

APPENDIX M

Detailed Emissions Calculations

**Appendix M - Construction Emission Calculations
Summary**

Description	Emissions (tons)							Total
	NOx	CO	Criteria Pollutants VOC	SO ₂	PM ₁₀	PM _{2.5}	HAPs Formaldehyde	
Off-Road Engine Emissions	25.90	6.04	1.89	0.01	1.01	1.01	0.00	0.00
Unpaved Roads	--	--	--	--	1.67	0.17	--	--
Earthmoving	--	--	--	--	16.22	1.71	--	--
TOTAL	25.90	6.04	1.89	0.01	18.91	2.88	0.00	0.00

Appendix M - Construction Emission Calculations
Emission Factors for Construction Engines

Equipment ^a	Total Hours Used ^b	Max Power (HP)	Load Factor ^c	Loaded Power (HP)	Emission Factors ^d (g/hp-hr)					
					VOC	CO	NOx	PM ₁₀	PM _{2.5}	SO ₂
Air Compressor	3,400	80	1	80	0.367	2.366	4.700	0.240	0.240	0.002
ATV	2,600	20	0.5	10	0.438	2.161	4.440	0.267	0.267	0.002
Backhoe	3,400	75	0.8	60	0.367	2.366	4.700	0.240	0.240	0.002
Bulldozer	800	250	1	250	0.309	0.748	4.000	0.132	0.132	0.002
Fork Lift	2,500	120	1	120	0.167	0.843	4.335	0.132	0.132	0.002
Concrete Mixer Truck	3,200	325	1	325	0.338	0.867	4.100	0.180	0.180	0.002
Dump Truck	4,500	325	0.8	260	0.338	0.867	4.100	0.180	0.180	0.002
Excavator	800	138	1	138	0.309	0.748	4.000	0.132	0.132	0.002
Generator	1,300	250	0.5	125	0.167	0.843	4.335	0.132	0.132	0.002
Manlift	3,840	50	1	50	0.338	0.867	4.100	0.180	0.180	0.002
Pickup Truck	14,600	150	0.25	38	0.167	0.843	4.335	0.132	0.132	0.002
Skid steer loader	6,800	50	1	50	0.309	0.748	4.000	0.132	0.132	0.002
Water truck	800	100	0.5	50	0.637	2.366	4.700	0.240	0.240	0.002
Large Crane	3,240	15	0.21	3	0.438	2.161	4.44	0.267	0.259	0.002
Medium Crane	3,240	450	0.7	315	0.3085	0.7475	4.0	0.132	0.128	0.002
Semitruck/Trailer	2,100	500	0.59	500	0.167	0.843	4.335	0.132	0.132	0.002

^a Equipment counts based on experience with construction of a similar projects.

^b Generally assumes work will occur 7 am - 7 pm, Monday through Friday.

^c Load Factors from Appendix A of EPA 420_P-04-005, Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling , USEPA, April 2004.

^d EPA 420-P-04-009, Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression Ignition, USEPA, April 2004 - Tier 2 Engines.

Assumption:

393.5 hp-hr/MMBtu

453.6 g/lb

Appendix M - Construction Emission Calculations
Emission Estimates from Construction Engines

Equipment	Potential Emissions (ton)					
	VOC	CO	NOx	PM ₁₀	PM _{2.5}	SO ₂
Air Compressor	1.10E-01	0.709	1.409	0.072	0.072	0.001
ATV	1.26E-02	0.062	0.127	0.008	0.008	0.000
Backhoe	8.26E-02	0.532	1.057	0.054	0.054	0.000
Bulldozer	6.80E-02	0.165	0.882	0.029	0.029	0.000
Fork Lift	5.52E-02	0.279	1.434	0.044	0.044	0.001
Concrete Mixer Truck	3.88E-01	0.994	4.700	0.206	0.206	0.002
Dump Truck	4.36E-01	1.118	5.288	0.232	0.232	0.003
Excavator	3.75E-02	0.091	0.487	0.016	0.016	0.000
Generator	2.99E-02	0.151	0.777	0.024	0.024	0.000
Manlift	7.16E-02	0.183	0.868	0.038	0.038	0.000
Pickup Truck	1.01E-01	0.508	2.616	0.079	0.079	0.001
Skid steer loader	1.16E-01	0.280	1.499	0.049	0.049	0.001
Water truck	2.81E-02	0.104	0.207	0.011	0.011	0.000
Large Crane	4.93E-03	0.024	0.050	0.003	0.003	0.000
Medium Crane	3.47E-01	0.841	4.500	0.149	0.144	0.002
TOTAL	1.89	6.04	25.90	1.01	1.01	0.01

Hazardous Air Pollutants from Construction Engines		
Species	Fraction of VOC	Emissions (tpy)
Benzene	0.02	3.78E-04
Formaldehyde	0.118	2.23E-03
Acetaldehyde	0.053	1.00E-03
1,3-butadiene	0.002	3.78E-05
Acrolein	0.003	5.66E-05
Total HAPs		3.70E-03

Appendix M - Construction Emission Calculations Fugitive Dust Emissions from Unpaved Roads

Equipment	Quantity ^a	Total Days		W	Emission Factor (lb/VMT) ^c		Emissions (ton/yr)	
		Used	VM T ^b		PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
ATV	1	260	130	20	1.73	0.17	0.11	0.01
Backhoe	4	435	218	50	2.62	0.26	0.28	0.03
Bulldozer	3	175	88	20	1.73	0.17	0.08	0.01
Fork Lift	4	610	305	20	1.73	0.17	0.26	0.03
Dump Truck	13	435	218	21	1.77	0.18	0.19	0.02
Excavator	3	175	88	22	1.81	0.18	0.08	0.01
Pickup Truck	17	610	305	24	1.88	0.19	0.29	0.03
Skid steer loader	5	610	305	26	1.95	0.20	0.30	0.03
Water truck	3	175	88	20	1.73	0.17	0.08	0.01
TOTAL	--	--	--	--	--	--	1.67	0.17

^a Equipment counts are estimated based current construction plan.

^b Each vehicle is assumed to travel 0.5 mile per day on site.

^c AP-42 Section 13.2.2 Unpaved Roads, dated November 2006, Equations 1a and 2 TOTALS 11.19 1.12 Surface Silt content based on Table 13.2.2-1 - construction sites.

Eq 1a: $E = k * (s/12)^a * (W/3)^b$

Eq 2: $E_{ext} = E * [(365-P)/365]$

where:

VM T = Vehicle Miles Traveled

W = Mean Vehicle Weight, tons

S = Mean Vehicle Speed, mph

P = 120 days with at least 0.01 inches rain, EPA's AP-42 Figure 13.2.2-1

s = 8.5 surface material silt content (%) for construction sites, EPA's AP-42 Table 13.2.2-1

E = size-specific emission factor, lb/ VMT

E_{ext} = annual size-specific emission factor extrapolated for natural migration, lb/VMT

Constants	PM	PM ₁₀	PM _{2.5}
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

**Appendix M - Construction Emission Calculations
Fugitive Dust Emissions from Earthmoving Activities**

Summary of Fugitive Dust Emissions From Earthmoving Activities								
Construction Activity	Average Exposed (acres)	Soil Volume (yd ³)	Soil Weight (tons)	Emission Factors ^{d - f}			Emissions (ton)	
				PM ₁₀	PM _{2.5}	Units	PM ₁₀	PM _{2.5}
Topsoil removed by scraper ^e	---	59,693	74,617	0.058	0.0061	lb/ton	2.16	0.23
Wind erosion of exposed areas	37.00	---	---	0.38	0.03999	ton/acre/yr	14.06	1.48
TOTAL							16.22	1.71

Notes and Assumptions:

^a Acreage calculated based on project details.

^b Assumes the entire workspace is cleared to 1 foot deep, 1.25 tons per cubic yard.

^c Soil density: 1.25 tons per yard

^d As worst case, PM₁₀ is set equal to Total Particulate Matter. PM_{2.5} is set to 0.105 times PM₁₀ per EPA's AP-42 Table 11.9-1

^e Emission factor: AP-42 Section 11.9 Western Surface Coal Mining, Table 11.9-4, July 1998, topsoil removal by scraper

^f Wind Erosion Exposed Areas emission factor: AP-42 Section 11.9 Western Surface Coal Mining, Table 11.9-4, July 1998, wind erosion of exposed areas (ton/yr/acre)

Appendix J - Construction Greenhouse Gas Emissions Summary

Greenhouse Gas Emissions From Construction Engines (tons)				
Description	CO ₂	CH ₄	N ₂ O	CO ₂ e ^a
Off-Road Engine Emissions	1129.59	0.05	0.01	1133.47
Commuters and Delivery Vehicles	418.55	0.00	0.00	418.55
TOTAL	1,548.14	0.05	0.01	1,552.02

^a CO₂e = carbon dioxide equivalent. Includes global warming potentials from 40 CFR 98 Table A-1.

Global Warming Potentials		
CO ₂	CH ₄	N ₂ O
1	25	298

Source: 40 CFR 98 Table A-1: <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98#Table-A-1-to-Subpart-A-of-Part-98>

Appendix J - Construction Greenhouse Gas Emissions
Greenhouse Gas Emissions from On Road Construction Traffic

On-Road Vehicles					
	Vehicles per day	Miles per vehicle	Number of Days	Fuel Used (gallons)	CO ₂ Emissions ^a (tons)
Commuter Vehicles - Gasoline ^t	25	60	610	38,125	373
Delivery Trucks - Diesel ^{c,d}	4	60	109	4,015	45.07

^a Assumes 1 gallon of gasoline = 8,887 grams CO₂ and 1 gallon of diesel = 10,180 g CO₂, per US EPA's "Greenhouse Gas Emissions from a Typical Passenger Vehicle," available online at: <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100U8YT.pdf>

^b Assumes commuters travel 30 miles each way (60 miles round trip) per day, with a fuel economy of 24 miles per gallon, per US EPA and US Department of Energy Fuel Economy data for combined city and highway driving in 2023, available online at: <https://www.fueleconomy.gov/feg/download.shtml>.

^c Equipment counts based on experience with construction of a similar projects.

^d Assumes delivery trucks travel 30 miles each way (60 miles round trip) per day, with a fuel economy of 6.5 miles per gallon, industry average.

1 short ton =	907,185	grams
1 gal gasoline =	8,887	g CO ₂
1 gal diesel =	10,182	g CO ₂
Commuter Vehicle MPG=	24	
Delivery Trucks (Diesel) MPG=	6.5	
Concrete Mixer Truck MPG=	3.4	

Appendix J - Construction Greenhouse Gas Emissions
Greenhouse Gas Emission Factors for Construction Engines

Equipment ^a	Total Hours Used ^b	Max Power (HP)	Load Factor ^c	Loaded Power (HP)	Emission Factors ^d (g/hp-hr)		
					CO ₂	CH ₄	N ₂ O
Air Compressor	3,400	80	1	80	188.262	0.008	0.002
ATV	2,600	20	0.5	10	188.262	0.008	0.002
Backhoe	3,400	75	0.8	60	188.262	0.008	0.002
Bulldozer	800	250	1	250	188.262	0.008	0.002
Fork Lift	2,500	120	1	120	188.262	0.008	0.002
Concrete Mixer Truck	3,200	325	1	325	188.262	0.008	0.002
Dump Truck	4,500	325	0.8	260	188.262	0.008	0.002
Excavator	800	138	1	138	188.262	0.008	0.002
Generator	1,300	250	0.5	125	188.262	0.008	0.002
Manlift		50	1	50	188.262	0.008	0.002
Pickup Truck	14,600	150	0.25	38	188.262	0.008	0.002
Skid steer loader	6,800	50	1	50	188.262	0.008	0.002
Water truck	800	100	0.5	50	188.262	0.008	0.002
Large Crane	3,240	15	0.21	3	188.262	0.008	0.002
Medium Crane	3,240	450	0.7	315	188.262	0.008	0.002
Semitruck/Trailer	2,100	500	0.59	500	188.262	0.008	0.002

^a Equipment counts based on experience with construction of a similar projects.

^b Generally assumes work will occur 7 am - 7 pm, Monday through Friday.

^c Load Factors from Appendix A of EPA 420_P-04-005, Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling , USEPA, April 2004.

^d GHG emission factors from Title 40 Subchapter C Part 98 Subpart C Table C-1 and C-2 to Subpart C.

Assumption:

393.5 hp-hr/MMBtu

453.6 g/lb

Appendix J - Construction Greenhouse Gas Emissions
Greenhouse Gas Emission Estimates from Construction Engines

Equipment	Potential Emissions (tons)			
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Air Compressor	56.45	2.3E-03	4.6E-04	56.64
ATV	5.40	2.2E-04	4.4E-05	5.41
Backhoe	42.33	1.7E-03	3.4E-04	42.48
Bulldozer	41.50	1.7E-03	3.4E-04	41.65
Fork Lift	62.26	2.5E-03	5.0E-04	62.47
Concrete Mixer Truck	215.82	8.8E-03	1.8E-03	216.56
Dump Truck	242.80	9.8E-03	2.0E-03	243.64
Excavator	22.91	9.3E-04	1.9E-04	22.99
Generator	33.72	1.4E-03	2.7E-04	33.84
Manlift	0.00	0.0E+00	0.0E+00	0.00
Pickup Truck	113.62	4.6E-03	9.2E-04	114.01
Skid steer loader	70.56	2.9E-03	5.7E-04	70.80
Water truck	8.30	3.4E-04	6.7E-05	8.33
Large Crane	2.12	8.6E-05	1.7E-05	2.13
Medium Crane	211.80	8.6E-03	1.7E-03	212.53
TOTAL	1,129.59	4.6E-02	9.2E-03	1,133.47

Global Warming Potentials		
CO ₂	CH ₄	N ₂ O
1	25	298

Source: Title 40 Part 98 Table A-1.