Appendix 5.1B
Commissioning and Operation Emission Calculations

APPENDIX 5.1B

Calculation of Maximum Hourly, Daily, and Annual Emissions

Tables presented in this Appendix are as follows:

Table 5.1B-1 Solar Salt Melting - Emission Source Characterization

Table 5.1B-2 Solar Salt Heating - Emission Source Characterization

Table 5.1B-3 Solar Salt Conditioning - Off-Gas Emission Characterization

Table 5.1B-4 Emergency Firewater Pump 1 Emission Estimates

Table 5.1B-5 Emergency Firewater Pump 2 Emission Estimates

Table 5.1B-6 Emergency Backup Generator Emission Estimates – Engine 1

Table 5.1B-7 Emergency Backup Generator Emission Estimates – Engine 2

Table 5.1B-8 Wet Surface Air Cooling Unit Particulate Emission Estimates

Table 5.1B-9 Wet Surface Air Cooling Unit TAC Emission Estimates

Table 5.1B-10 Summary of Vehicle Emissions Associated with Project Operation

Table 5.1B-1

Rice Solar Energy Project - Solar Salt Commissioning
Solar Salt Melting - Emission Source Characterization
October 2009

Solar Salt Melting - Combustion Emissions (Temporary - Non-Recurring, Part of Plant Construction)

Equipment Rating:	55	MMBTU/hr
Control system:	ow NOx Burner	

	Permitted	
Duration:	2,188	hours
Targeted melting duration:	91	days

Propane Firing Option

Propane heat value:	91,500	BTU/gal
Est. hourly Propane use:	751	Gal/hr
Est. exhaust Flowrate:	9,150	ACFM
Total project:	1,644.0	1,000 Gal

Emissions (Propane Case Using EPA Default Emission Factors)

Criteria Pollutants	Emission Factors (lb/KGal)	Emission Rates (lb/hr)	Total Process Emission (lbs)	
NOx	0.78	0.59	1,282	Based on EPA Ref. 19 and 7 ppm NOx
TOC:	1.0	0.75	1,644	
PM10 (Total):	0.7	0.53	1,151	
CO:	7.5	5.64	12,330	
SO2	1.5	1.13	2,466	Assumes a 15 gr/100 scf sulfur content
Greenhouse Gases	Emission Factors (kg/MMBtu)		Total Process Emissions (metric tons)	
CO2:		63.02	9,480	
CH4:		0.001	0.15	
N2O:		0.0001	0.02	

Criteria pollutant emission factors based on EPA AP-42 Section 1.5 (July 2008)
Greenhouse gas emission factors from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)

Note: The composition of LPG is typically 90% propane (C3H8) by liquid volume, 5% propylene (C3H6), and 2.5% butane (C4H10)

Natural Gas Firing Option

Natural Gas heat value:	1,020	Btu/1 scf NG	
Est. N.G. consumption:	53,922	CFH	
Est. N.G for project:	118.0	MMCF	
Est. LNG consumption:	88	CFH	Given: (1 ft3 LNG = 610 scf NG)
Est. LNG mass consumed:	2,334	lb/hr LNG	Given: (26.4 lb/ft3 for LNG)
Total LNG for project:	193,410	CF	

Criteria Pollutants	Emission Profile (#/mmBTU)	Emission Rates (lb/hr)	Total Process Emission (lbs)	
NOx:	0.0084	0.46	1,011	
TOC:	0.00418	0.23	503	
PM10:	0.010	0.55	1,203	
CO:	0.0731	4.02	8,797	

Table 5.1B-2
Rice Solar Energy Project - Solar Salt Commissioning
Solar Salt Heating - Emission Source Characterization
October 2009

Solar Salt Heating (Short-Term - Non-Recurring)

Using Propane to Fuel Salt Heater

Propane heat value:	91,500	BTU/gal
Total propane:	190,922	gal
Aux heater rating:	20	mmBTU/hr

	Permitted	
Total processing hours:	873	hours
Total 24-hour days:	36	days
Hourly propane consumption:	273	gal/hr

Emissions (Propane Case Using EPA Default Emission Factors)

Criteria Pollutants	Emission Factors (lb/KGal)	Emission Rates (lb/hr)	Total Process Emission (lbs)	
NOx:	0.78	0.21	186	Based on EPA Ref. 19 and 7 ppm NOx
TOC:	1	0.27	238	
PM10 (Total):	0.7	0.19	167	
CO:	7.5	2.05	1,787	
SO2:	1.5	0.41	357	Assumes a 15 gr/100 scf sulfur content
Greenhouse Gases	Emission Factors (kg/MMBtu)		Total Process Emissions (metric tons)	
CO2:	63.02		1,374	
CH4:	0.001		0.02	
N2O:	0.0001		0.002	

Criteria pollutant emission factors based on EPA AP-42 Section 1.5 (July 2008)
Greenhouse gas emission factors from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)

Table 5.1B-3
Rice Solar Energy Project - Solar Salt Commissioning
Solar Salt Conditioning - Off-Gas Emission Characterization
October 2009

Solar Salt Purification - Decomposition of Inpurities (Short-Term - Non-Recurring)

Descriptions:

Because the salts contain a fractional amount of magnesium nitrate as an impurity, conditioning the salt to 1,100 F will oxidize the magnesium nitrate (Mg(NO3)2) to magnesium oxide (MgO) and release oxides of nitrogen (NO & NO2).

$$Mg(NO_3)_2 \rightarrow MgO_{(s)} + 2NO_{2(g)} + \tfrac{1}{2}O_{2(g)}$$

Total salt amount:	35,000 (Maximum)	Short Tons
Max % (wt) Mg:	0.045	% (based on vendor guarantee)
Max % (wt) Mg(NO3)2:	0.275	
Total mass of Mg(NO3)2:	192,162	lb (maximum guarantee)
MWt of Mg:	24.31	lb/lb-mole
MWt of Mg(NO3)2:	148.30	lb/lb-mole
MWt of NO2:	46.05	lb/lb-mole
Max NO2 Emissions:	119,340	lbs - Lifetime estimate (Emission higher initially then tail off)
Salt curing duration:	69	24-hour days
NO2 release rate:	72.5	lb/hr (pre-control)
NO2 control efficiency:	85%	(4-stage packed bed chemical scrubber will exceed this requirement)

NO2 Release Rate (Calculated based on maximum salt melting rate & ideal gas law)

Molecular Wt of NO2:	46.02	lb/lb-mole
NO2 gas pressure:	14.7	psi
NO2 gas temperature:	1210	R (750 F)
Universal gas constant:	10.73159	ft3-psi/R/lb-mole
Max. NO2 release rate:	1,391.66	ft3/hr

Emission Source Data (Based on wet chemical scrubbing technology)

Stack Id:	Stack 3	Units (Descriptions)
Stack height:	50	ft above ground
Stack location:	STK 3	
Stack diameter:	14	in.
Est. Exhaust temperature:	120	°F
Exhaust flowrate:	3,000	ACFM

Energy Requirement for Salt Purification (Assumed electrical heating in Hot Tank)

Eutectic salt specific heat:	0.363	BTU/lb		
Energy to raise salt temp:	199.7	BTU/lb (0.363 BTU/lb-F) Additional		
Total energy requirement:	13,976	mmBTU		
Total **electrical** load:	4,836	MWh (Assume 85% heat transfer efficiency)		
Hot tank heating element:	3.0	MWe		
Length of curing:	1,612	hours or	67	days

Emissions (Based on control equipment performing at above stated efficiency)

Criteria Pollutants	Max. NOx Emissions	Units (Comments)
Max Hourly Pre-Control:	72.55	lb/hr
Max Hourly Post-Control:	10.88	lb/hr
Lifetime Pre-Control:	119,340	lb
Lifetime Post-Control:	17,901	lb

Indirect Greenhouse Gases	Emission Factors (lb/MWh)	Total Process Emissions (metric tons)
CO2:	724.12	1,588
CH4:	0.0302	0.07
N2O:	0.0081	0.02

Greenhouse gas emission factors from the California Climate Action Registry, General Reporting Protocol v. 3.1, January 2009

Table 5.1B-4
Rice Solar Energy Project
Emergency Firewater Pump 1 Emission Estimates
October 2009

Test Frequency:	52	Times/Year (Weekly)
Test Duration:	0.50	hour
Expected Annual Operation:	26	hours/year

Source Data:

Engine:	1 (2,000 GPM)	Unit & Descriptions
Make:	Caterpillar	
Model:	C18-DITA	
Rated Horsepower:	600	BHP at 1,750 RPM
Max. Diesel Usage:	31.38	Gal/hr
Stack height:	14	ft above ground
Stack Id:	STK 6	
Stack diameter:	8	in.
Exhaust temperature:	851.9	°F
Exhaust flowrate:	3,750	CFM

Criteria Pollutants	Emission Factor (lb/hr)	Emission Rates[a] (lb/hr)	Annual Emissions[a] (lb/yr)
NOx:	3.81	1.91	99.06
Non-methane HC:	0.06	0.03	1.56
PM:	0.14	0.07	3.64
CO:	0.74	0.37	19.24
SO2[b]:	-	0.00	0.17

[a] Based on 30 minutes of operation per week and 26 hours per year for maintenance and testing.

[b] Based on fuel consumption, fuel density of 7.05 lb/gal, 15 ppm ULSD, and complete combustion to SO2

Greenhouse Gases	Emission Factors (kg/MMBtu)	Annual Emissions (metric tons/yr)
CO2:	73.10	8.27
CH4:	0.003	0.00034
N2O:	0.0006	0.000068

Greenhouse gas emission factors from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133
Greenhouse gas emissions calcuated using a diesel heat content of 5.825 MMBtu/barrel from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)

TAC Emissions:	Emission Factor (lb/Mgal)	Emissions (lb/hr)	Emissions (lb/yr)	CAS
Benzene	0.1863	2.9E-03	1.52E-01	71432
Formaldehyde	1.7261	2.7E-02	1.41E+00	50000
Total PAHs (minus Naphthalene)	0.0362	5.7E-04	2.95E-02	1151
Naphthalene	0.0197	3.1E-04	1.61E-02	91203
Acetaldehyde	0.7833	1.2E-02	6.39E-01	75070
Acrolein	0.0339	5.3E-04	2.77E-02	107028
1,3 Butadiene	0.2174	3.4E-03	1.77E-01	106990
Chlorobenzene	0.0002	3.1E-06	1.63E-04	108907
Propylene	0.467	7.3E-03	3.81E-01	115071
Hexane	0.0269	4.2E-04	2.19E-02	110543
Toluene	0.1054	1.7E-03	8.60E-02	108883
Xylenes	0.0424	6.7E-04	3.46E-02	1330207
Ethyl Benzene	0.0109	1.7E-04	8.89E-03	100414
Hydrogen Chloride	0.1863	2.9E-03	1.52E-01	7647010
Arsenic	0.0016	2.5E-05	1.31E-03	7440382
Cadmium	0.0015	2.4E-05	1.22E-03	7440439
Hexavalent Chromium	0.0001	1.6E-06	8.16E-05	18540299
Copper	0.0041	6.4E-05	3.35E-03	7440508
Lead	0.0083	1.3E-04	6.77E-03	7439921
Manganese	0.0031	4.9E-05	2.53E-03	7439965
Mercury	0.0020	3.1E-05	1.63E-03	7439976
Nickel	0.0039	6.1E-05	3.18E-03	7440020
Selenium	0.0022	3.5E-05	1.79E-03	7782492
Zinc	0.0224	3.5E-04	1.83E-02	7440666
Total TAC (lbs/year)			3.17	

TAC Reference: Ventura County Air Pollution Control District, 2001

Table 5.1B-5
Rice Solar Energy Project
Emergency Firewater Pump 2 Emission Estimates
October 2009

Test Frequency:	52	Times/Year (Weekly)
Test Duration:	0.50	hour
Expected Annual Operation:	26	hours/year

Source Data:

Engine:	1 (2,000 GPM)	Unit & Descriptions
Make:	Caterpillar	
Model:	C18-DITA	
Rated Horsepower:	600	BHP at 1,750 RPM
Max. Diesel Usage:	31.38	Gal/hr
Stack height:	14	ft above ground
Stack Id:	STK 6	
Stack diameter:	8	in.
Exhaust temperature:	851.9	°F
Exhaust flowrate:	3,750	CFM

Criteria Pollutants	Emission Factor (lb/hr)	Emission Rates[a] (lb/hr)	Annual Emissions[a] (lb/yr)
NOx:	3.81	1.91	99.06
Non-methane HC:	0.06	0.03	1.56
PM:	0.14	0.07	3.64
CO:	0.74	0.37	19.24
SO2[b]:	-	0.00	0.17

[a] Based on 30 minutes of operation per week and 26 hours per year for maintenance and testing.

[b] Based on fuel consumption, fuel density of 7.05 lb/gal, 15 ppm ULSD, and complete combustion to SO2

Greenhouse Gases	Emission Factors (kg/MMBtu)	Annual Emissions (metric tons/yr)
CO2:	73.10	8.27
CH4:	0.003	0.00034
N2O:	0.0006	0.000068

Greenhouse gas emission factors from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133
Greenhouse gas emissions calcuated using a diesel heat content of 5.825 MMBtu/barrel from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)

TAC Emissions:	Emission Factor (lb/Mgal)	Emissions (lb/hr)	Emissions (lb/yr)	CAS
Benzene	0.1863	2.9E-03	1.52E-01	71432
Formaldehyde	1.7261	2.7E-02	1.41E+00	50000
Total PAHs (minus Naphthalene)	0.0362	5.7E-04	2.95E-02	1151
Naphthalene	0.0197	3.1E-04	1.61E-02	91203
Acetaldehyde	0.7833	1.2E-02	6.39E-01	75070
Acrolein	0.0339	5.3E-04	2.77E-02	107028
1,3 Butadiene	0.2174	3.4E-03	1.77E-01	106990
Chlorobenzene	0.0002	3.1E-06	1.63E-04	108907
Propylene	0.467	7.3E-03	3.81E-01	115071
Hexane	0.0269	4.2E-04	2.19E-02	110543
Toluene	0.1054	1.7E-03	8.60E-02	108883
Xylenes	0.0424	6.7E-04	3.46E-02	1330207
Ethyl Benzene	0.0109	1.7E-04	8.89E-03	100414
Hydrogen Chloride	0.1863	2.9E-03	1.52E-01	7647010
Arsenic	0.0016	2.5E-05	1.31E-03	7440382
Cadmium	0.0015	2.4E-05	1.22E-03	7440439
Hexavalent Chromium	0.0001	1.6E-06	8.16E-05	18540299
Copper	0.0041	6.4E-05	3.35E-03	7440508
Lead	0.0083	1.3E-04	6.77E-03	7439921
Manganese	0.0031	4.9E-05	2.53E-03	7439965
Mercury	0.0020	3.1E-05	1.63E-03	7439976
Nickel	0.0039	6.1E-05	3.18E-03	7440020
Selenium	0.0022	3.5E-05	1.79E-03	7782492
Zinc	0.0224	3.5E-04	1.83E-02	7440666
Total TAC (lbs/year)			3.17	

TAC Reference: Ventura County Air Pollution Control District, 2001

Table 5.1B-6
Rice Solar Energy Project
Emergency Backup Generator Emission Estimates - Engine 1
October 2009

Test Frequency:	52	Times/Year (Weekly)
Test Duration:	0.50	hour
Expected Annual Operation:	26	hours/year

Source Data:

Engine:	1 (2,500 KW)	Unit & Descriptions
Make:	Caterpillar	
Model:	3516C-HD	
Rated Horsepower:	3,604	BHP at 1800 RPM
Max. Diesel Usage:	173.3	Gal/hr at full load
Stack height:	20	ft above ground
Stack Id:	STK 4	
Stack diameter:	24	in.
Exhaust temperature:	921.9	°F
Exhaust flowrate:	19,049	ACFM

Criteria Pollutants	Emission Factors (g/HP/hr)	Emission Rates[a] (lb/hr)	Annual Emissions[a] (lb/yr)	
NOx (Expressed as NO2):	5.05	20.06	1043	
Non-methane HC:	0.10	0.40	20.66	
PM:	0.04	0.14	7.44	
CO:	0.41	1.63	84.70	
SO2[b]:	-	0.02	0.95	For 15 ppm S Diesel Fuel

[a] Based on 30 minutes of operation per week and 26 hours per year for maintenance and testing.

[b] Based on fuel consumption, fuel density of 7.05 lb/gal, 15 ppm ULSD, and complete combustion to SO2

Greenhouse Gases	Emission Factors (kg/MMBtu)	Annual Emissions (metric tons/yr)
CO2:	73.10	45.68
CH4:	0.0030	0.039
N2O:	0.0006	0.008

Greenhouse gas emission factors from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)
Greenhouse gas emissions calcuated using a diesel heat content of 5.825 MMBtu/barrel from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)

TAC Emissions:	Emission Factor (lb/Mgal)	Emissions (lb/hr)	Emissions (lb/yr)	CAS
Benzene	0.1863	1.6E-02	8.39E-01	71432
Formaldehyde	1.7261	1.5E-01	7.78E+00	50000
Total PAHs (minus Naphthalene)	0.0362	3.1E-03	1.63E-01	1151
Naphthalene	0.0197	1.7E-03	8.88E-02	91203
Acetaldehyde	0.7833	6.8E-02	3.53E+00	75070
Acrolein	0.0339	2.9E-03	1.53E-01	107028
1,3 Butadiene	0.2174	1.9E-02	9.80E-01	106990
Chlorobenzene	0.0002	1.7E-05	9.01E-04	108907
Propylene	0.467	4.0E-02	2.10E+00	115071
Hexane	0.0269	2.3E-03	1.21E-01	110543
Toluene	0.1054	9.1E-03	4.75E-01	108883
Xylenes	0.0424	3.7E-03	1.91E-01	1330207
Ethyl Benzene	0.0109	9.4E-04	4.91E-02	100414
Hydrogen Chloride	0.1863	1.6E-02	8.39E-01	7647010
Arsenic	0.0016	1.4E-04	7.21E-03	7440382
Cadmium	0.0015	1.3E-04	6.76E-03	7440439
Hexavalent Chromium	0.0001	8.7E-06	4.51E-04	18540299
Copper	0.0041	3.6E-04	1.85E-02	7440508
Lead	0.0083	7.2E-04	3.74E-02	7439921
Manganese	0.0031	2.7E-04	1.40E-02	7439965
Mercury	0.0020	1.7E-04	9.01E-03	7439976
Nickel	0.0039	3.4E-04	1.76E-02	7440020
Selenium	0.0022	1.9E-04	9.91E-03	7782492
Zinc	0.0224	1.9E-03	1.01E-01	7440666
Total TAC (lbs/year)			17.53	

TAC Reference: Ventura County Air Pollution Control District, 2001

Table 5.1B-7
Rice Solar Energy Project
Emergency Backup Generator Emission Estimates - Engine 2
October 2009

Test Frequency:	52	Times/Year (Weekly)
Test Duration:	0.50	hour
Expected Annual Operation:	26	hours/year

Source Data:

Engine:	1 (2,500 KW)	Unit & Descriptions
Make:	Caterpillar	
Model:	3516C-HD	
Rated Horsepower:	3,604	BHP at 1800 RPM
Max. Diesel Usage:	173.3	Gal/hr at full load
Stack height:	20	ft above ground
Stack Id:	STK 4	
Stack diameter:	24	in.
Exhaust temperature:	921.9	°F
Exhaust flowrate:	19,049	ACFM

Criteria Pollutants	Emission Factors (g/HP/hr)	Emission Rates[a] (lb/hr)	Annual Emissions[a] (lb/yr)	
NOx (Expressed as NO2):	5.05	20.06	1043	
Non-methane HC:	0.10	0.40	20.66	
PM:	0.04	0.14	7.44	
CO:	0.41	1.63	84.70	
SO2[b]:	-	0.02	0.95	For 15 ppm S Diesel Fuel

[a] Based on 30 minutes of operation per week and 26 hours per year for maintenance and testing.

[b] Based on fuel consumption, fuel density of 7.05 lb/gal, 15 ppm ULSD, and complete combustion to SO2

Greenhouse Gases	Emission Factors (kg/MMBtu)	Annual Emissions (metric tons/yr)
CO2:	73.10	45.68
CH4:	0.0030	0.039
N2O:	0.0006	0.008

Greenhouse gas emission factors from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)
Greenhouse gas emissions calcuated using a diesel heat content of 5.825 MMBtu/barrel from the ARB Mandatory Reporting of Greenhouse Gas Emissions (17 CCR §95100-95133)

TAC Emissions:	Emission Factor (lb/Mgal)	Emissions (lb/hr)	Emissions (lb/yr)	CAS
Benzene	0.1863	1.6E-02	8.39E-01	71432
Formaldehyde	1.7261	1.5E-01	7.78E+00	50000
Total PAHs (minus Naphthalene)	0.0362	3.1E-03	1.63E-01	1151
Naphthalene	0.0197	1.7E-03	8.88E-02	91203
Acetaldehyde	0.7833	6.8E-02	3.53E+00	75070
Acrolein	0.0339	2.9E-03	1.53E-01	107028
1,3 Butadiene	0.2174	1.9E-02	9.80E-01	106990
Chlorobenzene	0.0002	1.7E-05	9.01E-04	108907
Propylene	0.467	4.0E-02	2.10E+00	115071
Hexane	0.0269	2.3E-03	1.21E-01	110543
Toluene	0.1054	9.1E-03	4.75E-01	108883
Xylenes	0.0424	3.7E-03	1.91E-01	1330207
Ethyl Benzene	0.0109	9.4E-04	4.91E-02	100414
Hydrogen Chloride	0.1863	1.6E-02	8.39E-01	7647010
Arsenic	0.0016	1.4E-04	7.21E-03	7440382
Cadmium	0.0015	1.3E-04	6.76E-03	7440439
Hexavalent Chromium	0.0001	8.7E-06	4.51E-04	18540299
Copper	0.0041	3.6E-04	1.85E-02	7440508
Lead	0.0083	7.2E-04	3.74E-02	7439921
Manganese	0.0031	2.7E-04	1.40E-02	7439965
Mercury	0.0020	1.7E-04	9.01E-03	7439976
Nickel	0.0039	3.4E-04	1.76E-02	7440020
Selenium	0.0022	1.9E-04	9.91E-03	7782492
Zinc	0.0224	1.9E-03	1.01E-01	7440666
Total TAC (lbs/year)			17.53	

TAC Reference: Ventura County Air Pollution Control District, 2001

Table 5.1B-8
Rice Solar Energy Project
Wet Surface Air Cooling Unit Particulate Emissions
October 2009

Assumed

The WSAC operates 4,400 hours per year at the design recirculation rate with 5 cycles of concentration. [a]
Influent WSAC concentration based on a 50% raw water and 50% steam generator blowdown blend.
The water chemistry feeding the WSAC does not change between peak and annual

Givens

WSAC Flow Rate [b]			2,736 GPM	1,369,094	Pounds/Hr
WSAC Drift [c]				0.005	Percent
WSAC Cycles of Concentration [d]				5	
Drift	68.5	Pounds/Hr			
TDS Concentration	885	mg/L			
Raw Water Blend	50	%			
Hours of Operation	4400	hours/year			

Component [e]	Max Design Case Cooling Tower Influent (mg/L)	Average Case Cooling Tower Influent (mg/L)	Max. TDS for Cooling Tower Discharge (mg/L)	Annual Average TDS for Cooling Tower Discharge (mg/L)	Max Hourly Cooling Tower PM10/2.5 Emissions (Lb/Hr)	Annual Cooling Tower PM10/2.5 Emissions (Tons/Year)
Total Dissolved Solids	443	443	2213	2213	0.15	0.33

References:

[a] Conservative hours of operation estimate provided by Applicant
[b] WSAC flow rate provided by WorleyParsons
[c] Drift Eliminator Efficiency is 0.005% of flow rate
[d] WSAC Cycles of Concentration provided by WorleyParsons
[e] Water quality source from WorleyParsons

Table 5.1B-9
Rice Solar Energy Project
Wet Surface Air Cooling Unit TAC Emissions
October 2009

Assumed:
The WSAC operates 4,400 hours per year at the design recirculation rate with 5 cycles of concentration.[a]
Influent WSAC concentration based on a 50% raw water and 50% steam generator blowdown blend.
The water chemistry feeding the WSAC does not change between peak and annual

Given:

WSAC Flow Rate [b]			2,736 GPM	1,369,094	Pounds/Hr
WSAC Drift [c]				0.005	Percent
WSAC Cycles of Concentration [d]				5	
Drift	68.5	Pounds/Hr			
Raw Water Blend	50	%			
Hours of Operation	4400	hours/year			

Component [e]	Design Case WSAC Influent (mg/L)	Annual Case WSAC Influent (mg/L)	Design Case WSAC Discharge (mg/L)	Average Case WSAC Discharge (mg/L)	Hourly Emissions (Lb/Hr)	Annual Emissions (Lb/Year)
Arsenic	0.0125	0.0125	0.063	0.063	4.28E-06	0.019
Cadmium	0.002	0.002	0.010	0.010	6.85E-07	0.0030
Copper	0.006	0.006	0.03	0.03	2.05E-06	0.0090
Flouride	4.55	4.55	22.8	22.8	1.56E-03	6.9
Lead	0.010	0.010	0.0475	0.0475	3.25E-06	0.014
Manganese	0.003	0.003	0.02	0.02	1.03E-06	0.0045
Mercury	0.00015	0.00015	0.0008	0.0008	5.13E-08	0.00023
Nickel	0.005	0.005	0.025	0.025	1.71E-06	0.0075
Selenium	0.013	0.013	0.07	0.07	4.45E-06	0.020
Silica	16	16	80	80	5.48E-03	24.1
Vanadium	0.019	0.019	0.095	0.095	6.50E-06	0.029
Totat TAC (lb/yr)						31.1

References:
[a] Conservative hours of operation estimate provided by Applicant
[b] WSAC flow rate provided by WorleyParsons
[c] Drift Eliminator Efficiency is 0.005% of flow rate
[d] WSAC Cycles of Concentration provided by WorleyParsons
[e] Water quality source from WorleyParsons

Notes:
The design and annual constituent concentrations are the same, only the flow will vary from peak to average. The flow provided is the estimated annual average

Table 5.1B-10
Rice Solar Energy Project
Summary of Vehicle Emissions Associated with Project Operation
October 2009

Table 5.1B-10a Criteria Pollutant Emissions - Operation Vehicles

Emission Source	Number per day[a]	Roundtrip Vehicle Miles Traveled	Emissions (lbs/yr)[b]					
			ROG	CO	NOx	SOx	PM_{10}[c]	$PM_{2.5}$[c]
Operation Worker Commute	21	90	73	2,873	312	5	426	128
Heliostat Washers, Maintenance and Administration Worker Commute	26	90	64	2,534	275	4	376	113
Trucks for Heliostat Washing[d]	2	18.4	155	257	575	1	10,160	1,040
Material Deliveries	3	130	111	507	2,195	4	155	98
		TOTAL (lbs/yr)	**403**	**6,171**	**3,357**	**13**	**11,118**	**1,378**

[a] The number of workers is from Section 2.0 Project Description. The number of deliveries is based on a conservative estimate of truck deliveries (e.g., FedEx, garbage removal, chemical delivery, office supply deliveries, etc.).

[b] Calculations assume that operation workers are onsite 7 days per week and heliostat workers, maintenance, and admin staff would be onsite 5 days per week, 52 weeks per year.

[c] Calculations include paved road dust emissions for worker commutes and material deliveries and unpaved road dust for trucks for heliostat washing.

[d] The total distance traveled by one truck each day is approximately 18 miles (0.8 miles traveled per hour for washing + 1.5 miles traveled per hour to reload x 1 reload per hour x 8 hours per day = 18.4 miles traveled per truck).

Table 5.1B-10b. Criteria Pollutant Vehicle Emission Factors

Vehicle Type	Vehicle Emission Factors (lb/mile)[a]					
	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Passenger car	0.00011	0.00416	0.00045	0.00001	0.00006	0.00003
Trucks Used for Heliostat Washing	0.01616	0.02689	0.06009	0.00008	0.00317	0.00283
Material Delivery Truck	0.00109	0.00500	0.02165	0.00004	0.00097	0.00081

[a] Emission factors were derived from the emission factors [g/mi] from EMFAC2007 for calendar year 2013 for MDAQMD portion of Riverside County. A speed of 55 mph was assumed for offsite worker commutes and material deliveries and 2 mph was assumed for heliostat washing.

Motor Vehicles Fugitive Emission Factors for Travel on Unpaved Roads

Emission Factor [lb/mi] = 0.15 x (silt content [%] / 12)$^{0.9}$ x (average vehicle weight [tons] / 3)$^{0.45}$

Reference: AP-42, Section 13.2.2, November 2006

Parameter	PM_{10}	$PM_{2.5}$
Average Vehicle Weight (tons)	10	10
Silt Content (%)	8.5	8.5
Emission Factor (Uncontrolled, lb/mile)	1.89	0.19
Reduction from Speeds Less than 25 mph	44%	44%
Controlled Emission Factor (lb/mile)	1.06	0.11

Reference for Silt Content: AP-42, Section 13.2.2, Table 13.2.2-1, Average for a Construction Site, Scraper Route

Reference for Control Efficiency: SCAQMD Table XI-D (WRAP Fugitive Dust Handbook, September 7, 2006)
http://www.aqmd.gov/ceqa/handbook/mitigation/fugitive/MM_fugitive.html and
http://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf

Average vehicle weight assumes trucks used to wash heliostats weigh 10 tons.

Motor Vehicles Fugitive Emission Factors for Travel on Paved Roads

$E = [k(sL/2)^{0.65} * (W/3)^{1.5}] - C$

Reference: AP-42, Section 13.2.1, November 2006

Parameter	PM_{10}	$PM_{2.5}$
k, particle size multiplier	7.3	1.1
sL, silt loading (g/m2)	0.03	0.03
W, average vehicle weight (tons)	3	3
C, emission factor for 1980's vehicle fleet exhaust, brake wear, and tire wear, g/VMT	0.2119	0.161700
Emission Factor (g/mile)	0.252	0.070
Emission Factor (lb/mile)	0.001	0.0002

Parameters from tables in AP-42, Section 13.2.1.

Average vehicle weight assumes worker commute vehicles weigh 2.5 tons and delivery trucks weigh 10 tons.

Table 5.1B-10c. Greenhouse Gas Emissions - Operation Vehicles

Emission Source	Number per day[a]	Roundtrip Vehicle Miles Traveled	Fuel economy (miles per gallon)[b]	Emissions (metric tons/yr)[c]			
				CO_2	CH_4	N_2O	CO_2 equivalent
Operation Worker Commute	21	90	18	338	0.010	0.005	340
Heliostat Washers, Maintenance and Administration	26	90	18	298	0.009	0.005	301
Trucks Used for Heliostat Washing[d]	2	18	6	16	0.000	0.000	16
Material Deliveries	3	130	6	172	0.005	0.005	172
TOTAL (metric tons/yr)				**823**	**0.02**	**0.02**	**828**

[a] The number of workers is from Section 2.0 Project Description. The number of deliveries is based on a conservative estimate of truck deliveries (e.g., FedEx, garbage removal, chemical delivery, office supply deliveries, etc.).

[b] Fuel economy for trucks based on assumptions from the California Climate Action Registry, General Reporting Protocol, January 2009. Worker commute vehicle fuel economy based on assuming workers would drive model year 2005 or newer passenger cars and fuel economy data from EPA (www.fueleconomy.gov).

[c] Calcuations assume that operation workers are onsite 7 days per week and heliostat workers, maintenance, and admin staff would be onsite 5 days per week, 52 weeks per year.

[c] The total distance traveled by one truck each day is approximatey 18 miles (0.8 miles traveled per hour for washing + 1.5 miles traveled per hour to reload x 1 reload per hour x 8 hours per day = 18.4 miles traveled per truck).

Table 5.1-10d. Greenhouse Gas Emission Factors

Vehicle Type	Vehicle Emission Factors		
	CO_2 (kg/gallon)	CH_4 (g/mile)	N_2O (g/mile)
Passenger Car Model Year 2005-Present	8.81	0.0147	0.0079
Diesel Heavy-Duty Truck	10.15	0.051	0.048

Emission factors are from the California Climate Action Registry General Reporting Protocol, Version 3.1, Tables C.3 and C.4, January 2009.

Table 5.1-10e. Global Warming Potentials

CH_4	21
N_2O	310

Reference: Intergovernmental Panel on Climate Change, Second Assessment Report (SAR) (IPCC, 1996).