

Appendix E3

Emissions Worksheets



Operational Mobile Source Emissions

YEAR	Grams/mile				
	ROG	CO	NOx	CO ₂	PM ₁₀
2012	0.241	3.638	2.475	581	0.085

Assumed average speed of vehicles type to be 55 mph to and from the project site.

Paved Road	
Entrained PM lbs/VMT	
PM ₁₀	PM _{2.5}
0.0031	0.0002

EMISSIONS CALCULATION FOR ON-ROAD VEHICLES DURING OPERATIONS

Emissions = Vehicle Type x Emission Factor x Miles/Trip x Trips/Day

Miles/day
60

	Emission Factors					
	ROG	CO	NOx	CO ₂	PM ₁₀	PM _{2.5}
2012 emissions (grams/mile)	0.241	3.638	2.475	581	0.085	0.084
2012 emissions (pounds/mile)	5.31E-04	8.02E-03	5.46E-03	1.28E+00	1.87E-04	1.86E-04
Mobile Source Emissions (lbs/day)	0.03	0.48	0.33	76.85	0.01	0.01
Mobile Source Emissions (tons/yr)	0.006	0.088	0.060	12.721	0.002	0.002

Dust

	PM ₁₀	PM _{2.5}
lbs/day	0.19	0.01
tons/year	0.03	0.002

Provided by applicant: Less than 3 trips per day, 20 miles each ~ 60 miles/day

Construction GHG Emissions amortized over 30 years

	Tons from URBEMIS	Metric Tons	Amortized metric tons
Pipe	4547.21	4125.16	137.51
Wells	5186.45	4705.07	156.84
Storage	1925.73	1746.99	58.23
Total	11659.39	10577.23	352.57
Worker Trips		1703	57
Total		12280	409

Construction Worker Mobile Emissions Year 2012

YEAR	Grams/mile				
	ROG	CO	NOx	CO ₂	PM ₁₀
2012	0.241	3.638	2.475	581	0.085

Assumed average speed of vehicles type to be 55 mph to and from the project site.

Paved Road	
Entrained PM lbs/VMT	
PM ₁₀	PM _{2.5}
0.0031	0.0002

EMISSIONS CALCULATION FOR ON-ROAD VEHICLES DURING CONSTRUCTION ACTIVITIES

Emissions = Vehicle Type x Emission Factor x Miles/Trip x Trips/Day

Miles/day
8029

	Emission Factors					
	ROG	CO	NOx	CO ₂	PM ₁₀	PM _{2.5}
2012 emissions (grams/mile)	0.241	3.638	2.475	581	0.085	0.084
2012 emissions (pounds/mile)	5.31E-04	8.02E-03	5.46E-03	1.28E+00	1.87E-04	1.86E-04
Mobile Source Emissions (lbs/day)	4.27	64.40	43.81	10284.13	1.50	1.49
Mobile Source Emissions (tons/yr)	0.779	11.752	7.995	1702.306	0.275	0.272

Dust

	PM ₁₀	PM _{2.5}
lbs/day	24.99	1.42
tons/year	4.56	0.260

From Project Description Worker Trips

	Well	Pipeline	Storage	CRA
Mobilization Daily	100	2500	1000	1000
Commute once a week	6000	10000	4000	4000
Commute divided by 7	857.14	1428.57	571.43	571.43
Total daily miles	957	3929	1571	1571

8029 Total project trips

Basic Info and Equations from Another CTG (Combustion-Turbine Generator) Analysis
 (http://www.energy.ca.gov/sitingcases/elsegundo_amendment/documents/owner/Appendices/3.1-A1_Air_Emission_Data.pdf)

Standard Conditions Assumed: 29.92 inches Hg and 68 degrees Fahrenheit
 Emission Factor (lb/MMBTU) = (ppmvd)*(MW)*(1/SMV)*(20.9/5.9)*(Fd)*(1/1E6)

where,

controlled ppmvd = controlled concentration corrected to 15% O2

MW = molecular weight (lb/lb-mol)

SMV = specific molar volume at 68 degrees Fahrenheit = 385.3 dscf/lb-mol

Fd = dry oxygen F-factor for natural gas = 8,710 dscf/MMBTU at 68 degrees Fahrenheit

Emission Factors for CO, NOx, and VOC incorporate SCAQMD BACT Guidelines for Gas Turbines
 (Pollutant Conc. Controlled from BACT Guidelines, Part D: BACT Guidelines for Non-Major Polluting Facilities)

Pollutant	Pollutant Conc. Controlled (ppmvd)	Molecular Weight (lbs/lb-mole)	Specific Molar Volume (dscf/lb-mole)	Dry Fuel Factor (dscf/MMBTU)	Emission Factor Controlled (lb/MMBTU)
CO	6.0	28	385.3	8710	0.0135
NOx	2.5	46	385.3	8710	0.0092
VOC	2.0	16	385.3	8710	0.0026

Emission Factors for PM10 and CO2 are from AP-42 since there are no BACT Guidelines for Gas Turbines
 (AP-42 Chapter 3, Section 3.1: Stationary Gas Turbines)

Pollutant	Emission Factor Uncontrolled (lb/MMBTU)
PM10	0.0066
CO2	110

Calculations for Project Emissions from natural gas used by the project

Project Name: Cadiz

Pump station operations requires	22,000,000	kWh/year	
Wellfield operations requires	30,800,000	kWh/year	
Total operations requires	52,800,000	kWh/year	
For natural gas use pump station requires	73,333,333	kWh/year	Factoring 30% efficiency
For natural gas use wellfield requires	77,000,000	kWh/year	Factoring 40% efficiency
Total operations with NG requires	150,333,333	kWh/year	
1 kWh equals	3,412	BTU	
Pump station	250,213,333,333	BTU	
Wellfield	262,724,000,000	BTU	
Operations requires	512,937,333,333	BTU/year	
1 MMBTU equals	1,000,000	BTU	
Operations requires	512,937.33	MMBTU/year	
Operations requires	1,405.31	MMBTU/day	

Pollutant	Emission Factor	Emission per day	Emission per year	lbs/day	lbs/day
	lb/MMBTU	lbs/day	tons/year	Pump Station	Wellfield
CO	0.013	18.91	3.450	9.22	9.68
NOx	0.009	12.94	2.362	6.31	6.63
VOC	0.003	3.60	0.657	1.76	1.84
PM ₁₀	0.007	9.28	1.693	4.52	4.75

Conversion Factors

1	ton equals	2,000	lbs
1	g equals	0.001	kg
1	kg equals	0.001	metric tons
54.01	kg CO ₂ /MMBTU equals	0.054	metric tons/MMBTU
0.1	g N ₂ O/MMBTU equals	0.0000001	metric tons/MMBTU
1	g CH ₄ /MMBTU equals	0.000001	metric tons/MMBTU

Gases	Emission Factor	GHGs	CO ₂ equivalent	CO ₂ Equivalent
	metric tons/MMBTU	metric tons/year	factor	Emissions (metric tons)
CO ₂	0.054	27703.75	1	27703.75
nitrous oxide (N ₂ O)	0.0000001	0.05	296	15.18
Methane (CH ₄)	0.000001	0.51	23	11.80
Total GHG				27731

Source: U.S. Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program*
<http://www.eia.doe.gov/oiaf/1605/coefficients.html>

Calculations for Project Emissions from natural gas used by the project

Project Name: Cadiz

Pump station operations requires	22,000,000	kWh/year	
Wellfield operations requires	50,700,000	kWh/year	
Total operations requires	72,700,000	kWh/year	
For natural gas use pump station requires	73,333,333	kWh/year	Factoring 30% efficiency
For natural gas use wellfield requires	126,750,000	kWh/year	Factoring 40% efficiency
Total operations with NG requires	200,083,333	kWh/year	
1	kWh equals	3,412	BTU
Pump station		250,213,333,333	BTU
Wellfield		432,471,000,000	BTU
Operations requires		682,684,333,333	BTU/year
1	MMBTU equals	1,000,000	BTU
Operations requires		682,684.33	MMBTU/year
Operations requires		1,870.37	MMBTU/day

Pollutant	Emission Factor	Emission per day	Emission per year	lbs/day	lbs/day
	lb/MMBTU	lbs/day	tons/year	Pump Station	Wellfield
CO	0.013	25.16	4.592	9.22	15.94
NOx	0.009	17.22	3.143	6.31	10.91
VOC	0.003	4.79	0.875	1.76	3.04
PM ₁₀	0.007	12.34	2.253	4.52	7.82

Conversion Factors

1	ton equals	2,000	lbs
1	g equals	0.001	kg
1	kg equals	0.001	metric tons
54.01	kg CO ₂ /MMBTU equals	0.054	metric tons/MMBTU
0.1	g N ₂ O/MMBTU equals	0.0000001	metric tons/MMBTU
1	g CH ₄ /MMBTU equals	0.000001	metric tons/MMBTU

Gases	Emission Factor	GHGs	CO ₂ equivalent	CO ₂ Equivalent
	metric tons/MMBTU	metric tons/year	factor	Emissions (metric tons)
CO ₂	0.054	36871.78	1	36871.78
nitrous oxide (N ₂ O)	0.0000001	0.07	296	20.21
Methane (CH ₄)	0.000001	0.68	23	15.70
Total GHG				36908

Source: U.S. Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program*
<http://www.eia.doe.gov/oiaf/1605/coefficients.html>

Greenhouse Gas (GHG) Emissions Calculations

Project Name: cadiz

Indirect Greenhouse Gas (GHG) Emissions from Project use of Electricity (Power Plant Emissions)

Pump	30,800,000
Well 100 AFY	22,000,000
Estimated Project Annual Electrical Use	52,800,000 kWh (kilowatt hours)/year
	52,800 MWh (megawatt hours)/year

Indirect GHG gases	Emission Factor lb/MWh	Annual		CO ₂ Equivalent Factor	Annual CO ₂ Equivalent Emissions (metric tons)
		Project Electricity MWh	GHGs metric tons		
Carbon Dioxide (CO ₂)	641.26	52,800	15,358	1	15,358
Nitrous Oxide (N ₂ O)	0.0037	52,800	0.1	296	26
Methane (CH ₄)	0.0067	52,800	0.2	23	4
Total Indirect GHG Emissions from Project Electricity Use=					15,388

Total Annual Greenhouse Gas (GHG) Emission from Project Operations -- All Sources (CO₂ equivalent Metric Tons)

Electrical Use	<u>15388</u>
Total=	15,388

Notes and References:

Total Emissions from Indirect Electricity Use
 Formula and Emission Factor from The California Climate Action Registry Report Protocol
 Reporting Entity-wide Greenhouse Gas Emissions 2008
 Pg. 33 (CCARRP) gives Equations

Pg. 36 (CCARRP - April 2008 update) gives CO₂ output emission rate (lbs/mWh)
 878.71 (lbs/mWh)

Pg. 36 (CCARRP) gives CO₂ equivalency factors

Pg. 36 (CCARRP) gives Methane and Nitrous Oxide electricity emission factors (lbs/mWh)
 Methane - 0.0067 (lbs/mWh)
 Nitrous Oxide - 0.0037 (lbs/mWh)

lbs/metric ton = 2204.62
 Southern California Edison emission rate 641.26 from ARB local gov operations protocol 2008

Greenhouse Gas (GHG) Emissions Calculations

Project Name: cadiz

Indirect Greenhouse Gas (GHG) Emissions from Project use of Electricity (Power Plant Emissions)

Pump 50,700,000
 Well 100 AFY 22,000,000
Estimated Project Annual Electrical Use 72,700,000 kWh (kilowatt hours)/year
72,700 MWh (megawatt hours)/year

Indirect GHG gases	Emission Factor lb/MWh	Annual		CO ₂ Equivalent Factor	Annual CO ₂ Equivalent Emissions (metric tons)
		Project Electricity MWh	GHGs metric tons		
Carbon Dioxide (CO ₂)	641.26	72,700	21,146	1	21,146
Nitrous Oxide (N ₂ O)	0.0037	72,700	0.1	296	36
Methane (CH ₄)	0.0067	72,700	0.2	23	5
Total Indirect GHG Emissions from Project Electricity Use=					21,188

Total Annual Greenhouse Gas (GHG) Emission from Project Operations -- All Sources (CO2 equivalent Metric Tons)

Electrical Use 21188
 Total= 21,188

Notes and References:

Total Emissions from Indirect Electricity Use
 Formula and Emission Factor from The California Climate Action Registry Report Protocol
 Reporting Entity-wide Greenhouse Gas Emissions 2008
 Pg. 33 (CCARRP) gives Equations

Pg. 36 (CCARRP - April 2008 update) gives CO₂ output emission rate (lbs/mWh)
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 Methane - 0.0067 (lbs/mWh)
 Nitrous Oxide - 0.0037 (lbs/mWh)

lbs/metric ton = 2204.62
 Southern California Edison emission rate 641.26 from ARB local gov operations protocol 2008