

H. AIR QUALITY AND GREEN HOUSE GAS EMISSION CALCULATIONS

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AIR QUALITY 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 (NO_x), Reactive Organic Gasses (ROG), and Particulate Matter (PM₁₀ 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 (PM₁₀ and PM_{2.5}), Volatile Organic Compounds (VOC), and Oxides of Nitrogen (NO_x). 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 PM₁₀ 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 Simultaneous 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 EMISSIONS	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 Equipment Emissions	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 Equipment Emissions	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 Equipment Emissions	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 EMISSIONS	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										
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG		
	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). Assume half (50%) could happen at the same time over the state										
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG		
	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.										
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG		
	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	

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									
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
	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									
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
	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									
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
	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									
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
	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									
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
	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									
Equipment	EQ HOURS				AIR QUALITY EMISSIONS					GHG	
	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
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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). Assume 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

Mass Conversion Rates

Unit
2205 lb/MT

Source
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 Bus)						
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						
Number of Semis to Carry Herds	1 76 * Four trips per week over 19 weeks						
	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						
Number of Semis to Carry Herds	1 76 * Four trips per week over 19 weeks						
	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 HERBIVORY 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

Livestock Type	Avg Population Per Acre	Enteric Fermentation												
		Tree Dominated		Grass Dominated		Shrub Dominated		Emission Factor (kg CH ₄ /head-year)	Tree Dominated		Grass Dominated		Shrub Dominated	
		Total Acres	Total Population	Total Acres	Total Population	Total Acres	Total Population		kg CH ₄ /year	MT CO ₂ e/year	kg CH ₄ /year	MT CO ₂ e/year	kg CH ₄ /year	MT CO ₂ e/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 ₂ e/year
Total Tree	166
Total Gras	177.11
Total Shrub	106.06
TOTAL	449

Percent of the Year we are reasonable

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 (CH₄) 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
 CH₄
 (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 Quality						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		Sierra Nevada Mixed Conifer Sugar Pine - Douglas Fire - Oak Forest

*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation

Air Quality						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 Emmissions		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 Quality						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 Emmissions		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 Quality						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

Average Number of Days for a Project	1		Model: Mediterranean Climate
Total Acres Burned	260		Mixed Forest
Acres Burned in a Day Statewide	260		Sierra Nevada Mixed Conifer Sugar Pine - Douglas Fire - Oak Forest

*Limits to one Rx Burn per Air Basin in One day then distributes to each vegetation formation

Air Quality						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 Emmissions		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

Average Number of Days for a Project	1	Model: Mediterranean Climate
Total Acres Burned	260	Grassland
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 Quality						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

	PM	PM 10	PM 2.5	CO	VOC*	Greenhouse Gasses		
						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
 Total Acres Burned 11,072
 Acres Burned in a Day Statewide 1,300

Model: Mediterranean Climate
 Mixed Forest
 Sierra Nevada Mixed Conifer
 Sugar Pine - Douglas Fire -
 Oak Forest

	Air Quality					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 Shrubland Chamise Chaparral
Total Acres Burned	7,090	
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	0.08	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
Total Acres Burned	11,838	Grassland
Acres Burned in a Day Statewide	1,300	

Air Quality						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 explanations. Calculator provided by California Air Resources Board Coordination and Communication for Naturally Ignited Fires (2011).

DAILY PRESCRIBED FIRE EQUIPMENT EMISSIONS (LBS/DAY)

Equipment Emissions					
Formation				Particulate	
	ROG	CO	NO _x	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					
Formation				Particulate	
	ROG	CO	NO _x	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

*NO_x Calculated using the EPA standard, CONSUME does not provide NO_x 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 negligible amount

For Emission Factors associated with worker trips and vehicles see Worker Trip Emfacs worksheet.

	<u>Unit</u>	<u>Source</u>
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)

	<u>HP</u>	<u>ROG</u>	<u>CO</u>	<u>NOX</u>	<u>CO2</u>	<u>PM</u>	<u>Activity</u>
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)

	<u>HP</u>	<u>ROG</u>	<u>CO</u>	<u>NOX</u>	<u>CO2</u>	<u>PM</u>
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

<u>value</u>	<u>unit</u>	<u>source</u>
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

<u>HC/ROG</u>	<u>NOx</u>	<u>PM</u>	<u>CO</u>	<u>Fuel</u>	<u>Units</u>
0.51	3.36	0.091	0.61	284	kg/hr
<u>HC/ROG</u>	<u>NOx</u>	<u>PM</u>	<u>CO</u>	<u>CO2e</u>	
510	3,360	91	610	893,115	g/hr

Conversion Rate

<u>value</u>	<u>units</u>	<u>source</u>
1,000	g/hr	onlineconversion.com/weight.htm

GHG Emissions Rate for Helicopter

	<u>value</u>	<u>units</u>	<u>source</u>
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
CO2e 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

		<u>Unit</u> kg CO2/gallon	<u>Source</u>
<u>Propane</u>	0.1043	<u>fuel</u>	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
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Drip Torch (70% Diesel, 30% Gasoline)

Emission Factor

		<u>Unit</u> kg CO2/gallon	<u>Source</u>
<u>Diesel</u>	10.15	<u>fuel</u>	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
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		<u>Unit</u> kg CO2/gallon	<u>Source</u>
<u>Gasoline</u>	8.81	<u>fuel</u>	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

		<u>Unit</u> <u>kg CO2/gallon</u>	<u>Source</u>
<u>Diesel</u>	10.15	<u>fuel</u>	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

		<u>Unit</u> <u>kg CO2/gallon</u>	<u>Source</u>
<u>Gasoline</u>	8.81	<u>fuel</u>	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

		<u>Unit</u> <u>kg CO2/gallon</u>	<u>Source</u>
<u>Diesel</u>	10.15	<u>fuel</u>	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

		<u>Unit</u> kg CO2/gallon	<u>Source</u>
<u>Gasoline</u>	8.81	<u>fuel</u>	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
<u>Conversion Rate</u>			
	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

		<u>Unit</u> kg CO2/gallon	<u>Source</u>
<u>Diesel</u>	10.15	<u>fuel</u>	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

<u>Conversion Rate</u>			
	1000	g/kg	google.com

		<u>Unit</u> kg CO2/gallon	<u>Source</u>
<u>Gasoline</u>	8.81	<u>fuel</u>	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

<u>Conversion Rate</u>			
	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 (January). Reporting Entity-Wide Greenhouse Gas Emissions. Version 3.1. Gallon/Hr fuel and type of fuel breakdown provided by Cal Fire staff.