverse effects in any aquatic species, although there is no data available for amphibians or sensitive species of invertebrates or macrophytes, so risk is not characterized for these aquatic organisms.

Fish – There are no exposure scenarios for fish that approach a LOC. Chronic toxicity studies in fish are lacking. For the HQ in fish to reach a LOC they would have to be more sensitive than daphnids by a factor of 2500, based on the maximum HQ (0.0004) for daphnids for chronic exposures, at an application rate of 0.25 lb./acre. It is unlikely that fish would experience acute or chronic adverse effects at the maximum application rate.

Concentrations of clopyralid in ambient water with an application rate of 0.25 lb/acre are estimated to be no greater than 0.00325 mg/L over prolonged periods of time. The peak concentration associated with runoff or percolation is estimated to be no more than 0.0175 mg/L.

Amphibians – No toxicity data is available for amphibians so risk is not characterized.

Aquatic Invertebrates – There are no acute or chronic exposure scenarios for tolerant species of aquatic invertebrates where the HQ exceeds the LOC. No toxicity data is available for sensitive species of invertebrates, so risk is not characterized for these aquatic organisms. It is unlikely that aquatic invertebrates would experience acute or chronic adverse effects at the maximum application rate.

Aquatic Plants (Algae and Macrophytes) – The HQs for tolerant species of aquatic macrophytes for accidental acute exposures range from 11 at the central bound to 114 at the upper bound, well above the LOC. HQs for all other exposure scenarios for tolerant species are well below the LOC. No toxicity data is available for sensitive species of macrophytes, so risk is not characterized. The HQ for sensitive species of algae for accidental acute exposures is 1.7 at the upper bound. HQs at the central and lower bounds for both sensitive and tolerant algae are well below the LOC. There is no basis for asserting that effects on non-target aquatic plants are likely, except in cases of accidental contamination of a small body of water, when adverse effects in sensitive aquatic plants are plausible.

D.3.2.5.2.3 Glyphosate (Sources: FS WSM v. 6.00.10; SERA 2011b; U.S. EPA. 2009c)

Terrestrial and Aquatic Organism Overview

Glyphosate is a broad-spectrum, nonselective systemic herbicide that is formulated to suppress or kill many grasses, forbs, vines, shrubs, and trees. It is commonly used in natural areas to control many non-native invasive species. But because it is nonselective it should be used carefully so as not to damage or kill desirable native plants. (TNC 2001)

Glyphosate can be applied to the foliage, green stems, and cut-stems (cut-stumps) of terrestrial plants, but is unable to penetrate woody bark. Since glyphosate by itself is essentially non-toxic to submersed plants, specific formulations (e.g., Rodeo®) are registered for aquatic use. These formulations do not have the adjuvants that may be toxic to aquatic plants and animals. (ibid)

This risk characterization is based on the following ground application rates that may potentially be used under the VTP and Alternatives: lowest application rate of 0.29 lb. a.e./acre, typical application rate of 2.0 lbs. a.e./acre, and highest application rate of 8.0 lbs. a.e./acre.

This risk characterization of glyphosate is designed to clearly differentiate between the more toxic and less toxic formulations. As stated in SERA 2011b, p. 201: "*While some, formulations cannot be easily classified as more or less toxic, the general approach discussed in the dose-response assessment (Section 4.3.1) is applicable to the risk characterization: any formulation that contains a POEA surfactant should be regarded as more toxic, unless there is compelling evidence to the contrary. If the presence and/or toxicity of the surfactants in the formulation cannot be determined, it is prudent to classify the formulation as more toxic.*"

For terrestrial organisms other than plants, applications of up to 2.5 lb a.e./acre of the more toxic formulations of glyphosate do not present any apparent risks. At application rates greater than 2.5 lb a.e./acre, risks to mammals cannot be ruled out at upper bound estimates of exposure, but are not apparent at central estimates of exposure. At application rates greater than approximately 3.3 lb a.e./acre, the HQs for birds modestly exceed the LOC, but there is no demonstrated evidence that these exposure levels will cause overt toxicity in birds.

Risks to terrestrial insects from dietary exposures are of greater concern than risks from direct spray. As stated in the "Overview" in SERA 2011b, p. 201, "*Based on upper bound estimates of exposure at the maximum application rate of 8 lb a.e./acre, the HQs for terrestrial insects can reach a value of 10. Concern for terrestrial invertebrates is enhanced by two toxicity studies using South American formulations of glyphosate in which adverse effects on reproduction and development were noted. While most field studies suggest that effects on terrestrial invertebrates are due to secondary effects on vegetation, the field studies do not directly contradict the South American toxicity studies or the HQs.*"

"The risk characterization for aquatic organisms suggests that amphibians are the group at greatest risk both in terms of sensitivity and severity of effects. At an application rate of 1 lb a.e./acre, the upper bound HQ for amphibians is 2. The corresponding HQs for other groups of aquatic organisms are 1.7 for fish, 1.1 for invertebrates, 1.0 for algae, and 0.008 for aquatic macrophytes. Concern for amphibians is enhanced by the Howe et al., (2004) study which indicates that two formulations of Roundup as well as the POAE surfactant used in some of the more toxic formulations of glyphosate are associated with the development of intersex gonads. The HQs for aquatic species will increase linearly with the application rate. Because the upper bound HQs for most groups of aquatic organisms exceeds or reaches the level of concern at the relatively low application rate of 1 lb a.e./acre, care should be exercised when applying more toxic formulations of glyphosate near surface water." (SERA 2011b, p. 202)

"The less toxic formulations of glyphosate do not appear to present any risks to terrestrial organisms other than terrestrial plants. Unlike the case with more toxic formulations, risks to amphibians and aquatic invertebrates appear to be insubstantial. Algae appear to be the most sensitive group of nontarget aquatic organisms. At an application rate of 1 lb a.e./acre, the upper bound of the HQ for sensitive species of algae is 0.8." (ibid)

"Risks to fish cannot be ruled out based on standard and conservative assumptions and methods for applications of less toxic formulations of glyphosate at rates in excess of about 2.5 lb a.e./acre (acute effects). It seems most likely, however, that adverse effects would be observed in stressed populations of fish and less likely that effects would be noted in otherwise healthy populations of fish." (ibid)

"The less toxic formulations of glyphosate require the use of a surfactant. Some surfactants such as Agri-Dex (LC_{50} >1000 mg/L) are virtually nontoxic, and the use of a nontoxic surfactant would have no substantial impact on the risk characterization. Based on the available toxicity data in fish and aquatic invertebrates, some surfactants that may be used with the less toxic formulations of glyphosate could pose a much greater risk than the glyphosate formulation itself." (ibid)

Terrestrial Organisms

The most recent for glyphosate differentiates risk between the more toxic and the less toxic formulations. Formulations that are known to contain the surfactant POEA are considered more toxic. Formulations where the toxicity or presence of surfactants is unknown are also considered more toxic. As stated in the SERA risk assessment (SERA 2011d, p. 201):

For terrestrial organisms other than plants, applications of up to 2.5 lbs a.e./acre of the more toxic formulations do not present any apparent risk, based on upper bound *estimates of exposure levels. At application rates greater than 2.5 lbs a.e./acre, risks to mammals cannot be ruled out, based on upper bound estimates of exposure; however, no risks are apparent, based on central estimates of exposure. At application rates greater than approximately 3.3 lbs a.e./acre, the HQs for birds modestly exceed the level of concern; however, there is no demonstrated evidence that these exposure levels will cause overt toxicity in birds.*

The less toxic formulations of glyphosate do not appear to present any risks to terrestrial organisms other than terrestrial plants.

Mammals – For more toxic formulations of glyphosate, HQs for accidental acute exposures exceed the LOC only at the highest application rate at the central and upper bounds. For non-accidental acute exposure at the typical application rate, central bound, only small mammals have a HQ (1.6) exceeding the LOC, from consuming contaminated tall and short grass. At the upper bound, HQs range from 1.1 to 8 for non-accidental acute exposures to small mammals consuming broadleaf foliage (4), tall and short grass (both 8), and insects (1.1) and large (70 kg) mammals consuming short grass (HQs of 1.8). For chronic (long term) exposure at the typical application rate, upper bound, only small mammals consuming short grass have a HQ (1.3) exceeding the LOC.

At the highest application rate of glyphosate, the only HQ above the LOC for the accidental direct spray scenario is for a small mammal at the central (1.1) and upper (2) bounds. At the central bound non-accidental acute exposure HQs range from 3 to 7 for small mammals consuming broadleaf vegetation and at the upper bound HQs range from 3 to 32 for small mammals consuming fruit (3), broadleaf foliage (18), tall and short grass (each 32), and insects (4). HQs for larger (400g) mammals consuming vegetation or insects at the upper bound range from 3 to 7 and HQs for large mammals consuming vegetation range from 1.9 to 4, modestly greater than the LOC. For chronic (long term) exposure, HQs for small mammals consuming short grass (1.3) exceed the LOC only at the typical application rate (upper bound) and at the highest application rate central (1.1) and upper (5) bounds and for larger mammals consuming short grass (HQ 1.2). Based on the upper bound at the highest application rate, adverse effects are plausible only for small mammals consuming contaminated tall and short grass.

For these worst-case exposure assessments, at the central bound at the typical application rate and the upper bound at the highest application rate, adverse effects are plausible only for small mammals consuming contaminated broadleaf foliage and tall and short grass. However, well-documented field studies have not identified adverse effects in populations of small mammals following applications of Roundup and an unidentified formulation of glyphosate.

For less toxic formulations of glyphosate, at the typical application rate, HQs exceed the LOC only at the upper bound, for small mammals for the scenarios of accidental acute exposure from consuming contaminated broadleaf foliage (HQ 1.6) and tall and short grass (HQs 3). HQs for most of the other scenarios at the central bound are well below the LOC. Based on the upper bound at the highest application rate, adverse effects are plausible only for small mammals consuming contaminated broadleaf foliage and tall and short grass.

Birds – For more toxic formulations of glyphosate, there are no HQs that exceed the LOC for the accidental direct spray scenario. At the typical application rate, central bound, only small birds have a HQ (1.3) exceeding the LOC, for the scenario of non-accidental acute exposure from consuming contaminated short grass. At the upper bound, HQs range from 3 to 6 for non-accidental acute exposures to small birds consuming broadleaf foliage (4), tall (3) and short (6) grass. For chronic (long term) exposure at the typical application rate, upper bound, HQs exceed the LOC for small birds consuming tall (7) and short grass (6) and for large birds consuming short grass (1.4).

At the highest application rate of glyphosate, for the non-accidental acute exposure (central bound) HQs range from 2 to 5 for small birds consuming vegetation. At the upper bound, HQs range from 1.9 to 25 for small birds consuming fruit (1.9), broadleaf foliage (14), tall (12) and short (25) grass, and insects (3). HQs for larger (400g) birds consuming vegetation at the upper bound are 1.3 for tall grass and 3 for short grass, modestly greater than the LOC. For chronic (long term) exposure, HQs at the upper bound at the highest rate range from 4 to 51 for small birds consuming fruit (4), tall grass (29), short grass (23), and contaminated vegetation (51). Based on the upper bound at the highest application rate, adverse acute effects and longer term chronic effects from exposure to the more toxic formulations of glyphosate are plausible for small birds consuming contaminated tall and short grass and vegetation. However, longer term worst-case exposure assessments are based on the assumption that 100% of the diet is contaminated, which is unlikely, as birds may feed only sporadically in treated areas.

For less toxic formulations of glyphosate, there are no HQs that exceed the LOC for the accidental direct spray scenario at either the typical or highest rate of application. At the typical application rate, HQs exceed the LOC only at the upper bound for small birds for the scenarios of non-accidental acute exposure from consuming contaminated broadleaf foliage (1.3) and short grass (2). HQs for the other exposure scenarios at the central bound are well below the LOC. At the upper bound, HQs range from 1.2 to 9 for small birds consuming broadleaf foliage (5), tall (4) and short (9) grass, and insects (1.2). For chronic (long term) exposure, HQs at the upper bound at the highest rate range from 3 to 38 for small birds consuming fruit (3), tall grass (21), short grass (17), and contaminated vegetation (38) and large birds consuming tall and short grass (both 2) and contaminated vegetation (4). Based on the upper bound at the highest application rate, adverse acute effects and longer term chronic effects from exposure to the more toxic formulations of glyphosate are plausible for small birds consuming contaminated tall and short grass and vegetation. However, longer term worst-case exposure assessments are based on the assumption that 100% of the diet is contaminated, which is unlikely, as birds may feed only sporadically in treated areas.

Terrestrial Invertebrates – Risks from direct spray and off-site drift are based on the direct spray of a honeybee. At the highest application rate of 8 lb a.e./acre, the HQ would be about 2.4, modestly higher than the LOC. As stated in SERA 2011b, p. 205, “Thus, while risks to honeybees from a direct spray cannot be excluded at the highest application rate, the effects would not be substantial and probably would not be detectable. Regardless of the application rate, no exposures associated with spray drift exceed the level of concern at any application rate.”

At the upper bound at the highest application rate, HQs exceed the LOC for terrestrial invertebrates consuming short grass (10), broadleaf vegetation and small insects (6), and long grass (5). However, the use of toxicity data on honeybees as a surrogate for other terrestrial invertebrates consuming contaminated vegetation or prey adds uncertainty to this quantitative risk characterization. Two studies raise concerns that moderate to high application rates of more toxic formulations of glyphosate could have an adverse impact on some terrestrial invertebrates. For the most part, available field studies on terrestrial invertebrates do not reinforce a concern for terrestrial invertebrates. Most field studies suggest that effects on terrestrial invertebrates will be minimal and secondary to changes in vegetation.

Terrestrial Plants (Macrophytes) –SERA 2011d (p. 201) found that: “Glyphosate is an effective post emergent herbicide. Foliar applications of glyphosate with an effective surfactant (POEA or otherwise) may pose a risk to terrestrial plants. The direct spray of a nontarget terrestrial plant at an effective application rate is likely to kill or seriously injure most plants. Nonetheless, substantial differences in sensitivity to glyphosate are apparent among different species of plants. For sensitive species, offsite drift of glyphosate can pose a risk. The nature of the risk depends on the application rate, application method, and site-specific conditions that affect the extent of drift.”

In direct foliar applications, glyphosate is an extremely effective herbicide. No distinction is made in the dose-response assessment between more and less toxic glyphosate formulations for terrestrial plants. Direct spray HQs are 1,538 for sensitive species and 4 for tolerant species at the typical application rate. At the highest application rate the HQs are three times higher. Over the range of glyphosate application rates that might potentially be used under the VTP and Alternatives, the unintended direct spray of non-target terrestrial vegetation will potentially damage tolerant plant species and is certain to kill sensitive species.

The risk characterization for drift differs substantially for sensitive and tolerant species of macrophytes. At the typical application rate of 2 lb a.e./acre, risks to sensitive species from drift exceed the LOC at distances of 100 feet for backpack applications. To reach a LOC at 900 feet downwind would require glyphosate to be applied at a rate of 5 lbs. a.e./acre. For ground broadcast applications the LOC for sensitive species would be exceeded at 900 feet (HQ 1.7) from the application site, but tolerant species would exceed the LOC only at the application site. All of the HQs would increase by three times at the highest application rate. For tolerant species, risks associated with drift appear to be minimal as a result of backpack and ground broadcast applications.

Glyphosate is not particularly effective as an herbicide at any application rate when applied to soils. All HQs, even at the highest application rate, are substantially below the LOC, so the transport of glyphosate in runoff is of no concern. Since the central and upper bounds of the functional application rates of glyphosate in irrigation water are below those associated with runoff, the risks of contaminated irrigation water are not considered further. A similar risk characterization applies to wind erosion, as all HQs are substantially below the LOC at the highest application rate.

Terrestrial and Aquatic Microorganisms – In studies in which arthropods were fed prey contaminated with formulations of glyphosate, a spectrum of adverse effects were noted. Although glyphosate may be toxic to terrestrial microorganisms in laboratory cultures, numerous field studies fail to demonstrate adverse effects. Glyphosate is readily metabolized by soil bacteria and many species of soil microorganisms can use glyphosate as a sole carbon source. There is sufficient evidence that direct toxic effects on soil microorganism are not likely to occur due to glyphosate exposure.

Aquatic Organisms

SERA 2011d (p. 201) found that: "*Terrestrial applications of the more toxic formulations of glyphosate may pose a risk to sensitive species of aquatic plants with an upper bound HQ of 1 at the unit application rate of 1 lb a.e./acre and an HQ of 8 at an application rate of 8 lb a.e./acre.*"

The most recent SERA RA (SERA 2011d, p. 202) for glyphosate distinguishes risk based on the toxicity of the formulations. The risk from more toxic formulations is as follows:

> *The risk characterization for aquatic organisms suggests that amphibians are the group at greatest risk both in terms of sensitivity and severity of effects. At an application rate of 1 lb a.e./acre, the upper bound HQ for amphibians is 2. The corresponding HQs for other groups of aquatic organisms are 1.7 for fish, 1.1 for invertebrates, 1.0 for algae, and 0.008 for aquatic macrophytes. Concern for amphibians is enhanced by the Howe et al., (2004) study which indicates that two formulations of Roundup as well as the POEA surfactant used in some of the more*

> *toxic formulations of glyphosate are associated with the development of intersex gonads. The HQs for aquatic species will increase linearly with the application rate. Because the upper bound HQs for most groups of aquatic organisms exceeds or reaches the level of concern at the relatively low application rate of 1 lb a.e./acre, care should be exercised when applying more toxic formulations of glyphosate near surface water.*

SERA 2011d (p. 202) characterizes risk for less toxic formulations as follows:

> *Unlike the case with more toxic formulations, risks to amphibians and aquatic invertebrates appear to be insubstantial. Algae appear to be the most sensitive group of nontarget aquatic organisms. At an application rate of 1 lb a.e./acre, the upper bound HQ for sensitive species of algae is 0.8.*
>
> *Risks to fish cannot be ruled out based on standard and conservative assumptions and methods for applications of less toxic formulations of glyphosate at rates in excess of about 2.5 lbs a.e./acre (acute effects). It seems most likely, however, that adverse effects would be observed in stressed populations of fish and less likely that effects would be noted in otherwise healthy populations of fish.*
>
> *The less toxic formulations of glyphosate require the use of a surfactant. Some surfactants such as Agri-Dex (LC_{50}>1000 mg/L) are virtually nontoxic, and the use of a nontoxic surfactant would have no substantial impact on the risk characterization. Based on the available toxicity data in fish and aquatic invertebrates, some surfactants that may be used with the less toxic formulations of glyphosate could pose a much greater risk than the glyphosate formulation itself.*

Fish – For more toxic formulations of glyphosate, accidental acute exposures (from spills into small bodies of water) exceed the LOC even at the central bound at the lowest application rate of 0.29 lb. a.e./L. At the upper bound at the highest application rate the HQ for sensitive species of fish is 2,996 and for tolerant species it is 288. For non-accidental acute exposures at the upper bound at the highest application rate, HQs are much lower; 14 for sensitive species and 1.3 for tolerant species. All chronic exposure HQs are below the LOC and most are substantially lower.

Because of concerns with sublethal effects, all of the HQs are derived from surrogate NOAECs that are based on LC_{50} values. An HQ of 20, which is not exceeded in the non-accidental or chronic scenarios, would be associated with substantial mortality. However, all of the LC_{50} values used in the dose-response assessment involve fasted fish, and a study has shown that the toxicity of glyphosate is reduced by about a factor of 10 in fed fish, relative to fasted fish. HQs for populations of fish in areas where the food supply is adequate could overestimate risk. Water containing suspended sediments has been shown to reduce the toxicity of glyphosate to aquatic macrophytes, so it seems reasonable to assert that suspended sediments could reduce the bioavailability to fish of glyphosate and surfactants used with glyphosate.

As stated in SERA 2011b, p. 209, "*The most reasonable qualitative risk characterization is that risks to fish cannot be ruled out based on standard and conservative assumptions and methods for applications of more toxic formulations of glyphosate. Nonetheless, it is not clear that any effects would be evident in healthy populations of fish in habitats with adequate supplies of food. Adverse effects could be more likely, however, in stressed populations of fish.*" The obvious exception to this characterization would be in the event of an accidental spill into a small body of water.

For less toxic formulations of glyphosate, accidental acute exposures exceed the LOC for sensitive (but not tolerant) species of fish even at the central bound at the lowest application rate. At the upper bound at the highest application rate the HQ for sensitive species of fish is 288 and for tolerant species it is 7. For non-accidental acute exposures at the upper bound at the highest application rate, HQs slightly exceed the LOC only at the upper bound (1.3) for sensitive species and are substantially lower for tolerant species. All chronic exposure HQs are below the LOC and most are substantially lower.

For less toxic formulations of glyphosate, risks to tolerant species of fish are not evident from non-accidental or chronic exposures. In the event of an accidental spill into a small body of water, adverse effects are plausible, especially to sensitive species of fish. Adverse effects would appear to be more likely in stressed populations of fish and less likely in otherwise healthy populations.

Since a surfactant must be added to less toxic formulations, it is plausible that the surfactant could impact the toxicity of the formulations to fish. Some surfactants are virtually nontoxic while others are similar to POEA in toxicity. The risk characterization for less toxic glyphosate formulations using more toxic surfactants would be similar to that for more toxic formulations of glyphosate. The additive toxic effect of any surfactant can be computed using custom worksheets.

Amphibians – SERA 2011b, p. 205, "*The available data on terrestrial-phase amphibians do not lend themselves to the types of dose-response assessments conducted for mammals and birds. Based on the approach used by U.S. EPA/OPPTS (2004), risks to terrestrial-phase amphibians would be characterized as the same as risks to birds.*"

For more toxic formulations of glyphosate, HQs for accidental acute exposures (from spills into small bodies of water) exceed the LOC for aquatic-phase amphibians even at the central bound at the lowest application rate of 0.29 lb. a.e./L. At the upper bound at the highest application rate the HQ for sensitive species of amphibians is 3,596 and for tolerant species it is 55. For non-accidental acute exposures at the upper bound at the highest application rate, HQs are much lower; 17 for sensitive species and 0.3 for tolerant species.

Except for an upper bound HQ of 1.2 for sensitive species of amphibians, all chronic exposure HQs are substantially lower than the LOC.

At the highest application rate of 8 lb a.e./acre, the upper bound concentration of glyphosate in water is about 0.7 mg a.e./L, close to the lowest acute LC_{50} of 0.8 mg a.e./L. Mortality, perhaps substantial mortality, would be expected in sensitive species of aquatic-phase amphibians. In a toxicity study of two Roundup Original formulations, concentrations of 0.6 and 1.8 mg a.e./L were associated with decreases in growth and survival and development of intersex gonads over a 42-day exposure period. Developmental effects were not noted for glyphosate IPA and appear to be most clearly associated with the surfactants used in Roundup Original formulations rather than glyphosate itself. Several studies clearly indicate that the acute toxicity of glyphosate IPA to amphibians is very low.

For less toxic formulations of glyphosate, HQs for accidental acute exposures to aquatic-phase amphibians are all below the LOC. For non-accidental acute exposures at the upper bound at the highest application rate, sensitive species have an HQ of 1.6, the only HQ that exceeds the LOC. All chronic exposure HQs are substantially below the LOC. There is no basis for asserting that adverse effects in aquatic-phase amphibians would be apparent, even at the upper bound estimates of exposure at the highest application rate.

At the typical application rate, concerns for amphibians would be modest, and the likelihood of substantial or detectable effects appears to be low. However, as stated in SERA 2011b, p. 214, "*As application rates increase toward the maximum labeled rate of 8 lb a.e./acre, the likelihood of observing adverse effects increases. At the maximum application rate, the upper bounds of potential exposure levels suggest that mortality and/or developmental effects would be expected. Thus, if more toxic formulations of glyphosate are applied at high rates near surface water that serves as a habitat for amphibians, efforts may be warranted to refine the exposure assessment based on site-specific considerations and to minimize the likelihood of the contamination of surface water.*"

There is no information for amphibians regarding the toxicity of surfactants that may be used with the less toxic glyphosate formulations. The use of a relatively nontoxic surfactant would probably have no impact on the risk characterization, but a toxic surfactant could dominate it. Assuming a fixed concentration of a toxic surfactant in a field tank mix, low application volumes relative to high volumes will generally reduce adverse effects.

Aquatic Invertebrates – For more toxic formulations of glyphosate, HQs for accidental acute exposures (from spills into small bodies of water) exceed the LOC for sensitive aquatic invertebrates at the central (18) and upper (70) bounds at the lowest application rate of 0.29 lb. a.e./L. At the upper bound at the highest application rate the HQ for sensitive species of invertebrates is 1,918 and for tolerant species it is 63. For non-accidental acute exposures at the upper bound at the highest application rate, HQs are much lower; 9 for sensitive species and 0.3 for tolerant species. Except for an upper bound HQ of 1.2 for sensitive species of invertebrates, all chronic exposure HQs are substantially lower than the LOC. At the highest application rate of 8 lb a.e./acre, "*some studies suggest that mortality at about one-half of the EC_{50} would be quite modest and might be undetectable. This risk characterization is supported by several field studies in which very little impact was observed on aquatic invertebrates following applications of Roundup or other similar formulations.*"

For less toxic formulations of glyphosate, HQs for accidental acute exposures barely exceed the LOC for sensitive aquatic invertebrates at the upper (2) bound at the lowest application rate of 0.29 lb. a.e./L. At the upper bound at the highest application rate, the HQ for sensitive species of invertebrates is 53 and below the LOC for tolerant species. All non-accidental acute and chronic exposure HQs are substantially below the LOC. The risks associated with the less toxic formulations of glyphosate are minimal.

Aquatic Plants (Algae and Macrophytes) – The dose-response assessment for sensitive species of aquatic macrophytes is based on that for sensitive species of algae, so the risk characterizations for sensitive species (but not tolerant species) of aquatic plants are identical for both algae and macrophytes. For more toxic formulations of glyphosate, HQs for accidental acute exposures exceed the LOC for sensitive aquatic macrophytes at the lower (1.3) bound at the lowest application rate of 0.29 lb. a.e./L. At the upper bound at the highest application rate the HQ for sensitive species of macrophytes is 1,754 and for tolerant species it is 0.8 (below the LOC). For non-accidental acute exposures at the upper bound at the highest application rate, HQs are much lower; 8 for sensitive species and substantially below the LOC for tolerant species. All chronic exposure HQs are substantially below the LOC.

For less toxic formulations of glyphosate, HQs for acute accidental, acute non-accidental, and chronic exposures are the same as for the more toxic formulations, so the risk characterization is similar.

For less toxic formulations of glyphosate, HQs for accidental acute exposures exceed the LOC for tolerant algae at the central (6) bound at the lowest application rate. At the upper bound at the highest application rate the HQ for sensitive species of algae is 625 and for tolerant species it is 2. For non-accidental acute exposures at the upper bound at the highest application rate, HQs are much lower; 3 for sensitive species and substantially below the LOC for tolerant species. All chronic exposure HQs are substantially below the LOC.

Following an accidental spill, sensitive species of aquatic plants would likely be damaged or killed, but tolerant species of algae are unlikely to be killed. After non-accidental acute exposures, only at the upper bound at the highest application rate would it be plausible that sensitive, but not tolerant, aquatic plants could be damaged. Adverse effects from chronic exposures are implausible.

Several field studies found that the more toxic formulations of glyphosate, applied at up to the typical rate of 2 lb a.e./acre, did not have a substantial impact on what are presumed to be tolerant algae. Other field studies using sub-toxic concentrations of glyphosate found increases in the primary productivity of algae.

D.3.2.5.2.4 Hexazinone (Sources: FS WSM v. 6.00.10; SERA 2005; U.S. EPA 2002b and 2010d)

Terrestrial and Aquatic Organism Overview

Hexazinone is a broad-spectrum herbicide that is formulated to control annual and perennial herbaceous broadleaf weeds, some grasses, and some woody species. It is commonly used in tree plantations to control brush, in rangeland, and in pasturelands. (TNC 2001)

As stated in U.S. EPA. 2010d (p. 2): "*Hexazinone is a triazine herbicide, which is structurally and toxicologically dissimilar to the other triazines herbicides, such as atrazine. The selectivity of triazine herbicides depends on the plant's ability to degrade or metabolize the parent compound. Sensitive plants have limited ability to metabolize hexazinone. Hexazinone acts through inhibition of photosynthesis.*"

According to The Nature Conservancy (TNC 2001), "*Hexazinone is absorbed through the roots and foliage of plants, and best results are obtained for herbaceous species when applied in moist soil conditions, as either a foliage spray or basal soil treatment. Larger woody species are best controlled by injection or hack-and-squirt techniques. Species that have been controlled by hexazinone include: tansy-mustard (Descurainia pinnata), cheatgrass (Bromus tectorum), filaree (Erodium spp.), shepards-purse (Capsella bursa-pastoris), false dandelion (Hypochaeris radicata), privet (Ligustrum spp.), and Chinese tallowtree (Sapium sebiferum) (Du Pont 1993).*"

Hexazinone is registered for pre-emergent, post-emergence, directed spray and soil applications. Chemical end-use products are formulated as a liquid, soluble granules, water dispersible granules, and pellets. Products are applied by aerial, broadcast and directed spray, or injection. There are no reported impurities of toxicological concern in hexazinone. (U.S. EPA 2002b, p. 5)

The ground application rates of liquid and granular formulations of hexazinone considered in this risk assessment and potentially used under the VTP and Alternatives are as follow: the lowest anticipated application rate of 0.5 lb. a.i./acre, the typical application rate of 2 lbs. a.i./acre, and the highest anticipated application rate of 4 lbs. a.i./acre.

Adverse effects on terrestrial plants due to either drift or runoff are plausible from applications of granular or liquid formulations of hexazinone at rates that are effective in weed control. Depending on local conditions and the proximity of streams or ponds to the treatment site, damage to aquatic vegetation is also plausible and could be substantial.

The potential for adverse effects in animals is somewhat dependent on the hexazinone formulation. Granular formulations appear to pose a very low risk to any terrestrial or aquatic animal. Liquid formulation applications will result in much higher concentrations of hexazinone in terrestrial vegetation than will comparable applications of granular formulations. For mammals, this has a major impact on the potential for adverse effects.

As stated in the “Overview” in SERA 2005, p. 4-25: “Over the range of application rates used in U.S. Forest Service programs [and potentially used under the VTP and Alternatives], adverse effects are plausible in mammals consuming contaminated vegetation after the application of liquid formulations and adverse reproductive effects in some mammalian species could occur. There is no indication that substantial numbers of mammals would be subject to lethal exposure to hexazinone. Consequently, adverse effects such as weight loss and reproductive impairment could occur but might not be readily apparent or easy to detect. Birds appear to be much more tolerant to hexazinone than mammals and adverse effects on birds do not seem plausible. Similarly, there is no indication that direct toxic effects are likely in aquatic animals.”

Terrestrial Organisms

Mammals – Based on contaminated vegetation, there are large differences between the LOCs (HQs) for granular and liquid formulations for all exposure scenarios. These differences are attributable to the much higher estimates of hexazinone residue on contaminated vegetation following application of liquid formulations relative to granular formulations.

For granular formulations, directed or broadcast soil applications exceed the LOC only for chronic exposures, to small mammals consuming broadleaf foliage (HQ 3) and tall grass (HQ 2) at the typical application rate (upper bound) and short grass at the upper (HQ 5) bounds and larger mammals consuming short grass at the upper bound (HQ 1.1). Since all HQs are <8, it is plausible that minor adverse effects could occur, especially to small mammals consuming vegetation applied at the typical (upper bound) and highest rates.

For liquid formulations of hexazinone, the non-accidental acute exposure HQs exceed the LOC at the typical application rate (upper bound) only for small mammals consuming contaminated vegetation (HQs 1.9 & 3). Chronic exposure HQs (1.3 to 116) are exceeded for almost all of the scenarios involving small, larger, and large mammals consuming contaminated fruit and vegetation at the typical application rate (central and upper bound). At the lower bound, HQs (1.3 & 3) are only exceeded for small mammals consuming contaminated vegetation. As stated in SERA 2005, p. 4-27, "*Over the range of application rates used in Forest Service programs* [and likely to be used under the VTP and Alternatives]*, adverse effects could be anticipated in mammals who consume contaminated vegetation over prolonged periods of time. It is unclear whether or not frank effects such as severe weight loss might occur or be evident. Adverse reproductive effects do not appear to be plausible.*"

Birds – Birds appear to be substantially more tolerant of both liquid and granular formulations of hexazinone than do mammals. At none of the application rates, even at the upper limit of exposure, is the LOC exceeded. There is no basis for asserting that any adverse effects are plausible in birds. As stated in SERA 2005, p. 4-27, "*This unambiguous risk characterization is consistent with the risk characterization for birds given by the U.S. EPA/OPP (1994a) in the registration document for hexazinone.*"

Terrestrial Invertebrates – The only available information on the toxicity of hexazinone to terrestrial invertebrates are two bioassays in the honey bee, which severely limits the risk characterization. Based on this, there is no basis for asserting that terrestrial insects or other terrestrial invertebrates will be directly affected by the use of hexazinone in the VTP and Alternatives.

Terrestrial Plants (Macrophytes) – As stated in the SERA RA for hexazinone (SERA 2005, p. 4-25): "*Because hexazinone is an effective herbicide, unintended effects on nontarget vegetation are plausible. The effective use of hexazinone is achieved by applying the compound to target vegetation at a time and in a manner which will minimize effects on nontarget plant species. If this is done properly and with care, effects on nontarget vegetation should be minor and perhaps negligible. Nonetheless, in the normal course of applications of granular or liquid formulations at rates that are effective in weed control, adverse effects on terrestrial plants are plausible due to either drift or runoff.*"

There are few quantitative differences in the risk characterizations associated with the application of granular and liquid formulations of hexazinone. Both sensitive and tolerant plants, including special status species, could be adversely affected by off-site drift of hexazinone, sediment loss, or runoff under different scenarios, depending on local site-specific conditions that cannot be generically modeled. Direct spray of liquid formulations by low boom ground applications is likely to damage both tolerant and sensitive plant species by off-site spray drift at distances of up to about 300 feet at the highest application rate and up to about 25 feet at the lowest application rate. Patterns of drift will vary depending upon whether granular or liquid formulations are applied.

Relatively conservative estimates of pesticide transport by wind erosion of soil suggest that this process is not likely to result in exposures that would be of concern. Off-site transport of hexazinone by runoff and sediment losses could cause substantial damage to both sensitive and tolerant plants across the range of application rates under conditions that favor runoff and sediment loss, such as high rainfall rates and clay soil. As soil textures change from clay to loam to sand, off-site runoff will become increasingly less. If hexazinone is applied in the proximity of sensitive crops or other desirable sensitive plant species, site-specific conditions and anticipated weather patterns will need to be considered if unintended damage is to be avoided.

Terrestrial and Aquatic Microorganisms – The most useful toxicity study for risk characterization found no effects on mixed fungal and bacterial populations after field application at rates of up to 7 lbs/acre, a rate that is substantially higher than potentially used under the VTP and Alternatives.

Aquatic Organisms

It appears that aquatic animals are at a very low risk of direct toxic effects from granular formulations of hexazinone (such as Pronone 10G) but at more risk from liquid formulations (such as Velpar L), which are more likely to travel to aquatic environments. However, there is a much greater risk of direct toxic effects of hexazinone to aquatic vegetation, particularly following an accidental spill into a small water body. This risk may be heightened by the use of liquid formulations of hexazinone (such as Velpar L), which are more likely to travel to aquatic environments, than for granular formulations (such as Pronone 10G).

Fish – HQs did not exceed the LOC for fish for any exposure scenarios. There is no indication that hexazinone will cause direct toxic effects in fish even at the highest anticipated application rate of 4 lbs/acre.

Amphibians – The only relevant information that is available on the toxicity of hexazinone to amphibians is that a concentration of 100 mg/L in water caused transient reduced avoidance in newly hatched tadpoles. The highest estimated concentration in water after an accidental spill of the liquid formulation of hexazinone is about 36 mg/L, which might have a short-term effect on avoidance behavior. Whether or not this would result in any substantial impact on amphibian populations is unclear.

Aquatic Invertebrates – HQs did not exceed the LOC for aquatic invertebrates for any exposure scenario, although no toxicity data is indicated for sensitive species. However, a reproduction study in Daphnia magna resulted in a NOEC of 10 mg/L. As stated in SERA 2005, p. 4-31, "*Based on a conservative analysis of a reasonably complete set of standard toxicity studies, there is little basis for asserting that direct toxic effects on aquatic invertebrates are plausible.*"

Aquatic Plants (Algae and Macrophytes) – Adverse effects on aquatic plants are virtually certain unless effective measures at taken to ensure that bodies of open water are not contaminated. For accidental exposures, HQs range from 605 to 3,024 for tolerant macrophytes, from 48 to 242 for tolerant algae, and from 1,814 to 9,072 for sensitive algae. HQs for sensitive macrophytes were not calculated due to a lack of toxicity data.

For non-accidental exposures at the typical rate of exposure, HQs are 17 (central bound) and 67 (upper bound) for tolerant macrophytes, 1.3 (central bound) and 5 (upper bound) for tolerant algae, and 50 (central bound) and 200 (upper bound) for sensitive algae. HQs for sensitive macrophytes were not calculated due to a lack of toxicity data.

For chronic exposures at the typical rate of exposure, HQs are 3 (central bound) and 12 (upper bound) for tolerant macrophytes and 10 (central bound) and 35 (upper bound) for sensitive algae. HQs for sensitive macrophytes were not calculated due to a lack of toxicity data and HQs for tolerant algae are below the LOC.

D.3.2.5.2.5 Imazapyr (Sources: FS WSM v. 6.00.10; SERA 2011c; U.S. EPA 2006d)

Terrestrial and Aquatic Organism Overview

Imazapyr is a broad-spectrum herbicide that is formulated to control: "*. . terrestrial annual and perennial grasses and broadleaved herbs, woody species, and riparian and emergent aquatic species. It can be used where total vegetation control is desired or in spot applications. Imazapyr is relatively slow acting, does not readily break down in the plant, and is therefore particularly good at killing large woody species.*" (TNC 2001)

Imazapyr has been used to control saltcedar (*Tamarix ramossissima*), blackberries (*Rubus* spp.), field bindweed (*Convolvulus arvensis*), tree-of-heaven (*Ailanthus altissima*), pampasgrass (*Cortaderia selloana*), and downy brome (*Bromus tectorum*). But it can also adversely affect non-target plants. The Nature Conservancy (TNC 2001) has identified potential routes of transport of imazapyr that may cause adverse effects to non-target plants, as follows:

> *"Caution should be used when applying imazapyr, as a few reports to TNC from the field indicate that imazapyr might be exuded from the roots of target species. Some legume species, such as mesquite, may actively exude imazapyr (J. Vollmer pers. comm.). Imazapyr herbicide can be mobile within roots and transferred between intertwined root systems (root grafts) of many different plants and/or to several species. Movement of imazapyr via root grafts or by exudates (which is a defense mechanism of those plants) may therefore adversely affect the surrounding vegetation. This movement of herbicide may also be compounded when imazapyr is incorrectly over- applied. Movement of soil particles that contain imazapyr can also potentially cause unintended damage to desirable species."*
>
> *"Imazapyr is effective for creating openings for wildlife use. It can be applied pre-emergent, but is most effective when applied as a post-emergent herbicide. Care*

> *should be taken in applying it around non-target species, as it is readily adsorbed through foliage and roots, and therefore, could be injurious by drift, runoff, or leaching from the roots of treated plants. To avoid injury to desirable trees, do not apply imazapyr within twice the drip line (tree canopy.)"(ibid)*

As stated in SERA 2011c, p 87: "Imazapyr has been subject to a standard and relatively extensive series of acute, subacute, and chronic studies in mammals. There is little doubt that imazapyr is practically non-toxic (the classification assigned by the U.S. EPA/OPP) to mammals, birds, honeybees, fish, and aquatic invertebrates. None of the expected (non-accidental) exposures to these groups of animals raise substantial concern. The major uncertainties regarding toxic effects in animals are associated with the lack of toxicity data on either reptiles or amphibians.

Imazapyr is an effective herbicide for the control of both terrestrial and aquatic vegetation, so under some conditions ground application could damage non-target terrestrial and aquatic macrophytes. However, it is not an effective algaecide, so no adverse effects would be expected following ground applications.

The directed and broadcast foliar ground application rates of imazapyr considered in this risk assessment and potentially used under the VTP and Alternatives are as follow: the lowest anticipated application rate of 0.125 lb. a.e./acre, the typical application rate of 0.3 lb. a.e./acre, and the highest anticipated application rate of 1.5 lbs. a.e./acre.

Terrestrial Organisms

Mammals – The only HQ (1.4) that exceeds a LOC is the non-accidental acute exposure of a small mammal consuming grass at the upper bound at the maximum application rate. This is an extreme worst-case scenario, as it assumes that a small mammal will consume nothing but contaminated grass following a direct spray. Most small mammals have a more diverse diet. For all the other exposure scenarios, HQs are substantially below the LOC for mammals. Thus, adverse effects from exposure to imazapyr are unlikely.

Birds – The only HQs that exceed a LOC are for the chronic exposure of a small bird consuming tall (HQ 1.1) and short (HQ 2) grass at the upper bound at the maximum application rate. This is an extreme worst-case scenario. For almost all the other exposure scenarios, HQs are substantially below the LOC for both small and large birds. As toxic exposure levels of imazapyr are not defined for birds, the HQs probably overestimate risk. Thus, adverse effects to birds from exposure to imazapyr are unlikely.

Terrestrial Invertebrates **–** The upper bounds of the highest HQs for terrestrial invertebrates are below the LOC. These HQs are for invertebrates consuming contaminated short grass, which is expected to have substantially higher imazapyr residue concentrations than in tall grass, broadleaf vegetation, or fruit. As toxicity data on terrestrial invertebrates is limited to standard acute bioassays in honeybees, the potential risk of adverse effects in terrestrial invertebrates exposed to imazapyr is not characterized. However, due to the low HQs for imazapyr, concern with adverse effects is essentially negligible.

Terrestrial Plants (Macrophytes) – The U.S. EPA RED (U.S. EPA 2006d, p. 18): " . . *has determined that there are ecological risks of concern associated with the use of imazapyr for non-target terrestrial plants and aquatic vascular plants, and potential risks to endangered species (aquatic vascular plants, terrestrial and semi-aquatic monocots and dicots).*"

As stated in SERA 2011c, p. 87: "*The exposure scenarios developed for terrestrial plants result in an extremely wide range of HQs, some of which are far below the LOC and others substantially above it. This apparent ambiguity relates to the attempt made in the exposure assessments to encompass a wide range of potential exposures associated with different weather patterns and other regional or site-specific variables. Thus, for applications of imazapyr to areas in which potential effects on non-target plants are a substantial concern, refinements to the exposure scenarios for non-target plants should be considered based on site or region specific factors.*"

Direct spraying of sensitive plants at the typical application rate of 0.3 lb. a.e./acre, the lowest anticipated application rate of 0.125 lb. a.e./acre, and the highest anticipated application rate of 1.5 lbs. a.e./acre will cause total mortality. At the typical application rate (0.3 lbs a.e./acre) used in U.S. Forest Service programs and potentially used under the VTP and Alternatives, the HQ for tolerant plant species would be at the LOC, so damage to tolerant or very resistant species would probably not occur.

Off-site drift of imazapyr is likely to cause adverse effects on some species of non-target plants under certain application conditions and circumstances. Off-site drift from ground applications may cause damage to sensitive species at distances that could extend well beyond 900 feet, unless effective efforts are made to reduce drift from the application site. Tolerant species would probably show relatively little damage even close to treatment sites.

However, there is substantial uncertainty regarding drift estimates due to the numerous site-specific variables which can affect drift. The estimates for backpack applications are based on a modified set of assumptions for low-boom ground applications, so are likely to overestimate drift associated with carefully conducted applications during field conditions that do not favor drift.

The situational variability in the exposure assessments for runoff, irrigation water, and wind erosion has a substantial impact on the characterization of risk for sensitive non-target plant species. All of these scenarios may overestimate or underestimate risk under certain conditions.

For tolerant species of plants, HQs for exposure from runoff are 0.5 at the central bound and 22 at the upper bound at the highest application rate of 1.5 lbs. a.e./acre. The corresponding HQs for sensitive species are 49 (central) and 2,003 (upper). Since estimates of off-site transport in runoff and sediment are only crude approximations, the upper bound HQs represent estimates of exposure levels which may not be applicable to many site-specific applications potentially made under the VTP and Alternatives.

As stated in SERA 2011c, p. 91: "*Appendix 7, Table A7-1 should be consulted in any consideration of the consequences of potential risks to sensitive species of nontarget vegetation in a site-specific application. In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible and risks to nontarget plants should also be negligible. Conversely, risks will be greatest in areas with predominantly clay soils and moderate to high rates of rainfall. Risks may also be relatively high in cool locations with predominantly loam soils. Further generalizations do not appear to be warranted, because the modeling conducted for the current risk assessment is inherently conservative and a number of site-specific conditions could reduce, and perhaps substantially reduce, estimates of risks to nontarget vegetation.*"

Since the EPA requires language on all product labels restricting the use of imazapyr-contaminated water for irrigation, consideration of risks associated with this scenario reflects a misuse rather than an expected event. For tolerant species of plants, HQs for exposure due to contaminated irrigation water are substantially below a LOC at the highest application rate of 1.5 lbs. a.e./acre. The corresponding HQs for sensitive species are 106 (central) and 2,761 (upper). Considering reasonable variations that might be made in the exposure scenario, there is little basis for asserting that tolerant plant species will be at risk of adverse effects. However, risks to sensitive species appear to be substantial.

For wind erosion, the HQs for tolerant species of plants are substantially below a LOC while the HQs for sensitive species of plants modestly exceed a LOC at the central (1.6) and upper (3.2) bounds at the highest application rate of 1.5 lbs. a.e./acre. While potential damage to non-target vegetation due to wind erosion of contaminated soil cannot be totally dismissed, the risks associated with this scenario are far below those for runoff or irrigation water.

Terrestrial and Aquatic Microorganisms – The peak concentrations of imazapyr expected in the top 12 inches of soil range from 0.218 to 0.46 mg a.e./kg soil, far below the range of LC_{50} values that caused adverse effects to microorganisms in several studies. As stated in SERA 2011c, p. 93, "*Thus, there does not appear to be any basis for asserting that imazapyr is likely to affect soil microorganisms adversely. This conclusion appears to be consistent with the use of imazapyr as an effective herbicide. If imazapyr were extremely toxic to terrestrial microorganisms that are important for the maintenance of soil suitable for* *plant growth, it seems reasonable to assume that secondary signs of injury to microbial populations would have been reported.*"

Aquatic Organisms

The U.S. EPA RED (U.S. EPA 2006d, p. 18 has determined that there are no risks of concern to aquatic invertebrates and fish: "For aquatic organisms, available acute and chronic toxicity data indicate that imazapyr acid and salt are practically non-toxic to fish, invertebrates, and non-vascular aquatic plants."

The only ecological risks of concern to the U.S. EPA were: ". . associated with the use of imazapyr for non-target terrestrial plants and aquatic vascular plants, and potential risks to endangered species (aquatic vascular plants, terrestrial and semi-aquatic monocots and dicots). (ibid) However, "Registered uses of imazapyr acid and the imazapyr isopropylamine salt will have no direct effect on endangered or threatened fish, aquatic invertebrates, non-vascular aquatic plants (algae), birds or mammals." (U.S. EPA 2006d (p. 23) As per the annual Pesticide Use Reports (CDPR 2010), only imazapyr isopropylamine salt was used in forestry and rangeland applications in California during the years 2000-2010. This is the imazapyr formulation that is assessed in this Program EIR.

Although there is little concern for the risk of adverse effects to most aquatic organisms, risk characterization to amphibians is limited, as per SERA 2011e (p. 87), which states that: "There is little doubt that imazapyr is practically non-toxic (the classification assigned by the U.S. EPA/OPP) to mammals, birds, honeybees, fish, and aquatic invertebrates. None of the expected (non-accidental) exposures to these groups of animals raise substantial concern. The major uncertainties regarding toxic effects in animals are associated with the lack of toxicity data on either reptiles or amphibians. While the available studies on other groups of organisms fail to suggest hazards associated with exposure to imazapyr, confidence in extending this risk characterization to reptiles and amphibians is limited."

Fish – The only HQ (3) that exceeds a LOC is the accidental acute exposure of a sensitive species of fish at the upper bound at the maximum application rate. This HQ is based on a single acute NOAEC (10.4 mg a.e./L from a trout bioassay) for the Arsenal formulation, rather than on technical grade imazapyr. In chronic studies, experimental NOAECs are adjusted downward by a factor of 10 to account for Arsenal's greater toxicity to fish relative to imazapyr acid. As stated in SERA 2011c, p. 93, "Given the very low acute and chronic HQs in fish and the conservative assumptions used to derive these HQs, there is no basis for asserting that acute or longer-term exposure to imazapyr will cause toxic effects in fish."

Amphibians – No toxicity data is available for either terrestrial or aquatic phase amphibians (or reptiles), so a reasonably definitive risk characterization cannot be developed. Based on the risk characterization for birds and fish, and all other groups of terrestrial and aquatic animals for which data are available, there is no basis for assuming that amphibians are likely to be at risk from exposures to imazapyr.

***Aquatic Invertebrates* –** There are no exposure scenarios in which the HQ exceeds a LOC for tolerant aquatic invertebrates. For most scenarios HQs are substantially below the LOC. No scenarios were developed for sensitive species, as none of the 33 species on which data are available were so identified. The acute NOAEC for invertebrates is higher than that for fish (41 vs. 10.4 mg a.e./L) and the chronic NOAECs for tolerant species are identical (12 mg a.e./L). Potentially sensitive species would need to be 100 to 250 times more sensitive to imazapyr relative to tolerant species before the HQs would be high enough to suggest concern.

Aquatic Plants (Algae and Macrophytes) – The risk characterization for algae is similar to that for fish and aquatic invertebrates, as the acute NOECs for sensitive species of algae are only moderately below the acute NOAECs for sensitive species of fish (i.e., 7.6 mg a.e./L vs. 10.4 mg a.e./L) and the acute NOECs for tolerant species of algae are only moderately higher than the acute NOAECs for tolerant species of aquatic invertebrates (i.e., 50.9 mg a.e./L vs. 41 mg a.e./L). An HQ (4) is exceeded only for sensitive species in the accidental acute exposure scenario at the upper bound at the highest application rate. Most other HQs are substantially below a LOC. Imazapyr is not an effective algaecide. No adverse effects would be expected following terrestrial applications. However, in the event of a severe, accidental spill, populations of sensitive species of algae would probably be reduced.

Imazapyr is labeled for control of aquatic macrophytes, as it is highly toxic to them. The HQs for sensitive aquatic macrophytes following an accidental spill are 9 at the lower bound, 227 at the central bound, and 1,817 at the upper bound at the typical application rate. For tolerant macrophytes the lower bound is below the LOC and the HQ at the central bound is 7 and at the upper bound is 55. All of these HQs are substantially higher at the highest rate of application.

As stated in SERA 2011c, p. 93, "*In the event of an accidental spill, adverse effects are virtually certain in both sensitive and tolerant species of aquatic macrophytes. In the event of a severe or even a typical spill, extensive mortality would occur. In the event of a small spill, mortality would be expected in sensitive species of macrophytes. Tolerant species could also be adversely affected in areas close to the spill site.*"

For non-accidental acute exposures, the HQs for sensitive macrophytes are 2 at the central bound and 26 at the upper bound at the typical application rate and five times higher at the highest application rate. HQs for tolerant species are below the LOC, except for an HQ of 4 at the upper bound at the highest application rate.

For chronic exposures, the HQs for sensitive macrophytes are 0.7 at the central bound and 12 at the upper bound at the typical application rate, and five times higher at the highest application rate. HQs for tolerant species are below the LOC, except for an HQ of 1.8 at the upper bound at the highest application rate. In areas where the potential for water contamination is lower due to low rainfall rates, damage to aquatic macrophytes is unlikely, while in areas with moderate to high rainfall long term damage could occur to sensitive species.

D.3.2.5.2.6 NP9E (Sources: FS WS ver. 2.02; USDA/FS 2003b; U.S. EPA 2010e)

Terrestrial and Aquatic Organism Overview

According to US EPA 2010e, p. 7: "*Ecological receptors have the potential for significant exposure to NP and NPE for two reasons: 1) facilities that manufacture products containing NP or NPEs are discharging them into surface waters (Ellis et al., 1982); and 2) NP and NPEs tend to partition to sediments and accumulate (Naylor et al., 1992). Both freshwater and saltwater invertebrates, plants and fish are sensitive to this category of chemicals and have demonstrated toxicity to it in varying degrees.*"

However, it appears that there is little risk to terrestrial wildlife from the surfactant NP9E, as per USDA/FS 2003b (p. vi): "*Based on the expected chronic exposure levels, there is little risk to terrestrial wildlife at any application rate considered in this risk assessment.*" It also appears that normal applications of NP9E will not adversely affect aquatic plants, as stated in USDA/FS 2003b (p. vi): "*For aquatic plants, similar conclusions are reached; the normal applications should not represent a risk of effects, either through acute or chronic exposures, while the spill or over spray scenarios do represent a risk of effects.*"

The directed and broadcast foliar ground application rates of NP9E considered in this risk assessment and potentially used under the VTP and Alternatives are as follow: the lowest anticipated application rate of 0.167 lb. a.i./acre, the typical application rate of 1.67 lbs. a.i./acre, and the highest anticipated application rate of 6.68 lbs. a.i./acre.

Terrestrial Organisms

It appears that there is little risk to terrestrial wildlife from the surfactant NP9E, as per USDA/FS 2003b (p. vi): "*Based on the expected chronic exposure levels, there is little risk to terrestrial wildlife at any application rate considered in this risk assessment. With the typical application rates, two scenarios represent a slight risk of effects to mammals: direct spray to a small mammal (assuming the skin affords no protection) and consumption of contaminated vegetation by a large grazing mammal, such as a deer. None of the other acute exposures at the typical rates of application represent a risk of effects to terrestrial wildlife. At the highest application rates, acute exposures from the consumption of contaminated vegetation present a risk of effects, assuming 100% of consumed vegetation* *is contaminated. If we assume the skin is not a barrier at all (100% absorption), then the direct spray also provides a risk of effects at the highest application rates.*"

Terrestrial Organisms – As stated in USDA/FS 2003b, p. 53: "Based on the Hazard Quotients in Table 4-2, several of the scenarios represent potential risk to terrestrial wildlife. With the typical application rates, two of the acute scenarios result in hazard quotients that exceed unity (direct spray with 100% absorption [HQ 16 at the upper bound] and consumption of contaminated vegetation by a large animal [HQ 32 at the upper bound]). As stated in Section 3.3.3, acute doses from 10 to 40 mg/kg/day may not represent a risk to mammals, in which case these typical scenarios may be of low risk, even though the hazard quotient exceeds unity. As stated previously it is also less likely that a large grazing mammal, such as a deer would feed exclusively in a treated area. At the highest application rates, these same two acute exposures scenarios represent a high risk of effects. At exposures above 250 mg/kg/day (an HQ>25) frank toxic effects are possible. At exposures between 100 and 250 mg/kg/day, as stated in section 3.3.3, effects are uncertain in terms of seriousness, with inconsistent results in the various studies. Both scenarios are unlikely, as discussed previously. Given the assumptions, combined with typical animal behaviors, the actual exposure rate for a directly sprayed small mammal is likely somewhere in between the two scenarios of first order absorption and 100% absorption."

USDA/FS 2003b (p. 40) found no data in published literature on NPE toxicity to plants and only limited data on NP. The few studies on NP found that there was little to no plant uptake of NP applied to the soil, uptake was slow, NP was quickly metabolized by soil microorganisms, and/or there was generally a variable biomass growth reduction, from little to none to 50%. It was also stated that: "Since NP9E-based surfactants would not be applied alone, but would be applied in a mix with an herbicide, the herbicide would determine the effects to terrestrial plants."

"Existing soil microbes are able to utilize NPE and NP with little or no lag phase (Environment Canada 2001a; Topp 2000), at application rates (of NP) in the soil of from 1 to 250 mg/kg, indicating a lack of toxicity to soil microorganisms." (ibid)

Aquatic Organisms

According to the U.S. EPA (U.S. EPA 2010e): "NP and NPEs in the freshwater and saltwater ecosystems have the potential for ecological effects on all trophic levels of aquatic species exposed to them (USEPA, 2005)."

Many of the herbicide surfactants analyzed in USDA/FS 2003b (p. v) and likely to be used under the VTP and Alternatives, contain from 20-80% NPE. The chemical group of NPEs that are used in herbicide surfactants, NP9E, are of relative low acute toxicity to fish, as are the NPEC metabolites likely to be found in water. NP however, which is another environmental metabolite, is an order of magnitude more toxic to fish than the NP9E or

NPECs (USDA/FS 2003b, p. 43). Commercial NPE-based surfactants contain from 20-80% NP9E and are generally mixed with herbicides and water carriers at dilution rates of 0.25% to 2.5% (ibid, p. 1). The percentage of NP9E in a tank mix would therefore range from 0.0005% to 0.02%.

Further, as stated in USDA/FS 2003b:

> *Bioconcentration potential of the short-chain ethoxylates (NP, NP1E, NP2E) in freshwater fish and other aquatic biota appears to be low to moderate ranging up to about 740 (Ahel et al 1993; Liber et al 1999b;Snyder et al 2001; US EPA 1996). Little data exists on the bioconcentration of longer chain NPEs, but based on their structure they are not expected to bioaccumulate (Environment Canada 2001a, Servos 1999). (ibid, p. 45)*
>
> *The duration of an exposure must be considered, which, in the case of aquatic environments in the National Forests, would be short; the compounds of concern are broken down and their concentration reduced through dilution, as well as binding of the compounds to stream sediments. (ibid, p. 53)*
>
> *The ambient levels of NP9E (including a small percentage of NP and NP1-2E) assumed to be present from normal operations (12.5 ppb with a range of 3.1 to 31.2 ppb) would be protective of all aquatic organisms at all application rates. For fish, these assumed levels are at least 30 times lower than the 1,000 ppb protective level for NP9E. For aquatic invertebrates, exposure levels are at least 320 times lower than the 10,000 ppb protective level for NP9E. Given the chronic exposure to NP1-2EC of 7 ppb (0 to 14 ppb range), there should be no chronic toxic risk to aquatic species. (ibid)*
>
> *Both the overspray and the spill scenarios involve levels of NP9E that could represent a risk of toxic effects. The overspray scenario exceeds the acute NP9E threshold for fish by a factor of 1.5 (typical rate), up to a factor of 4.9 (highest rate). The overspray scenario should not represent an acute risk to aquatic invertebrates. With a spill, the NP9E threshold for acute effects to fish is exceeded by a factor of 6.1 (central estimate), up to a factor of 15.1 (highest rate), while for aquatic invertebrates, the threshold for acute effects is exceeded at the highest concentration rate, by a factor of 1.5 (Refer to Worksheet D05). Aquatic plants would have values intermediate between fish and invertebrates. In a stagnant small pond or stream reach, there could be effects seen to aquatic organisms. In a live stream, the more realistic scenario would be a short-term pulse of concentrated NP9E moving downstream, mixing with water and being broken down into NP1-2EC and/or partitioning into sediments. The effects of a short pulse should be minor on aquatic*

> *organisms as the short exposure time would result in lower doses than are discussed here. (ibid, p. 54)*

It appears that normal applications of NP9E will not adversely affect aquatic plants, as stated in USDA/FS 2003b (p. vi): "For aquatic plants, similar conclusions are reached; the normal applications should not represent a risk of effects, either through acute or chronic exposures, while the spill or over spray scenarios do represent a risk of effects."

The risks of adverse effects to aquatic organisms from the use of NP9E surfactants is slight, given that typically there is only a minor amount of surfactant in a tank mix, waterbodies will be buffered, any chemical mix that gets into moving water or waterbodies should dilute rapidly and exposure should be of short duration, and only terrestrial ground applications of chemical mixes will be made.

Fish –For fish, the assumed ambient levels of NP9E in water are at least 30 times lower than the 1,000 ppb protective level for NP9E. There should be no chronic toxic risk to aquatic species, as the chronic exposure level to NP1-2EC is 7 ppb (0 to 14 ppb range). There is also little potential for increased vitellogenin levels in fish at both acute and chronic exposure levels.

Both the overspray and the spill scenarios involve levels of NP9E that could represent a risk of toxic effects. The overspray scenario exceeds the acute NP9E threshold for fish by a factor of 1.5 at the typical application rate and up to a factor of 4.9 at the highest application rate. After an accidental spill into a small water body, the NP9E threshold for acute effects to fish is exceeded by a factor of 6.1 at the central estimate up to a factor of 15.1 at the upper estimate.

Amphibians – Limited data on aquatic amphibians suggests NP9E is equally or less toxic to aquatic amphibians compared to fish.

Aquatic Invertebrates – For aquatic invertebrates, exposure levels to NP9E are at least 320 times lower than the 10,000 ppb protective level for NP9E. The overspray scenario should not represent an acute risk to aquatic invertebrates. After an accidental spill into a small water body, the NP9E threshold for acute effects to aquatic invertebrates is exceeded by a factor of 1.5 at the highest concentration rate.

Aquatic Plants (Algae and Macrophytes) – After an accidental spill into a small water body, aquatic plants would have acute toxic threshold values intermediate between fish and invertebrates. As stated in USDA/FS 2003b, p. 54: "*In a stagnant small pond or stream reach, there could be effects seen to aquatic organisms. In a live stream, the more realistic scenario would be a short-term pulse of concentrated NP9E moving downstream, mixing with water and being broken down into NP1-2EC and/or partitioning into sediments. The* *effects of a short pulse should be minor on aquatic organisms as the short exposure time would result in lower doses than are discussed here.*"

D.3.2.5.2.7 Sulfometuron methyl (Sources: FS WSM v. 6.00.10; SERA 2004c; U.S. EPA 2008a, 2009g)

Terrestrial and Aquatic Organism Overview

Sulfometuron methyl is a non-selective, sulfonyl urea herbicide formulated to control the growth of broadleaf weeds and grasses. In California, it is used by the USFS primarily to control non-native invasive plants, and to a lesser extent for conifer release from competing vegetation. Oust and Oust XP are the most common formulations used and foliar applications, by backpack or boom spray, are the most common methods employed.

No recent SERA RA report is available for sulfometuron methyl. SERA 2004c (p. 4-29) found no data leading to a conclusion that this herbicide would cause adverse effects in terrestrial animals. The pertinent conclusions from the Risk Characterization "Overview" are as follow: "*There is no clear basis for suggesting that effects on terrestrial animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.045 lb a.e./acre.*"

The U.S. EPA RED for sulfometuron methyl (U.S. EPA 2008a, p.19) calculated a low Risk Quotient for aquatic and terrestrial animals and determined that "direct exposure of sulfometuron is not of concern for non-plant species." The U.S. EPA RED Amendment (U.S. EPA 2009g, p. 6) states that: "*When considering options to mitigate the ecological risk, the Agency also considered the benefits of sulfometuron methyl, namely its efficacy at extremely low rates and, its low ecological toxicity profile to other non-target organisms.*"

The directed and broadcast foliar ground application rates of sulfometuron methyl considered in this risk assessment and potentially used under the VTP and Alternatives are as follow: the lowest anticipated application rate of 0.03 lb. a.i./acre, the typical application rate of 0.045 lb. a.i./acre, and the highest anticipated application rate of 0.38 lbs. a.i./acre.

Terrestrial Organisms

Mammals – There are no HQs that exceed the LOC for accidental acute exposures to mammals. For non-accidental acute exposures, HQs exceed the LOC only at the upper range of the highest application rate and only for small mammals consuming tall and short grass (HQs 3) and broadleaf foliage (HQ 1.7). Adverse effects are unlikely even at the highest application rate that might be used under the VTP and Alternatives.

For chronic exposures, the HQs for small mammals consuming vegetation are all ≤2 at the upper bound at the typical rate of application and the central bound at the highest rate. At the upper bound at the highest rate of application, for all scenarios, the HQs for all mammals (small, larger, and large) range from 1.3 for a large animal consuming tall grass to 21 for a small mammal consuming short grass. These are very conservative/extreme screening scenarios that assume that animals stay in treated areas consuming nothing but contaminated vegetation, which is unlikely given that most vegetation would die or be damaged. Adverse effects are unlikely, even at the highest application rate.

Birds – There are no HQs that exceed the LOC for accidental or non-accidental acute exposures to birds. For chronic exposures, the only HQs exceeding the LOC are for small birds consuming tall grass (1.1) and short grass (2) at the upper bound at the highest application rate. HQs for all other scenarios are substantially below the LOC. Adverse effects are unlikely even at the highest application rate that might be used under the VTP and Alternatives.

***Terrestrial Invertebrates* –** Based on direct spray studies in honey bees, no mortality would be expected following acute exposure of doses up to 1075 mg/kg. For honey bees, the HQs are well below the LOC at all rates of application of sulfometuron methyl. There is no basis for anticipating the occurrence of adverse effects in bees, and perhaps other terrestrial invertebrates, at application rates that might be used under the VTP and Alternatives.

Terrestrial Plants (Macrophytes) – According to SERA 2004c, the toxicity of sulfometuron methyl to terrestrial plants has been studied extensively and is well characterized: "*Results of both pre-emergent and post-emergent bioassays show that terrestrial plants are highly susceptible to the effects of sulfometuron methyl.*" (SERA 2004c, p. 4-1)

Concern for the sensitivity of non-target plant species is further increased by field reports of substantial and prolonged damage to crops or ornamentals after the application of sulfometuron methyl in both an arid region, presumably due to the transport of soil contaminated with sulfometuron methyl by wind, and in a region with heavy rainfall, presumably due to the wash-off of sulfometuron methyl contaminated soil. Sulfometuron methyl exposure inhibited growth of several soil microorganisms and caused significant growth inhibition in Salmonella typhimurium after exposure periods of less than 3 hours. (ibid)

The U.S. EPA RED for sulfometuron methyl (U.S. EPA 2008a, p. 19) indicates that there is concern for adverse effects on terrestrial plants: "*RQs for direct exposure of sulfometuron to non-target aquatic and terrestrial plants range from 6.7 to >18000. These RQs exceed the LOC and show sulfometuron exposure to non-target aquatic and terrestrial plants to be of concern. Although use of 'typical' application rates would result in RQs of up to one order of magnitude lower than the maximum application rate these RQs would still exceed Agency*

LOC for terrestrial and aquatic plants. The conclusion of potential risks to aquatic and terrestrial plants from sulfometuron application in non-crop uses is consistent with findings from other sulfonylurea herbicide risk assessments and ecological incident reports associated with sulfometuron usage."

An amendment to the 2008 U.S. EPA RED (U.S. EPA 2009g, p. 5) reduced the potential risk to non-target plants for the following reasons: "No new data or comments were submitted that modified the Agency's ecological hazard profile for sulfometuron methyl and, therefore, the revised ecological risk assessment of sulfometuron methyl results from changes that reduced the estimated environmental concentrations and improved the overall risk picture. Overall, potential risk to non-target plants has been reduced due to comments and proposals submitted by stakeholders."

The dominant factor in the risk characterization for terrestrial plants is the potency of sulfometuron methyl relative to the application rate. At the typical application rate of 0.045 lb/acre, sulfometuron methyl is about 700 times higher than the NOEC in the vegetative vigor (direct spray) assay of the most sensitive non-target species (0.000064 lb/acre) and <1 times higher than the NOEC for the most tolerant species in the same assay (0.40 lb./acre).

Sulfometuron methyl is a potent herbicide, so adverse effects on some non-target, terrestrial, monocot and dicot plant species from direct spray are certain. Under unfavorable weather conditions and in areas in which drift is not reduced by foliar interception, off-site drift of sulfometuron methyl during ground broadcast applications may cause damage to sensitive plant species at distances >900 feet from the application site. However, when used in directed foliar applications (backpack spray), offsite drift could be reduced substantially. Tolerant plant species would probably not be impacted by drift and might show relatively little damage.

Runoff could pose a substantial risk to sensitive non-target plant species under conditions in which runoff is favored (clay soil over a very wide range of rainfall rates). Some tolerant plants species could be adversely affected under conditions which favor runoff and in regions with high rainfall.

Off-site losses of sulfometuron methyl due to wind erosion are substantially less than losses associated with runoff from clay or from drift at a distance of 500 feet or more from the application site. Wind erosion of contaminated soil is most plausible in relatively arid environments and if soil surface and topographic conditions favor wind erosion. In such locations wind erosion could lead to adverse effects in sensitive plant species.

The situational variability in the exposure assessments for runoff and wind erosion has a substantial impact on the characterization of risk for sensitive nontarget plant species. These scenarios may overestimate or underestimate risk under certain conditions. As stated in SERA 2011c, p. 4-31: "The simple verbal interpretation for this quantitative risk characterization is that sensitive and tolerant plant species could be adversely affected by the off-site drift or runoff of sulfometuron methyl under a variety of different scenarios depending on local site-specific conditions. If sulfometuron methyl is applied in the proximity of sensitive crops or other desirable plant species, site-specific conditions and anticipated weather patterns will need to [be] considered if unintended damage is to be avoided."

Terrestrial and Aquatic Microorganisms – Data regarding the toxicity of soil-incorporated sulfometuron methyl to soil microorganisms is not available. A study found that concentrations of ~73 µg/L in a liquid glucose medium inhibited the growth of soil microorganisms after exposure periods of less than 3 hours. Another study found that following light to heavy rainfalls sulfometuron methyl concentrations in runoff were <2400 µg g/L and in percolate were 100 µg g/L, at applications rates within the range used by the U.S. Forest Service and potentially used under the VTP and Alternatives. While the level of sulfometuron methyl in runoff may be substantially greater than levels that might inhibit microbial growth, concentrations in the percolate are more directly relevant to soil bacteria. It is uncertain if the level used in glucose medium is relevant to soil exposure, but if it is, microbial inhibition is likely to occur and could be substantial.

Aquatic Organisms

The U.S. EPA RED for sulfometuron methyl (U.S. EPA 2008a, p.19) calculated a low Risk Quotient for aquatic and terrestrial animals and determined that "direct exposure of sulfometuron is not of concern for non-plant species." However, for aquatic plants:

> *RQs for direct exposure of sulfometuron to non-target aquatic and terrestrial plants range from 6.7 to >18000. These RQs exceed the LOC and show sulfometuron exposure to non-target aquatic and terrestrial plants to be of concern. Although use of 'typical' application rates would result in RQs of up to one order of magnitude lower than the maximum application rate these RQs would still exceed Agency LOC for terrestrial and aquatic plants. The conclusion of potential risks to aquatic and terrestrial plants from sulfometuron application in non-crop uses is consistent with findings from other sulfonylurea herbicide risk assessments and ecological incident reports associated with sulfometuron usage.*

Aquatic macrophytes appear to be at risk of adverse, but transient, effects if sulfometuron methyl is applied at the highest application rate in areas where transport to water containing aquatic macrophytes is likely. Measures should be taken to substantially reduce the anticipated levels of exposure. Algae do not appear to be at risk from non-accidental or longer term exposure to sulfometuron methyl in water, although effects may be evident in sensitive species at the upper bound of the highest application rate. Accidental spills will certainly cause adverse effects in sensitive species and may cause adverse effects in tolerant species of both aquatic macrophytes and algae.

As per SERA 2004c (p. 4-2), "*There are no published or unpublished data regarding the toxicity of sulfometuron methyl to aquatic bacteria or fungi. By analogy to the effects on terrestrial bacteria and aquatic algae, it seems plausible that aquatic bacteria and fungi will be sensitive to the effects of sulfometuron methyl*."

To reduce the hazard of spray drift to non-target organisms, the 2009 U.S. EPA RED Amendment (U.S. EPA 2009g, p. 10) requires all sulfometuron methyl applications to be made with extremely coarse or coarser nozzles. It also requires product labels to carry the following language regarding aquatic vegetation buffer zones:

> *For broadcast ground applications, do not apply within 50 feet of aquatic vegetation including, but not limited to, lakes, reservoirs, rivers, streams, marshes, ponds, estuaries, and commercial fish ponds, or water used as an irrigation source, or crops.*
>
> *For hand held applications, do not apply within 30 feet of aquatic vegetation including but not limited to, lakes, reservoirs, rivers, streams, marshes, ponds, estuaries, and commercial fish ponds, or water used as an irrigation source, or crops.*

The U.S. EPA RED Amendment (U.S. EPA 2009g, p. 6) states that: "When considering options to mitigate the ecological risk, the Agency also considered the benefits of sulfometuron methyl, namely its efficacy at extremely low rates and, its low ecological toxicity profile to other non-target organisms."

Fish – There are no HQs that exceed the LOC for accidental or non-accidental acute exposures to fish or for chronic exposures. However, chronic exposure data are only available in one species of fish (fathead minnow), so confidence in this risk characterization is reduced by the lack of chronic toxicity studies in potentially sensitive fish. Nevertheless, adverse effects are unlikely even at the highest application rate that might be used under the VTP and Alternatives.

Amphibians – Tolerant and sensitive species of amphibians could not be identified due to insufficient data. HQs in non-accidental acute exposure and chronic exposure scenarios are substantially below the LOC. HQs exceed the LOC only for the accidental acute exposure scenario at the upper bound (HQ 2) at the typical application rate and the central (HQ 3) and upper (HQ 18) bounds at the highest application rate.

The endpoints for amphibians are an acute NOEC of 0.38 mg/L and a chronic NOEC of 0.00075 mg/L. Concentrations of sulfometuron methyl in ambient water over prolonged periods of time are estimated to be no greater than 0.0000032 mg/L and peak concentration of sulfometuron methyl associated with runoff or percolation are estimated to be no more than 0.0009 mg/L. Based on available data, sulfometuron methyl appears to have a very low potential to cause any adverse effects in amphibians.

Aquatic Invertebrates – The HQs for aquatic invertebrates are extremely low and the available data are sufficient to assert that no adverse effects are anticipated.

Aquatic Plants (Algae and Macrophytes) –The risk characterization for aquatic macrophytes is based on NOEC values in a single species and a most sensitive and most tolerant species could not be identified due to a lack of data. HQs in accidental acute exposure scenarios substantially exceed the LOC, ranging from 47 at the lower bound at the typical application rate to 32,803 at the upper bound at the highest application rate. HQs for the non-accidental acute exposure scenario exceed the LOC only at the upper bound (HQ 4) at the typical application rate and the central (HQ 1.8) and upper (HQ 36) bounds at the highest application rate. HQs for chronic exposure scenarios are substantially below the LOC. Aquatic macrophytes appear to be at risk of adverse, but transient, effects if sulfometuron methyl is applied in areas where transport to water containing aquatic macrophytes is likely. Measures should be taken to substantially reduce the anticipated levels of exposure.

Algae appear to be much less sensitive to sulfometuron methyl than macrophytes. HQs for sensitive species in accidental acute exposure scenarios substantially exceed the LOC, ranging from 4 at the lower bound at the typical application rate to 2,755 at the upper bound at the highest application rate. HQs for tolerant species range from 4 at the upper bound at the typical application rate to 19 at the upper bound at the highest application rate. HQs for the non-accidental acute exposure scenario exceed the LOC only for the most sensitive species and only at the upper bound (HQ 3) at the highest application rate. Most of the other HQs, as well as all of the HQs for chronic exposure scenarios, are substantially below the LOC. Algae do not appear to be at risk from non-accidental or longer term exposure to sulfometuron methyl in water, although effects may be evident in sensitive species at the upper bound of the highest application rate. Accidental spills will certainly cause adverse effects in sensitive species and may cause adverse effects in tolerant species.

D.3.2.5.2.8 Triclopyr (Sources: FS WSM v. 6.00.10; SERA 2011a & d)

Terrestrial and Aquatic Organism Overview

Triclopyr is an auxin-mimic herbicide that is formulated to control broadleaf herbs and woody species. "*It is particularly effective at controlling woody species with cut-stump or basal bark treatments. Susceptible species include the brooms (Cytisus spp., Genista spp., and Spartium spp.), the gorses (Ulex spp.), and fennel (Foeniculum vulgare). Triclopyr ester formulations are especially effective against root- or stem-sprouting species such as buckthorns (Rhamnus spp.), ash (Fraxinus spp.), and black locust (Robinia pseudoacacia), because triclopyr remains persistent in plants until they die.*" (TNC 2001)

"Even though offsite movement of triclopyr acid through surface or sub-surface runoff is a possibility, triclopyr is one of the most commonly used herbicides to control woody species in natural areas. Mr. Bill Neil, who has worked extensively on tamarisk/saltcedar (Tamarix spp.) control, concluded that Pathfinder II®, a triclopyr ester formulation by DowElanco, is the most cost effective herbicide for combating saltcedar. On preserves across the U.S., triclopyr has provided good control of tree-of-heaven (Ailanthus altissima), salt cedar (Tamarix spp.), glossy buckthorn (Frangula alnus), common buckthorn (Rhamnus cathartica), sweet fennel (Foeniculum vulgare), Brazilian peppertree (Schinus terebinthifolius), and Chinese tallow tree (Sapium sebiferum)…Triclopyr can also be used in forest plantations to control brush without significant impacts to conifers (Kelpsas & White). Spruces (Picea spp.) can tolerate triclopyr, but some species of pine (Pinus spp.), however, can only tolerate triclopyr during the dormant fall and winter months (Jotcham et al., 1989)." (ibid)

The following summary of the risks to organisms from exposure to triclopyr comes from the "Overview" in SERA 2011a, p. 130: "Based on the HQs resulting from extreme value exposure assessments, it appears that large mammals consuming contaminated vegetation are the non-target organisms at greatest risk. The available field studies neither support nor substantially refute concerns for adverse effects in large mammals. The lack of detailed field studies involving longer-term observations in populations of large mammals following applications of triclopyr adds substantial uncertainty to the risk characterization for mammalian wildlife."

> *"Some upper bound HQs exceed the level of concern for exposure scenarios in which smaller mammals or birds consume contaminated vegetation or insects. The magnitude of these HQs, however, is much lower than the magnitude of HQs for large mammals, particularly at the upper bounds. Based on the findings of available field studies, triclopyr is not likely to cause frank adverse effects in small mammals and birds. These observations are not contradicted by the relatively moderate exceedances above the level of concern (HQ 1) in the central estimates of the HQs for small mammals and birds." (ibid)*

Terrestrial applications of triclopyr TEA do not pose substantial risks to aquatic animals across the range of labeled application rates. "*Triclopyr BEE, however, is much more toxic than triclopyr TEA to aquatic animals. At application rates in excess of about 3 lb a.e./acre, peak concentrations of triclopyr BEE in surface water could pose acute risks to sensitive species of fish and aquatic phase amphibians. Similarly, acute risks to sensitive species of aquatic invertebrates could occur if application rates exceed about 1.5 lb a.e./acre. The likelihood of acute risks to aquatic animals depends very much on site-specific conditions. In areas with low rates of rainfall, acute risks to aquatic animals would be negligible, so long as drift to surface water were minimal. In areas with high rates of rainfall, the surface water contamination is more likely. Because triclopyr BEE is not persistent in soil or surface water, longer-term risks to aquatic animals after terrestrial applications of triclopyr BEE appear to be negligible.* (ibid)

> *"Since triclopyr is an effective herbicide, damage to terrestrial vegetation is to be expected in the event of direct spray, substantial drift, and substantial runoff from the application site. Substantial runoff from the treated site would depend on the same site-specific factors that determine contamination of surface water. Damage to aquatic plants, particularly macrophytes, may result from terrestrial applications of triclopyr. Triclopyr is an effective aquatic herbicide and damage to sensitive species of aquatic macrophytes following effective aquatic applications is certain."* (ibid)

The directed and broadcast foliar ground application rates of triclopyr considered in this risk assessment and potentially used under the VTP and Alternatives are as follow: the lowest anticipated application rate of 0.1 lb. a.e./acre, the typical application rate of 1 lb. a.e./acre, and the highest anticipated application rate of 6.6 lbs. a.e./acre.

Terrestrial Organisms

The SERA 2011d (p. 130) risk assessment found that: "*Based on the HQs resulting from extreme value exposure assessments, it appears that large mammals consuming contaminated vegetation are the nontarget organisms at greatest risk.*

> *This assessment based on HQs is consistent with the recent EPA risk assessment, U.S. EPA/OPP (2009a). The available field studies neither support nor substantially refute concerns for adverse effects in large mammals. The lack of detailed field studies involving longer-term observations in populations of large mammals following applications of triclopyr adds substantial uncertainty to the risk characterization for mammalian wildlife.*
>
> *Some upper bound HQs exceed the level of concern for exposure scenarios in which smaller mammals or birds consume contaminated vegetation or insects. The magnitude of these HQs, however, is much lower than the magnitude of HQs for large mammals, particularly at the upper bounds. Based on the findings of available field studies, triclopyr is not likely to cause frank adverse effects in small mammals and birds. These observations are not contradicted by the relatively moderate exceedances above the level of concern (HQ=1) in the central estimates of the HQs for small mammals and birds."*

The application rates for triclopyr anticipated in the VTP and Alternatives will be within the range of those analyzed in the SERA RA for Forest Service programs. It should be noted that the specimen labels for the two triclopyr products most commonly used in California, Garlon 3A and Garlon 4, prescribe application rates for forestry uses of up to 6 lbs a.e./acre/year (2 gallons), a smaller amount than used in the high application rate scenario in the SERA RA. For rangeland use, Garlon 3A and Garlon 4can be applied at rates of up to 2 lbs a.e./acre/growing season (2/3 gal. for 3A, 1/2 gal. for 4), again a smaller amount than used in the highest application rate scenario in the SERA RA.

The U.S. EPA/OPP database of ecological incidents associated with pesticide applications lists 63 reported incidents regarding triclopyr applications, none of which reported adverse effects in mammals. Also, none of the available field studies used in the SERA 2011f RA associate adverse effects in mammals with the direct toxicity of triclopyr. As stated in that RA (SERA 2011d, p. 133): "*Two general factors may contribute to the apparent discrepancy between the high HQs (as well as the high RQs) and the lack of reported adverse effects in field studies or incident reports. Like the human health risk assessment, the ecological risk assessment uses the extreme value approach. The upper bound HQs represent multiple worst case exposure assumptions that may not occur frequently in the field. Also, the field study by Leslie et al., (1996) suggests that some mammals, such as deer, may avoid treated areas. As discussed in the exposure assessment, the scenarios for the consumption of contaminated vegetation assume that 100% of the diet is contaminated. If larger mammals avoid treated areas, the proportion of the contaminated diet could be much less than 100%. As the proportion of the diet that is contaminated decreases, the consequent HQs will also decrease.*"

Mammals – HQs for triclopyr exceed the LOC for accidental acute exposures in only one scenario, a small mammal (HQ 2) and a canid (HQ 1.2) consuming contaminated fish at the upper bound at the highest rate of application (6.6 lbs. a.e./acre). For non-accidental acute exposures, HQs that exceed the LOC range from 1.1 for small and larger mammals consuming contaminated broadleaf vegetation at the central bound at the highest application rate to 74 for a large mammal consuming contaminated short grass at the upper bound. At the typical rate, HQs range from 1.2 (central bound) to 11 (upper bound) for a large mammal consuming short grass. HQs for chronic exposures are somewhat higher, at the highest application rate ranging from 1.8 (central bound) for small and larger mammals consuming contaminated tall grass to 351 (upper bound) for a large mammal consuming contaminated short grass. Exposure scenarios not involving the consumption of contaminated vegetation, direct spray and the consumption of contaminated water and fish, lead to HQs substantially lower than the LOC.

In all non-accidental and chronic exposure scenarios, except for the consumption of tall grass, the HQs are identical for small (20g) and larger (400 g) mammals, ranging from 1.5 for non-accidental consumption of insects to 49 for chronic consumption of short grass. Large (70 kg) mammals appear to be much more sensitive to triclopyr, as HQs are seven times higher, ranging from 6 for non-accidental consumption of fruit to 351 for chronic consumption of short grass.

The high HQs for mammals consuming contaminated vegetation suggest that triclopyr applications may cause adverse effects in mammalian wildlife populations at application rates typically used in U.S. Forest Service programs and potentially used under the VTP and Alternatives. For chronic exposures, HQs of about 4 at the typical application rate and about 26 at the highest application rate could be associated with adverse effects that could range from subclinical changes in blood chemistry to birth defects. As stated in SERA 2011a, p. 132, "This HQ-based risk characterization for mammals is similar to the EPA's RQ-based risk characterization in U.S. EPA/OPP (2009a, Table 5-9, p. 101): *Acute and chronic-dose based and chronic dietary-based RQs exceed the Agency's acute and chronic endangered species LOC (0.1 acute and 1.0 chronic) for all foliar application uses of triclopyr (Table 5-9). The recommended mitigated maximum foliar application rate of 9 lbs ae/A would still result in exceedances of the Agency's acute and chronic LOC of 0.1 and 1.0 respectively (Table 5-9).* U.S. EPA/OPP 2009a, p. 100."

To predict the actual effects of field applications of triclopyr, the preceding quantitative risk characterization must be tempered by information from actual field applications. In the U.S. EPA/OPP database of ecological incidents associated with pesticide applications, there are a total of 63 reported incidents regarding triclopyr applications. None of these incidents reported adverse effects in mammals. In addition, none of the available field studies associate adverse effects in mammals with the direct toxicity of triclopyr.

As stated in SERA 2011a, p. 133, "*Two general factors may contribute to the apparent discrepancy between the high HQs (as well as the high RQs) and the lack of reported adverse effects in field studies or incident reports. Like the human health risk assessment, the ecological risk assessment uses the extreme value approach. The upper bound HQs represent multiple worst case exposure assumptions that may not occur frequently in the field. Also, the field study by Leslie et al., (1996) suggests that some mammals, such as deer, may avoid treated areas. As discussed in the exposure assessment, the scenarios for the consumption of contaminated vegetation assume that 100% of the diet is contaminated. If larger mammals avoid treated areas, the proportion of the contaminated diet could be much less than 100%. As the proportion of the diet that is contaminated decreases, the consequent HQs will also decrease."*

Risk to mammals exposed to triclopyr at application rates potentially used under the VTP and Alternatives is as characterized in SERA 2011a, p. 133: "*Considering all of the above factors, the risk characterization for terrestrial mammals based on the HQ method does not appear to be unreasonable. Based on relatively standard methods used to estimate risks to mammals from well-conducted toxicity studies as well as reasonably well-documented estimates of exposure, it is likely that mammals will be exposed to triclopyr at doses that exceed the level of concern (HQ=1). In extreme cases, adverse effects could be anticipated in some mammals, particularly larger mammals, at application rates as low as 1 lb a.e./acre. These effects, however, might not involve overt signs of toxicity that would be observed in field studies.*"

> *"The chronic HQs for mammals are substantially higher than the acute HQs. This matter suggests that while overt signs of toxicity might not be evident shortly after triclopyr applications, longer-term adverse effects on mammalian populations,*

possibly involving changes in reproductive rates, could occur. While these effects are not reported or otherwise noted in field studies, it is the case that the available field studies focus on small mammals, and the available literature does not include longer-term studies on populations of larger mammals (carnivores or herbivores).”

HQs for TCP exceed the LOC only for first-order accidental acute exposures (direct spray) for a small mammal at the central (1.6) and upper (4) bounds at the highest application rate and for 100% absorption at the highest application rate (lower 3, central 6, upper 13) and at the upper (1.9) bound at the typical rate. The only TCP non-accidental and chronic exposure scenarios for mammals that approach or exceed the LOC involve the consumption of contaminated vegetation. For non-accidental acute exposures, HQs that exceed the LOC range from 1.2 for larger mammals consuming contaminated insects at the central bound at the highest application rate to 182 for a small mammal consuming contaminated grass at the upper bound. At the typical rate, HQs range from 1.2 (upper bound) for a canid consuming a small mammal to 28 (upper bound) for a small mammal consuming grass. HQs for chronic exposures are generally lower, at the highest application rate ranging from 1.8 (central bound) for a larger mammal consuming contaminated short grass to 90 (upper bound) for a small mammal consuming short grass. Exposure scenarios not involving the consumption of contaminated vegetation, direct spray and the consumption of contaminated water and fish, lead to HQs substantially lower than the LOC.

Unlike triclopyr, the HQs associated with exposure to TCP are highest for smaller mammals, which reflect the greater food consumption rate per body size for smaller mammals, as well as the use of the same NOAEL for all mammals. For contaminated grasses and fruit, the higher HQs for grasses reflect the higher estimated residue rates in short grass relative to fruit. For chronic exposures, HQs of about 4 at the typical application rate and about 26 at the highest application rate could be associated with adverse effects, which could range from subclinical changes in blood chemistry to birth defects.

Risk to mammals exposed to TCP at application rates potentially used under the VTP and Alternatives is as characterized in SERA 2011a, p. 136: “*As discussed in the previous subsection, field studies on forestry applications of triclopyr do not support the assertion that triclopyr applications in the range of about 2 lb a.e./acre will cause detectable adverse effects in populations of small mammals. These field observations are consistent with the above HQs. At the central estimate of the exposure assumptions for an application rate of 2 lb a.e./acre, the HQs would be in the range of about 0.6 to 2. The modest excursion above the level of concern (HQ = 1) would not necessarily result in detectable effects on populations of mammals. The upper bound HQs would mostly likely reflect extreme exposures which might occur only rarely.*”

Birds – Except for differences in the impact of body size on apparent risk, the risk characterization for birds is essentially identical to that for mammals. For birds, there is no clear indication of systematic differences in sensitivity with body size. Smaller birds have somewhat higher HQs than larger birds because they will consume more food per unit body weight.

No HQs for triclopyr exceed the LOC for accidental acute exposures. For non-accidental acute exposures, HQs that exceed the LOC range from 1.1 for a large bird consuming contaminated broadleaf vegetation at the central bound at the highest application rate to 90 for a small bird consuming contaminated short grass at the upper bound. At the typical rate, HQs range from 1.2 (central bound) to 14 (upper bound) for a small bird consuming tall and short grass, respectively. HQs for chronic exposures are somewhat higher, at the highest application rate ranging from 1.4 (central bound) for a large bird consuming contaminated fruit to 200 (upper bound) for a small bird consuming contaminated short grass. Exposure scenarios involving direct spray and the consumption of contaminated water and fish lead to HQs substantially lower than the LOC.

Based on the HQs, adverse effects in birds from exposure to triclopyr could be anticipated. Field studies on birds are not as numerous or as detailed as those involving mammals and neither confirm nor substantially refute concerns based on the HQs.

There is no chronic exposure data available on the toxicity of TCP to birds, so risks associated with chronic exposure to TCP residues cannot be characterized quantitatively. For acute exposures, risks are characterized based on a LOAEL of 116 mg/kg bw rather than a NOAEL. The LOAEL is based only on decreases in body weight gain and food consumption in which no overt signs of toxicity were observed, so the toxicological significance is questionable.

***Terrestrial Invertebrates* –** The quantitative risk characterization for terrestrial invertebrates is limited by the available toxicity data. HQs for the direct spray and the consumption of contaminated vegetation scenarios are based on an indeterminate LD_{50} of >620 mg a.e./kg bw for honeybees. At the highest application rate, the only HQs above the LOC are at the central (1.2) and upper bounds(5.6) for an insect consuming short grass, the upper (2.6) bound for an insect consuming tall grass, and the upper (3.2) bound for an insect consuming broadleaf foliage. All other HQs are substantially below the LOC.

There is little indication that concentrations of triclopyr in soil are likely to adversely affect soil invertebrates. The peak concentrations of triclopyr that are likely to occur in the upper 12 inches of soil following applications of triclopyr are about 1.6 ppm a.e. following an application at the highest rate of 6.6 lbs. a.e./acre. This maximum concentration is about four times lower than the chronic NOAEC for earthworms. Numerous field studies suggest that effects on terrestrial invertebrates are most likely to be associated with changes in habitat and food availability rather than direct toxic effects.

Terrestrial Plants (Macrophytes) – These findings are supported by SERA 2011f (p. 131), which found that: "Since triclopyr is an effective herbicide, damage to terrestrial vegetation is to be expected in the event of direct spray, substantial drift, and substantial runoff from the application site. Substantial runoff from the treated site would depend on the same site-specific factors that determine contamination of surface water."

The HQs for direct spray of terrestrial plants are the same for triclopyr TEA and BEE, but are higher for broadcast boom applications and sensitive plant species than for backpack applications and tolerant species. The HQs are 3,571 for sensitive species (5 for tolerant species) exposed by broadcast applications and 2,357 (3.3 for tolerant species) for backpack applications at the highest application rate. HQs at the typical application rate of 1 lb. a.e./acre are 357 for sensitive species and 0.5 for tolerant species, for both broadcast and backpack applications. Direct spray of triclopyr at the highest and typical application rates will kill and/or damage sensitive plants, as it is designed to do. It is plausible, but unlikely, that tolerant species of plants would be killed, but they might be damaged at the highest application rate.

Off-site spray drift of triclopyr is likely to kill or damage sensitive species of plants, with the extent of damage depending on the application rate and method and the distance from the application site. Estimates of drift used in this risk assessment are generic. Actual drift from applications in the field could vary substantially from these estimates, based on a number of site-specific conditions.

For broadcast applications of triclopyr TEA at the highest application rate, HQs for sensitive plants at various distances from the application site are as follow: 25'-125, 50'-63, 100 -34, 300'-13, 500'-7, and 900'-4. The only HQ above the LOC for tolerant plants is 5, at 25 feet from the application site. For backpack applications of triclopyr TEA at the highest application rate, HQs for sensitive plants are as follow: 25'-20, 50'-10.2, 100 -5.7, 300'-2.2, 500'-1.4, and 900'-0.7. The only HQ above the LOC for tolerant plants is 3.3, at 25 feet from the application site. HQs at the typical application rate of 1 lb a.e./acre are these HQs divided by 6.6.

For broadcast applications of triclopyr BEE at the highest application rate, HQs for sensitive plants at various distances from the application site are as follow: 25'-83, 50'-42, 100 -22, 300'-8.3, 500'-4.9, and 900'-2.6. There are no HQs above the LOC for tolerant plants. For backpack applications of triclopyr BEE at the highest application rate, HQs for sensitive plants are as follow: 25'-20, 50'-10.2, 100 -5.7, 300'-2.2, 500'-1.4, and 900'-0.7. There are no HQs above the LOC for tolerant plants. HQs at the typical application rate of 1 lb a.e./acre are these HQs divided by 6.6.

Off-site transport of triclopyr through runoff and sediment loss differs between the TEA and BEE formulations. For broadcast applications of triclopyr TEA, HQs for sensitive plants are

10 at the central bound and 39 at the upper bound at the maximum application rate. The corresponding values for backpack applications are 6.4 and 26. All other HQs for sensitive plants are substantially lower than the LOC. For triclopyr BEE, the HQ of 15 for sensitive plants at the upper bound at the maximum application rate is identical for both ground application methods. HQs for sensitive plants at the lower and central bounds and for tolerant plants are substantially lower than the LOC for BEE.

In many locations, runoff and sediment losses will be insubstantial. In other areas, sensitive species of plants could be damaged. If triclopyr is applied at a site that may be conducive to runoff or sediment loss, refined estimates of offsite transport should be considered.

For tolerant plant species contaminated by surface water used for irrigation, the HQs are far below a LOC, for both triclopyr formulations and application methods at the highest application rate. For triclopyr TEA, the HQs for sensitive plant species are above a LOC for broadcast application at the central (2) and upper (388) bounds at the highest application rate and for backpack applications at the central (1.6) and upper (256) bounds. For triclopyr BEE, the HQs for sensitive and tolerant plant species are identical; above a LOC for both broadcast and backpack application at the upper (32) bound at the highest application rate. The generic estimates of exposure on which these HQs are based may not represent all site-specific conditions. Site-specific HQs are influenced greatly by the extent of irrigation and concentrations of triclopyr in surface water.

HQs for the exposure of non-target plants to contaminated soil transported by wind are substantially below the LOC. Soil erosion by wind might pose a risk to sensitive plant species when triclopyr is applied to bare ground, but impacts could vary substantially with site-specific conditions.

Terrestrial and Aquatic Microorganisms – The potential for substantial effects on soil microorganisms appears to be low. As stated in SERA 2011a, p. 139: "*As summarized in Section 4.1.2.6, laboratory bioassays conducted in artificial growth media suggest a very high degree of variability in the response of soil bacteria and fungi to triclopyr with NOAELs of up to 1000 ppm in some species and growth inhibition at concentrations as low as 0.1 ppm in other species. For triclopyr BEE, concentrations of triclopyr in the top 12 to 36 inches of soil range from about 0.04 to 0.1 ppm (Appendix 4, Table A4-2 and A4-4). The corresponding values for triclopyr TEA are essentially identical. If the laboratory bioassays were used to characterize risks to terrestrial microorganisms, transient inhibition in the growth of some bacteria or fungi might be expected. This inhibition could result in a shift in the population structure of microbial soil communities, but substantial impacts on soil, including gross changes in capacity of soil to support vegetation, do not seem plausible. This assessment is consistent with the field experience involving the use of triclopyr to manage vegetation.*"

Aquatic Organisms

The SERA 2011d (p. 130) risk assessment concluded that: "*Neither terrestrial nor aquatic applications of triclopyr TEA pose substantial risks to aquatic animals across the range of labeled application rates. Triclopyr BEE, however, is much more toxic than triclopyr TEA to aquatic animals. At application rates in excess of about 3 lb a.e./acre, peak concentrations of triclopyr BEE in surface water could pose acute risks to sensitive species of fish and aquatic phase amphibians. Similarly, acute risks to sensitive species of aquatic invertebrates could occur if application rates exceed about 1.5 lb a.e./acre. The likelihood of acute risks to aquatic animals depends very much on site-specific conditions. In areas with low rates of rainfall, acute risks to aquatic animals would be negligible, so long as drift to surface water were minimal. In areas with high rates of rainfall, the surface water contamination is more likely. Because triclopyr BEE is not persistent in soil or surface water, longer-term risks to aquatic animals after terrestrial applications of triclopyr BEE appear to be negligible.*"

The application rates for triclopyr anticipated in the VTP and Alternatives will be within the range of those analyzed in the SERA RA for Forest Service programs. The specimen labels for the two triclopyr products most commonly used in California, Garlon 3A and Garlon 4, prescribe application rates for forestry uses of up to 6 lbs a.e./acre/year (2 gallons), a smaller amount than used in the high application rate scenario in the SERA RA. For rangeland use, Garlon 3A and Garlon 4 can be applied at rates of up to 2 lbs a.e./acre/growing season (2/3 gal. for 3A, 1/2 gal. for 4), again a smaller amount than used in the high application rate scenario in the SERA RA. However, chemical applications in the VTP and Alternatives will only be to terrestrial environments and will buffer waterbodies, so the likelihood of contamination of water will be minimal.

The risk characterization for TCP (an environmental metabolite of triclopyr) is considered quantitatively only for fish, because toxicity data are available only for fish. Except for accidental spills into small bodies of water, TCP is not likely to pose a risk to fish. Longer-term concentrations of TCP are far below the LOC.

Fish – For triclopyr TEA, the only HQ that exceeds the LOC for the accidental acute, non-accidental acute, and chronic exposure scenarios is for sensitive fish at the upper bound at the highest application rate. No risks to fish are identified, based on expected peak or longer-term concentrations of triclopyr acid in surface water.

Triclopyr BEE is much more toxic than triclopyr acid to fish. The HQs exceed the LOC for accidental acute exposures of fish even at the lowest application rate of 0.1 lb. a.e./acre (for sensitive species, 2 at the central bound and 20 at the upper bound and for tolerant species, 2.4 at the upper bound). At the upper bound at the highest application rate, the HQs are 1,331 for sensitive species and 161 for tolerant species. For non-accidental acute exposure, HQs are substantially below a LOC, except for a HQ of 2 for sensitive fish at the upper bound. For chronic exposures, all HQs are substantially below a LOC.

In the unlikely event of a large amount of triclopyr BEE being spilled into a small body of water, adverse effects on fish could be expected and would probably cause substantial fish kills. Because triclopyr BEE will not persist in surface water, no species of fish are likely to be at risk from longer-term exposure.

Terrestrial applications of both formulations of triclopyr will result in the contamination of surface water with TCP. The HQs exceed the LOC for accidental acute exposures of fish even at the lowest application rate of 0.1 lb. a.e./acre (for sensitive species, 1 at the central bound and 10.1 at the upper bound and for tolerant species, 2.9 at the upper bound). At the upper bound at the highest application rate, the HQs are 673 for sensitive species and 192 for tolerant species. Most HQs for non-accidental acute exposure are substantially below a LOC. All HQs for chronic exposures are substantially below a LOC. Except for accidental spills into small bodies of water, TCP is not likely to pose a risk to fish. Longer-term concentrations of TCP are far below the LOC.

Amphibians – No toxicity data are available for TCP for reptiles or terrestrial phase amphibians. Consequently, risks to these groups of organisms are not characterized for TCP. As stated in SERA 2011a, p. 137: "*In the absence of data, the U.S. EPA/OPP will typically characterize risks to amphibians based on the risk characterization for birds. In the recent EPA risk assessment on the California red-legged frog, U.S. EPA/OPP (2009a, p. 75) uses toxicity studies on birds, identical to those used in the current risk assessment, to derive RQs ranging from 0.01 to about 5, based on acute exposures, and from about 1 to 134, based on chronic exposures.*"

For aquatic-phase amphibians, characterization of risk is essentially identical to that for fish. Triclopyr TEA is much less toxic than triclopyr BEE to amphibians, TEA having no HQs exceeding a LOC. For triclopyr BEE, HQs exceed the LOC for accidental acute exposures of sensitive (but not tolerant) species of fish at the central (1.8) and upper (18.2) bounds at the lowest application rate of 0.1 lb. a.e./acre. At the upper bound at the highest application rate of 6.6 lbs. a.e./acre, the HQs are 1,211 for sensitive species and 29 for tolerant species. For non-accidental acute exposure, HQs are substantially below a LOC, except for a HQ of 2 for sensitive amphibians at the upper bound.

Except for accidental spills into small bodies of water, triclopyr is not likely to pose a risk to aquatic-phase amphibians. There is a lack of adequate chronic exposure data for aquatic-phase amphibians, so a formal quantitative risk characterization is not developed. This is not a major limitation in characterizing long-term risk, as concentrations of triclopyr BEE in surface water are very low.

Aquatic Invertebrates – For aquatic invertebrates, characterization of risk is very similar to that for fish. Triclopyr TEA is much less toxic than triclopyr BEE to aquatic invertebrates, TEA having no HQs exceeding a LOC, except for a HQ of 5 for sensitive species at the upper bound at the highest application rate after an accidental spill into a small water body. For triclopyr BEE, HQs exceed the LOC for accidental acute exposures of sensitive (but not tolerant) aquatic invertebrates at the central (4) and upper (40) bounds at the lowest application rate of 0.1 lb. a.e./acre. At the upper bound at the highest application rate of 6.6 lbs. a.e./acre, the HQs are 2,692 for sensitive species and 34 for tolerant species. For non-accidental acute exposure, HQs are substantially below a LOC, except for a HQ of 4 for sensitive aquatic invertebrates at the upper bound. All HQs for chronic exposures are substantially below a LOC. Except for accidental spills into small bodies of water, triclopyr is not likely to pose a risk to aquatic invertebrates.

Aquatic Plants (Algae and Macrophytes) – Triclopyr TEA is much less toxic than triclopyr BEE to algae. Triclopyr TEA HQs exceed a LOC for accidental acute exposures of sensitive algae at the upper bound (7.9) at the lowest application rate of 0.1 lb. a.e./acre. At the upper bound at the highest application rate, the HQs are 527 for sensitive species and 30 for tolerant species. For non-accidental acute exposure, HQs are substantially below a LOC, except for a HQ of 7 for sensitive algae at the upper bound. For chronic exposures, all HQs are substantially below a LOC, except for a HQ of 1.7 for sensitive algae at the upper bound. Except for accidental spills into small bodies of water, triclopyr TEA is not likely to pose a risk to aquatic algae.

Triclopyr BEE HQs exceed a LOC for accidental acute exposures of sensitive algae even at the lower bound (16.2) at the lowest application rate of 0.1 lb. a.e./acre. At the upper bound at the highest application rate, the HQs are 86,514 for sensitive species and 121 for tolerant species. For non-accidental acute exposure, most HQs are substantially below a LOC, except for a HQ of 141 for sensitive algae at the upper bound at the highest application rate (21 at the upper bound at the typical rate). Most HQs for chronic exposures, are substantially below a LOC. Accidental spills of triclopyr BEE into small bodies of water will likely kill sensitive species of aquatic algae and might damage tolerant species. Adverse effects are also likely in an area where substantial drift or offsite movement in runoff is likely. This is unlikely in arid regions, but as rainfall rates increase, so does the potential for substantial runoff and subsequent damage to aquatic algae.

For aquatic macrophytes, triclopyr TEA is much more toxic than triclopyr BEE. Triclopyr TEA HQs exceed a LOC for accidental acute exposures only for sensitive aquatic macrophytes at the lower bound (45) at the lowest application rate. At the upper bound at the highest application rate, the HQs are 242,240 for sensitive species and 22 for tolerant species. For non-accidental acute exposure, HQs are substantially below a LOC for tolerant species, but the HQ for sensitive species is 3,168 at the upper bound at the highest application rate.

Most HQs for chronic exposures are substantially below a LOC, with the exception of a HQ of 792 for sensitive species at the upper bound.

Triclopyr BEE HQs exceed a LOC for accidental acute exposures for aquatic macrophytes at the lower bound (4.2) for sensitive species and the upper bound (42.3) at the lowest application rate. At the upper bound at the highest application rate, the HQs are 2,817 for sensitive species and 391 for tolerant species. For non-accidental acute exposure, most HQs are substantially below a LOC, except for a HQ of 5 for sensitive species at the upper bound at the highest application rate. Most HQs for chronic exposures are substantially below a LOC.

Risks are characterized in SERA 2011a, p. 142 as follow: *"The HQs for aquatic macrophytes following terrestrial applications of triclopyr BEE are much lower than those for triclopyr TEA. The assessment of likely effects on aquatic macrophytes, however, is one example where the use of toxicity values and exposure estimates for triclopyr BEE to develop HQs is probably not justified. As discussed in Section 3.2.3.4.3, triclopyr BEE will rapidly degrade to triclopyr acid. Consequently, for the risk characterization of aquatic macrophytes, the HQs for triclopyr TEA applications should be applied to the assessment of triclopyr BEE applications, since triclopyr TEA is also rapidly hydrolyzed to triclopyr acid. Thus, for both triclopyr TEA and triclopyr BEE terrestrial applications, risks to aquatic macrophytes are substantial. As with algae, these risks will be much less in arid areas, so long as drift to surface water is avoided. If substantial drift occurs, damage to aquatic macrophytes following applications of either triclopyr TEA or triclopyr BEE could occur.*" Depending on site-specific conditions, damage to aquatic macrophytes could be evident over a prolonged period of time. The longer-term HQs for sensitive species of aquatic macrophytes are based on estimates of average concentrations of triclopyr in water over a 1-year period.

D.4 INDIRECT EFFECTS FROM IMPLEMENTING THE VTP AND ALTERNATIVES

D.4.1 ENVIRONMENTAL EFFECTS

D.4.1.1 Wildlife

The indirect effects of herbicide treatments on wildlife are dependent on many factors, including the habitat type, specific project design, climate, bioregion, and specific ecological requirements of individual species. Information on responses of wildlife to fuel reduction treatments, including herbicide treatments, is sparse to totally lacking. As a rule, negative effects will be greatest for species dependent on the fuels being removed, while positive effects will be greatest for species that have evolved in fire-dependent and other disturbance-prone ecosystems. Native species found in fire prone areas in California should generally be adapted to vegetation disturbances caused by herbicide treatments.

Some herbicide (but not borax) treatments, such as shrubland conversion to rangeland, are likely to significantly modify wildlife habitat. Others will only modify habitat slightly, such as noxious weed treatments on rangeland and understory shrub treatments following forest thinning. Herbicide treatments to control shrubs will normally increase the amount and diversity of grasses and forbs.

> *While herbaceous weed control results in a significant reduction in wildlife forage and cover species during the first growing season after application, research has shown that this effect is temporary, and many species begin to reappear in the first year. By the end of the second growing season, the diversity and quantity of herbaceous plants are comparable to untreated areas. (McNabb 1997)*

Indirect effects on wildlife will vary over time and differ depending upon the species. Certain effects might be detrimental for some species, as by a reduction in the supply of preferred food or a degradation of habitat, yet beneficial to others, as by an increase in food or prey availability or an enhancement of habitat. This is especially true for species that have very small, localized populations, such as the endangered Lange's metalmark butterfly that exists only in the 55-acre Antioch Dunes National Wildlife Refuge. However, it is unlikely that the effects on large populations of wildlife of vegetation modification, at the spatial and temporal scale of these treatments, would be substantial.

D.4.1.2 Vegetation

The indirect effects of herbicide treatments on special-status plant species depends upon whether the microsite created is favorable or not to the establishment, spread, growth, and/or viability of a particular species. Rangeland improvement treatments that remove shrubs will open the ground to full sunlight and the drying effects of increased wind speeds, which will adversely affect shade-adapted plants. Conversely, plants that thrive in hot, dry environments will likely spread, if a local seed source is available. Salvage logging after a large fire, followed by herbicide treatments to control shrubs to enhance establishment and growth of conifers, have in some cases resulted in a proliferation of herbaceous species compared to untreated areas (DiTomaso 1995).

Fuelbreak treatments, especially those that remove most of the native vegetation and disturb the soil, create microsites that are conducive to the introduction, establishment, and spread of noxious weeds. If noxious weeds are growing in the vicinity of such treatments, and especially if they are species that propagate from windblown seeds that establish in open areas, which most do, it can be expected that these species will dominate the treatment areas to the detriment of native species. This is especially true if herbicide maintenance treatments follow within a few years of each other.

Treatments to control or eradicate noxious weeds, to the extent that they are effective, will likely open new microsites for the expansion of adapted special status plants that are already growing in the treatment area, can spread too it, or are seeded in or planted by humans. These plants will then have the benefit of a growing site that has less competition for resources from other plants.

D.4.1.3 Invasive Non-Native Plants

Many of the noxious weeds that are aggressively invasive are adapted to disturbed sites with little or no shade. Conversion of shrub fields to rangeland or even for wildlife habitat improvement will generally be done by mechanical, hand, or prescribed fire or herbivory treatments. Herbicide treatments following the initial treatments will effectively prevent the regrowth of shrubs and perpetuate the microsite conditions that favor the establishment and spread of most species of noxious weeds.

Herbicide maintenance treatments in shaded fuelbreaks in forest environments are not common, but may become more so if vegetation treatment funding levels decrease. In many locations in California, shaded fuelbreaks are being established along road rights-of-way. Road openings provide abundant sunlight, which enhances the establishment and growth of new plants and the regrowth of sprouting species cut during fuelbreak establishment. To remain effective, these fuelbreaks will need to be maintained, which can be done cheaply and effectively using herbicides applied by backpack sprayers or from vehicles.

However, some studies indicate that repeated herbicide treatments, by controlling some species but not others and by creating favorable seedbeds, create microsites favorable to the invasion of noxious weeds. It is known that road openings are conducive to the spread of windborne seeds of such species as star thistle and pampas grass. Therefore, herbicide treatments of roadside shaded (or unshaded) fuelbreaks could result in invasion, reinvasion, or spread of noxious weeds found in the area.

Herbicide treatments to control or eradicate noxious weeds, to the extent that they are effective, will likely open new microsites for the expansion of adapted native plants, if they are already growing in the treatment area, can spread too it, or are planted or seeded by humans. To the extent that native plants are able to reoccupy and hold disturbed sites, there will likely be a reduction in the population of noxious weeds.

D.4.1.4 Air Quality

There is growing concern about pesticide pollution in California's air basins, especially in the Sacramento and San Joaquin Valley, Sierra Nevada, and Colorado Desert bioregions. There is evidence that current U.S. EPA and CDPR regulations, which define pesticide drift as the total amount of off-site drift that occurs during and immediately after a pesticide application, is inadequate to prevent 80-95% of the total drift of volatile pesticides (Kegley

2003). Detailed analysis of the California Air Resources Board (ARB) monitoring data shows that:

> *". . for about 45% of total pesticides applied in California, the bulk of off-site pesticide movement occurs as the pesticide volatilizes (evaporates) after application. ARB monitoring data show that concentrations of pesticides in air peak between eight and 24 hours after the start of application, with concentrations declining over several days to several weeks. Data presented in this report make it clear that while controls at the time of application are necessary to reduce application-related spray drift, such measures are not sufficient to control post-application drift of volatile pesticides. To adequately address the full range of adverse effects caused by drift, post-application drift must be regulated as well as drift that occurs during applications." (Kegley 2003)*

It is also thought that spray drift is not adequately controlled by regulatory language on pesticide labels. The U.S. EPA is in the process (since 2000) of making labels more consistent (ibid).

One of the highest priorities of the CDPR is reducing pesticide emissions that contribute to air pollution and health problems. Details of the Environmental Monitoring Branch "Air Protection Program" are available at http://www.cdpr.ca.gov/docs/emon/ehap.htm. As stated on the CDPR website (http://www.cdpr.ca.gov/docs/emon/pubs/tac/tac_prog.htm) (CDPR 2012):

> *"With the enactment of California's Toxic Air Contaminant Act the Legislature created the statutory framework for the evaluation and control of chemicals as toxic air contaminants (TACs). The statute defines TACs as air pollutants that may cause or contribute to increases in serious illness or death, or that may pose a present or potential hazard to human health. Included in the definition are substances listed as Hazardous Air Pollutants (HAPs) under section 7412 of Title 42 of the United States Code. The Department of Pesticide Regulation (DPR) is responsible for the evaluation of pesticides as TACs.*
>
> *In general, the law focuses on the evaluation and control of pesticides in ambient community air. In implementing the law, DPR must: 1) conduct a review of the physical properties, environmental fate and human health effects of the candidate pesticide; 2) determine the levels of human exposure in the environment; and 3) estimate the potential human health risk from those exposures. The law requires DPR to list in regulation those pesticides that meet the criteria to be TACs. DPR must then determine the appropriate degree of control measures for the pesticide. DPR may conduct compliance monitoring to assure that users adhere to the control measures as appropriate."*

As stated on CDPR's website (CDPR 2012), "DPR's TAC Program consists of two phases: risk assessment (evaluation and identification) and risk management (control)."

> *The law requires the preparation of a report: ". . for each pesticide evaluated that includes: an assessment of exposure of the public to ambient concentrations of the pesticide; a risk assessment, which includes data on health effects, including potency, mode of action, and other biological factors; an overview of the environmental fate and use of the pesticide; and the results of air monitoring studies conducted in California to measure the levels of the candidate pesticide present in ambient air. The report is reviewed by the Office of Environmental Health Hazard Assessment, the ARB, and is made available for public review. Based on the results of these reviews, the draft report is revised as appropriate. The draft undergoes a rigorous peer review for scientific soundness by the Scientific Review Panel, a panel of experts representing a range of scientific disciplines. Based on the results of this comprehensive evaluation, the Director of the DPR determines whether the candidate is a TAC. If the Director determines the pesticide the criteria to be a TAC, DPR declares the pesticide a TAC in regulation, and adds it to the TAC list."*

As per the California Code of Regulations Title 3. Food and Agriculture, Division 6. Pesticides and Pest Control Operations, Chapter 4. Environmental Protection, Subchapter 2. Air, Article 1. Toxic Air Contaminants, Section 6890, for a pesticide to be listed as a TAC its concentrations in ambient air must be:

> *". . greater than the following levels (for the purposes of this Section, a threshold is defined as the dose of a chemical below which no adverse effect occurs):*
>
> *(a) For pesticides which have thresholds for adverse health effects, this level shall be ten-fold below the air concentration which has been determined by the director to be adequately protective of human health.*
>
> *(b) For pesticides which do not have thresholds for adverse health effects, this level shall be equivalent to the air concentration which would result in a ten-fold lower risk than that which has been determined by the director to be a negligible risk."*

As per a CDPR memorandum (CDPR 2007):

> *"Pesticide VOCs [volatile organic compounds] can contribute to the formation of ground-level ozone, which when present in high concentrations is harmful to human health and vegetation. The federal Clean Air Act requires each state to submit a state implementation plan (SIP) for achieving and maintaining federal ambient air quality standards, including the ozone standard. In 1994, California's Air Resources Board and CDPR developed a SIP element to track and reduce pesticidal sources of VOCs in five regions that do not meet the 1-hour ozone standard (ozone nonattainment*

areas): Sacramento Metro, San Joaquin Valley, Southeast Desert, Ventura, and South Coast. On February 21, 2006, the U.S. District Court (Eastern District of California) ordered CDPR to implement regulations by January 1, 2008, to achieve the VOC emission reduction goals."

Herbicides can enter the air and drift as droplets, particles, or vapors to affect offsite, non-target species, including humans. Storrie (2004) describes these three modes of transport:

*"**Droplet drift** is the easiest to control because under good spraying conditions, droplets are carried down by air turbulence and gravity, to collect on plant surfaces. Droplet drift is the most common cause of off-target damage caused by herbicide application. For example, spraying fallows with glyphosate under the wrong conditions often leads to severe damage to establishing crops.*

***Particle drift** occurs when water and other herbicide carriers evaporate quickly from the droplet leaving tiny particles of concentrated herbicide. This can occur with herbicide formulations other than esters. Instances of this form of drift have damaged susceptible crops up to 30 km [18.6 miles] from the source.*

***Vapour drift** is confined to volatile herbicides such as 2,4-D ester. Vapours may arise directly from the spray or evaporation of herbicide from sprayed surfaces. Use of 2,4-D ester in summer can lead to vapour drift damage of highly susceptible crops such as tomatoes, cotton, sunflowers, soybeans and grapes. This may occur hours after the herbicide has been applied.*

Vapours and minute particles float in the airstream and are poorly collected on catching surfaces. They may be carried for many kilometres in thermal updraughts before being deposited. Sensitive crops may be up to 10,000 times more sensitive than the crop being sprayed. Even small quantities of drifting herbicide can cause severe damage to highly sensitive plants."

Herbicides can also move off site when sprayed vegetation is burned, although it is difficult to determine the exact amount due to the presence of large volumes of smoke, which is composed of many toxic compounds from combustion of vegetation.

Droplet and particle drift is largely dependent on droplet size, height above the ground of spray apparatus, herbicide formulation, tank mix, temperature, humidity, and wind velocity. Table D.4-1 shows the lateral distances that various sizes of droplets can drift in a 3 MPH wind and emphasizes why it is critical to manage herbicide spraying to reduce droplet size and drift.

Recommended droplet sizes for adequate herbicide coverage are related to the mode of action of the herbicide. Since pre-emergence herbicides (hexazinone and sulfometuron methyl) that are applied to the soil are generally dispersed by mechanical incorporation or precipitation, coarse droplets (greater than 450 microns) can reduce drift risk while ensuring uniform control. Spray droplet size has the greatest influence on the control effectiveness of post-emergence herbicides (clopyralid, glyphosate, imazapyr, triclopyr, and sometimes sulfometuron methyl). These herbicides are readily translocated within plants and may be applied with droplet sizes of around 350-450 microns. As a general rule for herbicides, spray droplet size should be greater than 200 microns. (Colquhoun 2001)

It is not expected that herbicide drift under the VTP and Alternatives would be excessive. Only ground spray methods would be used. Most sprays would likely be from low pressure, low volume equipment that produces relatively large droplets that are released close to the target. In addition, wind velocities near the ground tend to be lower than with increasing height. In combination, drift will be much less than that which would occur with aerial spraying.

Table D.4-1

Spray Droplet Size and Potential Drift Distance

Droplet Diameter (microns)	Type Of Droplet	Time Required to Fall 10 Feet	Lateral Distance Droplets Travel While Falling 10 Feet in a 3 MPH Wind
5	fog	66 minutes	3 miles
20	very fine spray	4.2 minutes	1,100 feet
100	fine spray	10 seconds	44 feet
240	medium spray	6 seconds	28 feet
400	coarse spray	2 seconds	8.5 feet
1,000	fine rain	1 second	4.7 feet

From Storrie 2004

Vapor drift is primarily affected by the volatility of the herbicide active ingredient formulation (esters are more volatile than salts or acids), climatic conditions (air temperature, humidity, and wind velocity), and soil conditions (texture and organic matter). Some herbicides are more volatile than others (see Table D.4-2). Ester formulations (i.e., triclopyr BEE) and the

Velpar L® formulation of hexazinone are relatively volatile in comparison to the other herbicides analyzed in this Program EIR.

A study conducted in Canada demonstrated that 3 to 4 percent of both 2,4-D amine and the highly volatile ester drifted out of the target area as spray droplets. An additional 25 to 30 percent of the ester, however, drifted as vapor in the first 30 minutes after spraying, while no additional movement of the amine was detected (Grover & Yoshida 1972).

In a study published by CDPR (CDPR 2002), monitoring was done off-site to determine the movement of three herbicides away from treatment areas following ground applications of glyphosate, triclopyr, and liquid hexazinone and aerial applications of granular hexazinone during 1997 to 2001. To summarize the results:

> *Glyphosate, triclopyr, and hexazinone were detected off-site following application. Triclopyr residues were detected up to 50-100 ft from the spray area in regions where it was co-applied with glyphosate. It is assumed that glyphosate also traveled distances equivalent to that of triclopyr, but remained undetected, likely due to its higher MDL [maximum detectable level]. Hexazinone is also suspected to have been transported off site in rain runoff/snowmelt from a liquid hexazinone treatment site and also transported off-site in dust residue from a granular hexazinone treatment site during aerial application.*

Table D.4-2

Emission Potential of VTP Chemicals Used in 2010 in California

Chemical	Emission Potential (EPtog & EProg in %) [1/]			
	Forestland Chemicals		Rangeland Chemicals	
	Range	Most Used Formulations	Range	Most Used Formulations
Borax, Sodium Tetraborate Decahydrate	1.53	1.53	not used '00-'10	not used '00-'10
Clopyralid, Monoethanolamine Salt	2.76	2.76	2.76	2.76
Glyphosate, Diammonium Salt	not used '00-'10	not used '00-'10	only 5 lbs. used '10	only 5 lbs. used '10
Glyphosate, Dimethylamine Salt				
Glyphosate, Isopropylamine Salt	0-5.71	0-1.31	0-39.15	0 & 5.71
Glyphosate, Potassium Salt	4.80	4.80	4.80	4.80
Hexazinone	0-37.6	0.99 & 37.6 [3/]	0-37.6	unknown - used '07 & '08
Imazapyr, Isopropylamine Salt	0.01-0.04	0.01	0.01-0.04	0.01
Sulfometuron-Methyl	1.02-3.70	1.02	not used '00-'10	not used '00-'10
Triclopyr, Butoxyethyl Ester (BEE)	1.89-39.15	31.63 & 39.15	31.33-44.72	31.33 & 31.63
Triclopyr, Triethylamine Salt (TEA)	11.23-11.70	11.70	5.71-11.70	5.71 & 11.70

[1/] EPtog = % of product that contributes to VOC emissions of total organic gases, EProg = % of product that contributes to VOC emissions of reactive organic gases; [2/] Also formerly known as isooctyl ester (U.S. EPA 2005d); [3/] Velpar L® formulation

Soil textures influence the degree of herbicide volatilization from soil surfaces. Most of the herbicides analyzed in this Program EIR do not adsorb tightly to soil particles (primarily clay and organic matter). Those that do not adsorb tightly (clopyralid, hexazinone, imazapyr, sulfometuron methyl, and triclopyr TEA) are more likely to volatilize, particularly if they are in a formulation that readily volatilizes. None of the herbicides with a low adsorption potential are more than moderately volatile in the formulations in which they are most commonly used, with the exception of the Velpar L® formulation of hexazinone, which has a high emission potential.

The length of time a chemical will remain on-site and will thus be able to volatilize will be determined to a large extent by its persistence. Persistence in soil is primarily affected by soil texture, climate, and microbial action. Persistence on plant surfaces is determined primarily by climate and exposure to sunlight. The herbicides with the longest potential persistence in soil (borax, clopyralid, hexazinone, imazapyr, sulfometuron methyl and triclopyr TEA), mostly have a low emission potential, with the exception of the Velpar L® formulation of hexazinone, which has a high emission potential and triclopyr TEA, which has a moderately high emission potential.

Herbicide treatments are sometimes done to “brown vegetation” prior to applying prescribed fire to remove the dead vegetation (usually six months to a year following the treatment). Prescribed fire could volatilize herbicide residues found in the vegetation. Burning by itself produces toxic compounds that are respiratory irritants and some of which are carcinogens. Although the combustion products of most herbicides have not been examined in detail, it is not likely that they will add significantly to the hazard of burning alone. It is not possible in this Program EIR to assess the extent to which the practice of brown and burn would occur or where it would occur on the landscape, as this practice is done on a voluntary basis.

It is possible that in some situations, such as in air quality non-attainment air basins or near residential areas, herbicide treatments will be used instead of prescribed burning as maintenance treatments. To the extent that this is done, additional smoke would be avoided, so air quality will be unaffected. It is not possible in this Program EIR to assess the extent to which prescribed burning will be replaced by herbicide treatments or where these treatments would occur on the landscape, as herbicide treatments are done on a voluntary basis.

D.4.1.5 Water Quality

To the extent that herbicide treatments remove vegetation that protects the soil surface from erosion by rainfall, especially on coarse-textured, erosive soils, such as those derived from granitic rocks, water quality could decline, at least temporarily. On the other hand, except for “brown and burn” scenarios, herbicide treatments kill or inhibit vegetation but do not remove it from the site, as does prescribed burning or mechanical treatments. Mechanical treatments that disturb the soil would likely result in greater surface erosion than herbicide treatments alone. In such cases herbicide treatments would protect the soil surface, and water quality, more than the aforementioned treatments.

Some of the herbicides likely to be used under the VTP and Alternatives have the potential to travel into waterbodies by spray drift, wind erosion of contaminated soil, surface runoff from treated areas, and/or by leaching into groundwater. Water quality impacts from herbicide treatments are addressed in Sections 4.4 and 4.5 of this EIR.

D.4.1.6 Recreation

Herbicide treatments under the VTP may occur on public lands. Herbicide treatments on these lands have a greater possibility of affecting the public than those on private lands, where access to the public is by invitation only.

Public perception of the hazards of herbicide treatments are variable and run the gamut, from the belief that they are benign and beneficial to certainty that they are poisoning humans and the wild denizens of the natural world. Vegetation treated with herbicides tends to be highly visible and unsightly as it yellows, withers, and dies. Until treated areas have re-vegetated, the aesthetic sensibilities of many recreational visitors to public lands will likely be offended if treatments are highly visible or of great extent.

The ultimate effect of negative public perception would likely result in, as it has to date, increased public pressure on resource managers, regulators, and legislators to restrict herbicide applications, not only on public lands but also on private lands. Negative public perception could be alleviated by more robust toxicity testing, as stated in an article by Guynn et. al. in the Wildlife Society Bulletin (WSB 2004):

> *Future research efforts should address public concerns about forest herbicide use and contribute to a basis for defining socially acceptable applications. Information on the toxicity of surfactants, nonactive ingredients, and chemical mixtures (tank mixes) and increasing the number of sentinel species, especially amphibians, would address major public concerns.*

D.4.1.7 Geology & Soils

Killing vegetation that is buffering the soil surface from rainfall impact has the potential to increase surface erosion. This is particularly likely when vegetation is removed from coarse-textured, erosive soils, such as those derived from granitic rocks. If such erosion occurs, it is conceivable that it could remove the duff and top soil horizons, where the bulk of the soil organic matter is located. This would likely reduce soil productivity, at least in the short term.

Such a scenario is unlikely, however, as herbicide treatments alone do not remove vegetation. It is more plausible that as vegetation dies and sheds leaves and other plant parts, the organic litter layer that protects the soil surface from rainfall impact and overland water flow would increase in depth. This would have the effect of increasing the depth of the protective layer and as the litter decomposes, increasing the organic matter in the upper soil layer, thus enhancing soil productivity.

There is some concern that herbicides would have an adverse effect on soil productivity by damaging soil microorganisms. All of the herbicides analyzed in this Program EIR, however, are broken down by microbial action, except for borax, which is an inorganic compound. Studies reported in the SERA RAs indicate that adverse effects from herbicides to soil microorganisms are unlikely for most herbicides, using typical or worst-case exposure assumptions at the typical application rates. Field studies indicate that for most herbicides (especially glyphosate) there may either be no effect or an increase in microorganisms. However, field studies indicate that sulfometuron methyl “inhibited growth of several soil microorganisms and caused significant growth inhibition in *Salmonella typhimurium* after exposure periods of less than 3 hours” (SERA 2004c).

The risk of borax to insects and soil microorganisms was not characterized in SERA 2006i. Although borax is used to control fungi and insects, the atypical method of application of Sporax® (to individual tree stumps) combined with the likelihood that it would only be applied under the CFIP in the VTP and Alternatives, makes it unlikely that there would be widespread exposure to insects and non-target microorganisms. Any effects to soil microorganisms, and thus soil productivity, would likely be localized and of limited extent.

The estimates of risk from soil contamination are general rather than site-specific, as the persistence and movement of chemicals in soil are complex and dependent upon variable, site-specific factors, primarily soil texture, organic matter content, microbial activity, and rainfall.

D.5 UNCERTAINTIES AND UNKNOWNS

There are a number of uncertainties and unknowns regarding the risks associated with using the herbicides analyzed in this Program EIR. The following summarizes the uncertainties and unknowns, as discussed in more detail in the preceding risk analysis and in Wildlife Society Symposium publications from the 10th annual conference of the Wildlife Society in Burlington, VT. (WSB 2004)

- Some aspects of the toxicity and fate of herbicides, such as the role of some surfactants and other adjuvants, and possible synergistic effects of multiple chemicals applied simultaneously (i.e., tank mixes), remain unknown.
- FIFRA toxicity testing is not entirely adequate. Herbicides are only tested on a small number of sentinel species, generally under controlled conditions, and only on herbicide active ingredients. Testing of impacts to adult amphibians and to reptiles is largely absent. Tests on individual organisms cannot be used to predict how complex ecosystems would react to herbicides.
- Inert ingredients are not necessarily chemically inert and can be toxic themselves, or can potentially affect toxicity of the herbicide when applied.
- No comprehensive studies have evaluated the impacts of tank mixtures of herbicides. The fundamental types of interactions in these mixtures are additive (toxicity of the mixture is equivalent to the sum of the toxicities of the individual components), antagonistic (less than the sum), or synergistic (greater than additive). Synergistic toxicity is problematic in assessing risk and is complicated by the existence of multiple mechanisms by which it can occur. The toxicity of tank mixtures is generally considered to be the same as the most toxic herbicide, which may or may not be an accurate portrayal.
- No comprehensive field studies have evaluated the impacts of multiple herbicide treatments for site preparation and release, or the combined impacts of mechanical treatments followed by herbicide treatments. Effects of herbicides in combination with fire are not well understood.
- Previous research on herbicide effects has suffered from being conducted at small temporal and spatial scales.
- More scientific rigor needs to be incorporated into herbicide-forest biodiversity studies. Only 25% of researchers collected pre-treatment data, only 40% used control plots, only 56% used replication, and only 45% of study results were peer reviewed (WSB 2004, Summary).
- Interagency consultations between the U.S. EPA and the U.S. FWS on the effects of 64 pesticides on the endangered California red-legged frog, including five of the herbicides proposed for use in the VTP (2,4-D, glyphosate, hexazinone, imazapyr, and triclopyr) and one (atrazine) that might be used off-program, need to be completed to determine the effects on this species, as per CBD v. U.S. EPA & U.S. FWS, 2011.
- There is a need for studies on alternatives to herbicides, including prescribed fire, manual and mechanical cutting, mulches, grazing animals, cover cropping, and ground based and spot application systems.
- Herbicides are often perceived by the public to cause harm to the environment, and as a result, many public land managers are reluctant to use them. A major problem in managing natural resources in today's sociopolitical environment is

> that there have been too few integrated comparisons of forest vegetation management alternatives, and too few syntheses of information to provide a scientific basis for decision-making.

Studies in California have shown what appears to be a strong association between upwind pesticide applications (but not with the herbicides analyzed in this Program EIR) and amphibian declines downwind. The relationship seems to be consistent across a number of different species representing at least three independent ranges. Given that amphibian populations appear to be declining worldwide, there is an urgent need for additional research on the role of pesticides in this decline. As reported in (Davidson 2004):

> *Several recent studies in the Sierra Nevada (Datta et al., 1998, Sparling et al., 2001) have documented current-use pesticide residues in the non-declining Pacific treefrog (Hyla regilla). This work needs to be extended to current-use pesticide residues in declining species, and with better geographic coverage to allow for an analysis of the relationship between declines and pesticide residues in frogs. In addition, laboratory experiments are needed to assess possible causal mechanisms of pesticide impacts at field-relevant doses. Given the findings here, examination of the impact of cholinesterase-inhibiting pesticides on immune response, hibernation, and other life functions could be especially illuminating.*

During research for this risk assessment, an abundance of information from different sources was evaluated. Some of this information was contradictory, some was from regions with different ecosystems, and some was based on herbicide formulations not approved for use in California. It is recommended that a solid science foundation be established, using organizational frameworks whenever possible, to capture social and ecological concerns and knowledge regarding herbicides specifically and pesticides in general. This would likely result in more light and less heat being generated in planning for and using herbicides in resource management.

D.6 EFFECTS IN RELATION TO VTP GOALS

To the extent herbicide treatments modify the type, quantity, and continuity of existing live fuels and reduce their regrowth in areas previously treated by other methods, wildland fire behavior would be modified, the risk and severity of high intensity fires and associated suppression costs would be reduced, catastrophic loss of life and property from fires would be less, there would be less air pollution and greenhouse gases produced, and adverse impacts to water quality would be lower. These goals would be met under the VTP and Alternatives, which all propose 6,000 acres of herbicide treatment per year.

Herbicide treatments may be used to reduce noxious weeds and non-native invasive plants or to increase the quantity or quality of plant species that would improve browse for wildlife and domestic stock. To the extent that herbicide treatments are used for these purposes, forestland and rangeland resources would be enhanced. These goals would be met by the VTP and Alternatives which all propose to treat 6,000 acres per year with herbicides.

Should funds be limited for the various CAL FIRE vegetation treatment programs, herbicide treatments, because they are generally less costly on a per acre basis than other vegetation treatment methods, would enable more acres to be treated than by other treatment methods. This will have the net effect of enhancing the VTP goals on more acres across California.

D.7 SUMMARY OF EFFECTS

D.7.1 HUMAN HEALTH EFFECTS

D.7.1.1 Overview

All chemicals potentially used under the VTP and Alternatives have low acute oral, dermal and inhalation toxicity (Categories III - Caution or Category IV) (there is currently no inhalation study for NP9E). All of the chemicals have low acute dermal irritation (Category IV), except for boric acid and NP9E. Boric acid (but not borax) is listed as a dermal irritant (Category III – Caution) and NP9E is listed as severely irritating (Category II – Warning). Given the low acute oral, dermal, and inhalation toxicity for most of the proposed chemicals, none are required to be labeled with the word POISON and a skull and crossbones. No chemicals are skin sensitizers, with the exceptions of triclopyr BEE and TEA.

Boron compounds are suspected of being absorbed more rapidly across damaged skin than intact skin. Thus, individuals with large areas of damaged skin should avoid using boron products, such as Sporax®. Undiluted NP9E may lead to skin sensitization, but such exposures are only likely to occur when it is mishandled. Some evidence suggests that dermal damage may also occur when in direct contact with high levels of clopyralid. Adverse effects can be largely avoided if workers use personal protective equipment and industrial hygiene procedures, as required by law.

Based on acute eye irritation studies, the Sporax® form of borax, clopyralid acid, hexazinone, and triclopyr TEA are all listed as primary eye irritants (Category I -

Danger) that can cause severe, irreversible eye damage. Depending on the test study, imazapyr varies from a Category I to a Category III classification. NP9E is listed as severely irritating (Category II – Warning). Adverse effects to workers who do not wear eye protection, as legally required, are plausible. Although acute eye irritation is minimal (Category III - Caution) for clopyralid monoethanolamine salt, glyphosate, sulfometuron methyl, and triclopyr BEE, it is also advisable for workers to wear eye protection when handling these chemicals.

The WHO primarily uses only oral and dermal acute toxicity test results to determine classification. The WHO (2009) did not find any chemicals potentially used in the VTP and Alternatives to be extremely or highly hazardous (Table D.3-6). Hexazinone, and triclopyr are categorized as moderately hazardous and borax, clopyralid and glyphosate as only slightly hazardous. Imazapyr and sulfometuron methyl were found to be unlikely to present acute hazard in normal use.

The WHO classifications are for the active ingredients only and are not for any specific formulation. The final classification of these chemicals might be different, depending upon their formulation. However, *evidence suggests that overall, whether assessed by the U.S. EPA or the WHO, chemicals potentially used in the VTP and Alternatives do not pose a high acute toxicity hazard.*

According to U.S. EPA chemical assessments, reproductive and developmental toxicity symptoms only occurred at chemical dosages that were at or above the threshold of parental toxicity (ATPT) for chemicals potentially used in the VTP and Alternatives, with the exception of borax (Table D.3-8). *None of the chemicals potentially used are listed on the California U.S. EPA's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) as chemicals known to cause reproductive toxicity* (OEHHA 2011).

According to the U.S. EPA, none of the active ingredients proposed for use in the VTP and Alternatives are known carcinogens or mutagens (Table D.3-9). Similarly, *none of the chemicals proposed for use are on the California EPA's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) list of chemicals that are known to cause cancer* (Cal EPA 2011). While clopyralid is not thought to be a carcinogen, hexachlorobenzene, a manufacturing contaminant of clopyralid, is a carcinogenic impurity of particular concern. However, *hexachlorobenzene is found at average concentrations of less than 2.5 ppm in technical grade clopyralid, well below the cancer risk level used by the USDA/FS when assessing carcinogenicity*.

While neurotoxicity and immunotoxicity studies are now required as a part of new data requirements, these tests have not yet been completed for all chemicals proposed for use under this ProgramEIR. Currently, most conclusions regarding neurotoxicity and immunotoxicity of chemicals are usually based on observations from toxicological studies not specific to evaluating the nervous and immune systems (see Table D.3-10). Of chemicals potentially used in the VTP and Alternatives, direct effects to the nervous system were only found for boric acid/ borate salts at high dosages. Direct immunotoxicity effects were not observed for any chemicals potentially used in the VTP.

Currently, information regarding endocrine disruption is vague, though according to U.S. EPA and USDA/FS risk assessments, glyphosate, hexazinone, imazapyr and sulfometuron methyl are thought to have the potential to cause effects on the endocrine system with exposure, though it remains unclear if the effects are direct or indirect (see Table D.3-10). Of the chemicals potentially used in the VTP and Alternatives, currently only glyphosate are on the U.S. EPA Final List of Initial Pesticide Active Ingredients and Pesticide Inert Ingredients to be Screened (as part of Tier 1) for effects of endocrine disruption (FR 2009, p. 17579).

Of the chemicals potentially used in the VTP and Alternatives, only triclopyr produces a metabolite - i.e., 3,5,6-trichloro-2-pyridinol (3,5,6-TCP) – that is toxic beyond the level of concern in some scenarios (see Table D.3-11). Clopyralid contains the impurities hexachlorobenzene and pentachlorobenzene, which are known carcinogens. Hexachlorobenzene is found at average concentrations of less than 2.5 ppm in technical grade clopyralid and pentachlorobenzene is found at average concentrations of less than 0.3 ppm. Hexachlorobenzene is ubiquitous and persistent in the environment and almost all people are exposed to it and have detectable concentrations in their bodies (SERA 2004a, p. 3-23). Some formulations of glyphosate that contain POEA surfactants contain the known carcinogenic contaminant 1,4-dioxane. These three carcinogens, however, are at concentrations well below the cancer risk level used by the USDA/FS when assessing carcinogenicity. Nicotinic acid, which is also known as Vitamin B3, is a metabolite of imazapyr and is a known neurotoxin; however, the minute amount in imazapyr poses no toxicity concern.

Forest Service risk assessments group chemical exposure to workers and members of the public into general exposure from normal use of chemicals and more severe accidental/incidental exposure resulting from misuse or unusual circumstances (SERA 2012). In Forest Service risk assessments, a number of specific scenarios are consistently used to characterize exposure of the general public (ibid and Table D.3-12). The assumptions made for these scenarios often make these scenarios implausible. When the standard scenarios were established for Forest Service public exposure assessments, the events were often designed to be intentionally extreme.

Extreme values, or upper and lower bounds of credible exposure levels, are typically used in Forest Service risk assessments. Particular consideration is also given to the estimated level of exposure most likely to occur, which is sometimes referred to as the central, or maximum likelihood estimate (ibid). The upper bound for each chemical is usually determined with the intent to encompass exposure of the most exposed individual. Moreover, when the lower bound exposure estimates are higher than the Level of Concern (LOC), this indicates that use of the pesticide will lead to an unacceptable risk (ibid).

In Forest Service risk assessments, the exposure and the dose-response assessments are used to quantitatively characterize risks. Hazard quotients (HQ) are values used to categorize risk for systemic toxicity effects (SERA 2012). All HQ values are directly proportional to the application rate (i.e., an HQ value of 2 at an application rate of 1 lb a.e./acre would be 6 at an application rate of 3 lb a.e./acre). For acute exposures, HQs are in units of mg/kg bw/event whereas chronic exposures are in units of mg/kg bw/day. The HQ is usually calculated by dividing a projected level of exposure by an acceptable level of exposure, such as an RfD (*ibid*). Generally, an HQ greater than 1 indicates that risk is above the Level of Concern (LOC), or unacceptably high for the situation being considered, and that adverse health outcomes may be plausible. By contrast, an HQ less than or equal to 1 indicates that exposures are below the LOC and adverse effects are not expected. Still, when HQ values are 1 or greater, the plausibility of scenarios and assumptions made for each scenario should be considered before conclusions regarding risk levels are drawn.

It needs to be emphasized that for the risk characterizations that follow, regardless of studies and findings, "***[a]bsolute safety cannot be proven and the absence of risk can never be demonstrated***" (SERA 2012). There are always uncertainties, such as those associated with using data from surrogate mammals to represent human health risk. Thus, individuals should remain prudent and minimize chemical exposure when possible.

D.7.1.2 Chemical-Specific Effects to Workers and the Public

Borax

Workers - Since Sporax® is only applied in a granular form in a specialized way, scenarios inapplicable to general worker exposure, direct spray, oral exposure by ingestion of contaminated vegetation, fruit, or fish, and direct exposure from contaminated vegetation, were omitted from the Forest Service risk assessments. The only scenarios assessed were for exposure to workers from wearing contaminated gloves for 1 minute and for 1 hour, with HQs at the upper bound ranging from 0.00072 to 0.00576 mg/kg bw/event, *well under the LOC*.

Public

Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs - Given that Sporax® is only applied in a granular form in a specialized way, the scenario involving a child being directly sprayed with a chemical was adapted to a child ingesting borax directly from a freshly treated stump. This scenario had a central HQ of 4.2 and values ranging from 2.1 to 16.2 for an ingestion of 50 to 400 mg of Sporax (5.67 to 45.36 mg B/day). According to the Forest Service risk assessment, such “estimated levels of exposure are below levels of exposure associated with nonlethal effects such as diarrhea and vomiting by factors of about 4 [184÷ 45.36] to 32 [184 ÷ 5.67]”. Moreover, “lethal doses are in the range 505 mg B/kg/day and 765 mg B/kg/day, factors of about 11 to 135 below the estimated levels of exposure.” *This indicates that if a child consumes borax from a stump, the child would likely experience vomiting and diarrhea as symptoms of toxicity. No other public exposure scenario was above the LOC.*

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman - None of these scenarios are applicable to borax.

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime - The exposures for the accidental spill scenario are based on 6.25 to 25 pounds of borax spilling into a small pond. At these rates, the HQs for a small child consuming water contaminated by an accidental spill of Sporax® into a small pond range from 0.07 to 0.7, all below the LOC. Since risk is linearly related to the amount of Sporax® that is spilled into a pond, for spills of larger amounts, HQs could exceed the LOC.

For exposure by consumption of water contaminated by runoff, the range of Sporax® application rates considered is 0.1 lb/acre to 5 lbs/acre (0.01 to 0.57 lb B/acre), with a typical rate of 1 lb/acre (0.11 lb B/acre). HQs for acute exposure of a child and chronic exposure of an adult male to water contaminated by runoff are below the LOC for all application rates considered. The highest hazard quotient of 0.3 is associated with the upper bound for acute exposure of a child. Thus, *even at the highest application rate, there does not appear to be a risk associated with acute or chronic exposure to water contaminated by runoff.*

Clopyralid

Workers - At an application rate of 0.25 lb a.e./acre, all of the general or incidental exposures to workers lead to HQ values substantially lower than the level of concern (LOC), so *no systemic effects are likely to occur among workers as a result of clopyralid exposure*.

Public

Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs - At an application rate of 0.25 lb a.e./acre, *none of the short or long-term exposure scenarios approach a LOC based on central estimates.*

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman - At an application rate of 0.25 lb a.e./acre, *none of the short or long-term exposure scenarios approach a LOC based on central estimates*. Only for chronic effects at the upper bound for consumption of vegetation does the HQ (1.2) modestly exceed the LOC.

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime - Only at the upper bound of the scenario of a child consuming water after a spill does the HQ (1.7) modestly exceed a LOC at the application rate of 0.25 lbs. a.e./acre. *This short-term exposure scenario is of no concern*. All other scenarios are substantially below a LOC.

<u>Glyphosate</u>

Workers - *Based on HQ values, the risk to workers from exposure to glyphosate is minimal.* The highest HQ for worker exposure is the upper bound for general broadcast spraying (HQ of 0.08 at normalized 1 lb a.e./acre). At the highest rate of application of 8 lbs a.e./acre used by the USDA/FS and potentially used under the VTP and Alternatives, the highest HQ for occupational exposure is the upper bound associated with workers participating in broadcast foliar application.

Public

Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs – Even at the upper bound at the highest application rate of 8 lbs. a.e./acre, none of these exposure scenarios leads to HQ values greater than 1, the LOC.

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman - *The only non-accidental exposure of potential concern involves contamination of vegetation shortly after application* (HQ of 0.7 at 1 lb a.e./acre). At the central (2 lb a.e./acre) and maximum (8 lb a.e./acre) application rates, the upper bound HQ values would be 1.35 and 5.4 respectively. Chronic exposure scenarios never resulted in LOCs, even when the maximum application of 8 lbs a.e./acre was used, as 0.9 was the highest HQ, which was for the chronic scenario involving contaminated vegetation. An HQ of 5 may raise concerns regarding adverse health effects to pregnant women and fetotoxicity. Formulas that contain surfactants and are used in South America have been associated with genotoxicity, though it is currently unclear if this finding is applicable to the U.S. formulations.

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime - The accidental acute exposure involving a child consuming contaminated water after a spill has an HQ of 2.05 at the upper bound at the typical application rate (HQ 8.2 at highest application rate). This scenario is quite arbitrary and thought to be inconsequential.

Hexazinone

Workers - Regardless of the formulation type, the upper bounds of general occupational exposure exceeded a LOC for broadcast and direct foliar application methods at a typical application rate of 2 lbs/acre (HQ of 6) and at the highest rate of 4 lbs/acre (HQ of 12). *Even at the lowest application rate (0.5 lbs/acre), the upper bound of hexazinone exposure exceeds the LOC (HQ of 1.5 lbs/acre) for broadcast application.* But *the highest upper bound HQ for any accidental exposure scenario was only 0.08, for wearing gloves contaminated with a liquid formulation for one hour. At central bounds, the LOC is exceeded (HQ 1.8) only at the highest application rate* while it only approaches the LOC (HQ 0.9) at the typical application rate. At the lower bounds, regardless of the application rate, HQs never reached a LOC. *The interpretation of these HQ values in the Forest Service risk assessment was that the level of acceptable risk for workers would be unacceptable unless all precautionary handling measures were followed (e.g. personal protection equipment is used) to minimize exposure.*

Public

Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs – For these accidental acute exposure scenarios, all HQs are substantially lower than a LOC at the upper bound at the highest application rate.

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman - The only non-accidental exposure scenario, long-term consumption of contaminated vegetation, that results in HQs that substantially exceed LOCs are at the highest application rate (4 lbs a.e./acre) of Velpar L (a liquid formulation) at low, central, and upper bounds (HQs of 0.4.1, 6, and 46 respectively). Even at the lowest application rate (0.5 lb a.e./acre), the LOC is exceeded at the upper range of exposure (HQ of 5.75) for broadleaf vegetation. The risk of exposure is much lower for granular formulations of hexazinone, with HQs of 0.2 for fruit and 1.8 for broadleaf vegetation at the upper bound at the highest application rate. *Given that granular application methods result in less residue on plants, particularly on the leaves of broadleaf vegetation and other plant parts that might collect similar levels of residue, this method should be favored over liquid hexazinone applications where public consumption of contaminated vegetation is probable.*

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime - The only acute exposure that leads to a HQ above the LOC is the accidental exposure involving consumption of contaminated water by a child after a spill into a small pond, which results in a HQ of 2 at the upper bound of the highest application rate (4 lbs a.e./acre) for Velpar L. However, *this scenario is highly arbitrary and implausible*. For chronic exposures other than the consumption of contaminated vegetation, the highest HQ is 0.2, the upper range for the consumption of contaminated water at the maximum application rate. *This is below the LOC by a factor of 5*.

<u>Imazapyr</u>

Workers - Risks are characterized only for workers applying imazapyr by ground broadcast methods. The highest HQ for general exposures is 0.02, the upper bound at the typical application rate of 0.30 lbs a.e./acre of the HQ for workers involved in ground broadcast applications of imazapyr. *This is below the LOC by a factor of about 50*. The highest accidental HQ is 0.004, at the upper bound for a worker wearing contaminated gloves for 1 hour. No exposure assessment was done for cut surface or basal bark applications, as adequate worker exposure studies were not available. However, since cut surface applications would require the use of concentrated imazapyr solutions, exposures could reach a LOC in five hours of wearing contaminated gloves. Workers who use highly concentrated solutions of imazapyr should be especially careful to prevent prolonged skin contact with the chemical. Eye irritation is the only clear risk to humans and is most pertinent to workers. Injury to the eye is most likely to occur with occupational mishandling of imazapyr, and thus workers should be prudent to follow personal protection measures, such as wearing goggles. Currently, *no evidence suggests that systemic effects are likely to occur among workers as a result of exposure to imazapyr.*

Public

Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs – Both of these scenarios resulted in accidental acute exposure HQs that were substantially below a LOC at the upper bound at the highest application rate.

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman **-** *The general public is not likely to be at risk due to applications of imazapyr.* None of these scenarios resulted in an HQ that exceeded 1, the LOC, when calculated at an application rate of 1 lb a.e./acre. When using the upper bound at the maximum application rate of 1.5 lbs a.e./acre, the non-accidental acute scenario of an adult woman consuming contaminated vegetation resulted in a HQs of 1. Given the lack of adverse effects detected, HQ values that do exceed 1 are difficult to interpret. *Currently, no evidence suggests that systemic effects are likely to occur in the general public as a result of imazapyr exposure.*

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime - The general public is not likely to be at risk due to applications of imazapyr. No dose has been identified that might pose a risk to humans. Based on the RfD of 2.5 mg/kg bw/day, the highest HQ is associated with an accidental spill of imazapyr into a small pond and the subsequent consumption of contaminated water by a small child. For this exposure scenario the HQ is 1 at the upper bound at the highest application rate of 1.5 lbs a.e./acre. The risk assessment suggests that only very severe accidental spills would approach a LOC. HQs for all other scenarios are substantially below a LOC. *Currently, no evidence suggests that systemic effects are likely to occur in the general public as a result of imazapyr exposure.*

<u>NP9E</u>

Workers - *No evidence indicates that typical acute and chronic exposures would lead to doses that exceed the LOC for workers, though some of the upper bounds did exceed it.* The upper bounds of general worker exposure resulted in levels above concern, with the LOC being double for broadcast application (HQ of 10.1) than directed (backpack) ground spray (HQ of 5.34). Despite the high LOCs at the upper bounds, there is not a high likelihood that workers will use such high levels of surfactants containing NP9E on a long-term basis. Additionally, workers are expected to use industrial hygiene practices while handling chemicals, which are not accounted for in worker exposures.

Public

Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs – Neither of these scenarios resulted in HQs that exceeded the LOC.

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman - *No evidence indicates that typical acute and chronic exposures would lead to doses that exceed the LOC for the general public, though some of the upper bounds did exceed it.* Chronic exposure leads to levels below concern. The scenario for consumption of contaminated fruit leads to acute or accidental exposures with unacceptable risk, but only the upper bounds were above the LOC (HQ 12). These findings indicate that *oral, rather than dermal, exposures are of the greatest concern for NP9E*, and help determine where the greatest mitigations may be necessary to minimize exposures to the public. According to the USDA/FS risk assessment, there should not be any substantial risk of long-term exposure to NP9E-based surfactants to the public.

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime - No evidence indicates that typical acute and chronic exposures would lead to doses that exceed the LOC for the general public, though some of the upper bounds did exceed it. Oral rather than dermal exposures are of the greatest concern for NP9E. Chronic exposure leads to levels substantially below the LOC, though some accidental exposure scenarios lead to exposures of concern. At the upper bound, the HQ is 1.7 for consumption of contaminated fish by subsistence populations following a spill. The scenario relating to consumption of water by a child after a spill leads to the highest risk at lower, typical, and upper exposures levels (HQ values of 1.4, 4.6, and 17 respectively), but this scenario is highly arbitrary, which means that LOCs are not indicative of realistic risk to the public. According to the USDA/FS risk assessment, there should not be any substantial risk of long-term exposure to NP9E-based surfactants to the public.

<u>Sulfometuron methyl</u>

Workers - At the typical application rate used by the Forest Service and potentially used under the VTP and Alternatives (0.045 lb a.e./acre), none of the upper limit HQ values for workers are at or above LOCs and most are substantially below a LOC. The highest general worker HQ is 0.34 at the typical application rate for broadcast application. At the maximum application rate (0.38 lb a.e./acre) the HQ for broadcast application is 2.9 and for direct foliar application it is 1.5, both of which are above the LOC.

The interpretation in Forest Service RAs is that an unacceptable level of risk could be expected for workers if the maximum application rates are used, the maximum acreage is treated per day, and the workers are not prudent in using sound hygiene practices and personal protection equipment. Given the low likelihood that all these factors would occur, and the conservative provisionary RfDs used by the Forest Service, *it is unlikely that workers would experience observable adverse effects.* The risk of adverse effects would be reduced or eliminated if lower application rates and fewer acres were treated.

Public

***Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs* -** At the typical application rate used by the Forest Service and potentially used under the VTP and Alternatives (0.045 lb a.e./acre), all of the upper bound HQ values for these scenarios are substantially below a LOC. For the general public, *all acute exposures, both accidental and non-accidental, remained below the levels of concern at the maximum application rate of 0.38 lb a.e./acre. The risk of adverse effects to the public would be reduced or eliminated if lower application rates and fewer acres were treated.*

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman - At the typical application rate, the upper bound HQ values are substantially below a LOC. All acute exposures, both accidental and non-accidental, remained below the levels of concern at the maximum application rate of 0.38 lb a.e./acre. For, chronic exposures, only the upper bound relating to the consumption of contaminated vegetation was above the level of concern, with an HQ of 4.1. The risk of adverse effects to the public would be reduced or eliminated if lower application rates and fewer acres were treated.

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime - At the typical and highest application rates, none of the upper bound HQ values for these scenarios are at or above LOCs and most are substantially below a LOC. It is unlikely that the public would experience observable adverse effects.

<u>Triclopyr</u>

Workers - *The LOC for occupational exposure is highly dependent on whether the acute or chronic RfD is used.* Based on the acute RfD, at an application rate of 1 lb a.e./acre none of the HQs were substantially above the LOC, but the acute RfD is only appropriate for male workers. Based on the chronic RfDs, HQs are below the LOC for triclopyr TEA. The central estimates for triclopyr BEE range from 0.7 to 1.2 at the typical application rate of 1 lb a.e./acre. All upper bound HQ values were above the LOC for both TEA and BEE forms of triclopyr when based on the chronic RfD for all application methods. In this case, BEE had higher HQ values than the TEA form of triclopyr (TEA 1.6 to 3, BEE 6 to 12). *One of the most likely exposures and risks for workers is from triclopyr being splashed into eyes, as it is moderately to severely damaging.* This as an avoidable hazard, as long as workers wear eye protection while handling triclopyr.

Public

Scenarios: 1) direct spray of a child's whole body, 2) direct spray of a woman's feet and lower legs – The HQ values for these two scenarios vary considerably between triclopyr TEA, BEE, and the metabolite TCP. The HQs for triclopyr TEA are both below a LOC at the upper bound at the typical application rate of 1 lb a.e./acre, but would exceed a LOC (HQs of 1.3 to 3.3) at the upper bound at the maximum application rate of 6.6 lbs a.e./acre. For triclopyr BEE, the HQ (1.4) exceeds the LOC for the direct spray of a woman's feet and lower legs at the upper bound at the typical application rate and exceeds a LOC (HQs of 4.6 to 9.2) at the maximum application rate. For TCP, the HQ for direct spray of a child exceeds a LOC at the central (8) and upper (123) bounds at the typical application rate and exceeds a LOC for the direct spray of a woman's feet and lower legs at the upper (HQ 12) bound at the typical application rate. These HQs would be 6.6 times higher at the upper bound at the highest application rate.

Because the upper bounds are above the LOC, caution is particularly warranted to avoid accidental spraying of the public. However, these scenarios are highly unlikely and are designed to be indicators of the most serious exposures that could result from accidental spraying of members of the general public.

Scenarios: 1) consumption of contaminated fruit or vegetation by a woman, 2) long-term consumption of contaminated fruit or vegetation by a woman - The only triclopyr or TCP exposure scenarios of substantial concern involve the consumption of contaminated vegetation and fruit. These risks do not differ between the TEA and BEE formulations. For acute non-accidental and chronic (chronic values in parentheses) exposures to a young woman consuming contaminated vegetation the HQs at the upper bound at the typical application rate of 1 lb a.e./acre are 27 (4). At the typical application rate, the central bounds for the consumption of contaminated vegetation exceed or reach the LOC for acute exposures to triclopyr (HQ of 0.3) and to TCP (HQ of 6) and for chronic exposures to TCP (HQ of 1.3). Lower bounds of exposures are used as *best case* estimates and are generally intended to represent the feasibility of risk mitigation. The lower bound HQ for the exposure scenario involving a young woman consuming vegetation contaminated with triclopyr is 0.2 at an application rate of 1 lb a.e./acre and would reach a LOC (HQ 1) at an application rate of 5 lbs a.e./acre, and exceed (HQ 1.3) the LOC at the maximum application rate of 6.6 lbs a.e./acre.

Potential exposures to triclopyr TEA, BEE, and TCP also exceed the LOC at the upper bound of the HQs for both the non-accidental acute and longer-term consumption of contaminated fruit. For TEA and BEE, the HQs are 4 for acute and 3 for chronic exposures and for TCP the HQs are 2 for acute and 10 for chronic exposures. These HQs would be 6.6 times higher at the upper bound at the highest application rate. *The upper bound HQs are intentionally based on very conservative exposure assumptions that lead to assessments that may unrealistically magnify risks.*

Scenarios: 1) water consumption by a child after a spill, 2) consumption of contaminated fish by a man after a spill, 3) consumption of contaminated fish by subsistence populations following a spill, 4) water consumption by a child, 5) consumption of fish by subsistence populations, 6) water consumption by a man over a lifetime – The scenarios of greatest concern are for a child consuming contaminated water after a spill. For triclopyr TEA and BEE, the HQ at the upper bound at the typical application rate is 2 and for TCP is 82 (5 at the central bound). The risk assessment suggests that only very severe accidental spills would exceed a LOC and only for the metabolite TCP. However, this scenario is highly arbitrary, which means that the LOCs are not indicative of realistic risk to the public. For all of the other scenarios, the HQs are substantially below a LOC.

D.7.1.3 Chemical-Specific Effects to Sensitive Subgroups, Connected Actions, and Cumulative Effects

Sensitive Subgroups - Potential adverse effects to sensitive subpopulations of humans from chemical treatments are highly dependent on the toxicity of a specific chemical, the exposure to that chemical, the dose and length of time to which an individual is exposed, and the sensitivity of that individual to a specific chemical.

Connected Actions - Connected actions are typically activities other than those associated with the agent of concern that might impact an individual's response to that agent. Potentially significant connected actions associated with the risk assessments done by SERA and the USDA/FS include exposures to other agents that might alter an individual's response to the agent of concern (SERA 2005, p. 3-42). The Food Quality Protection Act requires that chemicals that are mixed with other chemicals that have the same mode of action relating to toxicity be assessed for synergistic, additive, or antagonistic effects.

Cumulative Effects - Cumulative effects refers to the consequences of repeated exposure to the chemicals potentially used in the VTP and Alternatives as well as exposures to other chemicals that have the same mode of action as the chemical of concern. As stated in SERA 2005 (p. 3-41), "*It is beyond the scope of the current risk assessment to identify and consider all agents that might have the same mode of* *action. To do so quantitatively would require a complete set of risk assessments on each of the other agents that would be considered."*

Borax

Sensitive Subgroups - Developing fetuses are a primary target of boron exposure. Since the RfD is based on the adverse fetal effect of weight loss, the reproduction related subgroups are accounted for throughout the entire Forest Service risk assessment. Testes are also targeted in male mammals and thus, while data is currently lacking, males with underlying testicular dysfunction may be at an increased risk of testicular issues induced by boron exposure.

Connected Actions - Connected actions are not of concern since borax is not mixed with other chemicals.

Cumulative Effects - Multiple exposures are not concerns given that the chronic RfD was used to calculate risk through the entire boron assessment. The concern is also lessened by the fact that boron is ubiquitous in nature. Exposures occur naturally at rates of 0.14 to 0.36 mg/kg/day and potential application rates under the VTP and Alternatives will not substantially contribute to the already existent background levels.

Clopyralid

Sensitive Subgroups - In toxicity studies clopyralid has been implicated in causing decreased body weight, increased kidney and liver weight, deceased red blood cell counts, as well as hyperplasia in gastric epithelial tissue. The likely critical effect in humans cannot be identified and effects are not consistent among test species or even between different studies on the same species. *It is unclear if individuals with pre-existing kidney, liver, or blood diseases would be particularly sensitive to clopyralid exposures. There are no data or case reports on idiosyncratic responses to clopyralid by individuals who suffer from multiple chemical sensitivity.*

Connected Actions - Although clopyralid may be applied in combination with other herbicides, *no data in the literature suggests that it will interact, either synergistically or antagonistically, with them.*

Cumulative Effects - Repeated exposure to levels of clopyralid below the toxic threshold should not be associated with cumulative toxic effects. All longer-term exposures are substantially below the LOC.

Glyphosate

Sensitive Subgroups - Sensitive subgroups include women and fetuses, but these are accounted for since a developmental study was used to establish the NOAEL used for the RfD. While not well understood, MCS may be a potential concern for glyphosate, as with other chemicals.

Connected Actions - The U.S. EPA has not determined if glyphosate shares toxicity mechanisms with other chemicals. Potentially the most important connected action is associated with surfactants. Given that glyphosate functions to inhibit some mixed-function oxidases, this is a plausible mechanism of interaction for other chemicals that function similarly. There has been no evidence of such effects, however, and this is only likely to be a potential when glyphosate is applied at much higher rates than done by the Forest Service or likely under the VTP and Alternatives.

Cumulative Effects - The daily dose of glyphosate rather than the duration of exposure determines the toxicological response. Repeated exposure to levels of glyphosate below the toxic threshold should not be associated with cumulative toxic effects. All longer-term exposures are substantially below the LOC.

Hexazinone

Sensitive Subgroups - Hexazinone can induce fetal resorptions and other adverse developmental effects, so pregnant women and developing offspring may be sensitive subgroups particularly vulnerable to adverse effects of hexazinone. This potential has been explicitly accounted for given that the developmental endpoint was used in the risk assessment. The literature does not report any other subgroups that may be sensitive to hexazinone and there is no indication that it causes allergic responses or sensitization.

Connected Actions - There is almost no information available on the interaction of hexazinone with other compounds. There is no indication that the inerts and adjuvants in its formulations will increase the toxicity of hexazinone in humans or mammals. However, it is not unreasonable to suspect hexazinone would interact additively, synergistically or antagonistically with chemicals that share similar metabolic pathways. Such potential connected actions are beyond the scope of the risk assessment in this PROGRAM EIR and are not evaluated by the Forest Service or the U.S. EPA.

Cumulative Effects - Cumulative effects may result from repeated exposures, multiple routes of exposure (i.e.,, oral and dermal), or exposures to chemicals that have connected modes of action. Forest Service risk assessments consider the effects of multiple, long-term exposures, evaluating risk in terms of both acute and chronic exposures to workers and the general public.

Imazapyr

Sensitive Subgroups - Given the low toxicity of imazapyr, effects on sensitive subpopulations are thought to be minimal. Because imazapyr is a weak acid it would most likely be affected by other weak acids that are similarly excreted by the kidneys, though only at unrealistically high doses that nearly saturate kidneys.

Connected Actions - Given the low toxicity of imazapyr, the occurrence of connected actions is thought to be minimal. Both the low HQ values and conservative assumptions support that impacts of inerts, impurities and metabolites are minimal to imazapyr risk characterization. However, adjuvant interactions are a potential, but were beyond the scope of the USDA/FS risk assessment for imazapyr.

Cumulative Effects - Given the low toxicity of imazapyr to humans, cumulative effects are thought to be minimal. When characterizing risk of chemical use, cumulative effects may result if humans experience multiple exposures to imazapyr via multiple routes and/or events, or if humans are exposed to additional chemicals with the same toxicity mechanisms at the same time as exposure to imazapyr. At present, common mechanisms of toxicity have not been found between imazapyr and any other chemicals (similar or otherwise).

NP9E

Sensitive Subgroups - There are several groups of people that have the potential to be part of sensitive subgroups. There is some indication that some sensitive individuals are prone to develop contact allergies related to NP9E exposures. In addition, there is evidence that NP9E targets the kidneys and liver in mammals, so sensitive subgroups may consist of those individuals that have pre-existing impairment of the liver or kidneys. According to the Forest Service risk assessment, the likelihood of NP9E inducing reproductive effects should be low, though acute exposures may occur at the application rates that are within the range of fetal effects being a potential. Therefore, it is relevant to consider pregnant women an additional potential sensitive subgroup.

Connected Actions - NP9E has not been connected to any antagonistic or synergistic interactions relating to human health effects when mixed with other chemicals. This group of surfactants is not known to increase dermal absorption of herbicides and synergistic effects are not expected with repeated exposures of NP related compounds. Toxicological response appears to be dependent on daily doses rather than the duration of exposures. Additionally, any repeated-exposure effects should have been counted for through use of the chronic RfD. There is the potential for additive estrogenic effects to arise if NP related compounds or chemicals that act via similar estrogen-like (xenoestrogen) pathways cumulatively reach a high enough concentration. NP9E is abundant in a number of non-forestry related sources (e.g. personal care products, industrial and institutional detergents and cleaners, and the environment), and the amount of human exposure to NP9E as a result of forestry use is thought to be negligible.

Cumulative Effects - Repeated exposure to levels below the toxic threshold should not be associated with cumulative effects. However, estrogenic effects can be caused by additive amounts of NP, NPE, and their breakdown products. In other words, an effect could arise from the additive dose of a number of different xenoestrogens and phytoestrogens (hormone mimicking substances naturally present in plants), none of which individually have high enough concentrations to cause effects. Additive doses could come from sources removed from the herbicide application site, such as personal care products, detergents and soaps, foods, paints, and from the environment. Various studies have estimated the daily exposure of humans to NP and NPE from food and the environment. As presented in USDA/FS 2003b (p. 38), In terms of this risk assessment, the contribution of NP9E (workers exposure ranged from 0.000075 to 1.01 mg/kg/day) would contribute from 0.00075 up to 10 to any hazard quotient. This may be negligible depending upon the background exposures, lifestyles, absorption rates, and other potential natural or man-made chemical exposures that are used to determine overall risk to environmental xenoestrogens.

Sulfometuron methyl

Sensitive Subgroups - No adverse effects for sensitive subgroups was identified with evidence in the 2004 risk assessment for sulfometuron methyl conducted for the Forest Service. Given hematology and thyroid effects observed in mammalian studies, it was suggested that individuals with pre-existing anemia or thyroid function issues may be more susceptible to adverse effects.

Connected Actions - According to the Forest Service risk assessment, sulfometuron methyl formulations have not been connected to synergistic or antagonistic effects related to the mixing of sulfometuron methyl with other active ingredients and surfactants.

Cumulative Effects - Cumulative effects are not anticipated given that repeated exposures were explicitly considered through using a chronic RfD to evaluate the level of concern with repeated exposure.

Triclopyr

Sensitive Subgroups - Women of child bearing age are thought to be of concern due to reproductive and developmental effects found in exposure studies using mammals. Despite the lack of epidemiological evidence, there is a certain level of uncertainty, regarding the possibility of triclopyr causing adverse reproductive effects. Current evidence suggests, however, that toxicity to a fetus would only occur at doses that also caused frank signs of maternal toxicity. Despite the years triclopyr has been used, this chemical has never been implicated in causing frank signals of toxicity in male or female humans. Individuals with kidney disease may also be at greater susceptibility to adverse effects, since the kidneys are the target organ for triclopyr.

Connected Actions - Connected actions of triclopyr are associated with exposure to the triclopyr metabolite 3,5,6-trichloro-2-pyridinol (TCP). The Forest Service and U.S. EPA risk assessments consider all exposures to this compound as below the level of concern, although the Agency does not consider all oral exposures assessed in the Forest Service risk assessments. Like many herbicides, adjuvants are commonly used with triclopyr and some may be hazardous.

Cumulative Effects - The cumulative effects associated with triclopyr may include those associated with any additive effects that could potentially result from mixing of triclopyr with other chemicals, as well as effects resulting from repeated exposures. The additive effects associated with mixing particular adjuvants with triclopyr are beyond the scope of the USDA/FS risk assessments. It should be noted, however, that triclopyr is a weak-acid auxin herbicide, and thus, when mixed with other similar weak acids that function by the same mechanisms, such as clopyralid, additive risks would result. Repeated exposure is a cumulative effect accounted for by the use of chronic exposure information in each Forest Service risk assessment.

D.7.2 ECOLOGICAL EFFECTS

Implementation of chemical treatments could in some cases result in adverse effects to non-target biological resources, particularly under marginally plausible, worst-case scenarios at chemical application rates higher than are likely to be used in the VTP and Alternatives. Potential adverse effects are highly dependent on the lifeform, the toxicity of a specific chemical to that lifeform, the exposure of individuals to that chemical, the dose to which individuals are exposed, and the interaction of environmental factors that are not always fully understood.

Herbicides that would potentially be used in the VTP and Alternatives would most likely be applied either by backpack or boom spray. It is likely that during application some portion of the herbicides would enter the air and drift off-site. The amount and distance of spray drift is dependent on a number of factors, including droplet size, wind speed, air temperature, humidity, inversion layer, the chemical formulation and tank mix, type of spray equipment and application method, height of spray equipment above the ground, and the area treated. It is also possible that a portion of the herbicides would volatilize from the surfaces on which they land and would adversely affect air quality, although this was not identified as a risk for the herbicides analyzed in this Program EIR. The amount of volatilization is dependent primarily on the chemical formulation and tank mix, air temperature, humidity, and wind velocity. *Borax is unlikely to affect air quality* as it is not volatile, would be applied directly to fresh stumps that are moist (the chemical will likely adhere to the stump), will be applied in a manner (“salt shaker”) that would minimize off-site movement of powder in the air, and would be applied in forested areas where wind speeds tend to be minimal.

Because site-specific factors at the project level cannot be predicted, the amount of drift and/or volatilization of herbicides and the absolute effect on air quality cannot be quantified. However, an attempt was made to model spray drift in the 2012 Worksheets that accompany the risk assessments for each chemical, for both backpack and broadcast applications. Adverse effects to off-site, non-target plants were specifically related to the chemical and method of application and were by far most likely to occur in sensitive terrestrial plant species. The limits of modeled adverse effects for broadcast sprays varied from 100 feet away from the treatment site for 2,4-D to >900 feet for sulfometuron methyl. Distances for backpack applications were substantially less. Adverse effects to tolerant plant species were rarely shown off-site, and then only within 25 feet of the treatment site. The most appropriate use of this information is to assess the relative toxicity of chemicals and the effect of the application method, as the amount of chemical drift is largely a function of wind speed, spray droplet size, and height of the spray from the vegetation being sprayed.

Chemicals would potentially be used in the VTP and Alternatives only to treat terrestrial vegetation, so direct contamination of water resulting from normal use is unlikely. However, it is possible that chemicals would at times be used near Class I or II waterbodies and probable that they would be used near Class III watercourses. Inadvertent contamination of waterbodies or watercourses could occur. Direct spill, drift of spray, or runoff are the most likely routes for levels of chemical contamination of water that might cause adverse effects in aquatic organisms.

Other than for off-site drift of spray, the possibility of chemicals moving off-site into waterbodies is variable and dependent upon chemical properties (persistence, solubility in water, volatility, adsorption potential to soil) and environmental factors (soil texture, rainfall amount and timing, wind speed and topography, depth to water table, distance to waterbodies). As soil texture and rainfall amount and timing are highly variable across and within bioregions, both the primary routes of chemical transport (runoff, leaching, wind drift of soil, volatilization) and the mobility of chemicals would vary. Transport by runoff would be most likely on fine-textured soils (clay) and leaching most likely on coarse textured soils (sand) in bioregions with heavy rainfall events occurring shortly after chemical treatments. Wind erosion and volatilization will be most likely in drier, hotter bioregions with strong winds and topography that channels winds.

Although it is possible that chemical treatments would result in some portion of the herbicides, surfactants, or borax entering waterbodies, dilution and photolysis would generally rapidly minimize the chance of an organism receiving a high enough dose to cause adverse effects. Possible exceptions to this would be in shallow ponds, vernal pools, or narrow, shallow, and/or slow-moving streams, where dilution would either be less or at a slower rate. Sensitive aquatic macrophytes are likely to experience adverse effects, especially from spills of relatively large quantities of chemical. Borax is unlikely to move offsite into water and is nontoxic to humans and practically non-toxic to aquatic lifeforms, so would not affect water quality under normal use conditions.

Direct adverse effects are probable within treatment areas to **non-target terrestrial plants** that are sensitive to the specific chemicals applied. All of the herbicides are effective toward sensitive plants. Sulfometuron methyl in particular is known to be highly toxic to a wide variety of plants. In general, tolerant species would be unaffected or only slightly affected by herbicide treatments. Off-site effects are possible if chemicals move from treatment areas in sufficient quantities to adversely affect non-target plants. Off-site drift from broadcast spray can transport sufficient quantities of herbicides (especially glyphosate, imazapyr, and sulfometuron methyl) to adversely affect sensitive species over 900 feet from the application site. Backpack spray, however, would result in substantially lower concentrations of herbicides and for most herbicides would not result in off-site effects, even in sensitive species.

Direct adverse effects are plausible within treatment areas to **non-target terrestrial lifeforms** that are susceptible to the specific chemicals applied. However, *with the exception of 2,4-D, which is slightly to moderately toxic to mammals and practically non-toxic to moderately toxic to birds, the chemicals analyzed and likely to be applied under the VTP and Alternatives are only slightly toxic to practically non-toxic to terrestrial organisms*. Toxicity ranges are due to variable toxicities to different species in the same class. For example, dogs have an impaired ability to excrete weak acids so are more susceptible to toxic effects from herbicides and large mammals may be at greater risk from triclopyr than small mammals. Effects to reptiles are largely unknown, as no toxicity testing was available on this class of animal.

Direct adverse effects are also plausible within treatment areas to **non-target aquatic lifeforms** that are susceptible to the specific chemicals applied. However, *with the exception of glyphosate formulations containing POEA, and triclopyr BEE, which are likely to adversely affect sensitive aquatic species, the chemicals analyzed and likely to be applied under the VTP and Alternatives are only slightly toxic to practically nontoxic to aquatic organisms*. Although amphibians appear to be particularly at risk, little to no toxicity data exists for this class of animal, especially for adult amphibians, for most of the chemicals analyzed.

*Chemical treatments under the VTP and Alternatives have the potential to adversely affect individuals or populations of **special status species**.* Direct adverse effects are probable within treatment areas to plants that are susceptible to the specific chemicals applied. *Sulfometuron methyl in particular is known to be highly toxic to a wide variety of* *plants.* In general, tolerant species would be unaffected or only slightly affected by herbicide treatments. Off-site effects are possible if chemicals move from treatment areas in sufficient quantities to adversely affect non-target, sensitive plants.

Direct adverse effects are possible from specific chemicals to **special status terrestrial lifeforms** that are susceptible to the specific chemicals applied. However, *the chemicals analyzed and likely to be applied under the VTP and Alternatives are only slightly toxic to practically non-toxic to terrestrial organisms*. Toxicity ranges are due to variable toxicities to different species in the same class. Effects to reptiles are largely unknown as no toxicity testing was available on this class of animal.

Direct adverse effects are also probable within treatment areas to **special-status aquatic lifeforms** that are susceptible to the specific chemicals applied. However, *with the exception of glyphosate formulations containing POEA, and triclopyr BEE, which are likely to adversely affect sensitive aquatic species, the chemicals analyzed and likely to be applied under the VTP and Alternatives are only slightly toxic to practically nontoxic to aquatic organisms.* Although amphibians appear to be particularly at risk, little or no toxicity data exists for this class of animal for most of the chemicals analyzed.

Indirect effects from changes in plant species composition, cover, and/or population size, are likely to affect habitat for both plant and non-plant special status species, either adversely or beneficially, depending upon the species and site-specific conditions that cannot be determined at the Program EIR scale.

Because site-specific factors at the project level cannot be predicted, the amount of drift and/or volatilization of herbicides and the absolute effect on air quality cannot be quantified. What can be predicted is that *the more volatile herbicide formulations, the esters (triclopyr BEE) and the Velpar L® formulation of hexazinone, will be more likely to volatilize, move off-site in the air, and temporarily affect air quality.* This will be more likely in bioregions where volatile formulations are most used (North Coast, Modoc, and Sierra), in the vegetation lifeforms in which they are most used (Conifer Forest and Conifer Woodland), and where air temperatures and wind velocities are higher and humidities are lower during typical herbicide spray seasons.

Historically the main forestland applications of the most volatile herbicides (triclopyr BEE, and the Velpar L® formulation of hexazinone) has been for site preparation for planting and for release of tree seedlings from vegetative competition. These uses would be limited to practices funded through CFIP, so the acreage treated would be relatively small. In 2010, triclopyr BEE comprised a little over 4% of the total forestland acreage treated by the chemicals analyzed in this Program EIR, and hexazinone (formulations unspecified) comprised a little over 14%. *If herbicide treatments in the VTP and Alternatives follow historical patterns, herbicides suited for forest management* *would potentially be used primarily in conifer forests in the North Coast, Modoc, and Sierra bioregions*.

For rangeland applications of the most volatile herbicides, 2,4-D EHE has been among the top ten chemicals used between 2000 and 2010, although in 2010 it was applied to less than 1% of the total rangeland acreage treated by the chemicals analyzed in this Program EIR. Triclopyr BEE has been in the top ten for all years and is used more than 2,4-D EHE. It was applied to about 19% of the rangeland acreage treated in 2010. *If herbicide treatments on rangelands in the VTP follow historical patterns, these herbicides would potentially be used primarily in grasslands in the Sacramento Valley bioregion, grasslands and shrublands in Sierra and Central Coast bioregions, and shrublands in the South Coast bioregion.*

E. PROTECTION OF CULTURALRESOURCES

CAL FIRE STANDARD PROTOCOL FOR THE PROTECTION OF CULTURAL RESOURCES IN VTP PROJECTS

The CAL FIRE protocol for protecting cultural resources included below is excerpted from the CAL FIRE manual Archaeological Review Procedures for CAL FIRE Projects (Foster and Pollack, 2010, pages 6-18). The full document is available on the CAL FIRE website at http://calfire.ca.gov/resource_mgt/archaeology-resources.php (accessed 12/30/14).

II. Procedures for Archaeological Reviews of CAL FIRE Projects

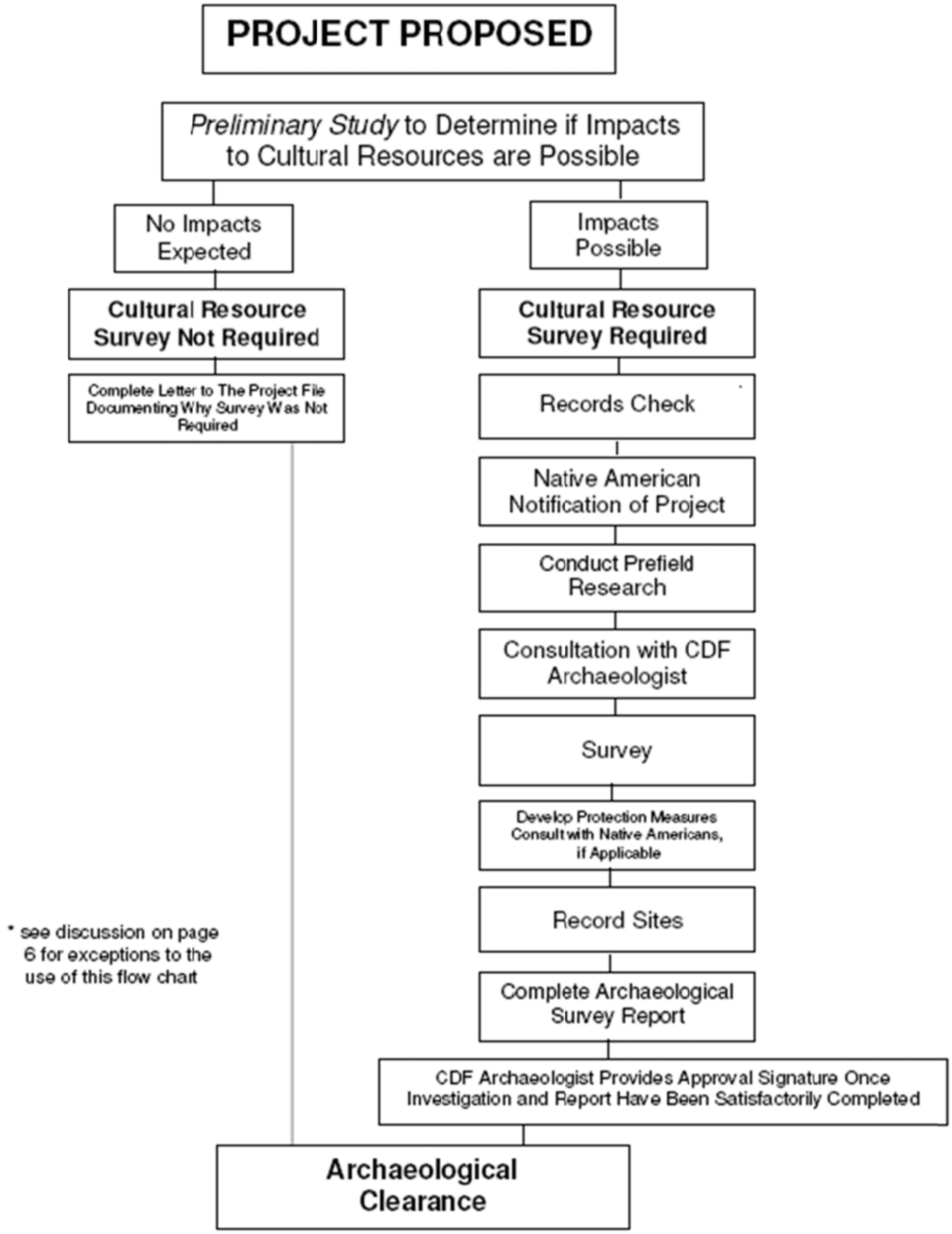
Preliminary Study: The first step in the process of conducting an archaeological review of a CAL FIRE project is the completion of a *Preliminary Study*. This study should be undertaken by the CAL FIRE project manager in consultation with the appropriate CAL FIRE Archaeologist. If the CAL FIRE project manager does not have current CAL FIRE archaeological training as described on pages 2 through 5, then the CAL FIRE project manager shall appoint a designee who has current CAL FIRE archaeological training, and who is familiar with the details of the proposed activities and locations. The purpose of the Preliminary Study is to determine if impacts to cultural resources are possible. This determination shall be made after considering the full range of specific project activities and practices, the location of the project, and other relevant factors.

The Preliminary Study will be conducted during a telephone conversation or face-to-face meeting between the CAL FIRE project manager and the appropriate CAL FIRE Archaeologist. Prior to this telephone conversation or face-to-face meeting, the CAL FIRE project manager shall provide the CAL FIRE Archaeologist with a copy of the project map(s) as well as a description of the proposed project in order to provide the adequate information the Archaeologists need to assess the likelihood of the presence of cultural resources. CAL FIRE Archaeologists are regularly available each week to participate in telephone consultations and assist in the completion of Preliminary Studies for CAL FIRE projects. The CAL FIRE project manager and CAL FIRE Archaeologist shall identify and evaluate the full range of project activities and compare those activities to the list of Exempt Practices provided in this document.

If the Preliminary Study concludes that the proposed project does not have the potential to affect cultural resources, pursuant to the list of Exempt Practices (listed below), or other circumstances, then an archaeological survey would not be required. The CAL FIRE Archaeologist must concur with this finding. In such cases, a records check, Native American notification, pre-field research, and survey report are not required. Archaeological clearance of the project must be documented in the form of a letter to the project file (prepared by the CAL FIRE project manager) that indicates the rationale supporting the decision to waive archaeological survey requirements. A copy of this letter shall also be sent to the appropriate CAL FIRE Archaeologist for his/her file.

The CAL FIRE project manager (or their designee) shall conduct an intensive cultural resource survey if the Preliminary Study reveals the potential to affect cultural resources. In most situations, this survey will include all of the procedural steps discussed below and shown on the *Cultural Resource Review Procedures* flow chart on page 7 of this document. Barring an unusual exception noted below, the list of tasks specified in *Cultural Resource Survey Procedures* shall be completed as part of the cultural resource review for every CAL FIRE project determined to have the potential to affect cultural resources. During the review of certain projects, the CAL FIRE project manager may determine that one or more of procedural steps 1 through 3 could be omitted. However, the concurrence of a CAL FIRE Archaeologist must be obtained in order to bypass any of these steps. The best way to track this concurrence is through email documentation.

In general, any project that includes ground disturbing practices shall be considered to have the potential to affect cultural resources and, consequently, shall require an archaeological survey. Typical examples of such practices include, but are not limited to, any type of use of heavy equipment to alter the landscape, site preparation, forestland conservation work such as erosion control, road repair, stabilization and abandonment of road beds, improvement of drainage facilities, and/or stream bank stabilization. Other types of projects may also require archaeological survey in spite of limited disturbance to the ground. Such projects include, but are not limited to, rural tree planting, prescribed burning, broadcast burning, and the burning of slash piles. CAL FIRE generally does not fund projects resulting in the planting of commercial species trees within the boundaries of archaeological sites. This practice is due to the possibility that eventual harvest of such trees might be prohibited by CAL FIRE enforcing California's Forest Practice Rules since timber harvesting operations can affect cultural resources. For this reason, archaeological survey shall be required prior to funding most tree planting projects in order to identify and avoid sites.


PROJECT PROPOSED
Preliminary Study to Determine if Impacts to Cultural Resources are Possible
No Impacts Expected
Impacts Possible
Cultural Resource Survey Not Required
Cultural Resource Survey Required
Complete Letter to The Project File Documenting Why Survey Was Not Required
Records Check
Native American Notification of Project
Conduct Prefield Research
Consultation with CDF Archaeologist
Survey
Develop Protection Measures Consult with Native Americans, if Applicable
Record Sites
Complete Archaeological Survey Report
CDF Archaeologist Provides Approval Signature Once Investigation and Report Have Been Satisfactorily Completed
Archaeological Clearance
* see discussion on page 6 for exceptions to the use of this flow chart

List of Exempt Practices: Because they are unlikely to impact cultural resources, the following practices are exempt from archaeological survey, investigation, and reporting requirements. An archaeological records check, notification to Native Americans, pre-field research, intensive cultural resource survey, or the completion of an archaeological survey report are not required for projects that involve only these practices.

1. Management Plan: A long term forest and land management plan to assist forest landowners in developing their land management objectives and feasible projects. The preparation of a forest land management plan is not, in itself, a ground disturbing practice and may be funded without an archaeological survey. In such cases, archaeological survey must precede any ground disturbing practice called for in the plan. However, CAL FIRE recommends the inclusion of some level of cultural resource planning in the management plan itself, such as a record search for the entire property, an overview of local archaeology, ethnography, and history as it relates to predicting the kinds of cultural resources likely to exist on the property, and a discussion regarding future archaeological survey work and how sites will be managed. This exemption also includes Coordinated Resource Management Planning, Fire Plans, and other forms of broadly scoped planning efforts by CAL FIRE that do not result in ground disturbing practices.

2. RPF Supervision: The practice of utilizing a Registered Professional Forester to supervise on-the-ground management activities.

3. Feasibility Studies and Market Analysis: The practice of conducting studies to determine the feasibility of future projects including, but not limited to, an investigation of the marketability of certain products derived from such projects.

4. Purchase of Tree Seeds and Seedlings The purchase of tree seeds and seedlings and costs of transporting and storing them. Note: The actual planting of seeds or small seedlings in rural forested areas is not an exempt practice. While such planting may be conducted without significant ground disturbance, CAL FIRE generally does not approve funding for projects resulting in the planting of commercial species trees within archaeological site boundaries. California’s Forest Practice Rules may restrict or prohibit the eventual harvest of such trees since the harvesting of commercial size trees is a practice that has potential to damage or destroy cultural resources. For these reasons, archaeological survey is required prior to funding most tree planting projects in rural forested areas in order to identify and avoid archaeological and historic sites.

5. Tree Shelters: The purchase and installation of vexar netting for browse control and shelter cards for shade necessary to assure survival of seedlings.

6. Follow-up (Release): Practices necessary to promote the survival of seed or seedlings within 36 months of planting. Generally such work is intended to control insects, diseases, rodents, weeds or brush competition and may include the use of herbicide, chain saw, weed-eater, or hand-grubbing. These practices are only implemented within tree planting units where an intensive cultural resource survey, conducted in accordance with the specifications and standards listed in this document, was completed. This follow-up work is exempt from

further review because the cultural resource inventory work does not need to be repeated. If, for some reason, follow-up activities are considered for treatment units that were not previously subjected to intensive cultural resource survey, these activities shall not be considered exempt.

7. Timber Stand Improvement: Activities designed to improve timber stands include pre-commercial thinning of young commercial tree species to reduce the number of stems per acre, release of commercial tree species by removing competing noncommercial species of trees and shrubs, and pruning of young trees by removing lower branches from commercial tree species. This work will usually be done by crews using hand tools and the slash is just left on the ground, typically lopped and scattered. Note: if the slash will be piled and burned, or mechanically collected and removed for biomass utilization, those activities may not be exempt. Some biomass harvesting operations can cause significant ground disturbance and, therefore, have the potential to disturb/damage archaeological and historic sites.

8. Wildlife Habitat Improvement: The creation of snags, installation of nest boxes, roost poles, platforms, or artificial cavities for animal habitat improvement where the ground is not disturbed.

9. Reseeding: Hand or aerial applications of seed or nutrients.

10. Mulch: Hand application of mulch, placement of weed barriers, hay bales, or animal repellant.

11. Irrigation: Surface installation of trickle irrigation system.

12. Educational Materials and Events: Production and distribution of flyers, pamphlets, brochures, booklets, newsletters, telephone helpline, videos, etc.; conducting meetings, seminars, conferences, classes, etc. to educate and disseminate information to landowners; and, lastly, the funding of CAL FIRE staff and contractors to deliver technical assistance to landowners.

13. Conservation Easement and Fee Title Purchase: Acquisition of easements and fee title purchase of forest lands with the intention of keeping the lands in traditional forest uses and to prevent conversion to non-forest uses. The title will be held by either federal, state or local government.

14. Acquisition: Land acquisitions or transfers of administrative control to CAL FIRE, where the historic properties received are not considered in exchange for any historic properties relinquished.

15. Urban Forestry Projects: Purchase and transport of trees and the planting of native and non native species of trees in urban settings. Typically, these settings occur in areas previously landscaped such as within public parks or schools. Such projects also occur in street medians and along sidewalks within developed areas. Note: Most of these projects will not require archaeological survey unless known cultural resources exist in a planning location or the area possesses high archaeological sensitivity. If the urban forestry grant proposes to plant trees in

undeveloped wildland settings, such projects are not exempt and will require archaeological survey. Similarly, the planting of trees suitable for the purpose of creating a windbreak in a rural or agricultural setting is not exempt. Note: Trees can be an important part of a historic landscape in both rural and urban areas. CAL FIRE project managers should keep in mind that planting new trees in a historic district or on the property of a historic building may affect the setting of that historic property. In such situations the appropriate CAL FIRE Archaeologist should be consulted at an early stage of project planning.

16. <u>Shaded Fuel breaks (Handwork Only)</u>: Thinning and pruning of trees, generally along both sides of a road or along the crest of a ridgetop, to create an effective fuel break to potentially stop a wildfire, provided such trees are not part of a historic landscape. The accomplishment of such projects involves removal of vegetation by hand, lopped and scattered or chipped and scattered. Note: Shaded fuel break projects involving mechanical timber harvesting or the piling and burning of slash are not exempt.

17. <u>Fire-Safe Projects</u>: Treatment of vegetation surrounding communities to reduce the risk of catastrophic wildfires through thinning and/or removal of vegetation by crews using hand tools. To be exempt such projects must involve the chipping and removal of woody material or the chipping and scattering of woody material. Note: Fire-Safe Projects involving the piling and burning of slash are not exempt.

18. <u>Disposal of Piled Brush</u>: This activity involves the disposal and removal of brush piles. CAL FIRE often administers federal grants to provide chipping and removal of biomass to homeowners doing their own legally mandated defensible space clearing required by PRC 4291. In these instances, the treatment of the vegetation is not a CAL FIRE project and CAL FIRE's responsibility for environmental review only pertains to the disposal of brush piles. A chipper may be utilized to chip and scatter woody material near the brush piles. If brush piles will be collected and transported to a location for biomass utilization, those activities must be carefully evaluated for potential effects to cultural resources.

19. <u>Diseased Oak Removal</u>: Activities related to the eradication, gathering and removal of diseased oak trees, limbs and slash from oak trees, including, but not limited to, infestation zones of *Sudden Oak Death* without causing significant ground disturbance. Note: Ground disturbing practices such as stump removal, mechanical yarding, site preparation, and/or the burning of slash piles, are not exempt activities and will require archaeological survey.

20. <u>Fuelwood and Christmas Trees</u>: The collection and personal use of fuelwood and the harvesting of Christmas trees.

21. <u>Sign Posts</u>: The installation of sign posts and monuments, when no new ground disturbance is involved.

22. <u>Log Jam Removal</u>: The removal of log jams and debris jams using hand labor or small mechanical devices.

23. <u>One Cubic Meter Disturbance</u>: Activities that involve less than one cubic meter of

cumulative ground disturbance per acre.

24. Disturbed Areas: Those activities or projects where the area of potential effect (APE) is entirely within obviously disturbed contexts, and the disturbance is such that the presence of historic properties is considered highly unlikely.

25. Pesticides: The application of pesticides where such application does not have the potential to affect use of plant resources by Native Americans. The CAL FIRE project manager may need to demonstrate how Native American plant gatherers will be protected.

26. Existing Borrow Pits: Work within the perimeter of existing material borrow pits. Expansion of the area of ground disturbance to outside of the existing borrow pit is not exempt.

27. Stream Channels: Activities limited within stream channels. Note: stream channel improvements resulting in alterations to streamside terraces or cut banks along the margins of stream channels are not exempt.

28. Handlines: The creation of narrow handlines using hand tools to establish a burn perimeter. Handlines are often used to keep prescribed fire from entering into an archaeological site. This includes hand grubbing around trees or near cultural resources to prevent fire from entering or damaging such resources. Such activities are limited to light brushing of vegetation to expose mineral soil using hand tools.

29. Trail Maintenance: Routine trail maintenance limited to brushing and light maintenance of existing tread with hand tools only.

30. Road Maintenance: Routine road maintenance and resurfacing where work is confined to previously maintained surfaces, ditches, culverts, and cut and fill slopes along road segments crossing no known archaeological or historic sites. Proposed road maintenance activities within known archaeological or historical sites must be carefully reviewed by the CAL FIRE project manager in consultation with the appropriate CAL FIRE Archaeologist.

31. Hazard Tree Removal: The felling of hazardous trees within recreation areas or other areas for health and safety reasons provided they are left in place or cut up for firewood using hand tools. This includes the felling and removal of hazard and windthrow trees from road prisms where deemed necessary for health, safety, or administrative reasons, so long as trees are felled into and removed from within existing road prisms (area clearly associated with road construction, from road surface to top of cut and/or toe of fill) where previous disturbance is such that the presence of historic properties is considered unlikely, and so long as ground disturbance is strictly limited to previously disturbed areas associated with road prisms.

32. Road Use Permits: The issuance of road use permits for commercial hauling over existing roads, whenever CAL FIRE’s involvement is incidental to activities associated with the permit's purpose and where effects to traditional cultural properties are not expected. If the permit includes road maintenance work on state lands, consideration must be given to known cultural resources that might be affected (see Exemption #30).

33. Temporary Road Closure: Temporary road closures involving no new ground disturbance.

34. Snow Fences: The construction of snow fences where no new ground disturbance is involved.

35. Existing Nonstructural Facilities: The maintenance or replacement in-kind of existing nonstructural facilities that does not involve new or additional ground disturbance (e.g., maintenance or replacement of existing cattle guards, gates, fences, stock tanks, guardrails, barriers, traffic control devices, light fixtures, curbs, sidewalks, etc.).

36. Recent Facilities: Activities or alterations involving facilities or structures that are less than 50 years of age. For activities involving CAL FIRE buildings or facilities older than 50 years of age, consult the *Management Plan for CAL FIRE's Historic Buildings and Archaeological Sites* (Foster and Thornton 2001), available on the CAL FIRE Archaeology Program Web Site, for guidance.

37. Trash Removal: The removal of trash that is less that 50 years old and does not otherwise qualify as a cultural resource.

38. Installation of Law Enforcement Detection Devices: The installation of law enforcement detection devices within historic properties to assist investigations of site looting and to prevent site vandalism where such installation is unlikely to cause substantial adverse change to the site. The CAL FIRE Archaeologist must be involved in the planning of this type of project.

39. Purchase of Equipment: The purchase of tools and equipment (such as a chipper) that may be utilized in subsequent projects for the treatment of brush and other vegetation. The purchase of such equipment shall be considered an exempt practice.

40. Project Areas Previously Surveyed: Project activities which are entirely within areas previously surveyed for cultural resources where no cultural resources were found, if the previous survey work was conducted in accordance with the specifications and standards listed in this document.

41. Other Practices: Other practices on an individual basis as agreed to by a CAL FIRE Archaeologist. If the project is federally funded, the State Historic Preservation Officer (SHPO) and the federal agency funding the project must also agree that the practice is exempt.

Cultural Resource Survey Procedures: Archaeological surveys for CAL FIRE projects must include the following tasks (these match the flow chart on page 7):

Records Check: A *current archaeological records check* (defined in Section 895.1 of the Forest Practice Rules) shall be utilized in project planning. CAL FIRE may use an existing records check previously completed for another project on the same property if that records check is current (i.e., was conducted within the previous five years) and if all of the current project areas were covered in the previous records check. For CAL FIRE properties, consult with a CAL FIRE Archaeologist first to find out if a records check has already been completed for the property. Typically, however, the CAL FIRE project manager or designee shall initiate a new archaeological records check specifically for the project being reviewed. It is recommended that the entire parcel be included in the request for a records check so that this information may be used if additional projects occur on the same property. This is particularly true if the records check is initiated as part of the preparation of a forest land management plan. The policies and procedures governing records checks for CAL FIRE projects are outlined in a 1996 Memorandum of Agreement (MOA) between CAL FIRE, SHPO, and the Information Centers, which is available on the CAL FIRE Archaeology Program Web Site. The Information Centers charge a fee for providing a records check and this fee must be paid in a timely manner. For some programs, the CAL FIRE Unit pays the fee. In other programs, the fee might be paid by the consulting RPF preparing a management plan or project in one of our cost-share programs. In such circumstances the records search fee may be reimbursed by CAL FIRE. In other circumstances the landowner or applicant may have to pay the fee. In some years, certain CAL FIRE programs establish a fund to be used for records check fees. The CAL FIRE Archaeology Program Web Site also contains a downloadable form to be completed when requesting an archaeological records check.

<u>Native American Project Notification and Information Gathering</u>: The CAL FIRE project manager shall send written notification of the proposed project to the appropriate Native Americans listed on the most current version of CAL FIRE's Native American Contact List (NACL) which is also available on the web site. The purpose of this notification is to inform Indian tribes, local Native American groups and the Native American Heritage Commission (NAHC) about the proposed project, and also to invite their views and comments about the project. It also serves as an information gathering step. Through this procedure, the CAL FIRE project manager shall request information concerning the location of any archaeological or cultural sites that may be known within the project area. In response, the NAHC will complete a check of its Sacred Lands File. CAL FIRE shall follow-up and investigate any potential positive result revealed through this request for information. We recommend this step be completed early in the process of developing a project (such as the same time as the archaeological records check) in order to avoid delays, allow time for Native American groups and/or individuals to respond, and create the opportunity to document the results of any consultation that may follow receipt of the notification letters and include this in the archaeological survey report. Use the most current version of the NACL available at the time the environmental impact review is being conducted. This list is updated monthly and the current list is usually posted during the first week of each month. The notification letter must include the following items:

- A request for information concerning their knowledge of archaeological, historical, or other cultural resources within the project boundaries,
- A description of the project location including the county, section, township, range, base and meridian, and the approximate direction and distance from the nearest community or well-known landmark,
- Two maps--a general location map such as a Thomas Brothers Map that shows the travel route from the nearest community or well known landmark to the project area <u>and</u> a copy of the relevant portion of the USGS topographic quadrangle map clearly depicting the location of the project boundaries as well as a map legend and scale,
- A statement that all replies, comments, questions or other information should be directed to CAL FIRE and provide the name, address, and telephone number of the CAL FIRE project

manager,

- A statement that CAL FIRE is requesting a response within thirty days from the date of the notice so the information can be utilized during project planning,
- A statement that the Native American groups and/or individuals may participate in the project review process by submitting written comments to CAL FIRE within 30 days,
- A statement that locations of sites disclosed will be kept confidential.

Additional guidance pertaining to consultation with Native Americans is provided on our web site at http://www.indiana.edu/~e472/CAL FIRE/contacts/procedures.html

Pre-field Research: The CAL FIRE project manager, designee, or archaeologist working on the cultural resources survey shall conduct appropriate levels of pre-field research as part of the investigation. The purpose of this research is to get prepared to conduct the survey, become familiar with the types of resources likely to be encountered within the project area, and to be ready to interpret, record, and evaluate these findings within the context of local history and prehistory. The investigator should review records, study maps, read pertinent ethnographic, archaeological, and historical literature specific to the area being studied, and conduct other tasks to maximize the effectiveness of the survey. The *Handbook of North American Indians - Volume 8 – California* (Smithsonian Institution 1978) and the *Handbook of the Indians of California* (Kroeber 1925) are two primary ethnographic sources; at least one of which should be reviewed. Determine which tribal group or groups occupied the area containing the proposed project and review information about those tribal groups. Another excellent source that should be checked every time is the General Land Office (GLO) plat maps for the township containing the project. Most GLO plat maps date from the 1850s to the 1870s although some are as late as 1900. The GLO surveyors often mapped homesteads, cabins, orchards, roads, trails, fence lines, mining areas, etc. that were observed during their survey. If any such features are depicted on the map within what is now the project area, a careful search should be made for surviving remnants of them or of unmapped associated features or artifacts. GLO plat maps can be an excellent source for dating historic features discovered on your archaeological survey. The GLO surveyor's notes usually accompany the plats and review of these is sometimes useful as well. GLO plat maps and records may be obtained through the mail or in-person at the Bureau of Land Management Office of Survey Records in Sacramento. It is prudent to call first: (916) 978-4330. The BLM usually charges a small fee per copy (24" X 36") but BLM has waived the fee for CAL FIRE. GLO plat maps are also kept on file at some of the Information Centers. Those Information Centers may provide a copy of a relevant portion of a GLO plat map as part of a Complete Records Check, if so requested. Old topographic maps, if available, should be examined for the locations of old houses, roads and other features that may have been displayed on these early maps but not on current USGS topographic quadrangle maps. Consulting a series of aerial photographs taken over a period of time can help date historic structures and aid in the assessment of the types of previous land-use practices and prior ground disturbances. Persons contacted should include individuals belonging to any local historical society, agency archaeologists, landowners, ranchers, neighbors, and/or other knowledgeable individuals that may have lived or worked in the area being studied. Pre-field research should also include a review of archaeological reports (either survey reports or excavation reports) and/or site records for the local area. This review will provide specific examples of the kinds of cultural resources that have been previously discovered in the general area, a discussion of archaeological, historical, and ethnographic information pertaining to the area being studied, and examples of typical artifact assemblages. Look for site location patterning and the types of artifacts or features being recorded. For projects on CAL FIRE facilities or state-owned lands, be sure to review *CAL FIRE's Management Plan for Historic Buildings and Archaeological Sites* (Foster and Thornton 2001), and *A Survey and Historic Significance Evaluation of the CAL FIRE Building Inventory* (Thornton 1994). This two-volume report includes a complete listing of all CAL FIRE buildings and provides the date of construction for each building. For projects containing CAL FIRE lookouts, review *An Inventory and Historical Significance Evaluation of the CAL FIRE Lookout Stations* (Thornton 1993). This volume also provides the age and historical significance of each surviving CAL FIRE lookout facility.

<u>Consultation with a CAL FIRE Archaeologist</u>: After the records check, Native American project notification, and pre-field research steps have been completed, the CAL FIRE project manager shall consult with a CAL FIRE Archaeologist to review these findings and determine appropriate survey strategy and methods. It will be determined at this time whether or not a CAL FIRE Archaeologist is available to assist in the completion of the survey, or if this work will be conducted entirely by an archaeologically trained resource professional.

<u>Survey</u>: An intensive cultural resource survey shall be made of the Area of Potential Effect (APE) of the project area. Such a survey shall only be performed by a *professional archaeologist*, or an *archaeologically trained resource professional* as defined in the Forest Practice Rules – if determined appropriate by the reviewing CAL FIRE Archaeologist. In most cases the work will be done by the CAL FIRE project manager, possibly assisted by a CAL FIRE Archaeologist. It is possible, however, that the survey work will be completed by a consulting RPF or professional archaeologist retained by the landowner, as part of the grant, or retained by CAL FIRE. In all cases, however, the work will be completed under close supervision by a CAL FIRE Archaeologist. The objective of this survey is to identify the specific location of all cultural resources within the project area, including but not limited to: historic landscapes, prehistoric or historic archaeological sites, features, or artifacts, historic buildings or structures, or other types of resources that have significant cultural importance to Native Americans such as traditional cultural properties, cemeteries, gathering areas, and/or sacred sites. In some situations, archaeological survey work may be delayed until after the project has begun. For example, certain exempt practices may begin without archaeological survey, and this staggered approach may be necessary to determine the precise location of Areas of Potential Effect for subsequent activities. Fuels reduction projects involving hand cutting of brush and the burning of brush piles are typical examples of the kinds of projects where archaeological survey may take place after the exact location of the brush piles becomes known.

Survey methods and techniques employed to achieve adequate coverage will vary based upon a variety of factors. These include the physical characteristics of the property, especially topographic and other environmental attributes, and other information gathered during the records check, in response to the Native American information request, and/or other pre-field research, as well as the results of archaeological inventories in areas with a similar cultural and natural setting. There are four different levels of archaeological survey coverage intensity: complete, general, intuitive, and cursory. These are described below:

- **Complete** A complete reconnaissance is one in which archaeologically-trained individuals systematically traverse the area at 10 meter intervals or less, looking carefully for all evidence of prior human activity. Team members usually walk abreast. All archaeological phenomena in a given area may not be visible or as easily definable at the same time: different seasons, varying light conditions, differential erosion, and/or deadfall and duff cover may obscure the investigator's vision or reveal certain remains at different times. Nevertheless, most features should be observable to a trained surveyor walking over the entire area under investigation in a complete manner. Coverage shall be sufficient to allow the investigator to encounter the smallest of the archaeological sites likely to occur in the area under study. Spacing must be narrow enough and ground cover must be modified (if it is an observational problem) to the extent that will allow the investigator to locate the sites. If needed, ground cover modifications (e.g., systematic removal of duff) shall be used to allow inspection of mineral soil for evidence of human activity. During a complete reconnaissance areas will be encountered that could contain archaeological remains (such as prominent rock outcroppings, benches, suspicious-looking features, possible artifacts, etc.). These areas should be intensively examined to determine if archaeological remains are present before transect coverage is resumed.

- **General** A general reconnaissance is one in which an attempt is made to systematically cover an area as in a complete reconnaissance but with wider transect intervals. This might be due to steepness of slope, absence of water, or because of other physical conditions or observational constraints (e.g., deadfall, brush, steep slopes). Transect spacing may be increased to 30 meters.

- **Intuitive** Detailed inspection is given only to specific localities that exhibit previously identified characteristics that may be associated with the location of archaeological properties. Coverage is usually accomplished by traverses 30-50 meters apart. For example, if the reconnaissance is within a steep timberland and controlled studies show that remains of historic activities are not expected for the area and prehistoric sites occur only on benches and near springs, the investigator might then be justified in covering the area in a manner sufficient to locate those natural phenomena that have potential for association with the location of archaeological sites. Detailed inspection is reserved for those areas identified as archaeologically sensitive. Localities within low potential areas that shall receive detailed inspection in this study include springs, seeps, and low rises in flat plains.

- **Cursory** A cursory reconnaissance is one in which the inspector gives the areas a quick field inspection rather than intensive coverage. Sometimes these areas can be examined by walking briefly through and checking likely or probable spots close to the line of travel. Such methods should be employed along with visual aids (e.g., aerial photographs) to ensure that specific localities that exhibit characteristics that may be associated with archaeological site locations are not overlooked. The environmental factors that should be scanned for have been mentioned above.

<u>Develop Protection Measures</u>: CAL FIRE shall develop effective protection measures for all identified cultural resources located within project areas. These measures may include adjusting the project location or design to entirely avoid cultural resource locations or changing project activities

so that damaging effects to cultural resources will not occur. These protection measures shall be written in clear, enforceable language, and shall be included in the archaeological survey report. CAL FIRE shall exercise a strategy of avoiding all adverse impacts to cultural resources. If impacts to cultural resources cannot be avoided, CAL FIRE is responsible for developing specific, effective measures to ensure the mitigation/reduction of impacts to cultural resources in order to avoid or prevent substantial adverse change as defined in state law (PRC Sections 5020-5024, 210833.2, 21084.1, and CCR Sections 15064.5 through 15360).

Consultation with Native Americans: In the event that *Native American Archaeological or Cultural Sites* (defined in the Forest Practice Rules) are identified within a project area, CAL FIRE shall notify Native Americans regarding the existence of such sites, provide information regarding the proposed protection measures, and provide Native Americans the opportunity to submit comments and participate in consultation to resolve issues of concern.

If, during review of certain CAL FIRE projects, the typical practice of allowing 30 days for reply to this second notice will create difficulties, the CAL FIRE project manager may consult over the telephone or through a face-to-face meeting with each required tribal contact and document this consultation in Part 3 of the report.

Record Sites: CAL FIRE shall record all archaeological or historical sites discovered within project areas. This recording work shall be conducted in accordance with the policies specified in OHP's *Instructions for Recording Historical Resources* (1995). Additional guidance for site recording is provided in CAL FIRE's *Suggestions for Preparing Archaeological Site Records and Site Maps* (2001). Both of these documents on site recording procedures and the forms used to record them are available on our web site. CAL FIRE is occasionally requested by Native American groups to not record certain types of cultural resources (such as ceremonial or sacred sites) as a condition upon their disclosure. In such instances, CAL FIRE will honor the request and not record these types of sensitive cultural resources, although some information will be included in the Survey Report.

Complete Archaeological Survey Report: CAL FIRE shall ensure that an archaeological survey report is completed for every cultural resource survey conducted for a CAL FIRE project. This report will be prepared using CAL FIRE's *Archaeological Survey Report Form for CAL FIRE Projects* (available on our web site) or an equivalent format containing the same information in the same order. Detailed instructions for completing this report are provided in Chapter III beginning on page 18.

CAL FIRE Archaeologist Provides Approval Signature Following Satisfactory Completion of Investigation and Report: A CAL FIRE Archaeologist shall carefully review all archaeological survey reports prepared for CAL FIRE projects. This review shall include elements of completeness, accuracy, content, and professional adequacy. If necessary, this review shall include a field inspection to examine cultural resource discoveries, spot-check areas to test adequacy of survey coverage, and review of site records in field settings. Most importantly, this review shall include a careful review of the proposed protection measures to ensure that the project has been designed or redesigned to be in full conformance with applicable state laws, regulations, and other mandates such as Programmatic Agreements, EIRs, and/or current professional standards. The CAL

FIRE Archaeologist shall provide approval signature ONLY after the investigation and report have been satisfactorily completed. The CAL FIRE Archaeologist shall ensure that a clean, complete copy of the survey report is provided to the appropriate Information Center for permanent retention. The CAL FIRE project manager shall ensure that a copy is included in the appropriate project file to demonstrate compliance with these procedures.

Archaeological Clearance: Archaeological clearance shall be given only after all these procedural steps have been completed and documented in the project file. This documentation shall include either a letter to the file or a survey report signed and approved by a CAL FIRE Archaeologist.

Procedures for Post-Approval Discovery of Cultural Resources: If a cultural resource is discovered within a project area after the project has been approved, the following procedures apply:

1. Project activities within 100 feet of the newly discovered cultural resource shall be immediately halted.
2. The appropriate CAL FIRE Archaeologist shall be immediately notified.
3. The CAL FIRE Archaeologist shall evaluate the new discovery and develop appropriate protection measures.
4. The CAL FIRE Archaeologist shall investigate how the project was reviewed for cultural resources to determine if the cultural resource should have been identified earlier.
5. The CAL FIRE Archaeologist shall ensure that the newly discovered site is recorded and its discovery and protection measures are documented in the project files.
6. For discoveries made on federally funded CAL FIRE projects, the CAL FIRE Archaeologist shall notify and consult with the federal agency funding the project and the SHPO prior to authorizing recommencement of project activities near the newly discovered site.
7. If the newly discovered site is a Native American Archaeological or Cultural Site (defined in the Forest Practice Rules), the CAL FIRE Archaeologist shall notify the appropriate Native American tribal group and the NAHC, if appropriate.

Private Landowner Involvement: Many CAL FIRE projects are located on privately owned lands. CAL FIRE shall respect landowner's rights when implementing these procedures. This courtesy includes notifying the landowner(s) of CAL FIRE's cultural resource responsibilities and inviting their comments and participation. Landowners shall be notified regarding the scheduling of archaeological survey or other inspection work carried out by CAL FIRE and given the opportunity to comment on and participate in such inspections. CAL FIRE shall provide a copy of any completed survey reports to the appropriate landowner(s), if so requested. Landowners shall also be advised that such reports containing specific site locations are confidential and shall not be distributed to the public.

F. NOISE

F.1 REGULATORY SETTING

Federal and state laws have led to the establishment of noise guidelines for the protection of the population from adverse impacts from environmental noise. Many local noise goals are implemented as planning guidelines and by enforceable noise ordinances.

F.1.1 FEDERAL

The Noise Control Act of 1972 directed the US EPA to develop noise guidelines that would protect the population from the adverse effects of environmental noise. These are guidelines and not construed as standards or regulations. In 1981, EPA concluded that noise pollution should be addressed at the local level and primary responsibility for regulating noise was transferred to State and local government (EPA, 2006).

F.1.2 OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA)

Under the Occupational Safety and Health Act of 1970 (29 USC § 651 et seq.), the federal Department of Labor, Occupational Safety, and Health Administration (OSHA) has adopted regulations (29 CFR § 1910.95) that establish maximum noise levels to which workers at a facility may be exposed. These OSHA noise regulations are designed to protect workers against the effects of noise exposure, and list permissible noise level exposure as a function of the amount of time during which the worker is exposed.

F.1.3 STATE

State law (GC 65300) requires that cities and counties prepare and adopt a General Plan. Government Code section 65302(f) establishes that a noise element is a required component of a General Plan. In addition, California Department of Health Services (1987) has developed noise guidelines for the noise elements in local General Plans. The state guidelines also recommend that local jurisdictions consider adopting local nuisance noise control ordinances.

F.1.4 CAL-OSHA

As a result of the passage of Cal-OSHA, the California Occupational Safety and Health Administration (Cal-OSHA) has promulgated Occupational Noise Exposure Regulations (8 CCR § 5095 et seq.) that set employee noise exposure limits. These standards are equivalent to the federal OSHA standards described above.

F.2 BACKGROUND

Noise is often described as sound traveling through the air, such as traffic from a nearby road. Sound is defined as any pressure variation in air that the ear can detect. If the pressure variations occur frequently enough, at least 20 times per second, they can be heard by the human ear and called "sound." The number of pressure variations per second is called the frequency of sound, and is expressed as cycles per second, called Hertz (Hz). The relative loudness or intensity of sound energy is measured in decibels (dB). A decibel is a logarithmic unit of sound energy that represents the smallest variance in sound that the human ear can detect.

The standard unit for measuring sound is the decibel (dB). Because the human ear is not equally sensitive to sound at all frequencies, a frequency-dependent rating scale has been devised to interpret noise levels relative to the sensitivity of human hearing. The A-weighted decibel scale accounts for this. Environmental noise is usually measured in A-weighted decibels (dBA) and typically fluctuates over time. An A-weighted decibel (dBA) is a decibel corrected for the variation in frequency response of the typical human ear at commonly encountered noise levels. The following noise descriptors are commonly used to evaluate environmental noise:

- L_{eq} – The energy-equivalent noise level (L_{eq}), is the average acoustic energy content of noise, measured during a specific time period.
- L_{dn} – The day-night average noise level (L_{dn}), is a 24-hour average L_{eq} with a 10 dBA penalty added to noise occurring during the hours of 10pm and 7am to account for the greater nocturnal noise sensitivity of people.
- CNEL – The Community Noise Equivalent Level (CNEL), is also a 24-hour average L_{eq} with no penalty added to noise during the day time hours between 7am and 7pm, a penalty of 5 dB added to evening noise occurring between 7pm and 10pm, an penalty of 10 dB added to nighttime noise occurring between 10pm and 7am.

Noise levels from a source diminish as distance to the receptor increases. A rule of thumb for traffic noise is that for every doubling of distance from the road, the noise level is reduced by 3 to 4.5 dBA. For a single source of noise (i.e. stationary equipment) the noise is reduced by 6dBA for each doubling of distance away from the source. Noise levels can also vary with the presence of structures that can reflect sound and either intensify or diminish the noise level. Community reaction to a change in noise levels varies, depending upon the magnitude of the change. In general, a difference of 3 dBA is a minimally perceptible change, while a 5 dBA difference is the typical threshold that would cause a change in community reaction.

In the urban setting, street and traffic noise can be considered background noise. But unless a rural home is on a highway, one might notice a car coming on a rural road for miles. Noises in the rural setting can seem amplified if there are no barriers to the source. But noise levels are reduced by increasing distance, air density, wind, and obstructions (trees, buildings, and natural landscape features). Table F.2-1 provides a list of expected decibel levels for common noise sources. Note that a forest in the absence of trucks and heavy machinery would have a relatively low background environmental noise level (30 dBA).

Table F.2-1 Decibel levels for Common Noise Sources[1]

Sound Pressure Level (dBA)	Noise Source
150	Jet Engine Takeoff at 25 meters
140	Aircraft Carrier Deck
130	Military Jet Takeoff
120	Chain Saw
110	Pneumatic Chipper
100	Power Lawn Mower
90	Boeing 737, one nautical mile before landing
80	Heavy Truck Traffic
70	Freeway at 10am
60	Business Office
50	Conservational Speech
40	Library, Bird Calls
30	Secluded Woods
20	Whisper

[1]Adapted from “Noise Sources and their Effects,” Purdue University Department of Chemistry, and “Best Practices Guide: Controlling Noise on Construction Sites,” Laborer’s Health and Safety Fund of North America

F.3 DATA AND ASSUMPTIONS

The Proposed Program potential treatment acreage by bioregion is described in Chapter 2. Total acreage treated over a ten-year period is projected to be approximately 600,000 acres, which represents about 2.5 percent of the total acreage of CAL FIRE jurisdiction lands that might be treatable in any ten-year period under this proposed Program. Annual acreage treated is expected to about 60,000 acres.

Table F.3-1 provides an estimation of noise levels associated with timber harvesting equipment. Machine equipment used to conduct VTP projects could be expected to produce comparable levels of noise. Table F.3-1 also includes the sound levels from chainsaws measured at 250 feet. Table F.3-2 describes the dBA at 50 feet of various types of equipment and machinery, which would be used or is similar to equipment likely to be used in the proposed Program and Alternatives. Noise impacts from helicopters (used for ignition of prescribed fire) are based on FAA Advisory Circular-AC36-1G, Bell Series and Hughes models noise levels (CAL FIRE, 2005).

Table F.3-1 Active Timber Harvest Site Equipment and Activity Noise Level Measurements.

Equipment/Activity	Source	Equivalent Continuous Noise Level (Leq)–dB[1]
Heel Boom Loader	Caterpillar 325	60[2]
Bull Dozer	Caterpillar D8N	63
Bull Dozer	Caterpillar D7G	63[3]
Chainsaw	Stihl 046	65
Clearing Deck Debris & Stacking Logs	Caterpillar 325	60
Skidding & Stacking Logs	Caterpillar 325, Caterpillar S8N w/ backup alarm	65
Shaking Heel Boom Grappler	Caterpillar 325	70
Skidding & Stacking Logs	Caterpillar 325, Caterpillar D7G	64
Skidding & Stacking Logs	Caterpillar 325, Caterpillar D8N, Caterpillar D7G	68
Cutting Trees	Stihl 046	68
Tree Falling	Tree	58[4]

[1] Sight line noise measurements distance = 150 feet
[2] Idling 56 dB
[3] Idling 58 dB
[4] Sight line noise measurement distance = 250 feet
Source: CAL FIRE, 2008, Jackson Demonstration State Forest Management Plan Final Environmental Impact Report.

Table F.3-2 noise levels of equipment likely to be operated under proposed program

Equipment	dBA at 50'		
Dozer	85-90		
Tractor	77-82		
Front End Loader	86-90		
Hydraulic backhoe	81-90		
Hydraulic excavator	81-91		
16 wheel Truck	81-87		
Chainsaw	90		
Mobile Chippers	115		
Helicopter	Flyover dBA at 150 meter	Takeoff dBA at 50’	Landing dBA at 50’
Bell 206 L-111	86.9	87.6	91.1
Bell 206 L-IV	83.3	84.1	87.3
Bell 206 B-III	85.2	88.4	90.7
Hughes 500 D	88.7	n/a	n/a

Table F.3-3 Production rates and associated noise levels for equipment used in proposed program.

	Production (acres/day)	Days to Complete a Project	Equipment	dBA @ 50'	Assumptions
Mechanical mowing	50	5.2	Tractor	80	BLM, plus 1 16-wheel lowbed for move in/out
Mechanical dozer blade and pile	6	44.2	Dozer	87	BLM, plus 1 16-wheel lowbed for move in/out
Mechanical chaining (2 dozers)	11	22.7	2 dozers	87	est., 2 dozers 500' apart at 2000'/day, also 2 16-wheel lowbed for move in/out
Mechanical excavator mastication	5	52	excavator	85	est., plus one 16 wheel lowbed for move in/out
Road side chipping	7	39	Feller bunches, skidder and mobile 200-400 hp chipper	115	Remove 190 tpa 7" in diameter with feller buncher, skid to landing, chip and blow into chip vans
Hand pulling cutting, shoveling	1	52	None	45	BLM 5-person crew clearing 5 acres/day
Hand cutting and hand clearing	1	52	5 chainsaws	90	BLM 5-person crew clearing 5 acres/day
Herbicide backpack spray	1	52	None	45	BLM 5-person crew spraying 5 acres/day
Herbicide ATV spray	10	26	ATV	70	BLM, 10 acres/day
Prescribed fire hand ignition	260	1	Pickup truck, fire engines	65	7 igniters, 1 command vehicle, 1 crew rig, 2 fire engines
Prescribed fire helitorch	260	1	Helicopter	90	2 fire engines, command vehicle, helicopter, helicopter support trucks
Prescribed herbivory	10	26	Pickup truck	65	1 person tending with 1 rt/day

Based on estimates from ENSR International (ENSR International, 2005) for BLM (USDI BLM, 2005)

G.RECREATION

G.1 STATE RECREATION LANDS

The following section describes the extent of land available for recreation on state lands.

G.1.1 CALIFORNIA DEPARTMENT OF PARKS AND RECREATION

The State Parks system encompasses over 1.5 million acres of land and consists of 279 parks and recreational areas. State Parks include 339 miles of coastline, 974 miles of lake, reservoir and river frontage, approximately 15,000 campsites and alternative camping facilities, and 4,456 miles of non-motorized trails (parks.ca.gov).

G.1.2 CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

The California Department of Fish and Wildlife (CDFW) manages over 1 million acres of fish and wildlife habitat across 711 properties throughout the state. The land provides habitat for fish, wildlife, and plant species for every major ecosystem in the state. DFW land includes bighorn sheep habitat, deer habitat, grassland/upland habitats, special habitats, and threatened and endangered species habitats (dfg.ca.gov/lands).

G.1.3 CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

The California Department of Forestry and Fire Protection (CAL FIRE) manages eight State Forests covering over 71,000 acres. CAL FIRE recreation facilities include over 190 campsites, 58 picnic sites, and two visitor centers. Most utilization of State Forests is categorized as day use; however, nearly all State Forests provide facilities for overnight camping. CAL FIRE expects acquire additional land increasing the number of acres of State Forests (fire.ca.gov).

G.1.4 CALIFORNIA STATE LANDS COMMISSION

The California State Lands Commission (CSLC) manages and protects important natural and cultural resources on certain public lands within the state and the public's rights to access these lands. The public lands under the Commission's jurisdiction are of two distinct types—sovereign and school lands. Sovereign lands encompass approximately 4 million acres. These lands include the beds of California's naturally navigable rivers, lakes and streams, as well as the state's tide and submerged lands along the state's more than 1,100 miles of coastline, extending from the shoreline out to three miles offshore. School lands are what remain of the nearly 5.5 million acres throughout the state originally granted to California by the Congress in 1853 to benefit public education. The state retains surface and mineral ownership of approximately 468,600 acres of these school lands and retains the mineral rights to an additional

790,000 acres. Today, revenues generated from school lands benefit California's retired teachers (slc.ca.gov).

G.1.5 CALIFORNIA DEPARTMENT OF WATER RESOURCES

The goal of the State Water Project is the storage and transport of water through a system of reservoirs, aqueducts, power plants, and pumping facilities, but many opportunities for recreation exist on land owned by the Department of Water Resources (DWR), particularly on lakes and reservoirs (see Table G.1-1). There are three visitor centers at Lake Oroville (Butte County), San Luis Reservoir (Merced County), and Pyramid Lake (Los Angeles County) (water.ca.gov/recreation/).

Table G.1-1 Department of Water Resources Recreational Areas

Recreational Area	Location	Main Activities
Antelope Lake	Plumas County	camping, picnicking, waterskiing, swimming, boating, hunting, hiking, snowmobiling, and wheelchair-accessible fishing
Bethany Reservoir	Alameda County	fishing, boating, windsurfing, hiking, picnicking, and bicycling
Castaic Lake and Lagoon	Los Angeles County	fishing, boating, waterskiing, camping, sailing, picnicking, and swimming
Lake Davis	Plumas County	camping, fishing, picnicking, boating, hunting, hiking, cross-country skiing and snowmobiling
Lake Del Valle	Alameda County	camping, picnicking, horseback riding, swimming, hiking, windsurfing, boating, and fishing
Frenchman Lake	Plumas County	camping, fishing, picnicking, swimming, water skiing, boating, hiking, hunting, cross-country skiing and snowmobiling
Lake Oroville	Butte County	fishing, boating, camping, swimming, water skiing, hiking, and hunting, DWR Visitor Center
Pyramid Lake	Los Angeles County	camping, picnicking, boating, water skiing, swimming, fishing, DWR Visitor Center
Quail Lake	Los Angeles County	fishing, hiking, bird watching
San Luis Reservoir	Merced County	sail and power boating, wind surfing, fishing, swimming, hunting, hiking, bicycling, jet skiing, water skiing, camping, picnicking, DWR Visitor Center
Silverwood Lake	San Bernardino County	hiking, swimming, camping, fishing, waterskiing and boating

G.1.6 CONSERVANCIES

The main goals of California conservancies are to protect, preserve, and enhance natural habitat corridors while providing public access and unique recreational opportunities to everyone. Conservancies provide recreational opportunities in the form of nature trails, wildlife viewing, and outdoor education. Conservancies are unique in that they provide recreation in biologically diverse areas where maintaining ecological integrity of the area is the most important component for management. The State funds several conservancy programs that acquire or manage land and easements for recreation and habitat protection purposes. The major conservancies related to forest and rangeland recreation include Baldwin Hills Conservancy (1,400 acres), California Tahoe Conservancy (148,000 acres), Coachella Valley Mountains Conservancy (1.25 million acres), San Gabriel & Lower Los Angeles Rivers & Mountains Conservancy (569,000 acres), San Joaquin River Conservancy (5,900 acres), Santa Monica Mountains Conservancy (551,000 acres) and the State Coastal Conservancy (300,000 acres). The San Diego River Conservancy was established in 2002 and has begun major restoration projects along the San Diego River (California Performance Review Report, 2007). The large acreages refer to the overall area within which the conservancies conduct acquisitions and projects rather than lands owned by the conservancies. Conservancy acreage has been growing since the emergence of the concept in the early 1990s. Recent initiatives will provide considerable additional funding for expanded acquisition and management by conservancies.

G.2 DATA AND ASSUMPTIONS

Table G.2-1 provides a summary of recreational use by land management category. In terms of visits, State and regional parks account for approximately two-thirds of all outdoor recreation visits on public lands; however, these same parks only make up four percent of the total public land available for outdoor recreation. With the exception of the large Yosemite and Sequoia-Kings Canyon Parks in the Sierra, most visits to National Parks are only partial day visits and have similar use patterns to State and regional parks. The USFS, along with the two large National Parks in the Sierra, supply the largest land base for multi-day outdoor recreational activities. BLM has the second largest holding of lands open for recreation, the majority of which are in desert areas. BLM is also expanding the range of recreational opportunities available on its holdings along rivers and coastlines. In terms of where outdoor wildland recreational activities occur, 50 percent of all visits and 40 percent of all hours of use occur on 13 percent of public land adjacent to major metropolitan areas.

Table G.2-1 Visits*, Recreational Visitor Days, and area by public outdoor recreation provider**

Major providers	Million acres	Million visits	Estimated RVD per visit	Million RVDs
NPS – rest of state	7.1	20	0.6	12
National Park Service – GGNRA***	0.1	14	0.4	5.6
U.S Bureau of Land Management	15	8	1.5	12
U.S. Forest Service - rural national forests	15	21	4.4	92.4
U.S. Forest Service - metro national forests	5	7	1.2	44.4
California Department of Fish and Wildlife	1	1.2	1	1.2
U.S. Fish and Wildlife Service- National Wildlife Refuge	0.4	1	1	1
California State Parks	1.1	39.8	0.75	29.9
California State Parks - Southern California beaches	0.05	17.8	0.4	7.1
California State Parks - other beaches	0.1	7.8	0.4	3.1
East Bay Regional Park District	0.1	14	0.4	5.6

***** "Visits" refers to a single trip by a person regardless of length of stay.***
***** "Recreational Visitor Day" (RVD) is a visit by one person for a 12-hour length of stay***
*****Golden Gate National Recreation Area***

Source: Compiled by FRAP from NPS, 2010; USFS, 2010; DFG, 2010; California Department of Parks and Recreation, 2010

Table G.2-2 below indicates the treatable recreational areas in the proposed program. It compares the amount of treatable recreational land in each bioregion to the overall treatable SRA acreage to find the percent of treatable acreage that is also potential recreational acreage in each bioregion.

For nearly all the bioregions, the treatable recreational land is less than 5 percent of the overall treatable acreage. In the Bay Area/Delta, Colorado Desert, and South Coast bioregions, where 9 percent or more of the treatable SRA acreage is state recreational acres, the likely distribution of VTP treatments is less than 10 percent in each bioregion (7, 3, and 6 percent, respectively).

Table G.2-2 Treatable Recreational Areas in Proposed Program

Bioregion	Treatable State Recreational Acreage	Treatable SRA Acreage	Percent of Treatable SRA Land	Distribution of Treatments in Bioregion	Distribution of Treatments in Bioregion (Acres)
Bay Area/Delta	242,343	2,636,347	9%	7%	194,816
Central Coast	125,045	4,530,930	3%	14%	646,225
Colorado Desert	363,568	488,627	74%	3%	15,872
Klamath/North Coast	263,501	7,052,889	4%	18%	1,251,151
Modoc	115,789	2,721,544	4%	14%	368,974
Mojave	16,580	642,050	3%	4%	26,448
Sacramento Valley	45,369	1,141,967	4%	12%	133,409
San Joaquin Valley	41,842	1,407,829	3%	7%	98,889
Sierra Nevada	131,125	5,760,930	2%	15%	848,446
South Coast	161,441	1,665,822	10%	6%	104,406
Total Acres	**1,506,601**	**28,048,935**	**5%**	**100%**	**28,054,112**

H. AIR QUALITY AND GREEN HOUSE GAS EMISSION CALCULATIONS

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AIR QUAILITY SUMMARY

Air Quality Concerns for activities within the VTP EIR:

1. Emissions of Criteria Air Pollutants and Precursors
2. Fugitive Dust
3. Naturally Occurring Asbestos (NOA)
4. Toxic Air Contaminants (TAC) Emissions
5. Objectionable Odors

Emissions of Criteria Air Pollutants and Precursors

Due to the diversity of activities under the VTP, two project types emerge under air quality emission standards thresholds: construction and prescribed fire.

Construction Phase Emissions are defined as those activities that utilize combustion producing emission equipment. While the activity of prescribed fire does utilize combustion producing emission equipment, all emissions related to prescribed fire activities are analyzed under prescribed fire. Construction Phase Emissions of concern are Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Reactive Organic Gasses (ROG), and Particulate Matter (PM_{10} and $PM_{2.5}$). The amount of emissions that meet the Threshold of Significance varies widely for each air district based on attainment status (Table 4.12-4 in the VTP). The VTP analyzed the number of units within each air district and placed project restrictions based off the most stringent air district standards to minimize air quality impacts throughout the state.

Prescribed Fire Emissions are emissions related to the burning of organic material. The Environmental Protection Agency (EPA) and California Air Resources Board (CARB) both acknowledge that emissions created by prescribed fire are very different than those created by construction projects. EPA's AP 42: Compilation of Air Pollutant Emission Factors' Fifth Edition identifies that prescribed fire emissions are typically much less than those created by wildfire due to less "available fuel" (combustible material that will be consumed by fire under specific climatic conditions) during prescribed burning. Prescribed Fire Emissions of concern are Carbon Monoxide (CO), Particulate Matter (PM_{10} and $PM_{2.5}$), Volatile Organic Compounds (VOC), and Oxides of Nitrogen (NOx). There are no published Thresholds of Significance for Prescribed Fire Emissions for any Air Quality Districts in California because that determination is made on a daily basis by CARB based on current weather and air conditions. However CEQA requires an analysis, therefore the VTP analyzes significance based on the same acre burning in a wildfire (Table 4.12-5 in the VTP); with the understanding that the CARB and the local air district will provide final approval for each Prescribed Fire project under the VTP.

Emissions created by the VTP are minimized through AIR-1 – AIR-2 – AIR-3 – AIR-4 – AIR-10 – AIR-11 – AIR-12 – MM AIR-1.

Fugitive Dust

Fugitive Dust is a Particulate Matter (PM) comprised of soil minerals that are suspended in the air by wind action and/or human activities. Fugitive dust, or dust not coming from a combustion source, accounts for 90% of all primary PM_{10} emissions in California. Fugitive Dust creation is regulated by Section 41700 of Health and Safety Code, with individual air districts further regulating through Fugitive Dust Rules. Many Fugitive Dust Rules prohibit the transport of dust off a property and require that a project "take every reasonable precaution to minimize emissions" (CARB).

The California Air Resources Board recommends that the impacts of Fugitive Dust can be minimized by:

- "Reducing Speed Limits on unpaved surface to 10-15 mph for well-traveled areas and heavy vehicles, never to exceed 25 mph for any vehicle on any unpaved surface", and
- "Water and/or Sweep often enough to ensure that vehicle traffic is not picking up dust for wind action and carryout."

Fugitive Dust created by the VTP are minimized through AIR-1 – AIR-5 – AIR-6 – AIR-7 – AIR-8.

Naturally Occurring Asbestos (NOA)

Naturally Occurring Asbestos (NOA) is contained in some serpentinite or other ultramafic rock and soil within California. Asbestos is classified as a known human carcinogen by state, federal, and international agencies, and as a toxic air contaminant by the Air Resources Board. The California Code of Regulations, Title 17, Section 93105, Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations (ATCM), applies to earthwork that disturbs, or potentially disturbs, naturally-occurring asbestos. Ground-disturbing treatment activities within the VTP shall not be performed in areas identified as "moderately likely to contain naturally occurring asbestos (NOA)" according to maps and guidance published by the California Geological Survey (CGS), unless an Asbestos Dust Control Plan is prepared by the Operational Unit and approved by the air district(s) with jurisdiction over the project site.

Disturbance of NOA by the VTP would be minimized through AIR-9.

Toxic Air Contaminants (TAC) Emissions

TACs in California are regulated primarily through the Tanner Air Toxics Act (Assembly Bill [AB] 1807, Chapter 1047, Statutes of 1983) and the Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588, Chapter 1252, Statutes of 1987). Vegetation treatment activities that would be implemented under the VTP would not result in the operation of new stationary sources of TACs and would not include development of any new sensitive receptors (e.g., residences, schools, hospitals). Equipment emissions from certain treatment activities could, however, result in short-term exhaust emissions of diesel PM from on-site heavy-duty equipment such as plows, rotary mowers, and tractors used to clear land. Diesel PM has been identified as a TAC by ARB since 1998.

TAC Emissions created by the VTP are minimized through AIR-10 – AIR-11 – NSE-4 – NSE-5.

Objectionable Odors

Vegetation treatment activities could include the temporary generation of objectionable odors associated with diesel equipment exhaust. Treatment activities approved under the VTP would not include the development of any new sensitive land uses or of any new major odor sources (e.g., wastewater treatment plant, landfill). However, multiple SPRs would limit exposure of sensitive receptors to excessive levels of odorous emissions generated by vegetation treatment-related activities.

Objectionable Odors created by the VTP are minimized through AIR-10 – AIR-11 – NSE-4 – NSE-5.

Summary of Emissions per Treatment Activity for 7 Simultanious Projects

Emissions of Criteria Air Pollutants and Precursors (lb/day)

	ROG	CO	NO_X	PM_{10}	$PM_{2.5}$
Prescribed Fire Activities					
Tree Dominated Equipment Emissions	0.23	1.61	2.17	0.34	0.20
Grass Dominated Equipment Emissions	0.09	0.60	0.81	0.06	0.04
Shrub Dominated EquipmentEmissions	1.84	4.21	13.13	0.78	0.54
Total Equipment Emissions	**2.15**	**6.42**	**16.12**	**1.19**	**0.78**
Tree Dominated Worker Trip Emissions	0.18	3.61	0.30	0.61	0.16
Grass Dominated Worker Trip Emissions	0.16	3.16	0.27	0.54	0.14
Shrub Dominated Worker Trip Emissions	0.27	5.41	0.46	0.92	0.25
Total Worker Trip Emissions	**0.6**	**12.2**	**1.0**	**2.1**	**0.6**
Total Prescribed Fire Activity Emissions	**2.77**	**18.60**	**17.14**	**3.26**	**1.33**
Tree Dominated Fire Emissions*	286,000	771,333	185	95,333	78,000
Grass Dominated Fire Emissions	0	39,000	35	13,000	13000
Shrub Dominated Fire Emissions	15,600	268,667	73	34,667	34,667
Total Fire Emissions	**301,600**	**1,079,000**	**293**	**143,000**	**112,667**
Total Prescribed Fire Activity Emissions	**301,603**	**1,079,019**	**17.1**	**143,003**	**112,668**
Mechanical Activities					
Tree Dominated Equipment Emissions	0.00	0.01	0.04	0.00	0.00
Grass Dominated Equipment Emissions	1.12	6.89	10.18	1.55	0.93
Shrub Dominated EquipmentEmissions	1.20	7.69	10.62	1.55	0.95
Total Equipment Emissions	**2.32**	**14.60**	**20.84**	**3.11**	**1.88**
Tree Dominated Worker Trip Emissions	0.09	1.80	0.15	0.31	0.08
Grass Dominated Worker Trip Emissions	0.09	1.80	0.15	0.31	0.08
Shrub Dominated Worker Trip Emissions	0.14	2.71	0.23	0.46	0.12
Total Worker Trip Emissions	**0.3**	**6.3**	**0.5**	**1.1**	**0.3**
Total Mechanical Activity Emissions	**2.6**	**20.9**	**21.4**	**4.2**	**2.2**
Manual Activities					
Tree Dominated Equipment Emissions	0.01	0.01	0.00	0.00	0.00
Grass Dominated Equipment Emissions	0.04	0.32	0.43	0.07	0.04
Shrub Dominated EquipmentEmissions	0.01	0.02	0.00	0.00	0.00
Total Equipment Emissions	**0.06**	**0.35**	**0.43**	**0.07**	**0.04**
Tree Dominated Worker Trip Emissions	0.13	0.94	1.64	0.23	0.09
Grass Dominated Worker Trip Emissions	0.19	1.41	2.46	0.34	0.14
Shrub Dominated Worker Trip Emissions	0.28	2.11	3.69	0.51	0.21
Total Worker Trip Emissions	**0.6**	**4.5**	**7.8**	**1.1**	**0.4**
Total Manual Activity Emissions	**0.7**	**4.8**	**8.2**	**1.2**	**0.5**
Prescribed Herbivory Activity Emissions					
Tree Dominated Worker Trip Emissions[1]	0.02	0.45	0.04	0.08	0.02
Grass Dominated Worker Trip Emissions	0.02	0.45	0.04	0.08	0.02
Shrub Dominated Worker Trip Emissions	0.03	0.68	0.06	0.11	0.03
Total Worker Trip Emissions	**0.1**	**1.5792**	**0.133**	**0.2681**	**0.0721**
Total Prescribed Herbivory Activity Emissions	**0.1**	**1.6**	**0.1**	**0.3**	**0.1**
Herbicide Activity Emissions					
Tree Dominated Worker Trip Emissions	0.07	1.35	0.11	0.23	0.06
Grass Dominated Worker Trip Emissions	0.07	1.35	0.11	0.23	0.06
Shrub Dominated Worker Trip Emissions	0.10	2.03	0.17	0.34	0.09
Total Worker Trip Emissions	0.2	4.7	0.4	0.8	0.2
Total Herbicide Activity Emissions	**0.2**	**4.7**	**0.4**	**0.8**	**0.2**
WORKER TRIP/ACTIVITY EMISSIONS	**6.39**	**50.63**	**47.27**	**9.67**	**4.27**
PRESCRIBED FIRE EMMISIONS	**301,600**	**1,079,000**	**-**	**143,000**	**112,667**
TOTAL EMISSIONS	**301,606**	**1,079,051**	**47.2686**	**143,010**	**112,671**

Summary of GHG Emissions Per Activity	CO2e (MT/year)
Prescribed Fire Activities	
Tree Dominated Equipment Emissions	6.35
Grass Dominated Equipment Emissions	1.70
Shrub Dominated EquipmentEmissions	13.63
Total Equipment Emissions	**21.69**
Tree Dominated Worker Trip Emissions	6.14
Grass Dominated Worker Trip Emissions	5.75
Shrub Dominated Worker Trip Emissions	3.86
Total Worker Trip Emissions	**15.7**
Total Prescribed Fire Activity Emissions	**37.43**
Tree Dominated Fire Emissions*	223,852
Grass Dominated Fire Emissions	12,028
Shrub Dominated Fire Emissions	61,868
Total Fire Emissions	**297,748**
Total Prescribed Fire Activity Emissions	**297,785**
Mechanical Activities	
Tree Dominated Equipment Emissions	1.43
Grass Dominated Equipment Emissions	36.90
Shrub Dominated EquipmentEmissions	77.95
Total Equipment Emissions	**116.28**
Tree Dominated Worker Trip Emissions	1.21
Grass Dominated Worker Trip Emissions	1.29
Shrub Dominated Worker Trip Emissions	0.00
Total Worker Trip Emissions	**2.5**
Total Mechanical Activity Emissions	**118.78**
Manual Activities	
Tree Dominated Equipment Emissions	0.01
Grass Dominated Equipment Emissions	5.65
Shrub Dominated EquipmentEmissions	0.00
Total Equipment Emissions	**5.66**
Tree Dominated Worker Trip Emissions	0.96
Grass Dominated Worker Trip Emissions	1.43
Shrub Dominated Worker Trip Emissions	0.80
Total Worker Trip Emissions	**3.2**
Total Manual Activity Emissions	**8.8**
Prescribed Herbivory Activity Emissions	
Tree Dominated Livestock Emissions	165.60
Grass Dominated Livestock Emissions	177.11
Shrub Dominated Livestock Emissions	106.06
Total Livestock Emissions	**448.77**
Tree Dominated Worker Trip Emissions[1]	12.21
Grass Dominated Worker Trip Emissions	12.21
Shrub Dominated Worker Trip Emissions	6.78
Total Worker Trip Emissions	**31.2**
Total Prescribed Herbivory Activity Emissions	**480.0**
Herbicide Activity Emissions	
Tree Dominated Worker Trip Emissions	0.48
Grass Dominated Worker Trip Emissions	0.48
Shrub Dominated Worker Trip Emissions	0.27
Total Worker Trip Emissions	**1.2**
Total Herbicide Activity Emissions	**1.2**
CONSTRUCTION EMISSIONS	**646**
PRESCRIBED FIRE EMMISIONS	**297,748**
TOTAL EMISSIONS	**298,394**

Treatment Activity Equipment Emissions

PRESCRIBED FIRE

Prescribed Fire - Tree Dominated

Planned Duration (days) **3** *Usually on Weekends Fri-Sun

Total Number of Projects **43**

Number of Projects Simultaneously **2** *43 projects to occur over Fall (3mo). Assume over half (55%) could happen at the same time over the state

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	**EQ #**	**Hrs of Use**	**Total EQ Hrs/Day**	**Total EQ Hrs/Yr**	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Tractors	2	4	5	344	0.227	1.609	2.170	0.345	0.197	14,006.30	6.35
Drip Torches	10	5	33	100	-	-	-	-	-	0.00	0.00
Total Tree Dominated Emissions			**39**	**444**	**0.23**	**1.61**	**2.17**	**0.34**	**0.20**	**14,006.31**	**6.35**

Prescribed Fire - Grass Dominated

Planned Duration (days) **2** *M-F

Total Number of Projects **46**

Number of Projects Simultaneously **2** *46 projects over summer (3mo). Asume half (50%) could happen at the same time over the state

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	**EQ #**	**Hrs of Use**	**Total EQ Hrs/Day**	**Total EQ Hrs/Yr**	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Tractors	1	2	2	92	0.085	0.603	0.814	0.065	0.037	3,745.872	1.7
Drip Torches	7	4	28	1288	-	-	-	-	-	0	0.0
Propane Torches	1	2	2	92	-	-	-	-	-	0.000	0.0
Total Grass Dominated Emissions			**32**	**1,472**	**0.09**	**0.60**	**0.81**	**0.06**	**0.04**	**3,746**	**1.70**

Prescribed Fire - Shrub Dominated

Planned Duration (days) **3** *M-F

Total Number of Projects **27** **Aerial Proj.** **5** **Hand Proj.** **22**

Number of Aerial Projects Simultaneously **2** *Assumes 20% of total 27 projects are Aerial over winter/spring (6 mo) & less than half (40%) could happen at same time over the state.

Number of Hand Firing Projects Simultaneously **1** *Assumes 80% of total 27 projects are hand over winter/spring (6 mo) & half (50%) could happen at the same time over the state.

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	**EQ #**	**Hrs of Use**	**Total EQ Hrs/Day**	**Total EQ Hrs/Yr**	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Aerial (20%)											
Helicopter	1	2	1	11	1.499	1.793	9.877	0.267	0.246	21,265.023	9.646
Tractor	2	4	5	43	0.227	1.609	2.170	0.345	0.197	1,758.931	0.798
Heli-Torches	1	2	1	11	-	-	-	-	-	0.013	0.000
Total Aerial			**8**	**65**	**1.726**	**3.402**	**12.047**	**0.612**	**0.443**	**23,023.966**	**10.444**
Hand Firing (80%)											
Tractor	2	4	3	173	0.114	0.804	1.085	0.172	0.099	7,035.72	3.19
Drip Torches	4	3	4	259	-	-	-	-	-	0.01	0.00
Propane Torches	2	3	2	130	-	-	-	-	-	0.00	0.00
Diesel Flame Throwers	2	3	2	130	-	-	-	-	-	0.08	0.00
Terra-Torches	1	3	1	65	-	-	-	-	-	0.07	0.00
Total Hand Firing			**12**	**756**	**0.114**	**0.804**	**1.085**	**0.172**	**0.099**	**7,035.88**	**3.19**
Total Shrub Dominated Emissions			**19.67**	**820.80**	**1.84**	**4.21**	**13.13**	**0.78**	**0.54**	**30,059.85**	**13.63**
TOTAL PRESCRIBED BURN EMISSIONS			**90.3**	**2,736.8**	**2.2**	**6.4**	**16.1**	**1.2**	**0.8**	**47,812.1**	**21.7**

		Unit	Source
Mass Conversion Rates	2205	lb/MT	google.com

Treatment Activity Equipment Emissions

MECHANICAL

Mechanical - Tree Dominated

Planned Duration (days) **60** *Average 2 months

Total Number of Projects **17**

Number of Projects Simultaneously **2** *17 projects to occur over Fall/Winter/Spring (9mo). Duration of a project is so long, assume 80% at same time

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	**EQ #**	**Hrs of Use**	**Total EQ Hrs/Day**	**Total EQ Hrs/Yr**	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Chipping Equipment	2	10	1	340	0.003	0.012	0.037	0.001	0.001	3,148.536	1.43
Total Tree Dominated Emissions			**1**	**340**	**0.00**	**0.01**	**0.04**	**0.00**	**0.00**	**3,148.54**	**1.43**

Mechanical - Grass Dominated

Planned Duration (days) **10** *M-F

Total Number of Projects **18**

Number of Projects Simultaneously **2** *18 projects to occur over Winter/Spring (6mo), can assume half will occur at the same time

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	**EQ #**	**Hrs of Use**	**Total EQ Hrs/Day**	**Total EQ Hrs/Yr**	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Chisel Plow	2	13	5	468	0.222	1.568	2.116	0.336	0.192	19,055	8.64
Rotary Mower	2	15	6	540	0.256	1.810	2.441	0.388	0.222	21,987	9.97
Crawler Type Tractor	3	11	7	594	0.454	2.186	3.836	0.543	0.351	24,182	10.97
Wheeled Tractor	1	22	4	396	0.187	1.327	1.790	0.284	0.163	16,124	7.31
Total Grass Dominated Emissions			**22**	**1,998**	**1.12**	**6.89**	**10.18**	**1.55**	**0.93**	**81,347**	**36.90**

Mechanical - Shrub Dominated

Planned Duration (days) **45** *Average 1-2 months

Total Number of Projects **11**

Number of Projects Simultaneously **3** *11 projects to occur over winter/spring (6mo). Assume 80% could happen at the same time over the state

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	**EQ #**	**Hrs of Use**	**Total EQ Hrs/Day**	**Total EQ Hrs/Yr**	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Rotary Mower	3	20	4	660	0.170	1.206	1.628	0.258	0.148	26,872.560	12.2
Chipping Equipment	2	10	1	220	0.006	0.025	0.073	0.002	0.002	2,037	0.9
Small Wheeled Tractor	4	14	4	616	0.159	1.126	1.519	0.241	0.138	25,081	11.4
Wheeled Tractor	3	15	3	495	0.128	0.905	1.221	0.194	0.111	20,154	9.1
Crawler Type Tractor	3	17	3	561	0.234	1.126	1.976	0.280	0.181	22,838	10.4
Excavator	3	13	3	429	0.198	1.848	1.647	0.217	0.134	45,313	20.6
Crawler Type Tractor (for Chaining)	3	22	4	726	0.303	1.457	2.557	0.362	0.234	29,555	13.4
Total Shrub Dominated Emissions			**22**	**3,707**	**1.20**	**7.69**	**10.62**	**1.55**	**0.95**	**171,852**	**78.0**

TOTAL MECHANICAL EMISSIONS			**45.33**	**6,045.00**	**2.32**	**14.60**	**20.84**	**3.11**	**1.88**	**256,347.68**	**116.28**

Treatment Activity Equipment Emissions

MANUAL

Manual - Tree Dominated

Planned Duration (days) **130** *Assumes 2 acres a day for average project of 260 acres

Total Number of Projects **9**

Number of Projects Simultaneously **2** *9 projects to occur year round. Duration of a project is so long, assume 80% at same time

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	EQ #	Hrs of Use	Total EQ Hrs/Day	Total EQ Hrs/Yr	ROG (lb/day)	CO (lb/day)	NOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (lb/Yr)	CO2e (MT/Year)
Chainsaws	10	8	1	720	0.005	0.009	0.000	0.000	0.000	14.627	0.01
Total Tree Dominated Emissions			**1**	**720**	**0.0051**	**0.0093**	**0.0001**	**0.0000**	**0.0000**	**14.6273**	**0.01**

Manual - Grass Dominated

Planned Duration (days) **65** *Assumes 4 acres a day for average project size of 260 acres

Total Number of Projects **9**

Number of Projects Simultaneously **2** *9 projects to occur year round. Duration of a project is so long, assume 80% at same time

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	EQ #	Hrs of Use	Total EQ Hrs/Day	Total EQ Hrs/Yr	ROG (lb/day)	CO (lb/day)	NOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (lb/Yr)	CO2e (MT/Year)
Wheeled Tractor	2	17	1	306	0.045	0.316	0.426	0.068	0.039	12,459.096	5.651
Total Grass Dominated Emissions			**1**	**306**	**0.04**	**0.32**	**0.43**	**0.07**	**0.04**	**12,459.10**	**5.65**

Manual - Shrub Dominated

Planned Duration (days) **65** *Assumes 4 acres a day for average project size of 260 acres

Total Number of Projects **5**

Number of Projects Simultaneously **3** *5 projects to occur year round. Duration of a project is so long, assume 80% at same time

	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
Equipment	EQ #	Hrs of Use	Total EQ Hrs/Day	Total EQ Hrs/Yr	ROG (lb/day)	CO (lb/day)	NOX (lb/day)	PM10 (lb/day)	PM2.5 (lb/day)	CO2e (lb/Yr)	CO2e (MT/Year)
Chainsaws	4	10	2	200	0.008	0.014	0.000	0.000	0.000	4.063	0.002
Power Brush Saw	3	10	1	150	0.006	0.010	0.000	0.000	0.000	3.047	0.001
Total Shrub Dominated Emissions			**3**	**350**	**0.01**	**0.02**	**0.00**	**0.00**	**0.00**	**7.11**	**0.00**

TOTAL MANUAL EMISSIONS			**6**		**0.06**	**0.35**	**0.43**	**0.07**	**0.04**	**12,480.83**	**5.66**

Worker Trip Emissions

PRESCRIBED FIRE

Prescribed Fire - Tree Dominated

Planned Duration (days)	3	
Total Number of Projects	43	
Number of Projects Simultaneously	2	*43 projects to occur over Fall (3mo). Assume over half (55%) could happen at the same time over the state
Crew Size Per Project	22	*From Cal Fire Staff
Number of Cars/Trucks Per Project	8	*From Cal Fire Staff
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.182	3.610	0.304	0.613	0.165	13,539.599	6.14
Total Tree Dominated Emissions	**0.18**	**3.61**	**0.30**	**0.61**	**0.16**		**6.14**

Prescribed Fire - Grass Dominated

Planned Duration (days)	2	
Total Number of Projects	46	
Number of Projects Simultaneously	2	*46 projects over summer (3mo). Asume half (50%) could happen at the same time over the state
Crew Size Per Project	50	*From Cal Fire Staff
Number of Cars/Trucks Per Project	7	*From Cal Fire Staff
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.160	3.158	0.266	0.536	0.144	12,673.695	5.7
Total Grass Dominated Emissions	**0.16**	**3.16**	**0.27**	**0.54**	**0.14**		**5.75**

Prescribed Fire - Shrub Dominated

Planned Duration (days)	3	
Total Number of Projects	27	
Number of Projects Simultaneously	3	*27 projects over winter/spring (6 mo) & around half could happen at the same time over the state.
Crew Size Per Project	70	*From Cal Fire Staff
Number of Cars/Trucks Per Project	8	*From Cal Fire Staff
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	**0.274**	**5.414**	**0.456**	**0.919**	**0.247**	**8,501.609**	**3.86**
Total Shrub Dominated Emissions	**0.27**	**5.41**	**0.46**	**0.92**	**0.25**	**8,501.61**	**3.86**
TOTAL PRESCRIBED BURN EMISSIONS	**0.6**	**12.2**	**1.0**	**2.1**	**0.6**		**15.7**

		Unit	Source
Mass Conversion Rates	2205	lb/MT	google.com

Worker Trip Emissions

MECHANICAL

Mechanical - Tree Dominated

Planned Duration (days)	60	*Average 2 months
Total Number of Projects	17	
Number of Projects Simultaneously	2	*17 projects to occur over Fall/Winter/Spring (9mo). Duration of a project is so long, assume 80% at same time
Crew Size Per Project	4	*From Cal Fire Staff
Number of Cars/Trucks Per Project	4	*From Cal Fire Staff
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.091	1.805	0.152	0.306	0.082	2,676.432	1.21
Total Tree Dominated Emissions	**0.09**	**1.80**	**0.15**	**0.31**	**0.08**		**1.21**

Mechanical - Grass Dominated

Planned Duration (days)	10	*M-F
Total Number of Projects	18	
Number of Projects Simultaneously	2	*18 projects to occur over Winter/Spring (6mo), can assume half will occur at the same time
Crew Size Per Project	20	*From Cal Fire Staff
Number of Cars/Trucks Per Project	4	*From Cal Fire Staff
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.091	1.805	0.152	0.306	0.082	2,833.870	1.3
Total Grass Dominated Emissions	**0.09**	**1.80**	**0.15**	**0.31**	**0.08**		**1.29**

Mechanical - Shrub Dominated

Planned Duration (days)	45	*Average 1-2 months
Total Number of Projects	11	
Number of Projects Simultaneously	3	*11 projects to occur over winter/spring (6mo). Assume 80% could happen at the same time over the state
Crew Size Per Project	20	*From Cal Fire Staff
Number of Cars/Trucks Per Project	4	*From Cal Fire Staff
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	**0.137**	**2.707**	**0.228**	**0.460**	**0.124**	**10.496**	**0.00**
Total Shrub Dominated Emissions	**0.14**	**2.71**	**0.23**	**0.46**	**0.12**	**10.50**	**0.00**
TOTAL MECHANICAL EMISSIONS	**0.3**	**6.3**	**0.5**	**1.1**	**0.3**		**2.5**

Worker Trip Emissions

MANUAL

Manual - Tree Dominated

Planned Duration (days)	130	*Assumes 2 acres a day for average project of 260 acres
Total Number of Projects	9	
Number of Projects Simultaneously	2	*9 projects to occur year round. Duration of a project is so long, assume 80% at same time
Crew Size Per Project	30	*From Cal Fire Staff
Number of Crew Buses Per Project	2	*From Cal Fire Staff (15 per Crew Bus)
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Crew Bus- Medium Duty	0.126	0.938	1.641	0.228	0.093	2,106.972	0.96
Total Tree Dominated Emissions	**0.13**	**0.94**	**1.64**	**0.23**	**0.09**		**0.96**

Manual - Grass Dominated

Planned Duration (days)	65	*Assumes 4 acres a day for average project size of 260 acres
Total Number of Projects	9	
Number of Projects Simultaneously	2	*9 projects to occur year round. Duration of a project is so long, assume 80% at same time
Crew Size Per Project	40	*From Cal Fire Staff
Number of Crew Buses Per Project	3	*From Cal Fire Staff (15 per Crew Bus)
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Crew Bus- Medium Duty	0.189	1.406	2.462	0.343	0.139	3,160.458	1.4
Total Grass Dominated Emissions	**0.19**	**1.41**	**2.46**	**0.34**	**0.14**		**1.43**

Manual - Shrub Dominated

Planned Duration (days)	65	*Assumes 4 acres a day for average project size of 260 acres
Total Number of Projects	5	
Number of Projects Simultaneously	3	*5 projects to occur year round. Duration of a project is so long, assume 80% at same time
Crew Size Per Project	40	*From Cal Fire Staff
Number of Crew Buses Per Project	3	*From Cal Fire Staff (15 per Crew Bus)
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Crew Bus- Medium Duty	**0.284**	**2.110**	**3.693**	**0.514**	**0.209**	**1,755.810**	**0.80**
Total Shrub Dominated Emissions	**0.28**	**2.11**	**3.69**	**0.51**	**0.21**	**1,755.81**	**0.80**
TOTAL MANUAL EMISSIONS	**0.6**	**4.5**	**7.8**	**1.1**	**0.4**		**3.2**

Worker Trip Emissions

PRESCRIBED HERBIVORY

Herbivory - Tree Dominated

Planned Duration (days): 130 *Assumes 20 acres a day for average project of 260 acres
Total Number of Projects: 9
Number of Projects Simultaneously: 2 *9 projects to occur year round. Assume 50% can occur at the same time.
Crew Size Per Project: 3 * Hired from Company
Number of Cars/Trucks Per Project: 1 *From Cal Fire Staff (15 per Crew
Number of Trips per Project: 76 * Four trips per week over 19 weeks
Number of trips per day per vehicle: 1 *Assume one round trip per car/truck per day
Number of Semis to Carry Herds: 1 *From Cal Fire Staff (Assume one-round trip for each project)

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.023	0.451	0.038	0.077	0.021	26,921.761	12.21
Semi to Carry Herd	0.045	0.462	0.639	0.054	0.022	370.568	0.17
Total Tree Dominated Emissions	**0.02**	**0.45**	**0.04**	**0.08**	**0.02**		**12.21**

Herbivory - Grass Dominated

Planned Duration (days): 130 *Assumes 20 acres a day for average project size of 260 acres
Total Number of Projects: 9
Number of Projects Simultaneously: 2 *9 projects to occur year round. Assume 50% can occur at the same time.
Crew Size Per Project: 3 *Hired from Company
Number of Cars/Trucks Per Project: 1 *From Cal Fire Staff (15 per Crew Bus)
Number of trips per day per vehicle: 1 — Number of Trips per Project: 76 * Four trips per week over 19 weeks
Number of Semis to Carry Herds: 1

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.023	0.451	0.038	0.077	0.021	26,921.761	12.21
Semi to Carry Herd	0.045	0.462	0.639	0.054	0.022	370.568	0.17
Total Grass Dominated Emissions	**0.02**	**0.45**	**0.04**	**0.08**	**0.02**		**12.21**

Herbivory - Shrub Dominated

Planned Duration (days): 130 *Assumes 20 acres a day for average project size of 260 acres
Total Number of Projects: 5
Number of Projects Simultaneously: 3 *5 projects to occur year round. Assume 50% can occur at the same time
Crew Size Per Project: 3 *From Cal Fire Staff
Number of Cars/Trucks Per Project: 1 *From Cal Fire Staff (15 per Crew Bus)
Number of trips per day per vehicle: 1 — Number of Trips per Project: 76 * Four trips per week over 19 weeks
Number of Semis to Carry Herds: 1

	AIR QUALITY EMISSIONS					GHG	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.034	0.677	0.057	0.115	0.031	14,956.534	6.78
Semi to Carry Herd	0.067	0.693	0.959	0.082	0.033	926.420	0.42
Total Shrub Dominated Emissions	**0.03**	**0.68**	**0.06**	**0.11**	**0.03**	**14,956.53**	**6.78**
TOTAL PRESCRIBED HERBIOVRY EMISSIONS	**0.1**	**1.6**	**0.1**	**0.3**	**0.1**		**31.2**

Worker Trip Emissions

HERBICIDES							
Herbicides- Tree Dominated							
Planned Duration (days)	1	*Assumes 20 acres a day for average project of 260 acres					
Total Number of Projects	9						
Number of Projects Simultaneously	2	*9 projects to occur year round. Assume 50% can occur at the same time.					
Crew Size Per Project	15	*From Cal Fire Staff					
Number of Cars/Trucks Per Project	3	*From Cal Fire Staff					
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day					
	AIR QUALITY EMISSIONS					**GHG**	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.068	1.354	0.114	0.230	0.062	1,062.701	0.48
Total Tree Dominated Emissions	**0.07**	**1.35**	**0.11**	**0.23**	**0.06**		**0.48**
Herbicides- Grass Dominated							
Planned Duration (days)	1	*Assumes 20 acres a day for average project size of 260 acres					
Total Number of Projects	9						
Number of Projects Simultaneously	2	*9 projects to occur year round. Assume 50% can occur at the same time.					
Crew Size Per Project	15	*From Cal Fire Staff					
Number of Cars/Trucks Per Project	3	*From Cal Fire Staff					
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day					
	AIR QUALITY EMISSIONS					**GHG**	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	0.068	1.354	0.114	0.230	0.062	1,062.701	0.5
Total Grass Dominated Emissions	**0.07**	**1.35**	**0.11**	**0.23**	**0.06**		**0.48**
Herbicides- Shrub Dominated							
Planned Duration (days)	1	*Assumes 20 acres a day for average project size of 260 acres					
Total Number of Projects	5						
Number of Projects Simultaneously	3	*5 projects to occur year round. Assume 50% can occur at the same time					
Crew Size Per Project	15	*From Cal Fire Staff					
Number of Cars/Trucks Per Project	3	*From Cal Fire Staff					
Number of trips per day per vehicle	1	*Assume one round trip per car/truck per day					
	AIR QUALITY EMISSIONS					**GHG**	
Vehicles Used	**ROG (lb/day)**	**CO (lb/day)**	**NOX (lb/day)**	**PM10 (lb/day)**	**PM2.5 (lb/day)**	**CO2e (lb/Yr)**	**CO2e (MT/Year)**
Cars/Trucks Light Duty	**0.103**	**2.030**	**0.171**	**0.345**	**0.093**	**590.390**	**0.27**
Total Shrub Dominated Emissions	**0.10**	**2.03**	**0.17**	**0.34**	**0.09**	**590.39**	**0.27**
TOTAL HERBICIDES EMISSIONS	**0.2**	**4.7**	**0.4**	**0.8**	**0.2**		**1.2**

GHG Emissions

Prescribed Herbivory GHG Emissions

Season	Spring/Summer
Number of Projects	23
Total Acres/Yr	6,000
Total Livestock Pop.	12,000

								Enteric Fermentation						
		Tree Dominated		Grass Dominated		Shrub Dominated			Tree Dominated		Grass Dominated		Shrub Dominated	
Livestock Type	**Avg Population Per Acre**	Total Acres	Total Population	Total Acres	Total Population	Total Acres	Total Population	**Emission Factor (kg CH_4/head-year)**	kg CH4/year	**MT CO_2e/year**	kg CH4/year	**MT CO_2e/year**	kg CH4/year	**MT CO_2e/year**
Slaughter Sheep			-		-		-	8	-	-	-	-	-	-
Goats	2	2,214	4,428	2,368	4,736	1,418	2,836.00	5	22,140	166	23,680.00	177	14,180	106
Total	**2**	**2,214**	**4,428**	**2,368**	**4,736**	**1,418**	**2,836**			**166**		**177.11**		**106.06**

Vegetation Type	**MT CO_2e/year**
Total Tree	**166**
Total Gras	**177.11**
Total Shrub	**106.06**
TOTAL	**449**

Percent of the Year we are reasonible 35.62%

*Assumes 130 days per project

* Heard size of 450 - 1 Herd per Project

Notes

Assume 450 sheep/goats (50/50 split) per 20 acres.

Emissions reported yearly, so all projects and acres are taken into consideration

GWP

Methane (CH_4) 21

Sources

Butte County 2006 Agricultural Crop Report

California Air Resources Board. 2008 Greenhouse Gas Emissions Inventory: Agriculture and Forestry. Livestock Population.

Emission Factors

	Enteric Fermentation CH_4 (kg/head)
Sheep	8
Goats	5

California Air Resources Board. 2007 Greenhouse Gas Emissions Inventory: Agriculture and Forestry. Livestock Population.

VTP Prescribed Fire Emissions (CONSUME)

Average Number of Days for a Project	2.67
Total Acres Burned	30,000
Acres Available by Project	3,900

*Limits to one Rx Burn per Air Basin in One day

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.08	0.05	0.04	0.41	0.05	9.67	0.02	0.03
Tons/Day	117	73	59	600	195			
lbs/day	234,000	146,250	117,000	1,199,250	390,000			
					Tons/Year	290,100	600	900
					MT/Year	263,174	544	816
					Global Warming Potential (GWP)	1	21	21
					Carbon Dioxide Equivalent	263,174	12,600	18,900
					Total CO2e Emmisions		**294,674**	**MT/Year**

VOCs are CH4 and NMHC

Conversion 1 ton = 2000 lbs 1 ton = 0.907185 MT

VTP Prescribed Fire Emissions - Tree

Average Number of Days for a Project	3		Model: Mediterranean Climate
Total Acres Burned	11,072		Mixed Forest
Acres Burned in a Day Statewide	1,300	*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation	Sierra Nevada Mixed Conifer Sugar Pine - Douglas Fire - Oak Forest

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.16	0.11	0.09	0.89	0.11	20	**0**	**0.05**
Tons/Day	69	48	39	386	143			
lbs/day	138,667	95,333	78,000	771,333	286,000			
					Tons/Year	218,561	**664**	**553.6**
					MT/Year	198,276	**603**	**502.21762**
					Global Warming Potential (GWP)	1	**21**	**21**
					Carbon Dioxide Equivalent	198,276	**13,951**	**11625.6**
					Total CO2e Emmisions		**223,852**	**MT/Year**

Conversion 1 ton = 2000 lbs 1 ton = 0.907185

VTP Prescribed Fire Emissions - Shrub

Average Number of Days for a Project	3	Model:	Mediterranean Climate
Total Acres Burned	7,090		Shrubland
Acres Burned in a Day Statewide	1,300		Chamise Chaparral

*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.08	0.04	0.04	0.31	0.06	8.23	0.01	0.05
Tons/Day	35	17	17	134	78			
lbs/day	69,333	34,667	34,667	268,667	156,000			
					Tons/Year	58,351	71	355
					MT/Year	52,935	64	322
					Global Warming Potential (GWP)	1	21	21
					Carbon Dioxide Equivalent	52,935	1,489	7,445
					Total CO2e Emmisions		**61,868**	**MT/Year**

Conversion 1 ton = 2000 lb 1 ton = 0.907185

VTP Prescribed Fire Emissions - Grass

Average Number of Days for a Project	2	Model: Mediterranean Climate Grassland
Total Acres Burned	11,838	
Acres Burned in a Day Statewide	1,300	*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.01	0.01	0	0.03	0	1.15	0.00	0.00
Tons/Day	7	7	0	20	0			
lbs/day	13,000	13,000	0	39,000	0			
Tons/Year						13,614	0	0
MT/Year						12,350	0	0
Global Warming Potential (GWP)						1	21	21
Carbon Dioxide Equivalent						12,350	0	0
Total CO2e Emmisions							**12,350**	**MT/Year**

Conversion 1 ton = 2000 lb 1 ton = 0.907185

VTP Prescribed Fire Emissions - Tree - One Project

verage Number of Days for a Project	1	Model:	Mediterranean Climate
Total Acres Burned	260		Mixed Forest
Acres Burned in a Day Statewide	260	*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation	Sierra Nevada Mixed Conifer Sugar Pine - Douglas Fire - Oak Forest

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.16	0.11	0.09	0.89	0.11	19.74	0.06	0.05
Tons/Day	42	29	23	231	29			
lbs/day	83,200	57,200	46,800	462,800	57,200			
					Tons/Year	5,132	16	13
					MT/Year	4,656	14	12
					Global Warming Potential (GWP)	1	21	21
					Carbon Dioxide Equivalent	4,656	328	273
					Total CO2e Emmisions		**5,257**	**MT/Year**

Conversion 1 ton = 2000 lb 1 ton = 0.907185

VTP Prescribed Fire Emissions - Shrub - One Project

verage Number of Days for a Project	1	Model:	Mediterranean Climate
Total Acres Burned	260		Shrubland
Acres Burned in a Day Statewide	260		Chamise Chaparral

*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.08	0.04	0.04	0.31	0.06	8.23	0.01	0.05
Tons/Day	21	10	10	81	16			
lbs/day	41,600	20,800	20,800	161,200	31,200			
					Tons/Year	2,140	3	13
					MT/Year	1,941	2	12
					Global Warming Potential (GWP)	1	21	21
					Carbon Dioxide Equivalent	1,941	55	273
					Total CO2e Emmisions		**2,269**	**MT/Year**

Conversion 1 ton = 2000 lb 1 ton = 0.907185

VTP Prescribed Fire Emissions - Grass - One Project

verage Number of Days for a Project	1	Model:	Mediterranean Climate Grassland
Total Acres Burned	260		
Acres Burned in a Day Statewide	260		

*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.01	0.01	0	0.03	0	1.15	0.00	0.00
Tons/Day	3	3	0	8	0			
lbs/day	5,200	5,200	0	15,600	0			
Tons/Year						299	0	0
MT/Year						271	0	0
Global Warming Potential (GWP)						1	21	21
Carbon Dioxide Equivalent						271	0	0
Total CO2e Emmisions							**271**	**MT/Year**

Conversion 1 ton = 2000 lb 1 ton = 0.907185

Wildfire Emissions (CONSUME)

Average Number of Days for a Project	2.67
Total Acres Burned	30,000
Acres Burned in a Day Statewide	3,900 *Limits to one Rx Burn per Air Basin in One day

						Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.16	0.09	0.08	0.67	17.16	17.12	0.03	0.04
Tons/Day	234	132	117	980	66,924			
lbs/day	468,000	263,250	234,000	1,959,750	133,848,000			
					Tons/Year	513,600	900	1,200
					MT/Year	465,930	816	1,089
					Global Warming Potential (GWP)	1	21	21
					Carbon Dioxide Equivalent	465,930	18,900	25,200
					Total CO2e Emmisions		**510,030**	
								MT/Year

VOCs are CH4 and NMHC

Conversion 1 ton = 2000 lb 1 ton = 0.907185

Wildfire Emissions - Tree

Average Number of Days for a Project	3	Model:	Mediterranean Climate Mixed Forest
Total Acres Burned	11,072		Sierra Nevada Mixed Conifer Sugar Pine - Douglas Fire - Oak Forest
Acres Burned in a Day Statewide	1,300		

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.3	0.18	0.17	1.31	39.98	40	**0**	**0.07**
Tons/Day	130	78	74	568	51,974			
lbs/day	260,000	156,000	147,333	1,135,333	103,948,000			
Tons/Year						441,884	886	775
MT/Year						400,870	804	703
Global Warming Potential (GWP)						1	21	21
Carbon Dioxide Equivalent						400,870	18,601	16,276
Total CO2e Emmisions							**435,747**	
								MT/Year

Conversion 1 ton = 2000 lb 1 ton = 0.907185

Wildfire Emissions - Shrub

Average Number of Days for a Project	3	Model:	Mediterranean Climate
Total Acres Burned	7,090		Shrubland
Acres Burned in a Day Statewide	1,300		Chamise Chaparral

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.08	0.04	0.04	0.31	8.28	8	**0**	**0.05**
Tons/Day	35	17	17	134	10,764			
lbs/day	69,333	34,667	34,667	268,667	21,528,000			
					Tons/Year	58,351	71	355
					MT/Year	52,935	64	322
					Global Warming Potential (GWP)	1	21	21
					Carbon Dioxide Equivalent	52,935	1,489	7,445
					Total CO2e Emmisions		**61,868**	

Conversion 1 ton = 2000 lb 1 ton = 0.907185

Wildfire Emissions - Grass

Average Number of Days for a Project	2	Model: Mediterranean Climate Grassland
Total Acres Burned	11,838	
Acres Burned in a Day Statewide	1,300	

	Air Quaility					Greenhouse Gasses		
	PM	PM 10	PM 2.5	CO	VOC*	CO2	CH4	NMHC
Tons/Acres	0.01	0.01	0	0.03	1.12	1.12	**0**	**0**
Tons/Day	7	7	0	20	1,456			
lbs/day	13,000	13,000	0	39,000	2,912,000			
					Tons/Year	13,259	0	0
					MT/Year	12,028	0	0
					Global Warming Potential (GWP)	1	21	21
					Carbon Dioxide Equivalent	12,028	0	0
					Total CO2e Emmisions		**12,028**	

Conversion 1 ton = 2000 lb 1 ton = 0.907185

DAILY PRESCRIBED FIRE EMISSIONS						
		lbs/day				
			Particulate			
Formation	Acres/Day	Carbon Monoxide	PM 10	PM 2.5	VOC*	NOx**
TREE	433	771,345	95,336	78,001	286,002	185
SHRUB	433	268,670	34,667	34,667	156,000	73
GRASS	650	39,015	13,003	2	4	35
		1,079,030	143,006	112,670	442,006	293
		tons/day				
			Particulate			
Formation	Acres/Day	Carbon Monoxide	PM 10	PM 2.5	VOC*	NOx**
TREE	433	386	48	39	143	0.09
SHRUB	433	134	17	17	78	0.04
GRASS	650	20	7	0	0	0.02
		540	72	56	221	0.15

*VOC includes ROG **NOx Calculated using the EPA standard, CONSUME does not provide NOx value.

DAILY WILDFIRE EMISSIONS						
		tons/day				
			Particulate			
Formation	Acres/Day	Carbon Monoxide	PM 10	PM 2.5	VOC	NOx
TREE	433	2,224	234	210	158	33
SHRUB	433	599	78	67	64	14
GRASS	650	27	4	4	3	1
		2,850	316	281	224	48

Assumes same acres per day as prescribed fire, see Appendix H for further explantations. Calculator provided by Calfiornia Air Resources Board Coordination and Communication for Natually Ignited Fires (2011).

DAILY PRESCRIBED FIRE EQUIPMENT EMISSIONS (LBS/DAY)					
	Equipment Emissions				
				Particulate	
Formation	ROG	CO	NOx	PM10	PM2.5
TREE	1.70	12.06	16.28	2.58	1.48
SHRUB	0.43	3.02	4.07	0.06	0.04
GRASS	3.95	14.75	31.09	2.99	1.85
	6.08	29.83	51.44	5.63	3.37
	Worker Trip Emissions				
				Particulate	
Formation	ROG	CO	NOx	PM10	PM2.5
TREE	0.46	9.02	0.76	1.53	0.41
SHRUB	0.40	7.90	0.67	1.34	0.36
GRASS	0.46	9.02	0.76	1.53	0.41
	1.31	25.94	2.19	4.40	1.18
Total Emissions	**7.39**	**55.78**	**53.62**	**10.04**	**4.55**

*NOx Calculated using the EPA standard, CONSUME does not provide NOx value.

Activity Equipment Emission Factors

Equipment	Equipment Category	Power Rating (HP)	Capacity	Unit	ROG (lb/hr)	CO (lb/hr)	NOX (lb/hr)	PM 10 (lb/hr)	PM 2.5 (lb/hr)	CO2 (lb/hr)	Equipment/Source Used to Determine Approximate Power Rating (HP)
Prescribed Fire											
Tractors	Tractors/Loaders/Backhoe	97			0.04	0.30	0.41	0.06	0.04	40.72	CalEEMod Run for Equipment Running for 1 Hour
Helicopter	Helicopter	NA	5000	lbs	1.12	1.34	7.41	0.20	0.18	1,969	(reported in g/hr)
Drip Torches	NA	NA			0.00	0.00	0.00	0.00	0.00	0.00002	Only CO2 emission factors available from CCAR
Propane Torches	NA	NA			0.00	0.00	0.00	0.00	0.00	0.000001	Only CO2 emission factors available from CCAR
Diesel Flame Throwers	NA	NA			0.00	0.00	0.00	0.00	0.00	0.001	Only CO2 emission factors available from CCAR
Terra Torches	NA	NA			0.00	0.00	0.00	0.00	0.00	0.001	Only CO2 emission factors available from CCAR
Heli-Torches	NA	NA			0.00	0.00	0.00	0.00	0.00	0.001	Only CO2 emission factors available from CCAR
Mechanical											
Chisel Plow	Tractors/Loaders/Backhoe	97			0.04	0.30	0.41	0.06	0.04	40.72	(Similar to Tractor) CalEEMod Run for Equipment Running for 1 Hour
Rotary Mowers	Tractors/Loaders/Backhoe	97			0.04	0.30	0.41	0.06	0.04	40.72	(Similar to Tractor) CalEEMod Run for Equipment Running for 1 Hour
Chipping Equipment (Brush)	Chipper	250			0.00	0.02	0.05	0.00	0.00	9	(reported in g/hr)
Chipper Clearing	Chipper	125			0.00	0.02	0.03	0.00	0.00	3	ziegler.com (reported in g/hr)
Small Wheeled Tractors	Tractors/Loaders/Backhoe	97			0.04	0.30	0.41	0.06	0.04	40.72	CalEEMod Run for Equipment Running for 1 Hour
Wheeled Tractors	Tractors/Loaders/Backhoe	97			0.04	0.30	0.41	0.06	0.04	40.72	CalEEMod Run for Equipment Running for 1 Hour
Crawler-Type Tractors	Crawler Tractors	97			0.07	0.33	0.58	0.08	0.05	40.71	CalEEMod Run for Equipment Running for 1 Hour
Excavators	Excavator	81			0.08	0.71	0.63	0.08	0.05	106	CalEEMod Run for Equipment Running for 1 Hour
Manual											
Chainsaws	Chain Saw	3.7	30	inches	0.0042	0.00752	0.00007	0.0000118	0.000011	0.020	northerntool.com (reported in g/hr)
Power Brush Saw	Chain Saw	3.7	30	inches	0.0042	0.00752	0.00007	0.0000118	0.000011	0.020	northerntool.com (reported in g/hr)
Wheeled Tractors	Tractors/Loaders/Backhoe	97			0.04	0.30	0.41	0.06	0.04	40.72	CalEEMod Run for Equipment Running for 1 Hour

Notes

Helicopter emissions for CO2 were calculated based on fuel consumption and are presented as CO2e not CO2. See Supplement Equipment Emfacs worksheet for calculations.

For non CalEEMod Sourced Emission Factors: Exhaust PM2.5 is assumed to be 92% of PM10 (SOURCE: SMAQMD 2012. Roadway Construction Emissions Model, Version 7.2.1)
For Emission Factors with a value of "0," data not available or neglible amount
For Emission Factors associated with worker trips and vehicles see Worker Trip Emfacs worksheet.

		Unit	Source
Mass Conversion Rates	453.59	g/lb	google.com

Worker Trip Emission Factors

	ROG (lb/day)	CO (lb/day)	NOX (lb/day)	PM 10 (lb/day)	PM2.5 (lb/day)	CO2e (lb/day)	Source
1 Round-Trip (Light Duty)	0.011	0.226	0.019	0.038	0.010	39.359	CalEEMod run for one round-trip
1 Round-Trip (Medium)	0.032	0.234	0.410	0.057	0.023	117.054	CalEEMod run for one round-trip
1 Round-Trip (Heavy Duty)	0.0449	0.4617	0.6392	0.0544	0.0219	185.2840	CalEEMod run for one round-trip

Notes

Assume 25 average mile to and from

Assume one round trip for each vehicle per day of activity

Supplement Equipment Exhaust Emission Factors

Chainsaws/Chippers

OFFROAD 2007 Emission Rates (tons/day)

	HP	ROG	CO	NOX	CO2	PM	Activity
Chainsaws	2	1.38E-02	2.50E-02	2.21E-04	6.76E-02	3.93E-05	277.09
Chipper	120	6.45E-05	3.69E-04	4.68E-04	5.88E-02	3.47E-05	1.55
Chipper	250	1.46E-06	5.53E-06	1.64E-05	2.78E-03	4.91E-07	0.02

Project Equipment (g/hr)

	HP	ROG	CO	NOX	CO2	PM
Chainsaw	3.7	1.89E+00	3.41E+00	3.01E-02	9.22E+00	5.36E-03
Chainsaw	3.7	1.89E+00	3.41E+00	3.01E-02	9.22E+00	5.36E-03
Chipper	120	1.57E+00	9.01E+00	1.14E+01	1.43E+03	8.47E-01
Chipper	250	2.21E+00	8.37E+00	2.49E+01	4.20E+03	7.42E-01

Conversion Rates	value	unit	source
	2,000	lb/ton	onlineconversion.com/weight_common.htm
	24	hr/day	
	453.592	g/lb	

Source: OFFROAD 2007 Emissions Output for Shasta County, 2016

Helicopter

Emission Rates of KMAX K-100 helicopter

HC/ROG	NOx	PM	CO	Fuel	Units
0.51	3.36	0.091	0.61	284	kg/hr

HC/ROG	NOx	PM	CO	CO2e	
510	3,360	91	610	893,115	g/hr

Conversion Rate	value	units	source
	1,000	g/hr	onlineconversion.com/weight.htm

GHG Emissions Rate for Helicopter	value	units	source
rate of fuel consumption by helicopter	284	kg/hr	Federal Office of Civil Aviation of Switzerland
density of jet A-1 fuel	0.804	kg/L	British Petroleum 2000
volume conversion rate	3.79	L/gal	onlineconversion.com/volume.htm
density of jet fuel	3.04	kg/gal	conversion calculation
jet A-1 fuel consumption rate	93.31	gal/hr	calculation
CO2 emission factor for jet fuel	9.57	kg/gal	CCAR 2009, Table C.3, p. 96
CO2 emission rate for jet fuel	893.0	kg/hr	calculation
N2O emission factor for jet fuel	0.31	g/gal	CCAR 2009, Table C.6, p. 100
CH4 emission factor for jet fuel	0.27	g/gal	CCAR 2009, Table C.6, p. 100
mass conversion rate	1,000	g/kg	onlineconversion.com/weight
global warming potential of CO2	1	unitless	CCAR 2009, Table A-1, p.722-723
global warming potential of N2O	310	unitless	CCAR 2009, Table A-1, p.722-723
global warming potential of CH4	21	unitless	CCAR 2009, Table A-1, p.722-723
CO2e emission rate for jet fuel	893.1	kg/hr	summation
mass conversion rate	2.205	lb/kg	onlineconversion.com/weight.htm
CO2e emission rate for jet fuel	1,969.0	lb/hr	conversion calculation

mass conversion rate	453.592	g/hr	onlineconversion.com/weight.htm
CO_2e emission rate for jet fuel	893,115	g/hr	calculation

Notes: A KMAX K-1200 was assumed as it has an approximate 5,000 lb weight and is commonly used for lifting operations such as removing trees and transporting materials.
Source: Federal Office of Civil Aviation (Switzerland). 2009 (March). Guidance on the Determination of Helicopter Emissions. Reference: 0 / 3/33/33-05-20. Available: www.bafu.admin.ch.

Propane Torch

Emission Factor

		Unit	Source
Propane	0.1043	kg CO2/gallon fuel	CCAR 2009
fuel consump	5	gallon/hour	
EF	0.5215	kg co2/hr	calculation
EF	**0.0005215**	g/hour	calculation

Conversion Rate

	1000	g/kg	google.com

Drip Torch (70% Diesel, 30% Gasoline)

Emission Factor

		Unit	Source
Diesel	10.15	kg CO2/gallon fuel	CCAR 2009
fuel consump	0.7	gallon/hour	*70% of 1 gallon/hr
EF	7.105	kg co2/hr	calculation
EF	**0.007105**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com

		Unit	Source
Gasoline	8.81	kg CO2/gallon fuel	CCAR 2009
fuel consump	0.3	gallon/hour	*30% of 1 gallon/hr
EF	2.643	kg co2/hr	calculation
EF	**0.002643**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com
EF Total	**0.009748**	**g/kg**	Sum of diesel and gas mix

Diesel Flame Throwers (70% Diesel, 30% Gasoline)

Emission Factor

		Unit	Source
Diesel	10.15	kg CO2/gallon fuel	CCAR 2009
fuel consump	21	gallon/hour	*70% of 30 gallons/hr
EF	213.15	kg co2/hr	calculation
EF	**0.21315**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com

		Unit	Source
Gasoline	8.81	kg CO2/gallon fuel	CCAR 2009
fuel consump	9	gallon/hour	*30% of 30 gallons/hr
EF	79.29	kg co2/hr	calculation
EF	**0.07929**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com
EF Total	**0.29244**	**g/kg**	sum of diesel and gas mix

Terra-Torches (70% Diesel, 30% Gasoline)

Emission Factor

		Unit	Source
Diesel	10.15	kg CO2/gallon fuel	CCAR 2009
fuel consump	35	gallon/hour	*70% of 50 gallons/hr
EF	355.25	kg co2/hr	calculation
EF	**0.35525**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com

		Unit	Source
Gasoline	8.81	kg CO2/gallon fuel	CCAR 2009
fuel consump	15	gallon/hour	*30% of 50 gallons/hr
EF	132.15	kg co2/hr	calculation
EF	**0.13215**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com
EF Total	**0.4874**	**g/kg**	sum of diesel and gas mix (Note, emission factors not found for Flash 21 gelling agent, so not included)

Heli-Torches (70% Diesel, 30% Gasoline)

Emission Factor

		Unit	Source
Diesel	10.15	kg CO2/gallon fuel	CCAR 2009
fuel consump	38.5	gallon/hour	*70% of 55 gallons/hr
EF	390.775	kg co2/hr	calculation
EF	**0.390775**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com

		Unit	Source
Gasoline	8.81	kg CO2/gallon fuel	CCAR 2009
fuel consump	16.5	gallon/hour	*30% of 55 gallons/hr
EF	145.365	kg co2/hr	calculation
EF	**0.145365**	**g/hour**	calculation

Conversion Rate

	1000	g/kg	google.com
EF Total	**0.53614**	**g/kg**	sum of diesel and gas mix (Note, emission factors not found for Flash 21 gelling agent, so not included)

Notes: Source is California Climate Action Registry (CCAR) General Reporting Protocol. 2009 (Janurary). Reporting Entity-Wide Greenhouse Gas Emissions. Version 3.1. Gallon/Hr fuel and type of fuel breakdown provided by Cal Fire staff.

I. MONITORING AND COMMUNICATION

I.1 INTRODUCTION

The following is the proposed monitoring and communications plan (MCP) for the Vegetation Treatment Program (VTP). The goals of the MCP are to track Program implementation and effectiveness, implement informal types of adaptive management, and to provide a mechanism for communication with affected entities and stakeholders. Additionally, the public will be provided an opportunity to participate in project scoping for certain types of projects. The MCP includes the following basic components:

- A mechanism for introducing independent science into the VTP
- A requirement to geospatially track project implementation over time
- Implementation monitoring to provide a rapid feedback loop for corrective action at the project scale
- Qualitative project effectiveness monitoring to communicate “lessons learned” during VTP implementation
- Post-incident effectiveness monitoring
- An annual workshop in each CAL FIRE Region to communicate Program implementation, effectiveness, and “lessons learned” to stakeholders
- A process that will allow for stakeholder involvement in scoping for non-WUI related projects in southern California
- A goal to implement “active” adaptive management by securing dedicated funding for research effectiveness and validation monitoring

Due to lack of resources the more rigorous “active” adaptive management program cannot be implemented at this time. However, components of the MCP will allow for informal adaptive management under the VTP in addition to a venue for stakeholder involvement. These components should be seen as the initial foundation for a more comprehensive adaptive management program once funding is secured.

I.1.1 CONCEPTUAL FRAMEWORK

Adaptive management can vary along a spectrum from informal “trial-and-error learning” to “passive” adaptive management all the way to formal “active” adaptive management. The option(s) selected will depend on the level of uncertainty with expected management outcomes and the risk the management action poses to the resource(s) of concern (Lee, 2004; Gregory et al., 2006). Trial-and-error learning places emphasis on project implementation and solving or mitigating particularly narrow problems with management actions (e.g., adequacy of BMP implementation) (Wilhere, 2002; Lee, 2004). This type of learning is often anecdotal and unreplicated, but is useful for managers when applied appropriately. Passive adaptive management is when existing information is used to guide decision-making and outcomes are monitored with the intent that management actions are changed in response to the monitored data, and that data is continually updated through monitoring (Gregory et al., 2006). Active adaptive management is where management actions are treated as experimental manipulations where competing hypotheses regarding the effect of management actions on resources of concern are rigorously tested (Gregory et al., 2006).

Trial-and-error learning is most appropriate when the range of management outcomes are narrow, the risk to the resource(s) of concern is low, and when the knowledge and experience of the practitioner is high. Passive adaptive management is a good option when there is high confidence in resource response and where there is already existing data on the resource of concern. However, passive adaptive management often results in slower learning without clear implications for management (Gregory et al., 2006). Theoretically, active adaptive management results in more statistically robust information in a shorter time frame. However, it requires more costs to implement and can be cost prohibitive for some management entities.

While an inclusive and structured decision-making process is necessary for successful adaptive management, monitoring will be the means for measuring outcomes related to VTP implementation and effectiveness. Ideally a hierarchical approach to monitoring is utilized; where monitoring is nested so that multiple objectives can be addressed in an integrated fashion (Ralph and Poole, 2003). There is inconsistency in monitoring method terminology. Hence, it is better to describe the general purpose for each type of monitoring. Resource monitoring is generally broken into the following categories:

- **Baseline and Trend Monitoring** – Baseline monitoring characterizes existing conditions. If the monitoring is continued at regular intervals over time it can be used to determine trends (i.e., trend monitoring). This type of monitoring will generally be long-term in nature.
- **Effectiveness Monitoring –** Effectiveness monitoring determines whether a particular action or set of actions had the desired outcome. Effectiveness monitoring can be applied to individual management practices or to suites of actions across the landscape. Larger scale effectiveness monitoring might also be referred to as Project or Program monitoring. Effectiveness monitoring can be either qualitative or quantitative. Quantitative effectiveness monitoring is typically slower and more complex than implementation monitoring, and should employ a robust statistical design for hypothesis testing.
- **Validation Monitoring –** Validation monitoring has multiple definitions. For the purposes of this proposal, validation monitoring refers to monitoring that verifies or refutes our assumptions regarding the underlying linkages between cause and effect. It answers not only whether we achieved a desired outcome, but why. Validation monitoring can be considered a more rigorous form of effectiveness

monitoring and is often done in a research setting. Validation monitoring is typically the slowest form of adaptive management and should employ a robust statistical design for hypothesis testing.

- **Implementation/Compliance Monitoring –** This type of monitoring determines whether management actions were carried out as planned. For example, were all the best management practices (BMPs) implemented as specified in the project documents? Implementation monitoring is crucial for rapid loop adaptive management.

Given this background, the VTP seeks to implement less formal types of adaptive management to aid in Program implementation and to help assess Program effectiveness. Implementing informal adaptive management will be a required element of the VTP until funding can be secured to employ the more rigorous active adaptive management. The communications component will provide more transparency during Program decision-making and will help aid the dissemination of new science and monitoring results.

I.2 REQUIRED MONITORING AND LEARNING COMPONENTS

I.2.1 A PROCESS FOR INTRODUCING INDEPENDENT SCIENCE INTO THE VTP

This process will provide a pathway for independent science to increase learning and potentially modify practices performed under the VTP (Figure I.2-1). Independent science will generally not identify clear pathways forward, but it may provide useful information that can be incorporated into the VTP. Relevancy for the Program can be determined by Department staff along with input from stakeholders and the research community. In order to facilitate trust, this process of introducing science is best led by an independent working group or other appropriate independent scientific research entity.

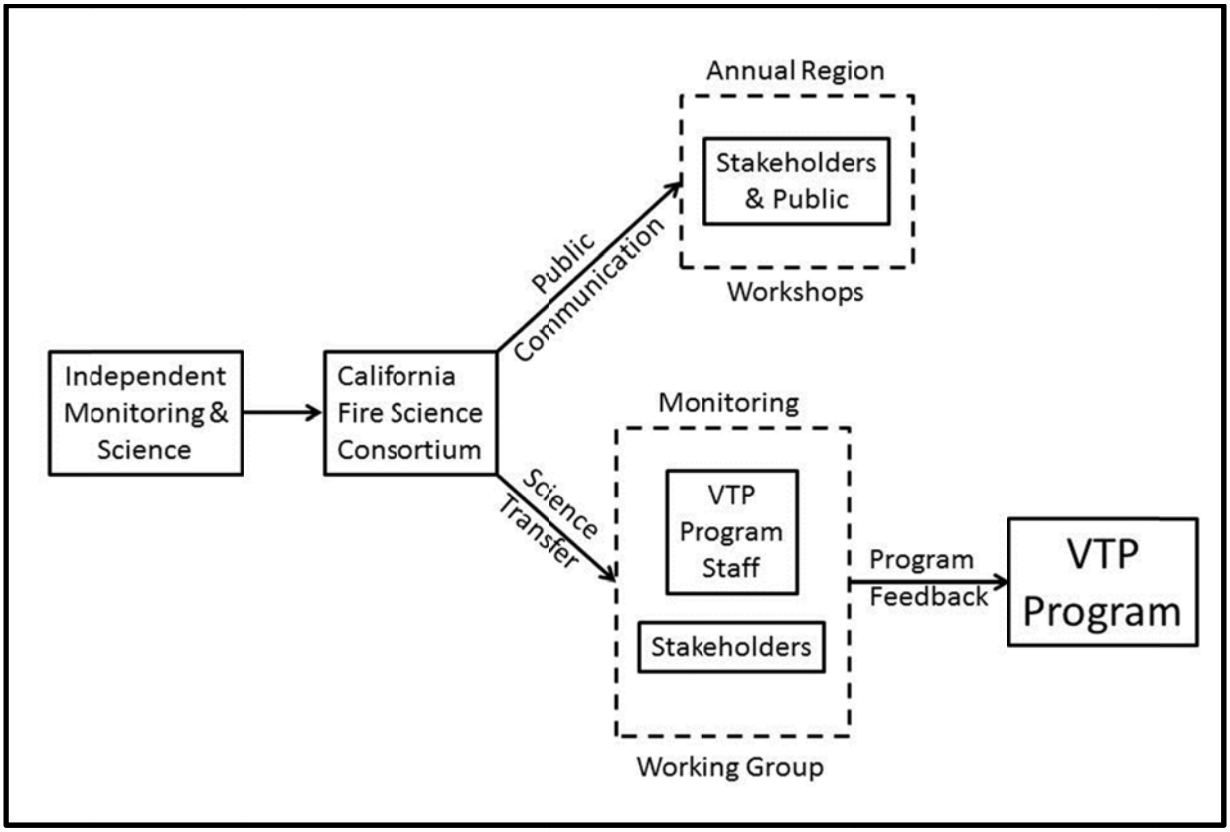

Figure I.2-1 A flowchart showing how independent science and monitoring relevant for the VTP is communicated to the public and is used to improve Program decision-making.

I.2.2 PROGRAM TREND MONITORING

Program trend monitoring requirements would include accounting for all VTP projects over time and space. This will demonstrate how much of the landscape is treated over a given planning horizon, and where these treatments are located spatially. This data is also essential for effectiveness monitoring at the project and program scales. This data would need to be collected and compiled by VMP foresters and program managers and entered into a geodatabase that is managed by the Fire Resource Assessment Program (FRAP) (Figure I.2-2). This will provide a geospatial means to track program implementation over time and space, and communicate this information to the BOF and public stakeholders (Figure I.2-3). Eventually, program trend monitoring, along with geospatial incident tracking, will provide the spatial database necessary for evaluating VTP effectiveness at the landscape scale (see Syphard et al., 2011).

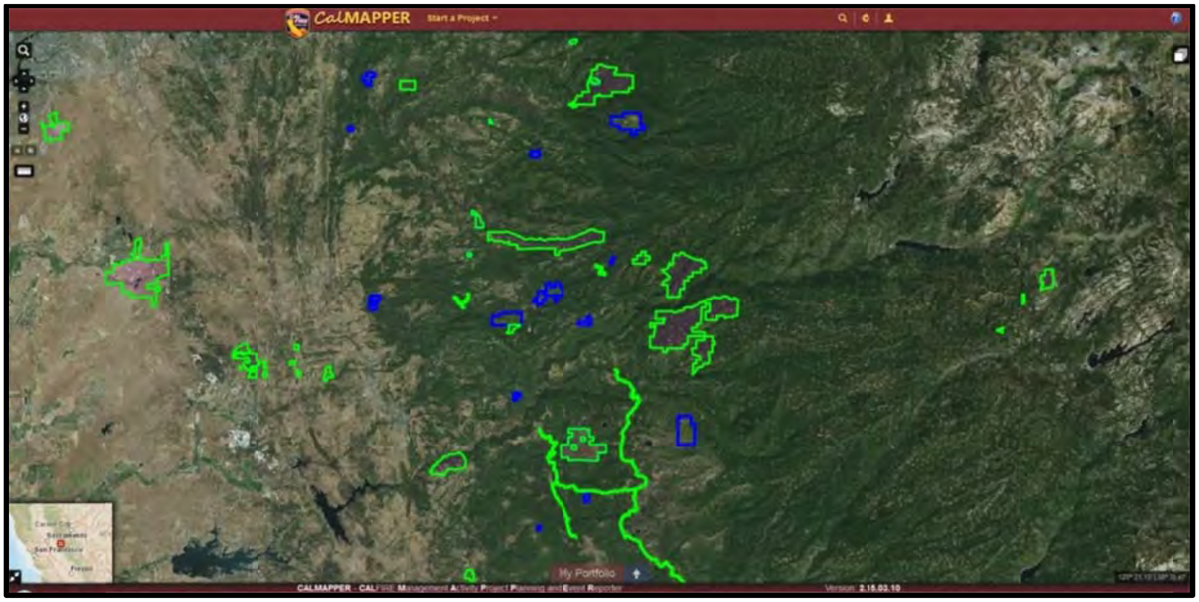

Figure I.2-2 The CalMAPPER web-based portal is an example of a geodatabase that can be used to track Program implementation and effectiveness over time and space.

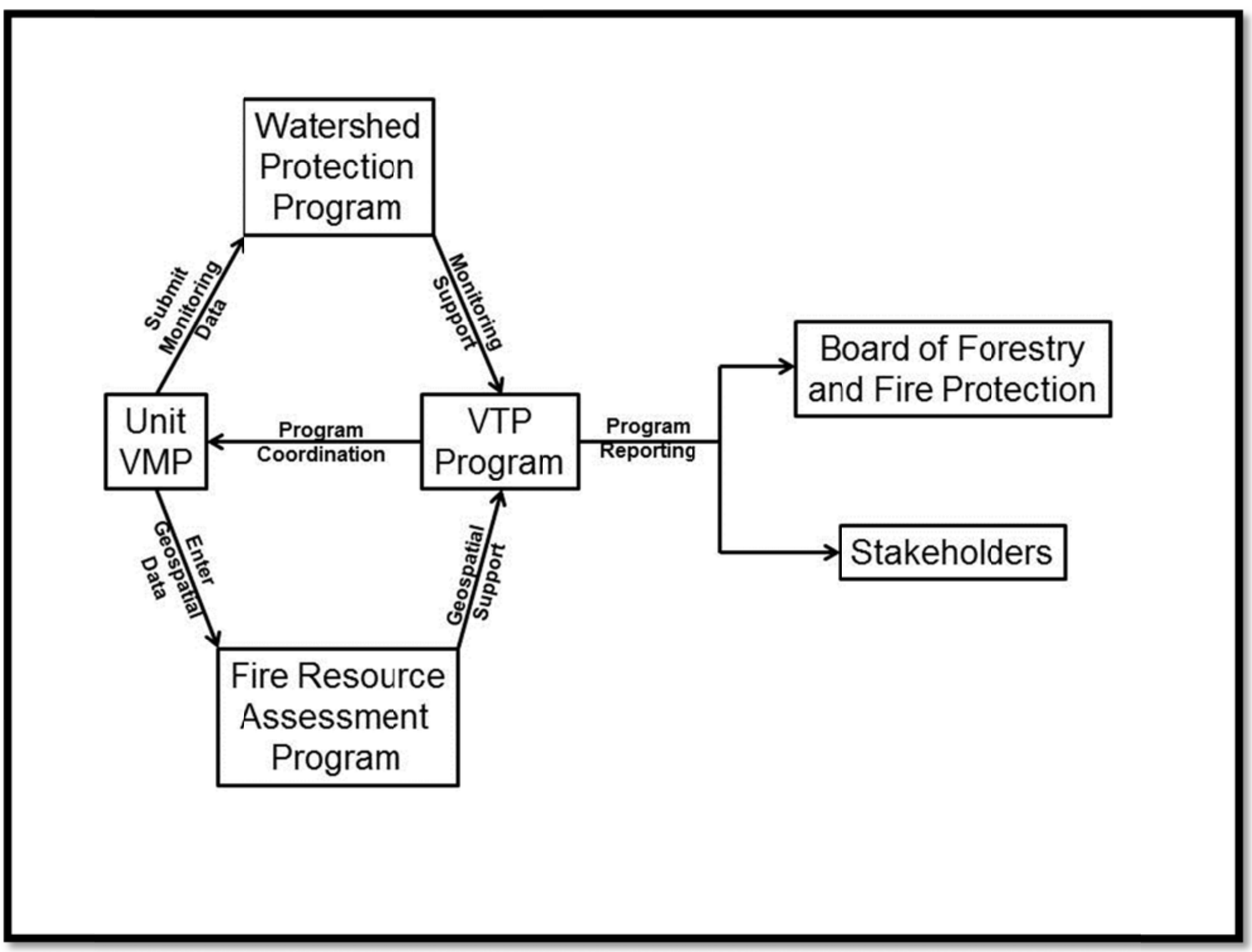

Figure I.2-3 A flowchart demonstrating how project and program data is tracked and communicated to the Board and to public stakeholders.

I.2.3 IMPLEMENTATION MONITORING

This type of monitoring determines whether management actions were carried out as planned. For example, were all the Standard Project Requirements and Project Specific Requirements implemented as specified in the project documents? Implementation monitoring is crucial for rapid corrective action. Qualitative implementation monitoring uses CAL FIRE VMP staff to determine if projects are implemented correctly. This monitoring component will add a systematic element to something that VMP foresters are already doing (i.e., administering projects for proper implementation). The VTP requires the use of an implementation checklist (Attachment A) so that there is a systematic methodology for implementation monitoring. This method is cost-effective and produces real-time corrective actions that can reduce ecological risk and provide accountability to stakeholders and the public.

I.2.4 PHOTO-POINT EFFECTIVENESS MONITORING

Effectiveness monitoring determines whether a particular action or set of actions had the desired outcome. Photo-point monitoring consists of repeat photography of the area of interest. Sequential photographs are taken from the same location and with the same field of view as the initial photograph (Figure I.2-4). By taking photos at fixed photo-points the effectiveness of vegetation treatments can be visually demonstrated. The pre- and post-treatment photos can also be compared to photographic representations of the 13 standard fire behavior models (Anderson, 1982), with treatment effectiveness being evaluated on how the treatment would affect the rate of spread and flame length (Scott and Burgan, 2005).

Photo-point monitoring is a standardized procedure for documenting rates of change, and is an effective communication tool for education and public outreach. **All projects under the VTP will require at least two pre- and post-treatment photos for each activity type (e.g., prescribed fire, mechanical, etc.) in the project.** Also, project coordinators are encouraged to photograph other project elements, such as PSRs around associated with sensitive resource areas (e.g., habitat retention areas, etc). Standardized procedures for photo-point monitoring are outlined in Attachment B of the Monitoring and Communications Plan.

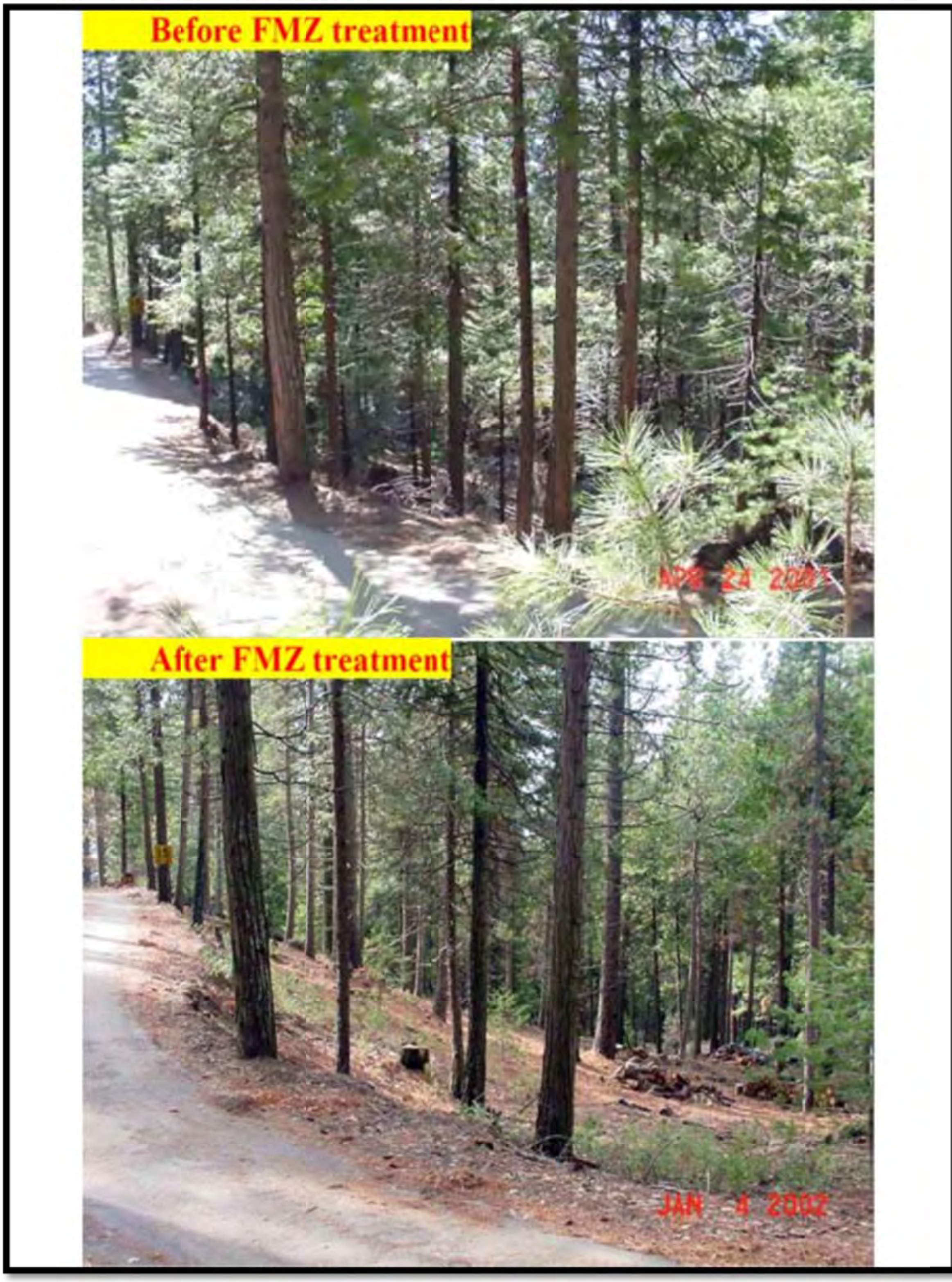

Figure I.2-4 Photo-point sequence showing pre- and post-treatment in a fuel modification zone (FMZ).

I.2.5 POST-INCIDENT EFFECTIVENESS MONITORING

The VTP will require the use of post-incident reporting to assess the effectiveness of treated areas during fire suppression activities.

Option 1: An additional element of reporting will be added to the post incident action summary (PIAS) to detail if and how existing fuel treatments are used in fire suppression activities.

Option 2: Unit VMP Foresters and Pre-Fire Engineers (PFEs) will report to VTP administrators when fuels treatments are used in fire suppression activities.

A subset of these incidents will be explored as more detailed case studies to document how the treated areas are utilized tactically (Figure I.2-5). In turn, this information can be used to improve fuel treatment design to optimize tactical effectiveness. A template for more detailed post-incident effectiveness monitoring is included as Attachment C.

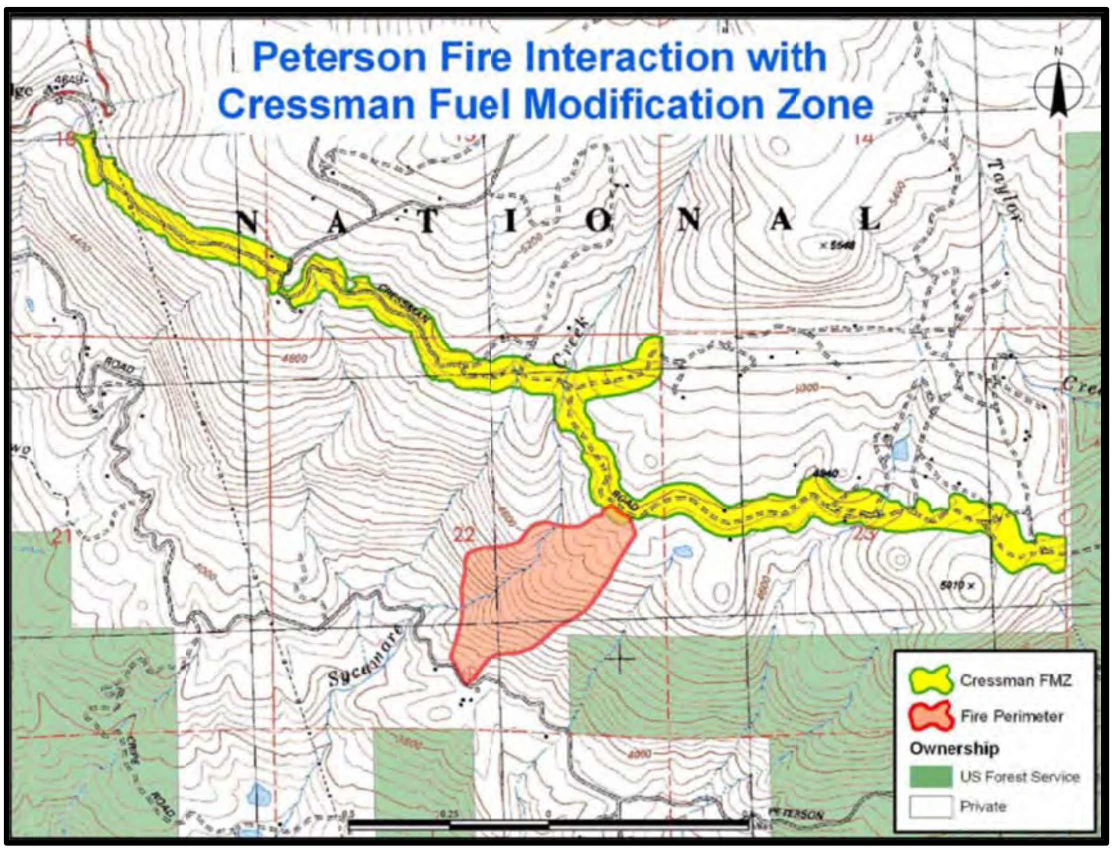

Figure I.2-5 A picture demonstrating the interaction of the Peterson Fire (July 12, 2004) with the Cressman Fuel Modification Zone (FMZ). Battalion Chief Jim Smith noted firefighters were able to attack the head of the fire once it reached the FMZ. Also, firefighters were able to anchor-in at the FMZ and safely make a downhill hoselay along the flank of the fire. The report on the Peterson Fire – Cressman Fuel Modification Zone will be used as a template for post-incident effectiveness monitoring (Attachment C)

I.3 FUTURE MONITORING COMPONENTS

A goal of the VTP is to secure funding for more rigorous types of effectiveness and validation monitoring. This type of monitoring involves structuring selected projects as experiments to statistically test hypotheses regarding treatment effectiveness in achieving a desired outcome. Due to the high cost of implementing this type of monitoring, the VTP is unable to commit to this monitoring upon VTP PEIR approval. However, a multi-stakeholder VTP Monitoring Working Group will be established to develop a process to fund and implement monitoring and/or research to improve VTP implementation and effectiveness.

Rigorous monitoring will allow for the implementation of more formal active adaptive management and greater certainty in decision-making. For example, fuel breaks in chaparral can be subject to invasion by exotic plant species. Through rigorous effectiveness monitoring, several manipulative experiments (including controls) would be monitored for invasive plant growth. The treated areas would then be statistically compared to determine which one is most effective in preventing invasive plant growth. Another example of rigorous effectiveness monitoring is determining whether any impacts to water quality occur through the treatment of vegetation within watercourse and lake protection zones (WLPZs). Currently, vegetation treatments are not allowed within WLPZs. Testing different WLPZ treatment scenarios in different vegetation types might allow practitioners more flexibility for treating these areas in the future if monitoring demonstrates that no significant impacts occur. Rigorous effectiveness monitoring can ultimately lead to refining the SPRs or PSRs over time.

Validation monitoring takes this one step further by illuminating the causal processes responsible for treatment effectiveness. This allows us greater understanding of why a given treatment works versus another. In turn, this increased understanding can lead to further innovation in project design. Quantitative effectiveness and validation monitoring can be done across a range of scales (i.e., plot scale to scale of the Program area) depending upon the type of monitoring question being answered. A nested, hierarchical design is extremely powerful for answering multiple questions simultaneously in an integrated fashion (Ralph and Poole, 2003).

I.4 REQUIRED COMMUNICATION COMPONENTS

I.4.1 PROJECT IDENTIFICATION

Landowners, stakeholders, local governments, and affected agencies are encouraged to propose fuels reduction projects and/or provide feedback on these projects to CAL FIRE Unit staff during Unit Fire Plan updates. This will provide a local feedback mechanism to account for community needs for wildfire protection and environmental protection. For example, projects with the highest level of advocates in the local community will generally get prioritized highest during the implementation process. Feedback on environmental constraints from local stakeholders will ensure that environmental protections remain robust and that controversial projects will avoided when possible. The process for this component is outlined in Chapter 2 and in Figure 2.4-1.

I.4.2 PROJECT NOTIFICATION AND PUBLIC MEETINGS IN SOUTHERN CALIFORNIA COUNTIES

For vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties, additional steps are required during project scoping. First, during the project planning phase for projects outside of the WUI, a public notice must be circulated locally, describing the proposed project. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase. Second, a noticed public meeting will be scheduled so that Unit staff and stakeholders can discuss issues of concern regarding the proposed project. The process for this component is outlined in SPR BIO-5 and in Figure 2.4-1.

I.4.3 PROJECT IMPLEMENTATION NOTIFICATION FOR PRESCRIBED BURNS

For all projects utilizing prescribed fire the following steps are required:

- Approximately two weeks prior to commencement of burning operations, post signs along major road ways in the area describing the project, timing and requesting for smoke sensitive persons in the area to contact the CAL FIRE VMP coordinator.
- Approximately two weeks prior to the commencement of operations, publish a public interest notification in a local newspapers describing the project, timing and requesting for smoke sensitive persons in the area to contact the CAL FIRE VMP coordinator.
- Send the local county supervisor(s) a notification letter describing the project, its necessity, timing, and summarize the measures being taken to protect the environment and prevent escape.
- Develop a list of smoke sensitive persons in the area and contact them prior to burning.
- Post large orange road signs notifying motorists of the prescribed fire operation and possible smoke impacts along all roads leading through the VMP area.
- Engage in traffic control operations if weather conditions do not allow for adequate smoke dispersion.

I.4.4 ANNUAL REGION WORKSHOPS

Annual workshops will be held in the CAL FIRE North and South Regions to allow for the dissemination of new science, monitoring results, and "lessons learned" through VTP implementation. The primary goal of these workshops is communication with the public regarding VTP implementation and effectiveness, as well as progress in the adaptive management process. The workshops will be organized by Region VMP coordinators in conjunction with CAL FIRE's Watershed Protection Program staff.

I.4.5 VTP MONITORING WORKING GROUP

A VTP Monitoring Working Group will be formed to prioritize the types of critical monitoring questions to be answered through more formal types of monitoring. The group will consist of Department staff, researchers, members of the public, and affected agency personnel. Key responsibilities of the group will include:

- Reaching consensus on the key uncertainties affecting fuels reductions treatments in the SRA.
- Framing the key uncertainties as general and specific questions to be addressed through monitoring and research.
- Prioritizing the monitoring and/or research questions so that they can be addressed in a step-wise fashion.
- Developing a process to fund and implement monitoring and/or research to improve VTP implementation and effectiveness.

I.5 ATTACHMENTS

- **Attachment A (I.5.1): VTP Implementation Checklist**
- **Attachment B (I.5.2): VTP Photo-Point Effectiveness Monitoring Protocol and Datasheet**
- **Attachment C (I.5.3): Post-Incident Effectiveness Monitoring Template**
- **(I.5.6): Interaction Report**

I.5.1 VTP IMPLEMENTATION MONITORING CHECKLIST

The following pages include the VTP Implementation Monitoring Checklist.

California Department of Forestry and Fire Protection

VTP Implementation Monitoring Checklist

The purpose of this checklist is to determine if the Standard Project Requirements (SPR) and any Project Specific Requirements (PSR) have been properly incorporated into the project.

Project Name:

CAL FIRE Unit:

Location:

Project Coordinator and Contact Information:

Treatment Type: ☐ *WUI* ☐ *Fuel Break* ☐ *Ecological Restoration*

Date: Observers:

N/A	Yes	No	Design features & Standard Project Requirements (SPR) :	[1]Reference	[2]Project Stage	Describe conditions if relevant and where deficiencies occur. If answer to question is "No," describe proposed corrective actions and provide date completed. Attach additional sheets as necessary.	Date Complete
			Were the administrative standards implemented in the project?	ADM-1 through 7	P - I		
			Was prescribed fire utilized as specified in the SPR?	FBE-1 through 3	P - I		
			Did the project description adequately describe the impacts to the aesthetics?	AES-1	P - C		

1- SPR reference
2- P = Planning; I = Implementation; C = Completion

California Department of Forestry and Fire Protection

VTP Implementation Monitoring Checklist

The purpose of this checklist is to determine if the Standard Project Requirements (SPR) and any Project Specific Requirements (PSR) have been properly incorporated into the project.

N/A	Yes	No	Design features & Standard Project Requirements (SPR) :	[1]Reference	[2]Project Stage	Describe conditions if relevant and where deficiencies occur. If answer to question is "No," describe proposed corrective actions and provide date completed. Attach additional sheets as necessary.	Date Complete
			Would the project result in any unique air quality impacts that were not addressed in the VTP Program EIR?	AIR – 1 through 12	I, P - C		
			Have all biological resources SPR been incorporated into the project?	BIO-1 through 13	P - I		
			Have all cultural resources SPR been incorporated into the project?	CUL – 1 through 5	P - I		
			Have all geology and soils SPR been incorporated into the project?	GEO –1 & 2	P - I		
			Have all GHG SPRs been incorporated into the project?	CC -1 through 4	P -I		
			Have all hazard and hazardous materials SPRs been incorporated into the project?	HAZ –1 through 14	P, I - C		
			Have all hydrology and water quality SPRs been incorporated into the project?	HYD-1 through 17	P, I - C		
			Have all noise SPRs been incorporated into the project?	NSE-1 through 5	P, I - C		

1- SPR reference
2- P = Planning; I = Implementation; C = Completion

California Department of Forestry and Fire Protection

VTP Implementation Monitoring Checklist

The purpose of this checklist is to determine if the Standard Project Requirements (SPR) and any Project Specific Requirements (PSR) have been properly incorporated into the project.

N/A	Yes	No	Design features & Standard Project Requirements (SPR) :	[1]Reference	[2]Project Stage	Describe conditions if relevant, and where deficiencies occur. If answer to question is "No," describe proposed corrective actions and provide date completed. Attach additional sheets as necessary.	Date Complete
			Have all transportation SPRs been incorporated into the project	TRA-1 & 2	I-C		
List any Project Specific Requirements (PSRs)							

1- SPR reference
2- P = Planning; I = Implementation; C = Completion

California Department of Forestry and Fire Protection

VTP Implementation Monitoring Checklist

The purpose of this checklist is to determine if the Standard Project Requirements (SPR) and any Project Specific Requirements (PSR) have been properly incorporated into the project.

Project Specific Requirements (PSRs):	[2]Project Stage	Describe conditions if relevant, and where deficiencies occur. If answer to question is "No," describe proposed corrective actions and provide date completed. Attach additional sheets as necessary.	Date Complete
(Continued) List any Project Specific Requirements (PSRs)			

1- SPR reference
2- P = Planning; I = Implementation; C = Completion

California Department of Forestry and Fire Protection

VTP Implementation Monitoring Checklist

The purpose of this checklist is to determine if the Standard Project Requirements (SPR) and any Project Specific Requirements (PSR) have been properly incorporated into the project.

Project Specific Requirements (PSRs):	[2]Project Stage	Describe conditions if relevant, and where deficiencies occur. If answer to question is "No," describe proposed corrective actions and provide date completed. Attach additional sheets as necessary.	Date Complete
(Continued) List any Project Specific Requirements (PSRs)			

Notes:

1- SPR reference
2- P = Planning; I = Implementation; C = Completion

I.5.2 STANDARD PROJECT REQUIREMENTS

ADMINISTRATIVE STANDARD PROJECT REQUIREMENTS

ADM-1: Prior to the start of operations, the project coordinator shall meet with the contractor to discuss all resources that must be protected using standard project requirements (SPRs). If burning operations are done with CAL FIRE personnel, the Battalion Chief and/or their Company Officer designee shall meet with the project coordinator onsite prior to operations to discuss resource protection measures. Additionally, the project coordinator shall specify the resource protection measures and details of the burn plan in the incident action plan (IAP) and shall attend the pre-operation briefing to provide further information.

ADM-2: All protected resources shall be flagged, painted or otherwise marked prior to the start of operations by someone knowledgeable of the resources at risk, their location, and the applicable protection measures to be applied. This work shall be performed by a Registered Professional Forester (RPF), or his/her supervised designee, for any project in a forested landscape as defined in PRC § 754.

ADM-3: The project coordinator or designee shall monitor SPR implementation (and effectiveness in some cases) as an adaptive management tool. If a SPR does not perform adequately to protect the specified resource, the project coordinator will determine adaptation strategies, in coordination with the contractor and/or CAL FIRE personnel, and require their implementation.

ADM-4: If monitoring is necessary (e.g., effectiveness monitoring), the project coordinator or designee shall notify the party responsible for monitoring a minimum of three weeks in advance of operations. More advanced notification is encouraged from project coordinators to parties responsible for more rigorous monitoring activities.

ADM-5: All ground disturbing treatment activities, including land clearing and bull dozer line construction, shall be suspended when a red flag warning is issued by the local National Weather Service office.

ADM-6: The project coordinator or designee shall consult with the USFS, CAL FIRE, or other public agencies as appropriate to develop a list of past, current, and reasonably foreseeable probable future projects within the planning watershed of the proposed project. If the total combined acreage disturbed in the planning watershed exceeds 20% in a 10-year period, compliance with HYD-16 must be met prior to any ground disturbing operations. Projects that may combine with VTP projects to create the potential for significant effects include, but are not limited to, controlled burning, fuel reduction, and commercial timber harvesting.

ADM-7: The Sacramento Program manager shall track the annual and 10-year average annual acreage treated by the VTP, by bioregion. If the acreage treated within any bioregion exceeds 110 percent of the yearly amounts as identified in **Error! Reference source not found.**, the Program manager will notify the affected CAL FIRE Units that any additional projects submitted within that bioregion fall outside of the scope of analysis by this PEIR and additional CEQA analysis will be required. Additional CEQA analysis, such as a mitigated negative declaration, shall assess the cumulative impacts of the proposed project and identify any additional project constraints that may be necessary to mitigate these to less than significant. Additional CEQA analysis may be tiered off this PEIR when the proposed project is otherwise consistent with the VTP.

ADM-8: During the project planning phase, the project proponent will provide a public workshop for projects outside of the WUI. A public notice will be advertised in a local newspaper. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

AESTHETICS-RELATED STANDARD PROJECT REQUIREMENTS

AES-1: See **BIO-5** for shrublands in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, and San Bernardino counties.

AIR QUALITY-RELATED STANDARD PROJECT REQUIREMENTS

AIR-1: The project shall comply with all local, state, and federal air quality regulations and ordinances. The local Air Pollution Control District (APCD) or Air Quality Management District (AQMD) will be contacted to determine local requirements.

AIR-2: Prior to approval of an CAL FIRE Unit project under the VTP, the project coordinator shall model the project’s Criteria Air Pollutant (CAP) emissions and compare the projected emissions levels to the thresholds identified by the local air district. If emissions levels exceed air district thresholds, consultation of the air district will occur.

AIR-3: In accordance with CCR Section 80160(b), all burn prescriptions shall require the submittal of a smoke management plan for all projects greater than 10 acres or are estimated to produce more than 1 ton of particulate matter. Burning shall only be done in compliance with the burn authorization program of the local air district having jurisdiction over the project area. Example of a smoke management plan is in Appendix J.

AIR-4: Fire emissions and fire behavior shall be planned, predicted, and monitored in accordance with SPRs FBE-1, FBE-2, and FBE-3 with the goal of minimizing air pollutant emissions.

AIR-5: Dust control measures shall be implemented in accordance with SPRs Hyd-9 with the goal of minimizing fugitive dust emissions.

AIR-6: The speed of activity-related trucks, vehicles, and equipment traveling on dirt areas shall be limited to 15 miles per hour (mph) to reduce fugitive dust emissions.

AIR-7: In areas where sufficient water supplies and access to water is available, all visible dust, silt, or mud tracked-out on to public paved roadways as a result of project treatment activities shall be removed at the conclusion of each work day, or at a minimum of every 24 hours for continuous fire treatment activities.

AIR-8: Ground-disturbing treatment activities, including land clearing and bull dozer lines, shall be suspended when there is a visible dust transport outside the project boundary.

AIR-9: Ground-disturbing treatment activities shall not be performed in areas identified as “moderately likely to contain naturally occurring asbestos (NOA)” according to maps and guidance published by the California Geological Survey (CGS), unless an Asbestos Dust Control Plan is prepared by the Operational Unit and approved by the air district(s) with jurisdiction over the project site. This determination would be based on a CGS publication titled *A General Location Guide for Ultramafic Rocks in California – Areas More Likely to Contain Naturally Occurring Asbestos* (Churchill and Hill 2000), or whatever more current guidance from CGS exists at the time the VTP project is evaluated. Any NOA-related guidance provided by the applicable local air district shall also be followed. If it is determined that NOA could be present at the project site, then an Asbestos Dust Control Plan shall be prepared and implemented in accordance with Title 17 of the Public Health CA Code of Regulations of Section 93105.

AIR-10: Operation of each large diesel- or gasoline-powered activity equipment (i.e., greater than 50 horsepower [hp]) shall not exceed 16 equipment-hours per day, where an equipment-hour is defined as one piece of equipment operating for one hour (daily CAPs, TACs, GHGs).

AIR-11: All diesel- and gasoline-powered equipment shall be properly maintained according to manufacturer's specifications, and in compliance with all state and federal emissions requirements. Maintenance records shall be available for verification.

AIR-12: A CAL FIRE Unit shall not conduct more than five simultaneous VTP activities on any day within an air district when multiple units reside within the same air district boundary. When a single CAL FIRE Unit resides within an air district boundary, one day total activity emission estimates will not exceed the current air district's Threshold of Significance. No more than one of these projects shall be a prescribed burn, unless additional prescribed burns have been approved by the local air district having authority over the project area.

Mitigation Measure AIR-1

To achieve compliance with local air district emission thresholds in the San Joaquin Valley Unified Air Quality Management District, simultaneous projects within that air district will be constrained to an appropriate number as not to exceed air quality standards. As a result, the Program shall implement the following:

- CAL FIRE shall not allow more than seven simultaneous treatment activities to occur in the San Joaquin Valley Unified Air Quality Management District, regardless of the number of CAL FIRE units in the district.

BIOLOGICAL STANDARD PROJECT REQUIREMENTS

BIO-1: Projects shall be designed to avoid significant effects and avoid take of special status species as defined in the glossary as a plant or animal species that is listed as rare, threatened, or endangered under Federal law; or rare, threatened, endangered, candidate, or fully protected under State law; or as a sensitive species by the California Board of Forestry and Fire Protection.

BIO-2: The project coordinator shall run a nine-quad search or larger search area (may be required if a project is on the boundary of two USGS quad maps) of the area surrounding the proposed project for special status species, using at a minimum, the California Natural Diversity Database (CNDDB) or its successor (e.g., DFW's Vegetation Classification and Mapping Program, VegCAMP).

BIO-3: The project coordinator shall write a summary of all special status species identified in the biological scoping including the CNDDB search with a preliminary analysis, identifying which species would be affected by the proposed project. A field review will then be conducted by the project coordinator to identify the presence or absence of any special status species, or appropriate habitat for special status species, within the project area.

BIO-4: The project coordinator shall ensure that a CAL FIRE Environmental Coordinator analyze impacts to any species identified in a CNDDB or BIOS search and shall submit the summary and preliminary analysis to the CDFW, USFWS, and [if applicable] NOAA Fisheries for consultation. The preliminary analysis shall be accompanied with a standard letter containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning; mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- The output from the CNDDB run, including a map of any special status species located during the field review, and the SPRs that will be implemented to minimize impacts on the identified special status species.
- A request for information regarding the presence and absence of special status species, including any applicable HCPs, in the project vicinity, and potential take avoidance measures to be implemented as PSRs.
- An offer to schedule a day to visit the project area with the project coordinator.

BIO-5: Vegetation treatment projects that are not deemed necessary to protect critical infrastructure or forest health in San Diego, Imperial, Riverside, Orange, Los Angeles, Ventura, Santa Barbara, Kern, and San Bernardino counties shall:

- Be designed to prevent vegetation type conversion.
- Not take place in vegetation that has not reached the age of median fire return intervals.
- Not re-enter treatment areas for maintenance in an interval shorter than the median fire return interval outside of the wildland urban interface and excluding fuel break maintenance.
- Not take place in old-growth chaparral without consultation regarding the potential for significant impacts with the CDFW and the CNPS.
- Take into account the local aesthetics, wildlife, and recreation of the shrub-dominated subtype during the planning and implementation of the project.
- During the project planning phase provide a public workshop or public notice in a newspaper that is circulated locally describing the proposed project during the project planning phase for projects outside of the WUI. The notification will be used to inform stakeholders and to solicit information on the potential for significant impacts during the project planning phase.

BIO-6: In shrublands containing native oaks, treatments may incorporate retention of older, acorn producing oaks to create deer forage. CAL FIRE or applicants may plant other vegetation to promote species diversity and improve wildlife habitat when such practices are not in conflict with program goals.

BIO-7: Unless otherwise directed by CDFW, a minimum 50 foot avoidance buffer shall be established around any special status animal, nest site, or den location and a minimum 15 foot avoidance buffer shall be established around any special status plant within the project area. Additional buffer distances may be required through consultation with the appropriate State or Federal agencies, or a qualified biologist to avoid significant effects to special status species (see BIO-4).

BIO-8: In order to reduce the spread of new invasive plants, only certified weed-free straw and mulch shall be used.

BIO-9: During the planning phase, if the project coordinator determines that there is a significant risk of introducing invasive plants, then project specific mitigation measures shall be developed using principles outlined in the document "Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (3rd edition)" or other relevant documents. Coordination of mitigation measures will also include consultation with CDFW.

BIO-10: If water drafting becomes a necessary component of the proposed project, drafting sites shall be planned to avoid adverse effects to special status aquatic species and associated habitat, in-stream flows, and depletion of pool habitat. Screening devices shall be used for water drafting pumps, and pumps with low entry velocity shall be used to minimize removal of aquatic species, including juvenile fish, amphibian egg masses, and tadpoles, from aquatic habitats.

BIO-11: Aquatic habitats and species shall be protected through the use of watercourse and lake protection zones (WLPZ), as described in California Forest Practice Rules (14 CCR Chapters 4, 4.5, and 10). Other operational restrictions may be identified through consultation with CDFW and RWQCB (see BIO-4). See HYD-3 for these standard protection measures.

BIO-12: For projects that require a non-construction-related CDFW Streambed Alteration Agreement, any BMPs identified in the agreement shall be developed and implemented.

BIO-13: If any special status species are identified within the project area, an onsite meeting shall occur between the project coordinator and operating contractor. At this meeting the project manager shall conduct a brief review of life history, field identification, and habitat requirements for each special status species, their known or probable locations in the vicinity of the treatment site, project specific requirements or avoidance measures, and necessary actions if special status species or sensitive natural communities are encountered.

CLIMATE CHANGE-RELATED STANDARD PROJECT REQUIREMENTS

CC-1: Prior to approval of a Unit project under the VTP, the project coordinator shall run the FOFEM, and/or other GHG-emissions models, as appropriate to the treatment activity, to confirm that GHG emissions will be the minimum necessary to achieve risk reduction objectives.

CC-2: Carbon sequestration measures shall be implemented per SPRs BIO-5 and BIO-6 to reduce total carbon emissions resulting from the treatment activity.

CC-3: Treatment activity-related air pollutant emission control measures for prescribed burns shall be implemented in accordance with SPRs AIR-3 and AIR-4.

CC-4: Treatment activity-related air pollutant emission control measures for equipment operation hours, practices, and maintenance shall be implemented in accordance with SPRs AIR-11 and AIR-12.

ARCHAEOLOGY AND CULTURAL RESOURCES-RELATED STANDARD PROJECT REQUIREMENTS

CUL-1: The project coordinator or designee shall order a current records check as per the most current edition of “Archaeological Review Procedures for CAL FIRE Projects” (CAL FIRE, 2010, see Appendix H). The project coordinator may contact landowners within the project area who might have already conducted a records check for a Timber Harvest Plan or other project on their land to limit costly redundant records searches. Records checks must be less than five years old at the time of project submission.

CUL-2: Using the latest Native Americans Contact List from the CAL FIRE website, the project coordinator or designee shall send all Native American groups in the counties where the project is located a standard letter notifying them of the project. The letter shall contain the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- A request for information regarding potential cultural impacts from the proposed project.

CUL-3: The project coordinator or designee shall contact a CAL FIRE Archaeologist or CAL FIRE Certified Archaeological Surveyor to arrange for a survey of the project area if necessary. The specific requirements need to comply with the most current edition of “Archaeological Review Procedures for CAL FIRE Projects” (CAL FIRE, 2010).

CUL-4: Protection measures for archaeological and cultural resources shall be developed through consultation with a CAL FIRE archeologist. If new archaeological sites are discovered, the project coordinator or designee shall notify Native American groups of the resource and the protection measure with the standard second letter (see Appendix H). Locations of archaeological resources should not be disclosed on a map to the members of the public, including Native American groups.

CUL-5: If an unknown site is discovered during project operations, operations within 100 feet of the identified boundaries of the new site shall immediately halt, and the project will avoid any more disturbances. A CAL FIRE Archaeologist shall be contacted for an evaluation of the significance of the site. In accordance with the California Health and Safety Code, if human remains are discovered during ground disturbing activities, CAL FIRE and/or the project contractor(s) shall immediately halt potentially damaging activities in the area of the burial and notify the County Coroner and a qualified professional archaeologist to determine the nature and significance of the remains.

FIRE BEHAVIOR-RELATED STANDARD PROJECT REQUIREMENTS

FBE-1: The prescribed fire burn prescription shall be designed to initiate a surface fire of sufficient intensity that will only consume surface and ladder fuels. The prescribed fire burn prescription shall be designed and implemented to protect soil resources from direct soil heating impacts. Soil damage will not occur as a result of this project.

FBE-2: A burn plan shall be created using the burn plan template. The burn plan shall include a fire behavior model output of BEHAVE or other fire behavior modeling simulation and performed by a fire behavior technical specialist (S-490 qualified). The burn plan shall be created with input from the vegetation project’s Battalion Chief and a fire behavior technical specialist (S-490 qualified).

FBE-3: The project coordinator shall run a First Order Fire Effects Model (FOFEM) to analyze fire effects. The results of the analysis shall be included with the Burn Plan. FOFEM calculates consumption of fuels, tree mortality, predicted emissions, GHG emissions, and soil heating.

FBE-4: Approximately two weeks prior to commencement of prescribed burning operations the project coordinator shall 1) post signs along the closest major road way to the project area describing the project, timing, and requesting for smoke sensitive persons in the area to contact the project coordinator; 2) publish a public interest notification in a local newspapers describing the project, timing, and requesting for smoke sensitive persons in the area to contact the CAL FIRE project coordinator; 3) send the local county supervisor a notification letter describing the project, its necessity, timing, and summarize the measures being taken to protect the environment and prevent escape; and 4) develop a list of smoke sensitive persons in the area and contact them prior to burning.

GEOLOGIC STANDARD PROJECT REQUIREMENTS

GEO-1: An RPF or licensed geologist shall assess the project area for unstable areas and unstable soils as per 14 CCR 895.1 of the California Forest Practice Rules. Guidance on identifying unstable areas is contained in the California Licensed Foresters Association *Guide to Determining the Need for Input From a Licensed Geologist During THP Preparation* and California Geological Survey (CGS) Note 50 (see Appendix C). Priority will be placed on assessing watercourse-adjacent slopes greater than 50%. If unstable areas or soils are identified within the project area, are unavoidable, and are potentially directly or indirectly affected by the project operations, a licensed geologist (P.G. or C.E.G.) shall conduct a geologic assessment to determine the potential for project-induced impacts and mitigation strategies. Project shall incorporate all of the recommended mitigations. Geologic reports should cover the topics outlined in CGS Note 45 (see Appendix C).

GEO-2: The potential impacts of prescribed fire on geologic processes shall be reduced by following the Fire Behavior-related SPRs FBE-1, FBE-2, and FBE-3.

HAZARDS AND HAZARDOUS MATERIAL-RELATED STANDARD PROJECT REQUIREMENTS

HAZ-1: Prior to the start of vegetation treatment activities, the project coordinator shall conduct an Envirofacts web search to identify any known contamination sites within the project area. If a proposed vegetation treatment project occurs in areas located on the DTSC Cortese List, no activities shall occur within 100 feet of the site boundaries.

HAZ-2: Prior to the start of vegetation treatment activities, the project coordinator or contractor shall inspect all equipment for leaks and regularly inspect thereafter until equipment is removed from the site.

HAZ-3: Prior to the selection of treatment activities, CAL FIRE shall determine if there are viable, cost-effective, non-herbicide treatment activities that could be implemented prior to the selection of herbicide treatments.

HAZ-4: Prior to the start of herbicide treatment activities, the project coordinator shall prepare a Spill Prevention and Response Plan (SPRP) to provide protection to onsite workers, the public, and the environment from accidental leaks or spills of herbicides, adjuvants, or other potential contaminants. This plan shall include (but not be limited to):

- A map that delineates VTP staging areas, where storage, loading, and mixing of herbicides will occur
- A list of items required in a spill kit onsite that will be maintained throughout the life of the project
- Procedures for the proper storage, use, and disposal of any herbicides, adjuvants, or other chemicals used in vegetation treatment

HAZ-5: If remediation of hazardous contamination is needed, the project coordinator shall hire a licensed contractor with expertise in performing such work. The contractor shall comply with all laws and regulations governing worker safety and the removal and disposal of any contaminated material.

HAZ-6: All pesticide use shall be implemented consistent with Pest Control recommendations prepared annually by a licensed Pest Control Advisor.

HAZ-7: All appropriate laws and regulations pertaining to the use of pesticides and safety standards for employees and the public, as governed by the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, and local jurisdictions shall be followed. All applications shall adhere to label directions for application rates and methods, storage, transportation, mixing, and container disposal. All contracted applicators shall be appropriately licensed by the state. The project coordinator shall coordinate with the County Agricultural Commissioners, and all required licenses and permits shall be obtained prior to pesticide application.

HAZ-8: Projects shall avoid herbicide treatment in areas adjacent to water bodies and riparian areas. Application of herbicides shall be outside the WLPZ and ELZ as specified in HYD-3, or at the distances set forth in the herbicide label requirements, whichever is greater. No aerial spraying of herbicides shall occur under this Program EIR.

HAZ-9: The following general application parameters shall be employed during herbicide application:

- Application shall cease when weather parameters exceed label specifications, when sustained winds at the site of application exceeds seven miles per hour (MPH), or when precipitation (rain) occurs or is forecasted with greater than a 40 percent probability in the next 24-hour period to prevent sediment and herbicides from entering the water via surface runoff

- Spray nozzles shall be configured to produce a relatively large droplet size
- Low nozzle pressures (30-70 pounds per square inch [PSI]) shall be observed
- Spray nozzles shall be kept within 24 inches of vegetation during spraying.

Drift avoidance measures shall be used to prevent drift in locations where target weeds and pests are in proximity to special status species or their habitat. Such measures can consist of, but would not be limited to, the use of plastic shields around target weeds and pests and adjusting the spray nozzles of application equipment to limit the spray area.

HAZ-10: All herbicide and adjuvant containers shall be triple rinsed with clean water at an approved site, and the rinsate shall be disposed of by placing it in the batch tank for application per 3 CCR § 6684. Used containers shall be punctured on the top and bottom to render them unusable, unless said containers are part of a manufacturer’s container recycling program, in which case the manufacturer’s instructions shall be followed. Disposal of non-recyclable containers will be at legal dumpsites. Equipment would not be cleaned and personnel would not bathe in a manner that allows contaminated water to directly enter any body of water within the treatment areas or adjacent watersheds. Disposal of all pesticides shall follow label requirements and local waste disposal regulations.

HAZ-11: Storage, loading and mixing of herbicides shall be set back at least 150 feet from any aquatic feature or special status species or their habitat or sensitive natural communities.

HAZ-12: Appropriate non-toxic colorants or dyes shall be added to the herbicide mixture where needed to determine treated areas and prevent over-spraying.

HAZ-13: For treatment activities located within or adjacent to public recreation areas, signs shall be posted at each end of herbicide treatment areas and any intersecting trails notifying the public of the use of herbicides. The signs shall consist of the following information: signal word, product name, and manufacturer; active ingredient; EPA registration number; target pest; treatment location; date and time of application; date which notification sign may be removed; and contact person with telephone number. Signs shall be posted at the start of treatment and notification will remain in place for 72 hours after treatment ceases.

HAZ-14: All heavy equipment shall be required to include spark arrestors or turbo chargers that eliminate sparks in exhaust and have fire extinguishers onsite.

HYDROLOGIC AND WATER QUALITY-RELATED STANDARD PROJECT REQUIREMENTS

HYD-1: The project shall comply with all applicable water quality requirements adopted by the appropriate Regional Water Quality Control Board and approved by the State Water Board (i.e., Basin Plan).

HYD-2: During the planning phase the project coordinator shall submit a standard letter to the appropriate RWQCB containing the following:

- A written description of the project location and boundaries.
- Brief narrative of the project objectives.
- A description of the types of activities used in the project (e.g., prescribed burning, mastication) and associated acreages.
- A project and general location map. Project map shall be of sufficient scale to indicate the spatial extent of activities within the project area.
- Notification of whether the project drains directly into an impaired water body, and the type of water quality constituent(s) that is impairing the water body.
- A request for information and recommendations regarding the potential for significant water quality impacts from the proposed project and an offer to schedule a day to visit the project area with the project coordinator. The project shall incorporate the recommendations that prevent significant impacts to water quality as PSRs.

HYD-3: A WLPZ shall be established on each side of all Class I and II watercourses that is equal to the standard widths specified in the current California Forest Practice Rules (**Error! Reference source not found.**). Fifty foot equipment limitation zones (ELZs) shall be established for Class III watercourses. Vegetation within the WLPZ or ELZ will not be disturbed by project activities, with the exception of backing prescribed fire. Class IV watercourse protections shall be PSRs specified in the PSA, and designed in conjunction with any recommendations from RWQCB staff.

Watercourse and lake protection zone buffer widths by watercourse classification and hill slope gradient (See HYD -3)

Note: ELZ-Equipment Limitation Zone, PSR-Project Specific Requirement

Water Class Characteristics or Key Indicator / Beneficial Use	1)Domestic supplies, including springs, on site and/or within 100 feet downstream of the project area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning	1) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for non-fish aquatic species. 3) Excludes Class III water that are tributary to Class I waters	No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II water under normal high water flow conditions of timber operations	Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use
Water Class	Class I	Class II	Class III	Class IV
Slope Class (%)	Width (ft.)	Width (ft.)	Width (ft.)	Width
<30	75	50	50 (ELZ)	PSR
30-50	100	75	50 (ELZ)	PSR
>50	150	100	50 (ELZ)	PSR

HYD-4: No direct ignition shall be allowed within the WLPZ or ELZs. However, it is acceptable for a fire to enter or back into a WLPZ's or ELZ's.

HYD-5: Compacted and/or bare linear treatment areas (e.g., fire breaks, roads, or trails) capable of generating storm runoff shall be drained via water breaks using the spacing guidelines contained in Sections 914.6, 934.6, and 954.6(c) of the California Forest Practice Rules.

HYD-6: Compacted and/or bare treatment areas shall be drained such that they are hydrologically disconnected from watercourses or lakes. Measures to hydrologically disconnect these areas shall be guided by consulting with Technical Rule Addendum #5 of the California Forest Practice Rules – Guidance on Hydrologic Disconnection, Road Drainage, Minimization of Diversion Potential, and High Risk Crossings

HYD-7: No high ground pressure vehicles shall be driven through project areas when soils are wet and saturated to avoid compaction and/or damage to soil structure. Saturated soil means that soil and/or surface material pore spaces are filled with water to such an extent that runoff is likely to occur. Indicators of saturated soil conditions may include, but are not limited to: (1) areas of ponded water, (2) pumping of fines from the soil or road surfacing material during timber operations, (3) loss of bearing strength resulting in the deflection of soil or road surfaces under a load, such as the creation of wheel ruts, (4) spinning or churning of wheels or tracks that produces a wet slurry, or (5) inadequate traction without blading wet soil or surfacing materials.

HYD-8: For remaining hydrologically connected areas of compacted or bare linear treatment areas, disturbed areas will be mulched with onsite native vegetative material (e.g., cut material).

HYD-9: During dry, dusty conditions, unpaved roads shall be wetted using water trucks or treated with a non-toxic chemical dust suppressant (e.g., emulsion polymers, organic material). Any dust suppressant product used shall be environmentally benign (i.e., non-toxic to plants and shall not negatively impact water quality) and its use shall not be prohibited by the ARB, U.S. Environmental Protection Agency (EPA), or the State Water Resources Control Board. Exposed areas shall not be over-watered such that water results in runoff. The type of dust suppression method shall be selected by the contractor based on soil, traffic, site-specific conditions, and local air quality regulations.

HYD-10: Prior to the start of onsite activities, all equipment will be inspected for leaks and regularly inspected thereafter until equipment is removed from the project area. All contaminated water, sludge, spill residue, or other hazardous compounds will be contained and disposed of outside the boundaries of the site, at a lawfully permitted or authorized destination.

HYD-11: Staging areas shall be designated and located to prevent leakage of oil, hydraulic fluids, or other chemicals into watercourses or lakes.

HYD-12: All heavy equipment parking, refueling, and service shall be conducted within designated areas outside of the WLPZ or ELZ.

HYD-13: No new roads (including temporary roads) shall be constructed or reconstructed (reconstruction is defined as cutting or filling involving less than 50 cubic yards/0.25 linear road miles). Existing roads, skid trails, fire lines, fuel breaks, etc. that require reopening or maintenance shall have drainage facilities applied at the conclusion of the project that are at least equal to those of the California Forest Practice Rules.

HYD-14: Heavy equipment is prohibited on slopes exceeding 65 percent or on slopes greater than 50 percent where the erosion hazard rating is high or extreme. Heavy equipment is prohibited on slopes greater than 50 percent that lead without flattening to watercourses.

HYD-15: Burn piles shall not exceed 20 feet in length, width, or diameter, except when on landings, road surfaces, or on contour.

HYD-16: At the CalWater Planning Watershed scale, if the combined, appropriately-weighted acreage subjected to fuels treatments and logging exceed 20% of the watershed area within a 10-year timespan (see Appendix K for calculation procedures); an analysis will be performed to determine the potential for hydrologically-induced significant impacts of the proposed activity.

HYD-17: If herbivory is proposed to treat vegetation in a project area containing watercourses, then the following items must be addressed as PSRs:

- The project will require water on site in the form of an on-site stock pond outside the WLPZ or ELZ, or a portable water source located outside the WLPZ or ELZ.
- The project will specify animal containment measures in the PSA to prevent animals from entering the WLPZ and/or ELZs. These might include the use of fencing (i.e., fixed or portable), the use of guard or herd dogs, or the use of an on-site herder.

NOISE-RELATED STANDARD PROJECT REQUIREMENTS

NSE-1: All powered equipment shall be used and maintained according to manufacturer's specifications.

NSE-2: Equipment engine shrouds shall be closed during equipment operation.

NSE-3: All heavy equipment and equipment staging areas shall be located as far as possible from nearby noise-sensitive land use (e.g., residential land uses, schools, hospitals, places of worship).

NSE-4: All motorized equipment shall be shut down when not in use. Idling of equipment or trucks shall be limited to 5 minutes.

NSE-5: Public notice of the proposed project shall be given to notify noise-sensitive receptors of potential noise-generating activities.

TRAFFIC-RELATED STANDARD PROJECT REQUIREMENTS

TRA-1: Public road ways leading into project area shall be signed to warn traffic of the project activities that are taking place. Road signage shall be posted the morning prior to the commencement of burning operations and shall remain until all operations are completed.

TRA-2: Direct smoke and dust impacts to roadway visibility and the indirect distraction of operations shall be considered during burning operations. Traffic control operations shall be implemented if weather conditions inhibiting smoke and dust dispersion have the potential to impact roadway visibility to motorists.

I.5.3 PHOTO POINT MONITORING

VTP Project Name or Number:				**Photographer:**		
Camera Type/Brand:				**Date:**		
Photo Point #	**Pre or Post Project**	**Location Description**	**GPS Coordinates**	**Heading**	**Photo #**	**File Saved As:**
Enter photo point #	Enter "Pre" or "Post" for project status	Describe where the photograph was taken and what feature(s) it's capturing	Coordinates (decimal degrees)	Enter compass heading	Enter # from digital camera	Enter file name as described in the protocol

I.5.4 FOR THE VTP PHOTO-POINT MONITORING DATA SHEET, RECORD THE FOLLOWING ITEMS:

VTP Project Name or Number:

Photographer: Last name of inspector or biologist

Camera Type/Brand: Record whether the camera used is smartphone or digital camera and the brand (ie, Smartphone, Samsung Galaxy S5 or Digital camera, Canon Powershot S110). It is important to use the same camera for pre-project and post-project photos.

Photo Point #: Record the number of the photo point. When returning for the post-project photo, return to the same photo point number location. Additionally, mark the photo point location on a copy of the project map.

Pre or Post Project: Record whether the photo is capturing “Pre” or “Post” project.

Location Description: Provide a brief description of the location from which the photo is being taken and provide any landmarks associated with the location - downed log, 3rd fence post, road markers, etc.

GPS Coordinates: Record GPS coordinates, preferably in decimal degrees.

Heading: Provide a compass heading for the direction in which the photo was taken. Take photos straight on when feasible and avoid taking photos pointed up to the canopy or down to the ground with an azimuth greater than 30% in either direction. If this can’t be achieved, then be sure to record the azimuth.

Photo #: Record the photo number from the smartphone or digital camera.

File Saved As: All digital photos shall be saved with the same naming convention that identifies the project, photo point, and project status.

Two photo-points are <u>required</u> for each activity type (e.g., prescribed burning, mechanical, hand treatment, etc) implemented in a project area. For example, if prescribed burning is utilized, then two series of pre- and post-treatments are required from different locations for that activity type. The two sets of photo-points should represent the range of fuel conditions in the project area treated by a particular activity type.

Voluntary pre- and post-treatment photo-points are also encouraged to be taken around:

- Habitat retention areas

- Watercourse and Lake Protection Zones and/or Equipment Limitation Zones
- Archaeological sites within the project area
- Unstable areas, if any are within the project area

It is best to take photos when light is optimal, such as in the early morning, late afternoon, or slightly overcast. Avoid taking photos when the visibility is poor such as in the rain, fog, or snow. Take photos with the sun at your back, when feasible. It is important to check each photo to determine if it is clear enough and provides enough detail to capture the necessary features.

I.5.5 INTERACTION REPORT

INTERACTION REPORT

THE PETERSON FIRE
(CAFKU 008548)

and

THE CRESSMAN FUEL MODIFICATION ZONE

July 12 – 15, 2004

Intro

The Peterson Fire was a wildland fire reported at 1205 hours on July 12, 2004 in Eastern Fresno County. As the initial attack Incident Commander, Battalion Chief Jim Smith, arrived at the scene, he found the fire rapidly spreading uphill threatening structures above and on each flank. The fire was burning in a mix of chaparral and timber mid-slope on a south aspect. Fuel moistures from surrounding counties indicate that the current fuel moistures were at least one month ahead of normal and were at or near critical levels. The 1200 hour weather reported at the Mountain Rest RAWS Station approximately 2 miles northwest of the incident at roughly the same elevation was as follows: Temperature 89 degrees Fahrenheit, wind southwest at 5 – 11 mph, relative humidity 17% and fuel moisture 4.7%. The fire was rapidly spreading towards the recently completed Cressman Road Fuel Modification Zone (FMZ).

Battalion Chief Jim Smith had these words to help explain how he considered and incorporated the Cressman Road FMZ into his incident strategy and tactics:

As Incident Commander on the Peterson Fire, the Cressman Fuel Modification Project provided me with:

1) *The confidence that the head of the fire would be stopped or slowed when it reached the FMZ;*
2) *That it would serve as a safe point of attack for firefighters even at the head of the fire;*
3) *That firefighters could "anchor-in" at the FMZ and safely make a downhill hoselay along the flank of the fire;*
4) *It significantly reduced the number of firefighting resources ordered for the incident;*
5) *Fire intensities and subsequent resource damage was significantly reduced in the FMZ compared to the non-treated areas in the fire perimeter.*

Background

CRESSMAN ROAD FUEL MODIFICATION ZONE

The California Department of Forestry and Fire Protection (CDF), in cooperation with the Pine Ridge Property Owners Association, the Highway 168 Fire Safe Council and the California Department of Corrections developed the Cressman Road FMZ. A FMZ is also commonly referred to as a shaded fuel break. A FMZ is an area where selected vegetation has been removed in such a way as to break the horizontal and vertical continuity of forest fuels.

The Cressman FMZ project is located along the Cressman Road in the Pine Ridge Area of eastern Fresno County below Shaver Lake. The project elevation ranges from 4,600 to 5,000 feet and is located mid-slope on a mostly southern aspect. The subdivision consists of approximately 75 residences on 113 parcels. The dwellings are a mix of seasonal and year-round use. The Cressman Road FMZ involved 60 parcels and 57 different landowners.

The purpose of this project was to try and increase the level of safety for both residents and firefighters that may be entering and/or leaving the Cressman Road area under wildfire conditions.

This increased level of safety has been achieved through the selective removal of vegetation along Cressman Road. The Cressman Road area was selected for this project because of several reasons:

1) The Fresno/Kings Unit of the California Department of Forestry and Fire Protection has identified the Pine Ridge area as a priority area for fuel reduction projects. This area was selected as a priority because of its high fuel loading, its potential for a large damaging fire and its high population density intermixed within the wildland.
2) The Highway 168 Fire Safe Council has identified the Pine Ridge area as a priority area for fuel reduction projects for similar reasons.
3) Cressman Road is a single lane road, open to the public, which accesses approximately 113 parcels and 75 residences.
4) At the initial discussion stages of this project, the Pine Ridge Property Owners Association expressed interest in and support of the proposed project.

This project was paid for by funding from the California Department of Forestry and Fire Protection as well as grant funding from the US Forest Service through the National Fire Plan. The Fresno/Kings Unit of the California Department of Forestry and Fire Protection was awarded the funding to complete the multi-year project.

Participation in this project was completely voluntary on the part of landowners. Landowners participating in the project needed to sign an agreement with CDF prior to any work being done on their property. There was no cost to landowners that participated.

Inmate firefighting crews, under the supervision of CDF personnel were utilized to develop the FMZ. These crews utilized chainsaws and hand tools to selectively remove vegetation within the project area. The vegetation that was removed was either piled and burned during safe conditions or chipped by the crews.

The FMZ extends along Cressman Road and Lower Cressman Road from Highway 168 to the National Forest boundary. In addition, it includes approximately the first quarter mile of Upper Cressman Road. Within the FMZ, vegetation was selectively removed within approximately 200 feet of either side of the roadway. This zone width varied based on topographic features and vegetation conditions. Consideration was given to screening of homes located within and/or adjacent to the zone.

Treatment Prescription

As stated above, this project selectively removed un-merchantable vegetation in order to break the horizontal and vertical continuity of forest fuels. The following specifications applied to vegetation removal:

1) Trees removed did not exceed a nine (9) inch diameter at breast height (DBH) i.e. 4.5 feet above the ground.
2) Trees were removed in order to eliminate fuel ladders and achieve crown separation.
3) Trees saved were selected based on the following criteria:
    a. Straight trunk with no defects, generally healthy and free of insects or disease.
    b. Save trees were selected in the following order of preference: black oak, ponderosa pine, sugar pine, Douglas-fir, white fir, incense cedar.

4) Remaining trees were pruned as follows:
    a. Trees under a six (6) inch DBH retained a minimum of a 50% live crown.
    b. Trees over a six (6) inch DBH were pruned to ten (10) feet above the ground.
5) The majority of brush was removed so as to achieve a separation of horizontal fuels.
6) Down trees and logs on the ground were removed when feasible.

Removed vegetation was piled and burned and/or chipped. Burn piles were located away from watercourses and residual trees. All pile burning was conducted in accordance with Air Pollution Control District regulations.

Future project maintenance will involve removal of vegetative re-growth, additional thinning and additional pruning. It is anticipated that individual landowners will be able to do the bulk of the project maintenance now that the initial development phase is over.

Cressman Road FMZ Project Costs

Various funding sources were used to complete the project. The first source of funds was from Fuel Load Reduction funding provided to CDF by the California State Legislature in Fiscal Year 1999. The next source of funds were from two Wildland Urban Interface Grants provided by the National Fire Plan and administered by the U.S. Forest Service.

1999 CDF funds:	$ 3,000.00
2001 WUI funds:	$53,548.61
2002 WUI funds:	$36,660.67
Total:	$93,209.28

$93,209.28 / 151 acres treated = $617.28 per acre treatment costs

These funds do not include budgeted personnel time.

Cost Effectiveness

Peterson Fire Suppression costs: $1.4 million
$1.4 million / 73 acres = **$19,178 per acre fire suppression cost**
Cressman FMZ Costs: $93,209.28
$93,209 / 151 acres = **$617 per acre FMZ treatment cost**
Estimated Potential Loss w/o Cressman Road FMZ: $65 million*

The cost effectiveness of fuel load reduction projects is often questioned. When the cost of a project is compared to the cost of an extended attack wildfire, the initial up-front costs of a project become justifiable.

*Estimated potential fire size of 1,500 acres. Estimated 200 homes within the 1,500 acres. Conservative average home value of $325,000. Does not include watershed or infrastructure values.

Fire Behavior

US Forest Service Battalion Chief, David Cooper observed the fire behavior as the fire approached the FMZ. He stated that the fire was torching in single trees with short crown runs as it approached the FMZ. Once the fire reached the FMZ the fire dropped to the surface and ground fuels and slowly spread through the FMZ until it reached Cressman Road. Battalion Chief David Cooper also stated that there were in excess of 20 spot fires at the head of the fire. Most of the spot fires occurred in the FMZ and were easily observed and extinguished. One of the spot fires occurred along the left shoulder of the fire, outside of the FMZ. This spot fire grew to approximately one acre in size before it was noticed and extinguished.

The attached photos help document and validate the observed fire behavior. The most noticeable indicator is the lack of torched trees in the FMZ. In the untreated area, single trees and groups of trees torched with short crown runs consuming all of the available fuels. In the FMZ, the surface fuels, primarily bear clover, were consumed and the trees were only scorched.

Other Considerations

The ultimate credit for the success of the Cressman Road FMZ project belongs to citizens of the Pine Ridge Property Owners Association (PRPOA), the Pine Ridge Volunteer Fire Dept. and the Highway 168 Fire Safe Council.

The PRPOA listened to CDF’s concern for their area and was receptive of Battalion Chief, Bill Johnson’s proposal to create the FMZ. With encouragement from the Highway 168 Fire Safe Council, the PRPOA signed up for the FMZ project and implemented several other Pre-fire actions in their community. The PRPOA made road signs that identified addresses, escape routes and water sources. The PRPOA created an emergency manual that contained plans and information for emergencies in their community. The PRPOA also formed the Pine Ridge Volunteer Fire Department. In 2003 the PRPOA was awarded the National Bronze Smokey Bear Award for their accomplishments in Pre-fire planning and fire prevention.

Battalion Chief David Cooper also added that he observed incredible teamwork by the newly formed Pine Ridge Volunteer Fire Department personnel and the various paid and volunteer fire departments that responded to the fire. He felt that the close working relationship and preparedness training that the Pine Ridge Volunteer fire Department has conducted with CDF and US Forest Service through the Highway 168 Fire Safe Council paid off.

Conclusion

The Cressman Road FMZ has now been tested and was a success. The project was designed to provide safe ingress of fire suppression personnel and equipment while allowing for the safe egress of residents. The project was not designed to stop a fast moving high intensity fire but to provide for the opportunity to stop a low to moderate intensity fire. Many have asked if the Cressman Road FMZ stopped the Peterson Fire. The answer is that it did exactly what it was designed to do and that is allow for the opportunity to stop the fire by providing a relatively safe area to work from. The Cressman Road FMZ did not stop the Peterson Fire by itself, but became a tool that the Incident Commander was able to utilize to help stop the fire.

Questions and/or Further Information

For further information on the Peterson Incident, the Cressman FMZ Project or to clarify information, please contact:

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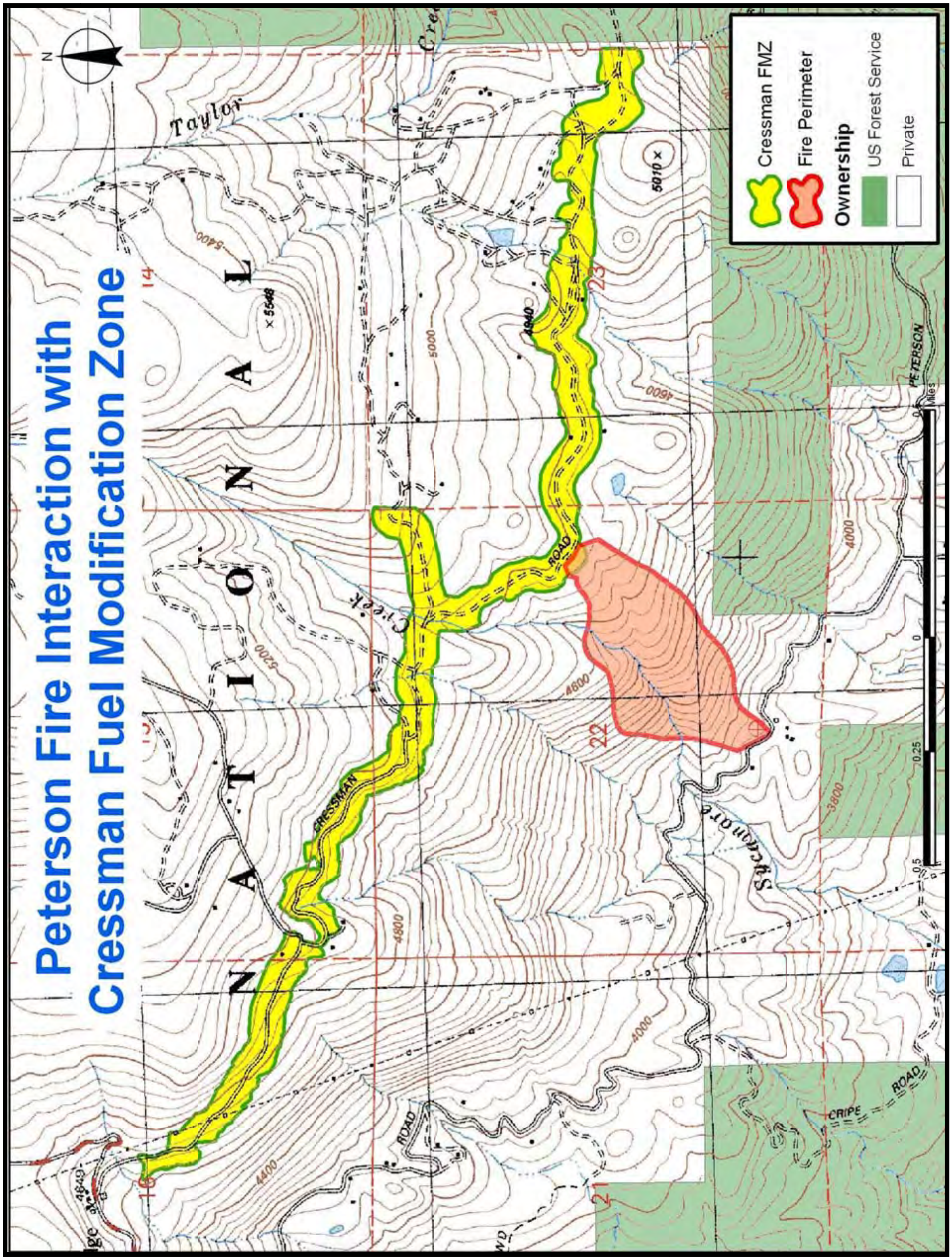
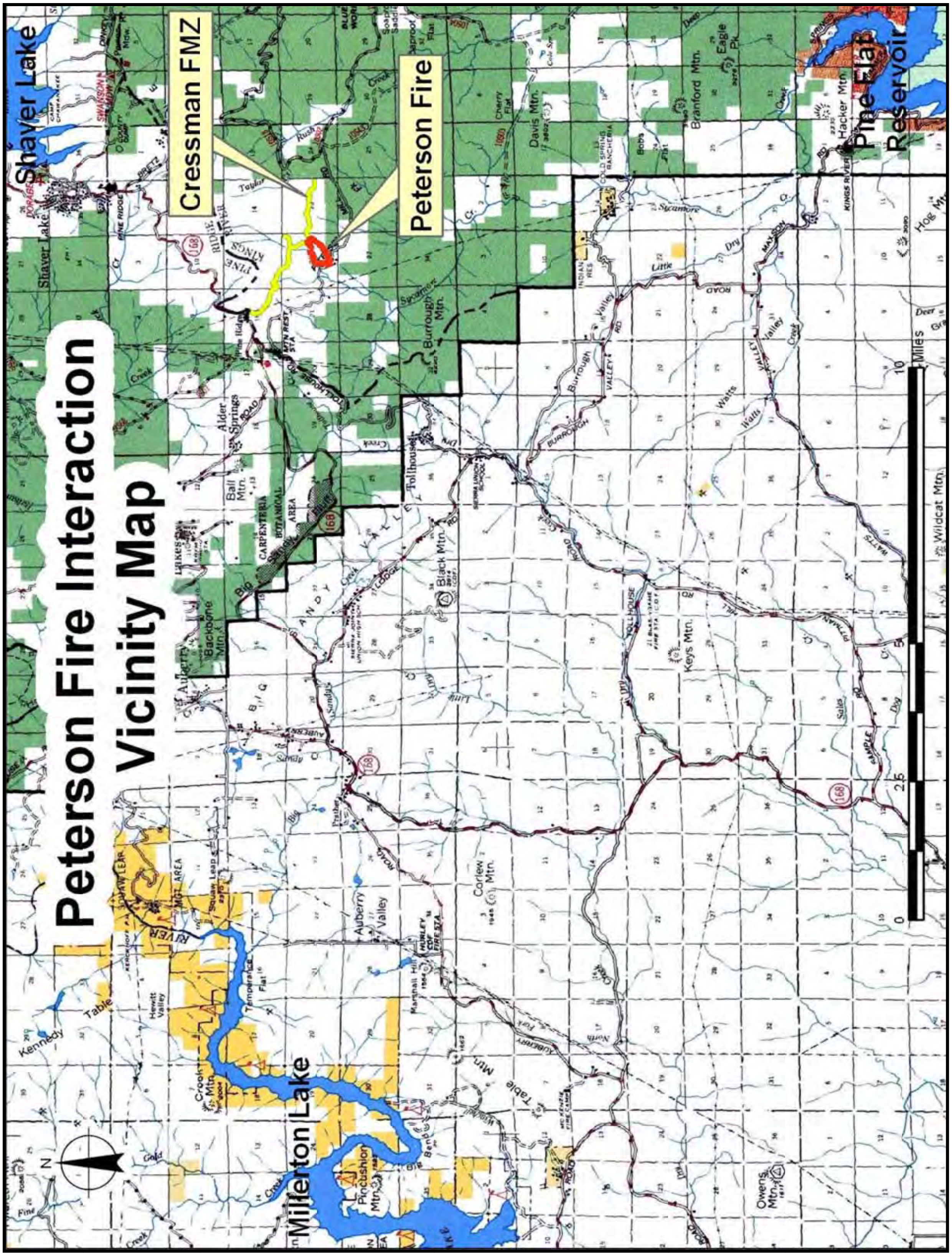

Peterson Fire Interaction with
Cressman Fuel Modification Zone
Cressman FMZ
Fire Perimeter
Ownership
US Forest Service
Private


Peterson Fire Interaction
Vicinity Map
Cressman FMZ
Peterson Fire
Shaver Lake
Millerton Lake
Pine Flat
Reservoir
N
0
2.5
5
10
Miles

Fire Area looking North

Unburned fuels next to fire line

Burned fuels next to fire perimeter

Burned fuels next to fire perimeter

Untreated fuels (torched trees) in foreground. FMZ in background. Divided by visible dirt road.

Example of burned ladder fuels in untreated area.

Scorch height in FMZ. No trees torched in FMZ

Scorch height in untreated area. Many trees torched in untreated area, a contributing factor to over 20 spot fires at the head of the fire.

Before FMZ treatment

After FMZ treatment

Before FMZ treatment

After FMZ treatment

Before FMZ treatment

After FMZ treatment

Before FMZ treatment

After FMZ treatment

J. PROJECT SCALE ANALYSIS BURN PLANNING

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VTP EIR Burn Plan

1.1 Project Identification:

A. DATE:

B. PROJECT NUMBER:

C. PROJECT NAME:

D. REGION:
UNIT:
COUNTY:
BATTALION:

E. PROJECT SPECIFICATIONS prepared by:

F. PROJECT ENVIRONMENTAL CHECKLIST prepared by:

G. LIST OF PARTICIPATING AGENCIES SIGNATORY TO THE "MULTI AGENCY AGREEMENT FOR COOPERATIVE USE OF PRESCRIBED FIRE":

H. LIST OF PARTICIPATING AGENCIES NOT SIGNATORY TO "MULTI AGENCY AGREEMENT FOR COOPERATIVE USE OF PRESCRIBED FIRE":

I. LIST OF PARTICIPATING PROPERTY OWNERS OR CONTROLLERS:

1.2 Burn Area Description:

A. PROJECT LOCATION:

B. PARCEL ZONING AND LAND USE DESCRIPTION:

C. PROJECT AREA TOTAL:

D. PROJECT AREA NET:

1.3 Environmental Setting and Impacts:

A. NARRATIVE DESCRIPTION OF THE PROPOSED PROJECT, OBJECTIVES AND TREATMENT METHODS:

B. PROJECT TOPOGRAPHY:

C. SOILS DESCRIPTION AND SENSITIVITY TO PROJECT ACTIVITIES:

D. VEGETATION COMMUNITY AND DOMINANT SPECIES:

E. WILDLIFE/FISHERIES HABITAT AND SENSITIVITY TO PROJECT ACTIVITIES:

F. CULTURAL RESOURCES AND SENSITIVITY TO PROJECT ACTIVITIES:

G. SMOKE AND COMMUNITY SENSITIVITY TO PROJECT:

H. IGNITION MAP/ CONTAINMENT MAP

1.4 <u>Burn Prescription:</u>

A. SCHEDULE:

B. FUEL DESCRIPTION:

1) FUEL MODEL(s):

2) VEGETATION LESS THAN 24" TALL:

3) VEGETATION GREATER THAN 24 INCHES TALL:

4) FUEL LOADING:

5) FUEL ARRANGEMENT:

6) FUEL CONTINUITY:

7) SURFACE FUEL DEPTH:

8) DUFF DEPTH:

C. FUEL CONSUMPTION PLANNED:

D. FUEL TREATMENT PLANNED:

E. NARRATIVE:

F. WEATHER AND FUEL MOISTURE:

1) WEATHER DATA COLLECTION:

a. LOCATION(S) /METHOD(S) OF DATA COLLECTION:

b. DATA TO BE COLLECTED:

c. SAMPLING PERIOD:

d. FORECASTS:

e. FORECASTING ENTITY:

f. SPECIFICATIONS, WARNINGS:

g. PROBABILITY OF ADVERSE WEATHER:

h. ADDITIONAL COMMENTS:

2) PRESCRIPTION FOR FUEL MOISTURE, WEATHER, AND SOILS

Provide allowable or acceptable range of values for the following fuel and weather characteristics.

a. RELATIVE HUMIDITY (%):

b. AIR TEMPERATURE (DRY BULB °F):

c. WIND DIRECTION:

d. WIND SPEED (mph):

e. FUEL MOISTURE:

f. SOIL MOISTURE:

g. DUFF MOISTURE:

1.5 <u>Fire Behavior Predictions:</u>

A. Provide outputs generated by fire behavior calculations (i.e. BEHAVE) using the determined environmental parameters as variables.

1) FIRE LINE INTENSITY (BTUs/foot/second): Target, Maximum.

2) RATE OF SPREAD (chains/hour): Head and Backing.

3) FLAME LENGTH (feet): Target and Maximum.

4) SCORCH HEIGHT: (feet): Target, Maximum.

5) PROBABILITY OF IGNITION: Target, Acceptable.

6) BURNOUT TIME (Hours): Target, Acceptable.

7) OTHER:

8) FIRE BEHAVIOR NARRATIVE:

Specific Resource Review questions -

Water Resources:

Will the removal of vegetative cover result in increased water runoff on slopes and subsequent adverse effects on water quality or other resources? ______

MITIGATION(s):

___ Geologic hazard areas will not be burned.

OTHER CONDITIONS:

___ Physical conditions are such that there will be no increased runoff resulting from the project.

___ There is an existing buffer strip of vegetation between the project site and any water course that will prevent degradation of water quality or watershed values.

___ There are no beneficial uses in the vicinity of this project that will be adversely affected by increased runoff.
___ Additional reasons:

If burning in a perennial watercourse, lake, or reservoir, will the removal of vegetative cover or other phases of the proposed project significantly increase turbidity or deposition of sediment? _____

MITIGATION(S):

A CDFW biologist has been asked to review the project and provided the following comments:

___ CDFW does not anticipate adverse effects to waterbodies as a result of this project as proposed.
___ Recommendations have been incorporated in the project design to prevent adverse impacts to water bodies present in the project area (See below under "Other Conditions").
___ Large areas will not be burned within a short time period, nor will the project be conducted in geologic hazard areas, sandy or shallow soils. High intensity fires will be avoided.
___ Areas where high intensity fire destroys seed stock or adversely alters soil structure will be seeded afterward with herbaceous species.
___ Project design was modified to reduce impact on domestic and instream water resources.
___ Riparian vegetation will not be disturbed.

OTHER CONDITIONS:

___ There is no perennial watercourse, lake, or reservoir in the vicinity of the project.
___ There is an existing buffer strip of vegetation between the project site and any water course that will prevent degradation of water quality or watershed values.
___ CDFW recommendations:
___ Additional reasons:

If removal of watercourse shading is planned, will this project cause a significant increase in water temperature that is detrimental to fish? ______

MITIGATION(S):

___ Riparian vegetation will be not be disturbed.

___ Any vegetation affecting maintenance of stream shade and temperature will not be disturbed.

OTHER CONDITIONS:

___ There are no watercourses in the vicinity of the project.
___ Additional reasons:

If using heavy equipment on unstable soils, will this project cause land- slides or slope failure? _____

MITIGATION(S):

___ Heavy equipment will not be allowed on current or potential slide areas.

OTHER CONDITIONS:

___ There are no known unstable soils in the project area.
___ Additional reasons:

Will this project cause slash or woody debris to be deposited in a watercourse, lake or reservoir? _____

MITIGATION(S):

___ All watercourses and areas below lake transition zone will be kept free of slash and debris. Accidental deposits will be cleaned up. (Needed erosion control structures, such as gully plugs or erosion control devices may be installed to prevent accelerated erosion as needed.)

OTHER CONDITIONS:

___ There are no watercourses, lakes or reservoirs in the project area.
___ There is an existing buffer strip of vegetation between the project site and any water course that will prevent degradation of water quality or watershed values.
___ Additional reasons:

Are there any other circumstances or site conditions present in this project as designed that have not been mitigated to avoid adverse impacts on water quality? _____

MITIGATION:

___ Article 6 of the Program Regulations (Resource Protection Guidelines) will be followed. The site-specific measures to be applied under Article 6 are listed below under "Other Conditions".

OTHER CONDITIONS:

___ Additional reasons:

Soils and Water Quality:

If this project will use a heavy disk, root or brush rake or dozer blade, and/or if this project incorporates low-blade crushing, anchor chaining, or ball-and-chaining of vegetation such as for fuel treatment or control line construction; will this project result in excessive soil disturbance, soil compaction, accelerated erosion or soil deposition in watercourses?

_____

MITIGATION(S):

___ Heavy equipment use will be minimized on slopes over 35%.
___ No heavy equipment, soil, or brush berms will be allowed within 50 feet of a watercourse or lake transition zone.
___ Slopes that present geologic or safety hazards have been identified and will be avoided.
___ These methods of pre-treatment will be used on no more of the project area than is necessary for safety, as determined by the CAL FIRE Regional Chief.
___ Equipment will not be allowed on soils when the moisture content is at/or above field capacity.
___ Brush removed from slopes will be windrowed along the contour and disposed of by burning or by other appropriate methods that leave effective berms of residual soil to impede surface water flow.
___ Buffer strips of vegetation will be left between treated areas and watercourses.
___ Vegetation in natural drainages will be left to trap sediment.
___ These methods will not be used in mid-late spring when the soil erosion potential from spring rains is high and corresponds with ineffectual treatment of young brush stands with a high moisture content.
___ Area will be drill-seeded with herbaceous species on contour in the Fall to reduce surface flow.

OTHER CONDITIONS:

___ Heavy equipment will not be used.
___ There is no watercourse, lake, or reservoir in the vicinity of the project.
___ Additional reasons:

SOIL STABILITY:

Will the project disturb any geologic hazard areas within or adjacent to the project? _____

MITIGATION:

___ Geologic hazard areas are marked and will be avoided.

OTHER CONDITIONS:

___ No geologic hazard areas were identified within the project area.
___ Additional reasons:

Vegetation:

If burning large areas of mature chaparral vegetation during winter or spring: will this project cause low regeneration and depletion of available wildlife forage? ______

MITIGATION(S):

___ No more of the project area will be burned than is necessary for fire safety, as determined by the CAL FIRE Regional Chief.
___ Areas of the project have been reserved for summer or fall burning to allow propagation of herbaceous plants.
___ The burn is located on ridge tops and/or canyon bottoms to minimize impacts to wildlife habitat.
___ The project will be burned in a pattern to create and maintain a mosaic of old and young growth with diverse habitat structure.

OTHER CONDITIONS:

___ Large areas of mature chaparral will not be burned in winter or spring.
___ Additional reasons:

If burning dense stands of chaparral occurring upon woodland soils in winter or spring: will this project which could cause significant adverse effects on plant regeneration and loss of wildlife habitat and oak woodlands? _____

MITIGATION:

___ No more of the project area will be burned than is necessary for fire safety, as determined by the CAL FIRE Regional Chief.
___ Landowner to re-seed if regeneration not apparent after burn, or if burn vegetation loss is greater than desired.

___ Trees will be protected through use of a cool prescription and/or clear around trees for protection.

OTHER CONDITIONS:

___ Dense stands of chaparral will not be burned in winter or spring.
___ Additional reasons:

Will burning in summer or fall cause a significant loss of wildlife habitat and/or damage to oak woodlands? _____

MITIGATION:

___ Area will be re-seeded if regeneration not apparent after burn, or if burn vegetation loss is greater than desired.
___ Trees will be protected through use of a cool prescription and/or clearing around trees for protection.
___ Burn will maintain islands and strips of chaparral to provide thermal protection and escape cover for wildlife.

OTHER CONDITIONS:

___ Dense stands of chaparral will not be burned in summer or fall.
___ The project will incorporate the Department of Fish and Game's recommendation to maintain forty percent cover for wildlife habitat.
___ Additional reasons:

If burning in areas with oak or conifer overstory: will this project result in undesired adverse effects on conifer and/or oak tree survival? _____

MITIGATION:

___ Conifer and/or oak trees will be protected through use of cooler prescriptions and/or chaparral understory will be cleared away from trunks.

OTHER CONDITIONS:

___ This project does not have a forest overstory.
___ Project will intentionally eliminate existing conifer/oak vegetation as part of a plan to prepare the site for reforestation.
___ Additional reasons:

Habitat:

Will the proposed project result in a reduction in oak trees that could adversely affect wildlife habitat, species diversity, or a cumulative lack of oak regeneration in the area? _____

MITIGATION:

The project has been reviewed by a biologist from DFG who has determined:

___ There are no significant undesired effects to oaks or oak-related habitat in the project as proposed.
___ The project incorporates wildlife/hardwood retention guidelines that maintains habitat diversity (see Other Conditions").
___ Landowner will protect oak seedlings from livestock grazing while regeneration is occurring.
___ Landowner will plant oaks when natural regeneration fails.
___ Landowner will seed with large seed-producing forbs to replace lost forage seed mast.
___ Fire will be low-intensity and is not expected to harm trees.

OTHER CONDITIONS:

___ Oaks are not present in the project area.
___ DFG recommendations:
___ Additional reasons:

Wildlife:
Will this project result in significant detrimental effects on wildlife habitat by creating a large homogeneous ecotone with no mosaic or strips of unburned vegetation? _____

MITIGATION(S):

___ The project will be burned in a pattern to create and maintain a mosaic of old and young growth with diverse habitat structure.
___ The area will be seeded with a variety of forbs to enhance the ground cover and available wildlife forage (include in Cost-Share description).
___ Spring burning will be avoided because plant species diversity might be adversely affected in such a large burn.
___ Adjacent areas will be burned only after project site recovers sufficiently to create a pattern of young and old growth with diverse habitat structure.

OTHER CONDITIONS:

___ Additional reasons:

Will any rare or endangered plant or animal species be adversely affected by this project? _____

MITIGATION:

The project has been reviewed by biologists from the Department of Fish and Wildlife and/or federal agency and...

___ There are no known rare or endangered plant or animal species in or adjacent to the project area.

___ Recommendations have been incorporated into the project design to avoid adverse environmental impacts to wildlife (see "Other Conditions").

OTHER CONDITIONS:

___ CDFW/USFWS recommendations:

___ Additional reasons:

Could burning this project as planned cause significant negative impacts to known and occupied habitats of rare, endangered, threatened, or sensitive species? _____

MITIGATION:

Project has been reviewed by biologists from the Department of Fish and Wildlife, U.S. Fish and Wildlife Service, or other federal agency...

___ The project area and vicinity is not known or suspected of being used by species of plants or animals so classified.

___ Recommendations have been incorporated into the project design to avoid adverse environmental impacts to known or potential wildlife habitat (see "Other Conditions").

OTHER CONDITIONS:

___ CDFW/USFWS recommendations:

___ Additional reasons:

Will the proposed project disrupt critical deer migration corridors or critical habitats of any game species?_____

MITIGATION:

A biologist from CDFW has reviewed this project and has concluded that:

- ___ This project does not contain known deer migration corridors or other critical habitats of any game species.
- ___ No adverse impacts to critical habitat are anticipated from burning this project as proposed.
- ___ Recommendations have been incorporated into the project design to avoid damage to habitat (see "Other Conditions")
- ___ Twenty percent of the area will be replanted with grasses and forbs to restore wildlife habitat.

OTHER CONDITIONS**:**

- ___ CDFW recommendations:

- ___ Additional reasons:

If burning in or adjacent to areas classified as wetlands or riparian zones: will this project result in undesired changes in vegetation character or other adverse impacts to riparian plants, fish, or wildlife habitat? _____

MITIGATION:

DFG biologists have inspected the area and concluded that:

- ___ The proposed burn will not cause undesired changes in riparian plants, fish, or wildlife habitat.
- ___ That by incorporating their recommendations the burn will not adversely affect fish, wildlife, or the vegetation character of riparian or wetland areas (see recommendations under "Other Conditions".)

OTHER CONDITIONS:

- ___ The project is not in or adjacent to any known wetland or riparian zone.
- ___ DFG recommendations:
- ___ Additional reasons:

Air quality:

Will smoke from the project create a significant hazard to human health or safety? _____

MITIGATION:

- ___ Through coordination with the local Air Pollution Control District (APCD), the project has been rated for air pollution potential, and an appropriate Smoke Management Plan has been prepared that will minimize the air quality impacts of this project (See attached Smoke Management Plan).

OTHER CONDITIONS:

___ Additional reasons:

Archaeology:

Will archaeological, cultural, or historical resources be adversely affected by this project?
_____

MITIGATION:

The attached record search by the Regional Officer of the California Archaeological Inventory recommends:

___ a. No site survey was warranted for this project as proposed.
___ b. A site survey was conducted and appropriate measures have been incorporated into the project design to avoid adverse impacts to located sites (see "Other Conditions").
___ Soil will not be disturbed in areas where this would harm the resources.
___ Specific sites will be left unburned if burning would tend to degrade the resources.
___ Crews will be carefully supervised to avoid unauthorized collecting or other disturbance of the site.
___ Areas have been marked to be avoided by machinery, handcrews or fire.

OTHER CONDITIONS:

___ Archaeology mitigation measures:
___ Additional reasons:

Survey Markers:

Are land survey markers vulnerable to damage or destruction during vegetation treatment or burning within the proposed project area? _____

MITIGATION:

___ Survey markers are protected from project impacts by excluding heavy equipment and fire from the vicinity of known markers.

OTHER CONDITIONS:

___ There are no known land survey markers within the project area that would be affected by project activities.
___ Additional reasons:

Visual:

If any part of the proposed project be located upon highly visible slopes; is this project of such a size and design as to cause significant visual distraction and/or loss of aesthetic value? (Include visual impact of pre-treatment effects, such as creation of mechanical or hand-constructed firelines.) _____

MITIGATION:

___ Straight line boundaries and other strong linear configurations will be avoided as much as feasible.
___ Area will not be 100% cleared through burning operations; unburned areas will be left to add textural variety.
___ Natural or existing features will be followed, such as streamcourses, vegetation type lines, ridgetops, etc.
___ Fireline edges on the outside-of-the-burn side will be feathered into the natural landscape, with brush cuttings used to disguise the lines and provide soil cover after the burn.

OTHER CONDITIONS:

___ Project will not be burned upon highly visible slopes and/or visual impact expected to be minimal.
___ Additional reasons:

SMOKE MANAGEMENT PLAN

In accordance with the a Air District's Smoke Management Program, this Smoke Management Plan (SMP) or simularily required plan from a specific Air District is to be completed by the applicant and submitted to the appropriate Air District Official as part of the overall burn plan review process. Once approved by the Air District, the SMP serves as a conditional permit to burn, when used in conjunction with a standard permit.

The information required herein is considered the minimum needed to effectively evaluate the effectiveness of smoke management efforts. Individual Air Districts may require supplemental information if the proposed prescribed burn project is:

1) Extremely large,
2) Likely to adversely impact smoke sensitive areas, such as Class I airsheds,
3) Likely to have multi-jurisdictional smoke impacts, or
4) Contains other site-specific complexities, which would require the need for further information.

Information may need to be extracted from the project burn plan on an infrequent basis in order to supplement the SMP. Air District review of individual burn plans would be for informational purposes only. The Air District assumes no approval authority or liability for individual, project-specific burn plans. The Permittee is responsible for ensuring firefighter and public safety and all other plan elements, which pertain to matters not related to smoke management.

The terms used in this SMP have the same meaning as those defined in the Air District's open burning regulations or the California Code of Regulations, Title 17, Section 80101. Where differences occur, the Air District's definitions apply.

I. GENERAL INFORMATION

A. 1. PERMITTEE NAME AND ORGANIZATION:________________________________

2. FIRE MANAGER/BURN BOSS NAME: ____________________ PHONE/DISPATCH:________________

B. PROJECT NAME**:** ____

C. PERMIT NUMBER**:**____________________ **D.** TOTAL ACRES: ____________________

E. LEGAL LOCATION**:** **TOWNSHIP** ____________ **RANGE** ____________ **SECTION(S)** ____________

UNIT NAME	LEGAL DESCRIPTION

F. AIR QUALITY MANAGEMENT DISTRICT:________________________________

G. Indicate the category which best describes this prescribed burn project:

1. ☐ **Forest Management Burning:** Use of open outdoor fires as a part of forest management practice to remove forest debris or for forest management practices which include timber operations, silvicultural practices or forest protection.

2. ☒ **Range Improvement Burning:** Use of open, outdoor fires to remove vegetation for wildlife, game or livestock habitat or for the initial establishment of an agricultural practice on previously uncultivated land.

3. ☐ **Wildland Vegetation Management Burning:** Use of prescribed burning conducted by a public agency, or through a cooperative agreement with a private manager or contract involving a public agency, to burn land predominately covered by chaparral (as defined in The California Code of Regulations Title 14, Section 1561.1), trees, grass, or standing brush.

4. ☐ **Wildfire Managed for Resource Benefit:** Use of naturally occurring fire (i.e., lightning) exceeding ten acres in size to achieve resource management objectives. NOTE: When a natural ignition fire occurs on a no-burn day, the initial "go/no-go" decision to manage the fire for resource benefit will be a "no-go" unless, after consultation with the Air District, the Air District decides, for smoke management purposes, that the fire can be managed for resource benefit. A "no-go" decision does not necessarily mean that the fire must be extinguished, but that the fire cannot be considered a prescribed fire. A SMP must be submitted within 72 hours of project declaration for those fires that are expected to exceed 10 acres in size.

II. PROJECT INFORMATION

A. Acres by type of Burn

1) Machine Pile Burn________ 2) Hand Pile Burn________ 3) Landing Pile Burn________
4) Broadcast Burn ________ 5) Understory Burn________

B. **PREDOMINANT VEGETATION TYPE** (check all that apply):

1) Brush________ 2) Grass________ 3) Timber Litter________ 4) Timber Slash________

C. DESIRED SEASON OF PROJECT:________ ACCEPTABLE ALTERNATIVE: ________

D. ARB 48/72-HOUR CONTROLLED BURN NOTICE REQUIRED? **YES** ☐ **NO** ☐

E. SPOT WEATHER FORECAST REQUIRED? **YES** ☐ **NO** ☐

F. PROJECT/UNIT ELEVATION (feet): Top: 800 Bottom: 700

G. DURATION OF BURN: 1) Ignition________Days 2) Burndown________ Days 3) TOTAL________ Days

H. DRYING TIME REQUIRED FOR HAND AND MACHINE PILES:________

III. EMISSIONS ESTIMATES

A. TOTAL ESTIMATED PARTICULATE MATTER (PM_{10}):________ Tons

IV. WIND PRESCRIPTION

A. SURFACE WIND SPEED AND DIRECTION <20 FEET: IDEAL ______ ACCEPTABLE ______ UNACCEPTABLE______
B. WIND DIRECTION ALOFT >20 FEET: IDEAL ______ ACCEPTABLE ______ UNACCEPTABLE______

C. IDENTIFY POTENTIAL METEOROLOGICAL CONDITIONS THAT WOULD INHIBIT ACCEPTABLE SMOKE DISPERSAL:

____

V. SMOKE DISPERSAL SURVEILLANCE AND MONITORING

Smoke dispersal surveillance and monitoring will be accomplished by the following methods when indicated. If the project is conducted near smoke sensitive areas or if the smoke from the project may impact smoke sensitive areas, smoke monitoring is required on all projects over 250 acres/day and on those projects that would continue burning or producing smoke overnight. It is recommended that the Burner should obtain a current Smoke Transport and Stability Forecast from the Interagency Fire Forecast Warning Unit (IFFWU). The Internet Web Address is: http://www.fs.fed.us/r5/fire/north/fwx. A test burn shall be conducted on a small portion of the project area prior to project implementation. All weather and surveillance records shall be filed in the project folder and be available for Air District Review upon request.

A. Balloon_________ RAWS_x_______ Aircraft_________ Visual Monitoring_________

Weather Forecast _________ Hygrothermograph_________ Belt Weather Kit_________

B. METHOD/LOCATION OF VISUAL MONITORING:____________________

C. INTERVAL BETWEEN DISPERSAL MONITORING OBSERVATIONS:____________________

VI. IDENTIFICATION OF SMOKE SENSITIVE AREAS (SSA)

Smoke Sensitive Areas (SSA's) include, but are not limited to the following: Population Centers (towns, villages, home sites, subdivisions), hospitals, schools, daycare centers, nursing homes, shopping centers, populated recreation areas, well-attended public events, major roads, airports, mandatory Class I Airsheds, and may include campgrounds and trails extensively used by recreationalists.

A. LIKELY TO IMPACT CLASS I AIRSHED**?** **YES** ☐ **NO** ☐

B. LIKELY TO IMPACT OTHER SMOKE SENSITIVE AREAS? **YES** ☐ **NO** ☐

C. LIKELY TO IMPACT ANOTHER AQMD OR STATE (Oregon or Nevada)? **YES** ☐ **NO** ☐

D. LOCATION OF PROJECT LIES WITHIN MORE THAN ONE AQMD? **YES** ☐ **NO** ☐

If yes, list other AQMD(s): ____________________

E. PREVIOUS HISTORY OF ADVERSE SSA SMOKE IMPACTS (does NOT imply disapproval of project)? **YES** ☐ **NO** ☐

If yes, list examples____________________

VII. MITIGATIONS

Items checked below will be implemented as mitigation measures as part of this SMP.

A. LIMIT IGNITION TO __________**ACRES / PILES** per day. (Circle appropriate measure)

B. NO MORE THAN____________**ACRES / PILES** SHALL BE BURNED AT ONE TIME. (Circle appropriate measure)

C. ALLOW _________________HOURS BETWEEN IGNITION OF **PILES / UNITS**. Check here if not applicable ☐

D. IGNITE BETWEEN___________AND ___________ HOURS. (Use military time).

VIII. EVALUATION OF ALTERNATIVES TO BURNING

Projects, which have met applicable National Environmental Policy Act (NEPA) or California Environmental Quality Act (CEQA) requirements, will be considered to have complied with this provision. Either a copy of the applicable environmental document can be attached to this SMP or a sufficiently detailed narrative of how alternatives to burning were carried out in order to reduce fuel loads and emissions.

Alternatives to burning the project could include: (1) mechanical or hand removal of exotic grass plants, (2) herbicide treatment of unwanted species, (3) burning at a different time of year, (4) use of biological controls such as introduction of predatory insects, viruses or ultracompetative plants, or (5) no action.

IX. CONTINGENCIES

Actions shall be taken if adverse smoke impacts affect smoke sensitive areas. Adequate resources or assets will be provided for the items checked below.

- **A.** ☐ HALT IGNITIONS, EXCEPT AS NEEDED TO MAINTAIN CONTROL OF FIRE.
- **B.** ☐ ALLOW FIRE TO BURN TO CONTINGENCY CONTROL LINES.
- **C.** ☐ SUPPRESS FIRE.
- **D.** ☐ BEGIN IMMEDIATE MOP UP.
- **E.** ☐ BEGIN MOP UP WITHIN ______________ HOURS OF PROBLEM IDENTIFICATION.
- **F.** ☐ COMPLETE MOP UP WITHIN ____________ HOURS OF INITIATION.
- **G.** ☐ DISCONTINUE MOP UP IF FAVORABLE CONDITIONS RETURN.
- H. ☐ Other (explain): ______________________________

X. Public Notification

All of the actions checked below will be taken in order to advise the public and known sensitive receptors that prescribed burning will be conducted in their vicinity and to assure the public that measures will be taken to minimize the smoke impacts.

A. Type of Notification — **Describe Activity and Timing**

- ☐ RADIO.. ______________________________
- ☐ NEWSPAPER.................................... ______________________________
- ☐ TELEVISION .... ______________________________
- ☐ POSTERS/FLYERS/LETTERS............. ______________________________
- ☐ PERSONAL CONTACT .... ______________________________
- ☐ SIGNING at appropriate sites........... ______________________________
- ☐ OTHER (Explain) .... ______________________________

B. If potential impacts were identified in Section VI, additional notifications may be required within the potentially impacted area. If required, describe supplemental notifications that will be undertaken to mitigate adverse impacts: N/A
C. Notify Unit Emergency Command Center
D. Notify Northern Region Duty Chief at the Cal-Fire Northern Region HQ for ignition approval
E. Complete a Go-No-Go checklist to insure the project is in compliance with the prescription

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XI. COMPLAINT PROCEDURES

Specific information concerning smoke complaints must be given by any complainant. Refusal by the complainant to provide essential information to officials regarding smoke impacts could minimize the urgency of the individual complaint. The person receiving a smoke complaint should make a good faith effort to obtain the following information:

A. Name, location, phone number, and a short description of the situation, the areas affected by the smoke, whether people are physically suffering from smoke exposure and whether there is a public safety concern due to reduced visibility.

B. All smoke-related complaints shall be forwarded as soon as possible to the Air District, but no later than 24 hours after the receipt of the complaint.

C. The Air District will forward to the appropriate Burners any smoke-related complaints, which are received at the Air District Office as soon as possible, but no later than 24 hours after receipt of the complaint.

D. A log of all complaint calls related to burn projects shall be kept in the project file for a period, of no less than, one year after completion of the specific project.

CONTACTING RESPONSIBLE OFFICIALS

DO NOT DISPLAY PERSONAL PHONE NUMBER INFORMATION IN BURN OR SMOKE PLANS

Make available to the Air District the names of the Prescribed Fire Manager/Burn Boss/Incident Commander and how they can be reached at all times (See General Information Section I.A.2). Include cell phone numbers, pager numbers, dispatch number and any other pertinent contact information. Burners are required to contact the Air District on a daily basis to verify that conditions are still favorable when implementing multi-day projects.

XIII. CERTIFICATION

If the burn project is to be implemented primarily for wildlife and game habitat improvement, the Applicant shall file with the Air District a statement from the California Department of Fish and Wildlife certifying that the burn is desirable and proper. The statement shall also specify if any brush treatment or other desired objective is required by the California Department of Fish and Wildlife**.**

XIV. MAPS

A map must be attached to this Smoke Management Plan that identifies nearby smoke sensitive areas, burn unit perimeters, available interior control lines (if suitable for this project), and areas subject to smoke inversions due to the burn project. Also, the map must indicate estimated path of unacceptable smoke transport.

XV. REPORTS

For fires greater than 250 acres, a post-burn smoke management evaluation/summary is required to be kept in the project folder. The post burn smoke management evaluation may be subject to review by the Air District.

XVI. APPROVALS

A. SMOKE MANAGEMENT PLAN

Submittal of this Smoke Management Plan (SMP) acknowledges that ignition of this burn project will not occur unless all conditions and requirements as stated in this SMP are met prior to ignition on the day of the burn event, the ARB and the Air District have both declared the day to be a burn day, and the Air District has authorized the burn on the day of the burn.

1. PREPARED BY:______________________________ 2. TITLE: __________________________

3. PREPARER'S ORGANIZATION:____________________________
4. PREPARER'S SIGNATURE:__________________ DATE: __________________

B. AIR DISTRICT SMP DECISION

1. AIR QUALITY MANAGEMENT DISTRICT NAME:____________________________
2. APPROVED AS SUBMITTED BY:__________________ DATE:____________
3. APPROVED WITH CHANGES OR CONDITIONS BY:__________________ DATE:____________
4. ARB NOTIFICATION BY:__________________ DATE:____________
5. DOCUMENT CHANGES OR CONDITIONS:____________________________
6. DISAPPROVED AS SUBMITTED BY:__________________ DATE:____________

   For the following Reasons:____________________________

VTP EIR Prescribed Fire GO-NO GO CHECKLIST

PROJECT NAME________________________________
PROJECT NUMBER_____________________________

YES NO PRESCRIBED FIRE GO / NO-GO CHECKLIST

[ ] [ ] 1. Weather Forecast Requirements have been met.
[ ] [ ] 2. Current conditions are within minimum/maximum prescription criteria
TIME________TEMP_______R.H.______WIND DIR. ________
WIND SPEED_______FUEL STICK________LIVE FUEL________
[ ] [ ] 3. The fire weather forecast indicates no adverse change expected.
[ ] [ ] 4. Applicable permits have been issued and the project complies with all requirements of the permits.
[ ] [ ] 5. Personnel and equipment required in the IAP are in position.
[ ] [ ] 6. All personnel have been briefed on the IAP
- [ ] Prescribed Burn Plan
- [ ] Communications Plan
- [ ] Safety Plan

[ ] [ ] 7. Backup and support resources are available in strength needed to contain escapes within the burning period.
[ ] [ ] 8. Notifications have been made
- [ ] Adjacent Landowners
- [ ] Unit ECC
- [ ] Lookouts & Air Attack Bases (summer only)
- [ ] Region ECC/Duty Chief
- [ ] A.P.C.D

Other:____
9. If a test burn is not required, go to #10
[ ] [ ] [ ] N/A A test plot has been burned satisfactorily

[ ] [ ] 10. Has any "No" box been checked? If so, do not burn unless approval to modify the plan has been received.

BEGIN PRESCRIBED FIRE OPERATION!

[ ] [ ] 11. Can the plan be modified or action taken to rectify the situation?

STOP

IF "NO", DO NOT BURN!

Describe plan change or action to be taken:__________________________

Obtain approval of: UNIT CHIEF or Unit Duty Chief.

Name_____________________Date_____________Time______________________
Method of contact [ ] Radio [ ] Phone [ ] Personal Contact

BEGIN PRESCRIBED FIRE OPERATIONS!

K. HYD-16 PROCEDURES FOR COMPLYING

Compliance with HYD-16 requires that the combined acreage of fuel treatments and logging activities be calculated for the Calwater Planning Watershed where VTP projects are proposed. Since the potential for disturbance from different fuel treatment activities and logging systems vary due to disturbance intensity, disturbance coefficients will be assigned for each specific activity (Table K-1) and percent disturbance will be calculated using equation K-1. Additional hydrologic analysis will be performed when the percent watershed disturbance exceeds 20 percent.

K.1

Percent Watershed Disturbance = [(Acres TreatedA1 x Disturbance CoefficientA1)+(Acres TreatedA2 x Disturbance CoefficientA2)+ ……….] ÷ (Calwater Planning Watershed Acres)

Where A1, A2, ….. represent specific activities.

Table K-1. Disturbance coefficients to be used for HYD-16.

General Activity	Specific Activity	Per Acre Disturbance Coefficient
Fuel Treatment	Prescribed Fire	0.16
Fuel Treatment	Burn Piles	0.08
Fuel Treatment	Mechanical	0.5
Fuel Treatment	Hand Treatment	0.08
Fuel Treatment	Herbivory	0.08
Fuel Treatment	Herbicide	0.08
Logging	Clearcut	1
Logging	Shelterwood/Overstory Removal	0.75
Logging	Selection	0.5
Logging	Commercial Thinning	0.5