

APPENDIX F

Construction Emission Calculations

Great River Energy
Laketown 115-kV Transmission Line Project
Substation Construction Emission Calculations
Emission Factors for Construction Engines

Equipment	Quantity ^a	Hours per Day	Days per Week	Number of Weeks	Total Hours Used ^b	Max Power (HP)	Load Factor ^c	Loaded Power (HP)	VOC	Emission Factors ^{d,e} (g/hp hr)				
										CO	NOx	PM ₁₀	PM _{2.5}	SO ₂
Backhoe	1	6	3	4	72	75	0.8	60	0.367	2.366	4.700	0.240	0.240	0.002
Bulldozer	1	8	5	4	160	250	1	250	0.309	0.748	4.000	0.132	0.132	0.002
Compactor, Vibratory	1	4	5	5	100	100	1	100	0.338	0.867	4.100	0.180	0.180	0.002
Concrete Mixer Truck	3	5	2	3	90	325	1	325	0.338	0.867	4.100	0.180	0.180	0.002
Concrete Pump	1	10	3	2	60	300	1	300	0.338	0.867	4.100	0.180	0.180	0.002
Dump Truck	3	6	5	5	450	325	0.8	260	0.338	0.867	4.100	0.180	0.180	0.002
Excavator	1	8	5	4	160	138	1	138	0.309	0.748	4.000	0.132	0.132	0.002
Manlift	2	6	4	5	240	50	1	50	0.338	0.867	4.100	0.180	0.180	0.002
Pickup Truck	2	2	5	10	200	150	0.25	38	0.167	0.843	4.335	0.132	0.132	0.002
Skid steer loader	1	8	5	10	400	50	1	50	0.309	0.748	4.000	0.132	0.132	0.002
Large Crane	1	10	2	2	40	15	0.21	3	0.438	2.161	4.44	0.267	0.259	0.002
Medium Crane	1	6	2	5	60	450	0.7	315	0.3085	0.7475	4.0	0.132	0.128	0.002
Hydrovac Truck	1	4	1	2	8	200	0.59	118	0.3085	0.7475	4.0	0.132	0.128	0.002
Semitruck/Trailer	1	3	2	2	12	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 - 5 pm, Monday through Friday, for a total of 50 work hours per week over 10 weeks

^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.

^e 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

Great River Energy
Laketown 115-kV Transmission Line Project
Substation Construction Emission Calculations
Emission Estimates from Construction Engines

Equipment	Potential Emissions (tons)					
	VOC	CO	NOx	PM ₁₀	PM _{2.5}	SO ₂
Backhoe	1.75E-03	1.13E-02	2.24E-02	1.14E-03	1.14E-03	9.52E-06
Bulldozer	1.36E-02	3.30E-02	1.76E-01	5.80E-03	5.80E-03	8.82E-05
Compactor, Vibratory	3.73E-03	9.55E-03	4.52E-02	1.98E-03	1.98E-03	2.20E-05
Concrete Mixer Truck	1.09E-02	2.79E-02	1.32E-01	5.80E-03	5.80E-03	6.45E-05
Concrete Pump	6.71E-03	1.72E-02	8.14E-02	3.57E-03	3.57E-03	3.97E-05
Dump Truck	4.36E-02	1.12E-01	5.29E-01	2.32E-02	2.32E-02	2.58E-04
Excavator	7.51E-03	1.82E-02	9.74E-02	3.20E-03	3.20E-03	4.87E-05
Manlift	4.48E-03	1.15E-02	5.42E-02	2.38E-03	2.38E-03	2.65E-05
Pickup Truck	1.38E-03	6.97E-03	3.58E-02	1.09E-03	1.09E-03	1.65E-05
Skid steer loader	6.80E-03	1.65E-02	8.82E-02	2.90E-03	2.90E-03	4.41E-05
Large Crane	6.08E-05	3.00E-04	6.17E-04	3.71E-05	3.60E-05	2.78E-07
Medium Crane	6.43E-03	1.56E-02	8.33E-02	2.75E-03	2.67E-03	4.17E-05
Hydrovac Truck	3.21E-04	7.78E-04	4.16E-03	1.37E-04	1.33E-04	2.08E-06
TOTAL	0.11	0.28	1.35	0.05	0.05	0.00

Great River Energy
Laketown 115-kV Transmission Line Project
Substation Construction Emission Calculations
Fugitive Dust Emissions from Unpaved Roads

Equipment	Quantity ^a	Total Days Used	VMT ^b	W	Emission Factor (lb/VMT) ^c		Emissions (tons)	
					PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Backhoe	1	12	6	50	2.62	0.26	0.01	0.00
Bulldozer	1	20	10	20	1.73	0.17	0.01	0.00
Concrete Mixer Truck	3	18	9	20	1.73	0.17	0.01	0.00
Dump Truck	3	75	38	21	1.77	0.18	0.03	0.00
Excavator	1	20	10	22	1.81	0.18	0.01	0.00
Manlift	2	40	20	24	1.88	0.19	0.02	0.00
Pickup Truck	2	100	50	24	1.88	0.19	0.05	0.00
Skid steer loader	1	50	25	26	1.95	0.20	0.02	0.00
Large Crane	1	4	2	50	2.62	0.26	0.00	0.00
Medium Crane	1	10	5	25	1.92	0.19	0.00	0.00
Hydrovac Truck	1	2	1	33	2.17	0.22	0.00	0.00
TOTAL	--	--	--	--	--	--	0.17	0.02

^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:

VMT = 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

Great River Energy
Laketown 115-kV Transmission Line Project
Substation Construction Emission Calculations
Fugitive Dust Emissions from Earthmoving Activities

Summary of Fugitive Dust Emissions From Earthmoving Activities							
Construction Activity	Daily Material Handling		Average Exposed Area	Emission Factors ^{b - f}		Emissions	
	Construction Rate ^a	Handling Time		(lb/ton)		(tons)	
	(ton/day)	(days)	(acres)	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Topsoil removed by scraper ^g	359.0	50	---	0.058	0.006	0.52	0.05
Topsoil replacement	359.0	50	---	0.012	0.001	0.11	0.01
Wind erosion of exposed areas ^h	--	50	8.90	0.380	0.040	0.46	0.05
TOTAL						1.09	0.12

Notes and Assumptions:

^a Soil density: 1.25 tons per yard

^b Excavation and loading to storage piles emission factor: AP 42 Section 11.9 Western Surface Coal Mining, Table 11.9 4, July 1998, truck loading by batch dump

^c Topsoil replacement emission factor: AP 42 Section 11.9 Western Surface Coal Mining, Table 11.9 4, July 1998, overburden replacement

^d As worst case, PM₁₀ is set equal to Total Particulate Matter. PM_{2.5} is set to 0.105 times PM₁₀ per 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)

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

^h Emission factor units are tons/acre*year

Construction Schedule	
Work Days	5
Weeks:	10
Total Days:	50

Topsoil Removed by Scraper ^a				
Facility	Total (Acres)	Soil Volume (yd ³)	Soil Weight (ton)	Daily Material Handling Rate (ton/day)
Substation	8.9	14,359	17,948	359
TOTAL	8.9	14,359	17,948	359

^a Conservatively assumes the entire parcel is disturbed.

Great River Energy
Laketown 115-kV Transmission Line Project
Substation Construction Emission Calculations
Summary

Description	Emissions (tons per year)					
	Criteria Pollutants					
	NO _x	CO	VOC	SO ₂	PM ₁₀	PM _{2.5}
Off-Road Engine Emissions	1.35	0.28	0.11	0.00	0.05	0.05
Unpaved Roads	--	--	--	--	0.17	0.02
Earthmoving	--	--	--	--	1.09	0.12
TOTAL	1.35	0.28	0.11	0.00	1.31	0.19

Great River Energy
Laketown 115-kV Transmission Line Project
Transmission Line Construction Emission Calculations
Emission Factors for Construction Engines

Equipment	Quantity ^a	Hours per	Days per	Number of	Total Hours	Max Power	Load	Loaded	VOC	CO	Emission Factors ^{d,e} (g/hp hr)			
		Day	Week	Weeks	Used ^b	(HP)	Factor ^c	Power (HP)			NOx	PM ₁₀	PM _{2.5}	SO ₂
Air Compressor	1	2	5	16	160	80	1	80	0.367	2.366	4.700	0.240	0.240	0.002
Backhoe	1	8	5	8	320	75	0.8	60	0.367	2.366	4.700	0.240	0.240	0.002
Bulldozer	1	8	5	4	160	250	1	250	0.309	0.748	4.000	0.132	0.132	0.002
Compactor	1	4	5	6	120	300	1	300	0.167	0.843	4.335	0.132	0.132	0.002
Compactor, Vibratory	1	4	5	6	120	100	1	100	0.338	0.867	4.100	0.180	0.180	0.002
Fork Lift	1	5	5	16	400	120	1	120	0.167	0.843	4.335	0.132	0.132	0.002
Concrete Mixer Truck	5	5	5	4	500	325	1	325	0.338	0.867	4.100	0.180	0.180	0.002
Concrete Pump	1	10	5	1	50	300	1	300	0.338	0.867	4.100	0.180	0.180	0.002
Dump Truck	1	5	5	8	200	325	0.8	260	0.338	0.867	4.100	0.180	0.180	0.002
Excavator	1	8	5	4	160	138	1	138	0.309	0.748	4.000	0.132	0.132	0.002
Generator	1	5	5	16	400	250	0.5	125	0.167	0.843	4.335	0.132	0.132	0.002
Manlift	2	8	5	4	320	50	1	50	0.338	0.867	4.100	0.180	0.180	0.002
Pickup Truck	5	2	5	16	800	150	0.25	38	0.167	0.843	4.335	0.132	0.132	0.002
Skid steer loader	2	10	5	16	1,600	50	1	50	0.309	0.748	4.000	0.132	0.132	0.002
Welding machine	1	8	5	3	120	35	0.8	28	0.367	2.366	4.700	0.240	0.240	0.002
Large Crane	1	10	5	1	50	15	0.21	3	0.438	2.161	4.44	0.267	0.259	0.002
Medium Crane	1	10	5	4	200	450	0.7	315	0.3085	0.7475	4.0	0.132	0.128	0.002
Hydrovac Truck	1	8	2	2	32	200	0.59	118	0.3085	0.7475	4.0	0.132	0.128	0.002
2-inch Water Pump	1	3	5	4	60	5	0.69	3	0.438	2.161	4.44	0.267	0.259	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 Saturday, for a total of 72 work hours per week over 20 weeks

^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.

^e 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

Great River Energy
Laketown 115-kV Transmission Line Project
Transmission Line Construction Emission Calculations
Emission Estimates from Construction Engines

Equipment	Potential Emissions (tons)					
	VOC	CO	NOx	PM ₁₀	PM _{2.5}	SO ₂
Air Compressor	5.18E-03	3.34E-02	6.63E-02	3.39E-03	3.39E-03	2.82E-05
Backhoe	7.77E-03	5.01E-02	9.95E-02	5.08E-03	5.08E-03	4.23E-05
Bulldozer	1.36E-02	3.30E-02	1.76E-01	5.80E-03	5.80E-03	8.82E-05
Compactor	6.62E-03	3.34E-02	1.72E-01	5.22E-03	5.22E-03	7.94E-05
Compactor, Vibratory	4.48E-03	1.15E-02	5.42E-02	2.38E-03	2.38E-03	2.65E-05
Fork Lift	8.83E-03	4.46E-02	2.29E-01	6.96E-03	6.96E-03	1.06E-04
Concrete Mixer Truck	6.06E-02	1.55E-01	7.34E-01	3.22E-02	3.22E-02	3.58E-04
Concrete Pump	5.60E-03	1.43E-02	6.78E-02	2.98E-03	2.98E-03	3.31E-05
Dump Truck	1.94E-02	4.97E-02	2.35E-01	1.03E-02	1.03E-02	1.15E-04
Excavator	7.51E-03	1.82E-02	9.74E-02	3.20E-03	3.20E-03	4.87E-05
Generator	9.20E-03	4.64E-02	2.39E-01	7.25E-03	7.25E-03	1.10E-04
Manlift	5.97E-03	1.53E-02	7.23E-02	3.17E-03	3.17E-03	3.53E-05
Pickup Truck	5.52E-03	2.79E-02	1.43E-01	4.35E-03	4.35E-03	6.61E-05
Skid steer loader	2.72E-02	6.59E-02	3.53E-01	1.16E-02	1.16E-02	1.76E-04
Welding machine	1.36E-03	8.76E-03	1.74E-02	8.89E-04	8.89E-04	7.41E-06
Large Crane	7.60E-05	3.75E-04	7.71E-04	4.64E-05	4.50E-05	3.47E-07
Medium Crane	2.14E-02	5.19E-02	2.78E-01	9.17E-03	8.89E-03	1.39E-04
Hydrovac Truck	1.28E-03	3.11E-03	1.66E-02	5.49E-04	5.33E-04	8.32E-06
TOTAL	0.21	0.66	3.05	0.11	0.11	0.00

Great River Energy
Laketown 115-kV Transmission Line Project
Transmission Line Construction Emission Calculations
Fugitive Dust Emissions from Unpaved Roads

Equipment	Quantity ^a	Total Days Used	VMT ^b	W	Emission Factor (lb/VMT) ^c		Emissions (tons)	
					PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Backhoe	1	40	20	50	2.62	0.26	0.03	0.00
Bulldozer	1	20	10	20	1.73	0.17	0.01	0.00
Fork Lift	1	80	40	20	1.73	0.17	0.03	0.00
Concrete Mixer Truck	5	100	50	20	1.73	0.17	0.04	0.00
Dump Truck	1	40	20	21	1.77	0.18	0.02	0.00
Excavator	1	20	10	22	1.81	0.18	0.01	0.00
Manlift	2	40	20	24	1.88	0.19	0.02	0.00
Pickup Truck	5	400	200	24	1.88	0.19	0.19	0.02
Skid steer loader	2	160	80	26	1.95	0.20	0.08	0.01
Large Crane	1	5	3	50	2.62	0.26	0.00	0.00
Medium Crane	1	20	10	25	1.92	0.19	0.01	0.00
Hydrovac Truck	1	4	2	33	2.17	0.22	0.00	0.00
Welding Machine	1	15	8	20	1.73	0.17	0.01	0.00
TOTAL	--	--	--	--	--	--	0.45	0.04

^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:

VMT = 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

Great River Energy
Laketown 115-kV Transmission Line Project
Transmission Line Construction Emission Calculations
Fugitive Dust Emissions from Earthmoving Activities

Summary of Fugitive Dust Emissions From Earthmoving Activities							
Construction Activity	Daily Material Handling		Average Exposed Area (acres)	Emission Factors ^{b-f} (lb/ton)		Emissions (tons)	
	Construction Rate ^a	Handling Time		PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
	(ton/day)	(days)					
Topsoil removed by scraper ^g	1,300.8	80	---	0.058	0.006	3.02	0.32
Transmission Line Pole Excavation	17.3	80	---	0.037	0.004	0.03	0.00
Transmission Line Pole Excavation Soil Dispersion	17.3	80	---	0.037	0.004	0.03	0.00
Topsoil replacement	1,300.8	80	---	0.012	0.001	0.62	0.07
Wind erosion of exposed areas ^h	--	80	51.60	0.38	0.040	4.30	0.45
TOTAL						7.99	0.84

Notes and Assumptions:

^a Soil density: 1.25 tons per yard

^b Excavation and loading to storage piles emission factor: AP 42 Section 11.9 Western Surface Coal Mining, Table 11.9 4, July 1998, truck loading by batch dump

^c Topsoil replacement emission factor: AP 42 Section 11.9 Western Surface Coal Mining, Table 11.9 4, July 1998, overburden replacement

^d As worst case, PM₁₀ is set equal to Total Particulate Matter. PM_{2.5} is set to 0.105 times PM₁₀ per 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)

^g Conservatively assumes the entire right-of-way is cleared to 1 foot deep, 1.25 tons per cubic yard.

^h Emission factor units are tons/acre*year

Construction Schedule		
Work Days	5	Monday through Saturday
Weeks:	16	transmission line fall 2027, energizing summer 2028
Total Days:	80	

Topsoil Removed by Scraper ^a				
Facility	Total (Acres)	Soil Volume (yd ³)	Soil Weight (ton)	Daily Material Handling Rate (ton/day)
Transmission Line	51.6	83,248	104,060	1,301
TOTAL	51.6	83,248	104,060	1,301

Substation: 1.5 acres

^a Conservatively assumes the entire right-of-way is disturbed.

Transmission Line Pole Excavations							
Project Segment	Number of Poles ^a	Diameter (ft)	Depth (ft)	Total Volume (ft ³)	Total Volume (yd ³)	Soil Weight (ton)	Daily Material Handling Rate (ton/day)
Transmission Line Pole Excavations	76	5	20	29,845	1,105	1,382	17.3
TOTAL				29,845	1,105	1,382	17.3

^a Assumes pole every 300 feet of the proposed 4.3 mile transmission line

Great River Energy
 Laketown 115-kV Transmission Line Project
 Transmission Line Construction Emission Calculations
 Summary

Description	Emissions (tons)					
	Criteria Pollutants					
	NO _x	CO	VOC	SO ₂	PM ₁₀	PM _{2.5}
Off-Road Engine Emissions	3.05	0.66	0.21	0.00	0.11	0.11
Unpaved Roads	--	--	--	--	0.45	0.04
Earthmoving	--	--	--	--	7.99	0.84
TOTAL	3.05	0.66	0.21	0.00	8.55	1.00

Great River Energy
Laketown 115-kV Transmission Line Project
Construction Emission Calculations
Criteria Pollutant Summary

	Emissions (tons)					
	Criteria Pollutants					
	NO _x	CO	VOC	SO ₂	PM ₁₀	PM _{2.5}
Transmission Line						
Off-Road Engine Emissions	3.05	0.66	0.21	0.00	0.11	0.11
Unpaved Roads	--	--	--	--	0.45	0.04
Earthmoving	--	--	--	--	7.99	0.84
Subtotal	3.05	0.66	0.21	0.00	8.55	1.00
Substation						
Off-Road Engine Emissions	1.35	0.28	0.11	0.00	0.05	0.05
Unpaved Roads	--	--	--	--	0.17	0.02
Earthmoving	--	--	--	--	1.09	0.05
Subtotal	1.35	0.28	0.11	0.00	1.31	0.12
TOTAL	4.40	0.94	0.32	0.00	9.86	1.12