Appendix D

AIR EMISSION CALCULATIONS

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Table D1. Emissions Summary

Scenario	Annual Emissions (tons per year) NOx	PM	ROG	CO	CO2	Metric Tons CO2	Metric Tons CO2e
Baseline (2002-2007 av.)							
Hanson (TS&G)	42.7	1.5	3.7	11.7	2,656.2		
Hanson (DS-10)	32.6	1.3	3.3	10.4	2,525.7		
Suisin Assoc. (TS&G)	1.8	0.1	0.2	0.5	110.3		
Suisun Assoc. (DS-10)	0.7	0.0	0.1	0.2	51.2		
Suisun Assoc. (Jerico)	0.4	0.0	0.1	0.2	38.5		
Jerico	1.9	0.1	0.3	0.9	183.5		
Cemex	4.8	0.2	0.4	1.4	330.8		
TOTAL	*84.8*	*3.1*	*8.0*	*25.3*	*5,896.2*	*5,349*	*5,400*
~~Future (2012) - No New Emission Controls~~							
~~Hanson (TS&G)~~	~~128.1~~	~~4.4~~	~~11.2~~	~~35.1~~	~~7,978.6~~		
~~Hanson (DS-10)~~	~~0.0~~	~~0.0~~	~~0.0~~	~~0.0~~	~~-~~		
~~Suisin Assoc. (TS&G)~~	~~12.1~~	~~0.4~~	~~1.1~~	~~3.3~~	~~751.8~~		
~~Suisun Assoc. (DS-10)~~	~~0.0~~	~~0.0~~	~~0.0~~	~~0.0~~	~~-~~		
~~Suisun Assoc. (Jerico)~~	~~1.4~~	~~0.1~~	~~0.2~~	~~0.7~~	~~137.6~~		
~~Jerico~~	~~1.4~~	~~0.1~~	~~0.2~~	~~0.7~~	~~137.6~~		
~~*TOTAL*~~	~~143.1~~	~~4.9~~	~~12.6~~	~~39.9~~	~~9,005.7~~	~~*8,170*~~	~~*8,247*~~
~~*Change from Existing*~~	~~***58.3***~~	~~*1.8*~~	~~*4.6*~~	~~*14.5*~~	~~*3,109.4*~~	~~*2,821*~~	~~*2,847*~~
~~Future (2012) - With Applicant Proposed E-POD Retrofits for Half Year~~							
~~Hanson (TS&G)~~	~~85.5~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Hanson (DS-10)~~	~~0.0~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Suisin Assoc. (TS&G)~~	~~8.1~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Suisun Assoc. (DS-10)~~	~~0.0~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Suisun Assoc. (Jerico)~~	~~1.4~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Jerico~~	~~1.4~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~*TOTAL*~~	~~96.4~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~*Change from Existing*~~	~~***11.7***~~	~~--~~	~~--~~	~~--~~	~~--~~	~~--~~	~~--~~
~~Future (2013) - With Applicant Proposed E-POD Retrofits all Year~~							
~~Hanson (TS&G)~~	~~42.8~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Hanson (DS-10)~~	~~0.0~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Suisin Assoc. (TS&G)~~	~~4.0~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Suisun Assoc. (DS-10)~~	~~0.0~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Suisun Assoc. (Jerico)~~	~~1.4~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~Jerico~~	~~1.4~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~*TOTAL*~~	~~49.7~~	~~--~~	~~--~~	~~--~~	~~--~~		
~~*Change from existing*~~	~~***(35.0)***~~	~~--~~	~~--~~	~~--~~	~~--~~	~~-~~	~~-~~
Future (2014) Emissions with Required Regulatory Upgrades							
Hanson (TS&G)	85.7	4.4	11.2	35.1	7,978.6		
Hanson (DS-10)	0.0	0.0	0.0	0.0	0.0		
Suisin Assoc. (TS&G)	8.1	0.4	1.1	3.3	751.8		
Suisun Assoc. (DS-10)	0.0	0.0	0.0	0.0	0.0		
Suisun Assoc. (Jerico)	1.4	0.1	0.2	0.7	137.6		
Jerico	1.4	0.1	0.2	0.7	137.6		
TOTAL	*96.7*	*4.9*	*12.6*	*39.9*	*9005.7*	*8,170*	*8,247*
Change from existing	***12.0***	***1.8***	***4.6***	***14.5***	***3,109.4***	*2,821*	*2,848*

Global Warming Potential for CH4 = 25; GWP for N2O = 298.

Diesel emission of GHG (CCAR, 2009)

10150	g CO2/gal	
0.26	g N2O/gal	
0.74	g CH4/gal	
N2O emissions =	0.000026	ratio of N20 emission to CO2 Emissions
CH4 emissions =	0.000073	ratio of N20 emission to CO2 Emissions

References:

California Climate Action Registry, General Reporting Protocol, Reporting Entity-Wide Greenhouse Gas Emissions, Version 3.1, January 2009. Tables C.3 and C.6.

The IPCC developed revised GWPs for the Fourth Assessment Report (AR4).

Table D2. Mining Events (Current and Requested)

Parcel	2002-2007 Annual Average		Requested Conditions	
	Annual Volume	Mining Events [a]	Annual Volume	Mining Events [a]
State Lands Commission Parcels				
PRC 709 Presidio Shoals (Hanson)	290,331	145	340,000	170
PRC 2036 Point Knox South (Hanson)	252,637	126	450,000	225
PRC 7779 Point Knox Shoal (Hanson)	390,440	195	550,000	275
PRC 7780 Alcatraz South Shoal (Hanson)	127,248	64	200,000	100
PRC 7781: Suisun Associates	85,746	43	300,000	150
PRC 5871: Alcatraz Shoal (Cemex)	80,383	40	0	0
State Lands Lease Totals	*1,226,785*	613	*1,840,000*	*920*
Private Parcels				
Grossi Middle Ground: ACOE Permit No. 25653N (Hanson)	0	0	25,000	13
Grossi Middle Ground: ACOE Permit No. 24996N (Hanson)	0	0	25,000	13
Grossi Middle Ground: ACOE Permit No. 24913N (Jerico)	199,866	100	150,000	75
Private Parcel Lease Totals	*199,866*	*100*	*200,000*	*101*
Total All Leases	**1,426,651**	**713**	**2,040,000**	**1,021**
Net Change in Mining Events	**308**			

[a] Assumes that 2,000 cubic yards of sand are collected during each mining event

1,346,268

Table D3. Emission Factors for Mining Equipment (Baseline)

Equipment Name	Type	Manufacture Year [a]	Horsepower [a]	Load Factor [b]	Emission Factor (g/bhp-hr) [c,d]					Emission Rate (lb/hr)				
					NOx	PM	ROG	CO	CO2	NOx	PM	ROG	CO	CO2
Hanson American River	Tug (2 engines)	2003	1,710	0.5	6.93	0.29	0.68	1.97	568.3	13.1	0.5	1.3	3.7	1,071.2
Hanson San Joaquin River	Tug (2 engines)	2001	2,600	0.5	6.93	0.29	0.68	1.97	568.3	19.9	0.8	1.9	5.6	1,628.8
	Barge - Main Engine	1983	1,000	0.52	13.17	0.36	0.95	3.07	568.3	15.1	0.4	1.1	3.5	651.5
	Barge - Generator (Aux)	1984	265	0.43	10.23	0.32	1.07	4.33	568.3	2.6	0.1	0.3	1.1	142.8
Hanson TS & G	Barge - Thruster (Aux)	1984	304	0.43	10.23	0.32	1.07	4.33	568.3	2.9	0.1	0.3	1.2	163.8
	Barge - Main Engine	2001	1,100	0.52	6.93	0.29	0.68	1.97	568.3	8.7	0.4	0.9	2.5	716.7
	Barge - Monitor Pump (Aux)	2002	440	0.43	6.93	0.26	0.81	2.78	568.3	2.9	0.1	0.3	1.2	237.0
	Barge - Flood Pump (Aux)	2002	440	0.43	6.93	0.26	0.81	2.78	568.3	2.9	0.1	0.3	1.2	237.0
Hanson DS-10	Barge - Generator (Aux)	1984	375	0.43	10.23	0.32	1.07	4.33	568.3	3.6	0.1	0.4	1.5	202.0
	Tug (2 engines)	2001	1,060	0.5	6.93	0.29	0.68	1.97	568.3	8.1	0.3	0.8	2.3	664.0
Jerico Tug	Tug (generator)	2000	64	0.31	6.93	0.46	1.18	3.59	568.3	0.3	0.0	0.1	0.2	24.9
	Barge Generator (Aux)	2004	99	0.43	4.62	0.46	1.18	3.59	568.3	0.4	0.0	0.1	0.3	53.3
Jerico Barge	Barge Pump (Aux)	2001	230	0.43	6.93	0.26	0.81	2.78	568.3	1.5	0.1	0.2	0.6	123.9
Jerico Loader	Loader	2007	195	0.43	4.83	0.12	0.81	3.73	568.3	0.9	0.0	0.1	0.7	105.1

[a] Provided by Project Applicants.

[b] Based on information provided in Appendix B - Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, from CARB's*Technical Support Document: Initial Statement of Reason for Proposed Rule Making, Proposed Regulation for Commercial Harbor Craft,* September 2007.

[c] Criteria pollutant emission factors obtained from Appendix B (cited above). All Equipment except for the TS&G assumes a fuel correction factor of 0.948 and 0.8 for NOx and PM respectively while the TS&G assumes a fuel correction factor of 0.930 and 0.720 for NOx and PM10 respectively.

[d] CO2 emission factors derived from OFFROAD2007. Represents CO2 emission factors for diesel fueled engines.

Table D4. Emission Rates by Activity (Baseline)

Equipment - Activity	Emission Rate (lb/hr-equipment)				
	NOx	PM	ROG	CO	CO2
Hanson TS&G 230 - Mining					
San Joaquin Tug	19.9	0.8	1.9	5.6	1,628.8
TS&G - Barge - Main	15.1	0.4	1.1	3.5	651.5
TS&G - Barge - Gen - Aux	2.6	0.1	0.3	1.1	142.8
Total	***37.5***	***1.3***	***3.3***	***10.3***	***2,423.0***
Hanson TS&G 230 - Cruising					
San Joaquin Tug	19.9	0.8	1.9	5.6	1,628.8
TS&G - Barge - Gen - Aux	2.6	0.1	0.3	1.1	142.8
Total	***22.4***	***0.9***	***2.2***	***6.7***	***1,771.5***
Hanson TS&G 230 - Unloading					
TS&G - Barge - Main	15.1	0.4	1.1	3.5	651.5
TS&G - Barge - Gen - Aux	2.6	0.1	0.3	1.1	142.8
Total	***17.7***	***0.5***	***1.4***	***4.6***	***794.3***
Hanson DS-10 - Mining					
American River Tug	13.1	0.5	1.3	3.7	1,071.2
DS-10 - Barge (Main)	8.7	0.4	0.9	2.5	716.7
DS-10 - Barge (Generator)	3.6	0.1	0.4	1.5	202.0
Total	***25.4***	***1.0***	***2.5***	***7.7***	***1,989.9***
Hanson DS-10 - Cruising					
American River Tug	13.1	0.5	1.3	3.7	1,071.2
DS-10 - Barge (Generator)	3.6	0.1	0.4	1.5	202.0
Total	***16.7***	***0.7***	***1.7***	***5.3***	***1,273.3***
Hanson DS-10 - Unloading					
Barge - Main	8.7	0.4	0.9	2.5	716.7
Barge - Monitor Pump - Aux	2.9	0.1	0.3	1.2	237.0
Barge - Flood Pump- Aux	2.9	0.1	0.3	1.2	237.0
Barge - Gen - Aux	3.6	0.1	0.4	1.5	202.0
Total	***18.2***	***0.7***	***1.9***	***6.3***	***1,392.8***
Jerico Barge - Mining					
Jerico Barge - Generator	0.4	0.0	0.1	0.3	53.3
Jerico Barge - Monitor	1.5	0.1	0.2	0.6	123.9
Total	***1.9***	***0.1***	***0.3***	***0.9***	***177.2***
Jerico Barge - Cruising					
Jerico Tug - Main	8.1	0.3	0.8	2.3	664.0
Jerico Barge - Generator	0.4	0.0	0.1	0.3	53.3
Total	***8.5***	***0.4***	***0.9***	***2.6***	***717.4***
Jerico Unloading					
Loader	0.9	0.0	0.1	0.7	105.1
Total	***0.9***	***0.0***	***0.1***	***0.7***	***105.1***

Table D5. Annual Emissions (Baseline)

Barge	Mining Events	Activity	Hours	Emission Rates (lb/hr)					Annual Emissions (tons per year)				
				NOx	PM	ROG	CO	CO2	NOx	PM	ROG	CO	CO2
		Cruising	2	22.4	0.9	2.2	6.7	1,771.5	5.9	0.2	0.6	1.8	469.5
		Mining	5.5	37.5	1.3	3.3	10.3	2,423.0	27.3	1.0	2.4	7.5	1,765.8
Hanson (TS&G 230)	265	Unloading	4	17.7	0.5	1.4	4.6	794.3	9.4	0.3	0.7	2.4	421.0
		Cruising	2	16.7	0.7	1.7	5.3	1,273.3	4.4	0.2	0.4	1.4	337.4
		Mining	5.5	25.4	1.0	2.5	7.7	1,989.9	18.5	0.7	1.8	5.6	1,450.1
Hanson (DS-10)	265	Unloading	4	18.2	0.7	1.9	6.3	1,392.8	9.6	0.4	1.0	3.4	738.2
		Cruising	2	22.4	0.9	2.2	6.7	1,771.5	0.2	0.0	0.0	0.1	19.5
Suisun Associates		Mining	5.5	37.5	1.3	3.3	10.3	2,423.0	1.1	0.0	0.1	0.3	73.3
(TS&G 230)	11	Unloading	4	17.7	0.5	1.4	4.6	794.3	0.4	0.0	0.0	0.1	17.5
		Cruising	2	16.7	0.7	1.7	5.3	1,273.3	0.2	0.0	0.0	0.1	14.0
Suisun Associates (DS-		Cruising	2	25.4	1.0	2.5	7.7	1,989.9	0.3	0.0	0.0	0.1	21.9
10)	11	Cruising	2	18.2	0.7	1.9	6.3	1,392.8	0.2	0.0	0.0	0.1	15.3
		Cruising	2	8.5	0.4	0.9	2.6	717.4	0.2	0.0	0.0	0.1	15.1
Suisun Associates		Mining	5.5	1.9	0.1	0.3	0.9	177.2	0.1	0.0	0.0	0.1	10.2
(Jerico Barge)	21	Unloading	12	0.9	0.0	0.1	0.7	105.1	0.1	0.0	0.0	0.1	13.2
		Cruising	2	8.5	0.4	0.9	2.6	717.4	0.9	0.0	0.1	0.3	71.7
		Mining	5.5	1.9	0.1	0.3	0.9	177.2	0.5	0.0	0.1	0.3	48.7
Jerico	100	Unloading	12	0.9	0.0	0.1	0.7	105.1	0.5	0.0	0.1	0.4	63.0
Total Emisisons Excluding Cemex (tons per year)									**80.0**	**2.9**	**7.5**	**23.9**	**5,565.5**
Cemex	40								4.8	0.2	0.4	1.4	330.8
Total Emisisons Including Cemex (tons per year)									**84.8**	**3.1**	**8.0**	**25.3**	**5,896.2**

Table D6. Emission Factors for Mining Equipment (2012)

Equipment Name	Type	Manufacture Year [a]	Horsepower [a]	Load Factor [b]	Emission Factor (g/bhp-hr) [c,d]					Emission Rate (lb/hr)				
					NOx	PM	ROG	CO	CO2	NOx	PM	ROG	CO	CO2
Hanson American River	Tug (2 engines)	2003	1,710	0.5	6.93	0.29	0.68	1.97	568.3	13.1	0.5	1.3	3.7	1,071.2
Hanson San Joaquin River	Tug (2 engines)	2001	2,600	0.5	6.93	0.29	0.68	1.97	568.3	19.9	0.8	1.9	5.6	1,628.8
	Barge - Main Engine	1983	1,000	0.52	13.17	0.36	0.95	3.07	568.3	15.1	0.4	1.1	3.5	651.5
	Barge - Generator (Aux)	1984	265	0.43	10.23	0.32	1.07	4.33	568.3	2.6	0.1	0.3	1.1	142.8
Hanson TS & G	Barge - Thruster (Aux)	1984	304	0.43	10.23	0.32	1.07	4.33	568.3	2.9	0.1	0.3	1.2	163.8
	Barge - Main Engine	2001	1,100	0.52	6.93	0.29	0.68	1.97	568.3	8.7	0.4	0.9	2.5	716.7
	Barge - Monitor Pump (Aux)	2002	440	0.43	6.93	0.26	0.81	2.78	568.3	2.9	0.1	0.3	1.2	237.0
	Barge - Flood Pump (Aux)	2002	440	0.43	6.93	0.26	0.81	2.78	568.3	2.9	0.1	0.3	1.2	237.0
Hanson DS-10	Barge - Generator (Aux)	1984	375	0.43	10.23	0.32	1.07	4.33	568.3	3.6	0.1	0.4	1.5	202.0
	Tug (2 engines)	2001	1,060	0.5	6.93	0.29	0.68	1.97	568.3	8.1	0.3	0.8	2.3	664.0
Jerico Tug	Tug (generator)	2000	64	0.31	6.93	0.46	1.18	3.59	568.3	0.3	0.0	0.1	0.2	24.9
	Barge Generator (Aux)	2004	99	0.43	4.62	0.46	1.18	3.59	568.3	0.4	0.0	0.1	0.3	53.3
Jerico Barge	Barge Pump (Aux)	2001	230	0.43	6.93	0.26	0.81	2.78	568.3	1.5	0.1	0.2	0.6	123.9
Jerico Loader	Loader	2007	195	0.43	4.83	0.12	0.81	3.73	568.3	0.9	0.0	0.1	0.7	105.1

[a] Provided by Project Applicants.

[b] Based on information provided in Appendix B - Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, from CARB's *Technical Support Document: Initial Statement of Reason for Proposed Rule Making, Proposed Regulation for Commercial Harbor Craft*, September 2007.

[c] Assumes all Jerico engines would meet USEPA Tier 2 NOx standard of 7.8 grams per kilowatt-hour (5.8 grams per brake-horsepower hour) by 2010.

[d] CO2 emission factors derived from OFFROAD2007. Represents CO2 emission factors for diesel fueled engines.

Table D7. Emission Rates by Activity (2010)

Equipment - Activity	Emission Rate (lb/hr-equipment)				
	NOx	PM	ROG	CO	CO2
Hanson TS&G 230 - Mining					
San Joaquin Tug	19.9	0.8	1.9	5.6	1,628.8
TS&G - Barge - Main	15.1	0.4	1.1	3.5	651.5
TS&G - Barge - Gen - Aux	2.6	0.1	0.3	1.1	142.8
Total	***37.5***	***1.3***	***3.3***	***10.3***	***2,423.0***
Hanson TS&G 230 - Cruising					
San Joaquin Tug	19.9	0.8	1.9	5.6	1,628.8
TS&G - Barge - Gen - Aux	2.6	0.1	0.3	1.1	142.8
Total	***22.4***	***0.9***	***2.2***	***6.7***	***1,771.5***
Hanson TS&G 230 - Unloading					
TS&G - Barge - Main	15.1	0.4	1.1	3.5	651.5
TS&G - Barge - Gen - Aux	2.6	0.1	0.3	1.1	142.8
Total	***17.7***	***0.5***	***1.4***	***4.6***	***794.3***
Hanson DS-10 - Mining					
American River Tug	13.1	0.5	1.3	3.7	1,071.2
DS-10 - Barge (Main)	8.7	0.4	0.9	2.5	716.7
DS-10 - Barge (Generator)	3.6	0.1	0.4	1.5	202.0
Total	***25.4***	***1.0***	***2.5***	***7.7***	***1,989.9***
Hanson DS-10 - Cruising					
American River Tug	13.1	0.5	1.3	3.7	1,071.2
DS-10 - Barge (Generator)	3.6	0.1	0.4	1.5	202.0
Total	***16.7***	***0.7***	***1.7***	***5.3***	***1,273.3***
Hanson DS-10 - Unloading					
Barge - Main	8.7	0.4	0.9	2.5	716.7
Barge - Monitor Pump - Aux	2.9	0.1	0.3	1.2	237.0
Barge - Flood Pump- Aux	2.9	0.1	0.3	1.2	237.0
Barge - Gen - Aux	3.6	0.1	0.4	1.5	202.0
Total	***18.2***	***0.7***	***1.9***	***6.3***	***1,392.8***
Jerico Barge - Mining					
Jerico Barge - Generator	0.4	0.0	0.1	0.3	53.3
Jerico Barge - Monitor	1.5	0.1	0.2	0.6	123.9
Total	***1.9***	***0.1***	***0.3***	***0.9***	***177.2***
Jerico Barge - Cruising					
Jerico Tug - Main	8.1	0.3	0.8	2.3	664.0
Jerico Barge - Generator	0.4	0.0	0.1	0.3	53.3
Total	***8.5***	***0.4***	***0.9***	***2.6***	***717.4***
Jerico Unloading					
Loader	0.9	0.0	0.1	0.7	105.1
Total	***0.9***	***0.0***	***0.1***	***0.7***	***105.1***

Table D8. Annual Emissions (2012)

Barge	Mining Events	Activity	Hours	Emission Rates (lb/hr)					Annual Emissions (tons per year)				
				NOx	PM	ROG	CO	CO2	NOx	PM	ROG	CO	CO2
Hanson (TS&G 230)	796	Cruising	2	22.4	0.9	2.2	6.7	1,771.5	17.9	0.7	1.8	5.4	1410.1
		Mining	5.5	37.5	1.3	3.3	10.3	2,423.0	82.2	2.9	7.2	22.4	5,304.0
		Unloading	4	17.7	0.5	1.4	4.6	794.3	28.1	0.8	2.2	7.3	1,264.5
Hanson (DS-10)	0	Cruising	2	16.7	0.7	1.7	5.3	1,273.3	0.0	0.0	0.0	0.0	-
		Mining	5.5	25.4	1.0	2.5	7.7	1,989.9	0.0	0.0	0.0	0.0	-
		Unloading	4	18.2	0.7	1.9	6.3	1,392.8	0.0	0.0	0.0	0.0	-
Suisun Associates (TS&G 230)	75	Cruising	2	22.4	0.9	2.2	6.7	1,771.5	1.7	0.1	0.2	0.5	132.9
		Mining	5.5	37.5	1.3	3.3	10.3	2,423.0	7.7	0.3	0.7	2.1	499.8
		Unloading	4	17.7	0.5	1.4	4.6	794.3	2.7	0.1	0.2	0.7	119.1
Suisun Associates (DS-10)	0	Cruising	2	16.7	0.7	1.7	5.3	1,273.3	0.0	0.0	0.0	0.0	0.0
		Cruising	2	25.4	1.0	2.5	7.7	1,989.9	0.0	0.0	0.0	0.0	0.0
		Cruising	2	18.2	0.7	1.9	6.3	1,392.8	0.0	0.0	0.0	0.0	0.0
Suisun Associates (Jerico Barge)	75	Cruising	2	8.5	0.4	0.9	2.6	717.4	0.6	0.0	0.1	0.2	53.8
		Mining	5.5	1.9	0.1	0.3	0.9	177.2	0.4	0.0	0.1	0.2	36.6
		Unloading	12	0.9	0.0	0.1	0.7	105.1	0.4	0.0	0.1	0.3	47.3
Jerico	75	Cruising	2	8.5	0.4	0.9	2.6	717.4	0.6	0.0	0.1	0.2	53.8
		Mining	5.5	1.9	0.1	0.3	0.9	177.2	0.4	0.0	0.1	0.2	36.6
		Unloading	12	0.9	0.0	0.1	0.7	105.1	0.4	0.0	0.1	0.3	47.3
Total Emisisons (tons per year)									**143.1**	**4.9**	**12.6**	**39.9**	**9,005.7**

Table D9. Emission Factors for Mining Equipment (2013) with Proposed E-POD* Retrofits

Equipment Name	Type	Manufacture Year [a]	Horsepower [a]	Load Factor [b]	Emission Factor (g/bhp-hr) [c,d] NOx	Emission Rate (lb/hr) NOx
Hanson American River	Tug (2 engines)	2003	1,710	0.5	6.93	13.1
Hanson San Joaquin River	Tug (2 engines)	2001	2,600	0.5	2.41	6.9
	Barge - Main Engine	1983	1,000	0.52	2.41	2.8
	Barge - Generator (Aux)	1984	265	0.43	10.23	2.6
Hanson TS & G	Barge - Thruster (Aux)	1984	304	0.43	10.23	2.9
	Barge - Main Engine	2001	1,100	0.52	6.93	8.7
	Barge - Monitor Pump (Aux)	2002	440	0.43	6.93	2.9
	Barge - Flood Pump (Aux)	2002	440	0.43	6.93	2.9
Hanson DS 10	Barge - Generator (Aux)	1984	375	0.43	10.23	3.6
	Tug (2 engines)	2001	1,060	0.5	6.93	8.1
Jerico Tug	Tug (generator)	2000	64	0.31	6.93	0.3
	Barge Generator (Aux)	2004	99	0.43	4.62	0.4
Jerico Barge	Barge Pump (Aux)	2001	230	0.43	6.93	1.5
Jerico Loader	Loader	2007	195	0.43	4.83	0.9

* E-POD is a CleanAIR Systems emissions reduction technology that uses selective catalytic reduction (SCR) plus diesel oxidation catalyst (DOC).

[a] Provided by Project Applicants.

[b] Based on information provided in Appendix B - Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, from CARB's Technical Support Document: Initial Statement of Reason for Proposed Rule Making, Proposed Regulation for Commercial Harbor Craft, September 2007.

[c] Assumes all Hanson engines manufactured in or prior to 1985 would meet USEPA Tier 2 NOx + THC standard of 7.8 grams per kilowatt-hour (5.8 grams per brake-horsepower hour) by 2013. It is assumed that 100% of THC is ROG. 2011 and that all Jerico engines met the USEPA Tier 2 NOx standard of 7.8 grams per kilowatt-hour (5.8 grams per brake-horsepower hour) by 2010.

[d] CO2 emission factors derived from OFFROAD2007. Represents CO2 emission factors for diesel fueled engines.

Table D10. Emission Rates by Activity (2013) with Proposed E-POD* Retrofits

Equipment - Activity	Emission Rate (lb/hr-equipment)
	NOx
Hanson TS&G 230 - Mining	
San Joaquin Tug	6.9
TS&G - Barge - Main	2.8
TS&G - Barge - Gen - Aux	2.6
Total	***12.2***
Hanson TS&G 230 - Cruising	
San Joaquin Tug	6.9
TS&G - Barge - Gen - Aux	2.6
Total	***9.5***
Hanson TS&G 230 - Unloading	
TS&G - Barge - Main	2.8
TS&G - Barge - Gen - Aux	2.6
Total	***5.3***
Hanson DS-10 - Mining	
American River Tug	13.1
DS-10 - Barge (Main)	8.7
DS-10 - Barge (Generator)	3.6
Total	***25.4***
Hanson DS-10 - Cruising	
American River Tug	13.1
DS-10 - Barge (Generator)	3.6
Total	***16.7***
Hanson DS-10 - Unloading	
Barge - Main	8.7
Barge - Monitor Pump - Aux	2.9
Barge - Flood Pump- Aux	2.9
Barge - Gen - Aux	3.6
Total	***18.2***
Jerico Barge - Mining	
Jerico Barge - Generator	0.4
Jerico Barge - Monitor	1.5
Total	***1.9***
Jerico Barge - Cruising	
Jerico Tug - Main	8.1
Jerico Barge - Generator	0.4
Total	***8.5***
Jerico Unloading	
Loader	0.9
Total	***0.9***

* E-POD is a CleanAIR Systems emissions reduction technology that uses selective catalytic reduction (SCR) plus DOC.

Table D11. Annual Emissions (2013) with Proposed E-POD* Retrofits

Barge	Mining Events	Activity	Hours	Emission Rates (lb/hr) NOx	Annual (tons per year) NOx
	796	Cruising	2	9.5	7.5
		Mining	5.5	12.2	26.8
Hanson (TS&G 230)		Unloading	4	5.3	8.5
	0	Cruising	2	16.7	0.0
		Mining	5.5	25.4	0.0
Hanson (DS-10)		Unloading	4	18.2	0.0
	75	Cruising	2	9.5	0.7
		Mining	5.5	12.2	2.5
(TS&G 230)		Unloading	4	5.3	0.8
	0	Cruising	2	16.7	0.0
		Cruising	2	25.4	0.0
10)		Cruising	2	18.2	0.0
	75	Cruising	2	8.5	0.6
		Mining	5.5	1.9	0.4
(Jerico Barge)		Unloading	12	0.9	0.4
	75	Cruising	2	8.5	0.6
		Mining	5.5	1.9	0.4
Jerico		Unloading	12	0.9	0.4
Total Emisisons (tons per year)					**49.7**

* E-POD is a CleanAIR Systems emissions reduction technology that uses selective catalytic reduction (SCR) plus DOC.

Table D12. Emission Factors for Mining Equipment (2014) with Required Airborne Toxic Control Measures

Equipment Name	Type	Manufacture Year [a]	Horsepower [a]	Load Factor [b]	Emission Factor (g/bhp-hr) [c,d]					Emission Rate (lb/hr)				
					NOx	PM	ROG	CO	CO2	NOx	PM	ROG	CO	CO2
Hanson American River	Tug (2 engines)	2003	1,710	0.5	6.93	0.29	0.68	1.97	568.3	13.1	0.5	1.3	3.7	1,071.2
Hanson San Joaquin River	Tug (2 engines)	2001	2,600	0.5	6.93	0.29	0.68	1.97	568.3	19.9	0.8	1.9	5.6	1,628.8
	Barge - Main Engine	1983	1,000	0.52	4.85	0.36	0.95	3.07	568.3	5.6	0.4	1.1	3.5	651.5
	Barge - Generator (Aux)	1984	265	0.43	4.73	0.32	1.07	4.33	568.3	1.2	0.1	0.3	1.1	142.8
Hanson TS & G	Barge - Thruster (Aux)	1984	304	0.43	4.73	0.32	1.07	4.33	568.3	1.4	0.1	0.3	1.2	163.8
	Barge - Main Engine	2001	1,100	0.52	6.93	0.29	0.68	1.97	568.3	8.7	0.4	0.9	2.5	716.7
	Barge - Monitor Pump (Aux)	2002	440	0.43	6.93	0.26	0.81	2.78	568.3	2.9	0.1	0.3	1.2	237.0
	Barge - Flood Pump (Aux)	2002	440	0.43	6.93	0.26	0.81	2.78	568.3	2.9	0.1	0.3	1.2	237.0
Hanson DS-10	Barge - Generator (Aux)	1984	375	0.43	4.73	0.32	1.07	4.33	568.3	1.7	0.1	0.4	1.5	202.0
	Tug (2 engines)	2001	1,060	0.5	6.93	0.29	0.68	1.97	568.3	8.1	0.3	0.8	2.3	664.0
Jerico Tug	Tug (generator)	2000	64	0.31	6.93	0.46	1.18	3.59	568.3	0.3	0.0	0.1	0.2	24.9
	Barge Generator (Aux)	2004	99	0.43	4.62	0.46	1.18	3.59	568.3	0.4	0.0	0.1	0.3	53.3
Jerico Barge	Barge Pump (Aux)	2001	230	0.43	6.93	0.26	0.81	2.78	568.3	1.5	0.1	0.2	0.6	123.9
Jerico Loader	Loader	2007	195	0.43	4.83	0.12	0.81	3.73	568.3	0.9	0.0	0.1	0.7	105.1

[a] Provided by Project Applicants.

[b] Based on information provided in Appendix B - Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, from CARB's *Technical Support Document: Initial Statement of Reason for Proposed Rule Making, Proposed Regulation for Commercial Harbor Craft,* September 2007.

[c] Assumes all Hanson engines manufactured in or prior to 1985 would meet USEPA Tier 2 NOx+ THC standard of 7.8 grams per kilowatt-hour (5.8 grams per brake-horsepower hour) by2013. It is assumed that 100% of THC is ROG. ~~2011 adn that all Jerico engines met the USEPA Tier 2 NOx standard of 7.8 grams per kilowatt-hour (5.8 grams per brake-horsepower hour) by 2010~~

[d] CO2 emission factors derived from OFFROAD2007. Represents CO2 emission factors for diesel fueled engines.

Table D13. Emission Rates by Activity (2014)

Equipment - Activity	Emission Rate (lb/hr-equipment)				
	NOx	PM	ROG	CO	CO2
Hanson TS&G 230 - Mining					
San Joaquin Tug	19.9	0.8	1.9	5.6	1,628.8
TS&G - Barge - Main	5.6	0.4	1.1	3.5	651.5
TS&G - Barge - Gen - Aux	1.2	0.1	0.3	1.1	142.8
Total	***26.6***	***1.3***	***3.3***	***10.3***	***2,423.0***
Hanson TS&G 230 - Cruising					
San Joaquin Tug	19.9	0.8	1.9	5.6	1,628.8
TS&G - Barge - Gen - Aux	1.2	0.1	0.3	1.1	142.8
Total	***21.0***	***0.9***	***2.2***	***6.7***	***1,771.5***
Hanson TS&G 230 - Unloading					
TS&G - Barge - Main	5.6	0.4	1.1	3.5	651.5
TS&G - Barge - Gen - Aux	1.2	0.1	0.3	1.1	142.8
Total	***6.7***	***0.5***	***1.4***	***4.6***	***794.3***
Hanson DS-10 - Mining					
American River Tug	13.1	0.5	1.3	3.7	1,071.2
DS-10 - Barge (Main)	8.7	0.4	0.9	2.5	716.7
DS-10 - Barge (Generator)	1.7	0.1	0.4	1.5	202.0
Total	***23.5***	***1.0***	***2.5***	***7.7***	***1,989.9***
Hanson DS-10 - Cruising					
American River Tug	13.1	0.5	1.3	3.7	1,071.2
DS-10 - Barge (Generator)	1.7	0.1	0.4	1.5	202.0
Total	***14.7***	***0.7***	***1.7***	***5.3***	***1,273.3***
Hanson DS-10 - Unloading					
Barge - Main	8.7	0.4	0.9	2.5	716.7
Barge - Monitor Pump - Aux	2.9	0.1	0.3	1.2	237.0
Barge - Flood Pump- Aux	2.9	0.1	0.3	1.2	237.0
Barge - Gen - Aux	1.7	0.1	0.4	1.5	202.0
Total	***16.2***	***0.7***	***1.9***	***6.3***	***1,392.8***
Jerico Barge - Mining					
Jerico Barge - Generator	0.4	0.0	0.1	0.3	53.3
Jerico Barge - Monitor	1.5	0.1	0.2	0.6	123.9
Total	***1.9***	***0.1***	***0.3***	***0.9***	***177.2***
Jerico Barge - Cruising					
Jerico Tug - Main	8.1	0.3	0.8	2.3	664.0
Jerico Barge - Generator	0.4	0.0	0.1	0.3	53.3
Total	***8.5***	***0.4***	***0.9***	***2.6***	***717.4***
Jerico Unloading					
Loader	0.9	0.0	0.1	0.7	105.1
Total	***0.9***	***0.0***	***0.1***	***0.7***	***105.1***

Table D14. Annual Emissions (2014) with Required Airborne Toxic Control Measures for Diesel Engines

Barge	Mining Events	Activity	Hours	Emission Rates (lb/hr)					Annual Emissions (tons per year)				
				NOx	PM	ROG	CO	CO2	NOx	PM	ROG	CO	CO2
		Cruising	2	21.0	0.9	2.2	6.7	1,771.5	16.8	0.7	1.8	5.4	1,410.1
		Mining	5.5	26.6	1.3	3.3	10.3	2,423.0	58.2	2.9	7.2	22.4	5,304.0
Hanson (TS&G 230)	796	Unloading	4	6.7	0.5	1.4	4.6	794.3	10.7	0.8	2.2	7.3	1,264.5
		Cruising	2	14.7	0.7	1.7	5.3	1,273.3	0.0	0.0	0.0	0.0	-
		Mining	5.5	23.5	1.0	2.5	7.7	1,989.9	0.0	0.0	0.0	0.0	-
Hanson (DS-10)	0	Unloading	4	16.2	0.7	1.9	6.3	1,392.8	0.0	0.0	0.0	0.0	-
		Cruising	2	21.0	0.9	2.2	6.7	1,771.5	1.6	0.1	0.2	0.5	132.9
Suisun Associates		Mining	5.5	26.6	1.3	3.3	10.3	2,423.0	5.5	0.3	0.7	2.1	499.8
(TS&G 230)	75	Unloading	4	6.7	0.5	1.4	4.6	794.3	1.0	0.1	0.2	0.7	119.1
		Cruising	2	14.7	0.7	1.7	5.3	1,273.3	0.0	0.0	0.0	0.0	-
Suisun Associates (DS-		Cruising	2	23.5	1.0	2.5	7.7	1,989.9	0.0	0.0	0.0	0.0	-
10)	0	Cruising	2	16.2	0.7	1.9	6.3	1,392.8	0.0	0.0	0.0	0.0	-
		Cruising	2	8.5	0.4	0.9	2.6	717.4	0.6	0.0	0.1	0.2	53.8
Suisun Associates		Mining	5.5	1.9	0.1	0.3	0.9	177.2	0.4	0.0	0.1	0.2	36.6
(Jerico Barge)	75	Unloading	12	0.9	0.0	0.1	0.7	105.1	0.4	0.0	0.1	0.3	47.3
		Cruising	2	8.5	0.4	0.9	2.6	717.4	0.6	0.0	0.1	0.2	53.8
		Mining	5.5	1.9	0.1	0.3	0.9	177.2	0.4	0.0	0.1	0.2	36.6
Jerico	75	Unloading	12	0.9	0.0	0.1	0.7	105.1	0.4	0.0	0.1	0.3	47.3
Total Emisisons (tons per year)									**96.7**	**4.9**	**12.6**	**39.9**	**9,005.7**

Table D15. Factors for Alternatives Comparison

Emission Factors

Vehicle Type	Running Exhaust Emission Factors (pounds/mile)						Starting Emission Factors (pound/start-up)					
	ROG	NOx	CO	SOx	PM10	PM2.5	ROG	NOx	CO	SOx	PM10	PM2.5
Heavy duty truck -25 mph	0.0028	0.0351	0.0159	0.0000	0.0012	0.0011	0.0145	0.0233	0.2274	0.0000	2.425E-05	2.425E-05
Heavy duty truck -65 mph	0.0023	0.0347	0.0112	0.0000	0.0016	0.0014						

Note: used EMFAC 2007, for model years 1985 through 2010.

Pounds per trip (40-mile round trip)

Vehicle Type	Trips	miles/trip	ROG	NOx	CO	Sox	PM10	PM2.5
Heavy duty truck -25 mph	1	2	0.02	0.09	0.26	0.00	0.00	0.00
Heavy duty truck -65 mph	1	38	0.09	1.32	0.43	0.00	0.06	0.05
Total Emissions Per Trip	NA	NA	0.11	1.41	0.69	0.00	0.06	0.06
Emissions per 1,000 CY Transport (based on 18.4 CY/load)	54	2,160	5.77	76.35	37.01	0.08	3.36	3.09

Pounds per trip (10-mile round trip)

Vehicle Type	Trips	miles/trip	ROG	NOx	CO	Sox	PM10	PM2.5
Heavy duty truck -25 mph	1	2	0.02	0.09	0.26	0.00	0.00	0.00
Heavy duty truck -65 mph	1	8	0.02	0.28	0.09	0.00	0.01	0.01
Total Emissions per Trip	NA	NA	0.04	0.37	0.35	0.00	0.02	0.01
Emissions per 1,000 CY Transport (based on 18.4 CY/load)	54	540	2.08	20.06	18.84	0.02	0.81	0.75

All trips per day are roundtrips.
It is assumed that each trip would include 2.0 miles of 25 mph travel.
The emissions for 25 mph include the start-up emissions, each round-trip would generate two start-ups.

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Emission Factors

Vehicle Type	Running Exhaust Emission Factors (pounds/mile)			Starting Emission Factors (pounds/start-up)		
	CO2	CH4	N2O	CO2	CH4	N2O
Heavy duty truck -25 mph	5.6784	0.0000	0.0000	0.0384	9.319E-08	9.901E-08
Heavy duty truck -65 mph	3.7424	0.0000	0.0000			

Note: used EMFAC 2007, for model years 1989 through 2010.

Metric tons per trip (40-mile round trip)

Vehicle Type	Trips	miles/trip	CO2	CH4	N2O	CO2e
Heavy duty truck -25 mph	1	2	0.01	0.00	0.00	0.01
Heavy duty truck -65 mph	1	38	0.06	0.00	0.00	0.06
Total (metric tons)	NA	NA	0.07	0.00	0.00	0.07
Emissions per 1,000 CY Transport (based on 18.4 CY/load)	54	2,160	3.76	0.00	0.00	3.77

Metric tons per trip (10-mile round trip)

Vehicle Type	Trips	miles/trip	CO2	CH4	N2O	CO2e
Heavy duty truck -25 mph	1	2	0.01	0.00	0.00	0.01
Heavy duty truck -65 mph	1	8	0.01	0.00	0.00	0.01
Total (metric tons)	NA	NA	0.02	0.00	0.00	0.02
Emissions per 1,000 CY Transport (based on 18.4 CY/load)	54	540	1.01	0.00	0.00	1.01

All trips per day are roundtrips.
It is assumed that each trip would include 2.0 miles of 25 mph travel.
The emissions for 25 mph include the start-up emissions, each round-trip would generate two start-ups.
Notes: 0.907194 metric tons = 1 ton; 2000 pounds = 1 ton.
Global Warming Potential for CH4 = 25; GWP for N2O = 296.

Diesel emission of GHG (CCAR, 2009)

1977.4	g CO2/mile	Offroad at 25 mph
0.0048	g CH4/mile	(CCAR, 2009)
0.0051	g NO2/mile	(CCAR, 2009)
CH4 emissions =	0.000002	ratio of CH4 emission to CO2 Emissions
N2O emissions =	0.000003	ratio of N20 emission to CO2 Emissions

References:

California Climate Action Registry, General Reporting Protocol, Reporting Entity-Wide Greenhouse Gas Emissions, Version 3.1, January 2009. Tables C.3 and C.6.

Table D16. EMFAC Run

Title : Sand Mining Final EIR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/11/02 15:39:06
Scen Year: 2010 -- All model years in the range 1985 to 2010 selected
Season : Annual
Area : San Francisco
****

Year: 2010 -- Model Years 1985 to 2010 Inclusive -- Annual
Emfac2007 Emission Factors: V2.3 Nov 1 2006

San Francisco Basin Average Basin Average

Table 1: Running Exhaust Emissions (grams/mile)

Pollutant Name: Reactive Org Gases Temperature: 50F Relative Humidity: 50%

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
25	0	0	0	1.291	0	0	1.291
65	0	0	0	1.035	0	0	1.035

Pollutant Name: Carbon Monoxide Temperature: 50F Relative Humidity: 50%

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
25	0	0	0	7.208	0	0	7.208
65	0	0	0	5.086	0	0	5.086

Pollutant Name: Oxides of Nitrogen Temperature: 50F Relative Humidity: 50%

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
25	0	0	0	15.918	0	0	15.918
65	0	0	0	15.761	0	0	15.761

Pollutant Name: Carbon Dioxide Temperature: 50F Relative Humidity: 50%

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL

25	0	0	0	1977.4	0	0	1977.4
65	0	0	0	1663.744	0	0	1663.744

Pollutant Name: Sulfur Dioxide Temperature: 50F Relative Humidity: 50%

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
25	0	0	0	0.019	0	0	0.019
65	0	0	0	0.016	0	0	0.016

Pollutant Name: PM10 Temperature: 50F Relative Humidity: 50%

Speed MPH	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
25	0	0	0	0.562	0	0	0.562
65	0	0	0	0.712	0	0	0.712

Title : Sand Mining Final EIR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/11/02 15:39:06
Scen Year: 2010 -- All model years in the range 1985 to 2010 selected
Season : Annual
Area : San Francisco
****

Year: 2010 -- Model Years 1985 to 2010 Inclusive -- Annual
Emfac2007 Emission Factors: V2.3 Nov 1 2006

San Francisco Basin Average Basin Average

Table 2: Starting Emissions (grams/trip)

Pollutant Name: Reactive Org Gases Temperature: 50F Relative Humidity: ALL

Time min	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	0	0	0	0.885	0	0	0.885
10	0	0	0	1.725	0	0	1.725
20	0	0	0	3.271	0	0	3.271
30	0	0	0	4.637	0	0	4.637
40	0	0	0	5.823	0	0	5.823

50	0	0	0	6.829	0	0	6.829
60	0	0	0	7.656	0	0	7.656
120	0	0	0	6.191	0	0	6.191
180	0	0	0	6.569	0	0	6.569
240	0	0	0	6.936	0	0	6.936
300	0	0	0	7.29	0	0	7.29
360	0	0	0	7.632	0	0	7.632
420	0	0	0	7.962	0	0	7.962
480	0	0	0	8.28	0	0	8.28
540	0	0	0	8.586	0	0	8.586
600	0	0	0	8.88	0	0	8.88
660	0	0	0	9.162	0	0	9.162
720	0	0	0	9.432	0	0	9.432

Pollutant Name: Carbon Monoxide Temperature: 50F Relative Humidity: ALL

Time min	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	0	0	0	14.295	0	0	14.295
10	0	0	0	28.008	0	0	28.008
20	0	0	0	53.693	0	0	53.693
30	0	0	0	77.055	0	0	77.055
40	0	0	0	98.094	0	0	98.094
50	0	0	0	116.809	0	0	116.809
60	0	0	0	133.201	0	0	133.201
120	0	0	0	81.896	0	0	81.896
180	0	0	0	84.29	0	0	84.29
240	0	0	0	86.763	0	0	86.763
300	0	0	0	89.315	0	0	89.315
360	0	0	0	91.946	0	0	91.946
420	0	0	0	94.656	0	0	94.656
480	0	0	0	97.444	0	0	97.444
540	0	0	0	100.312	0	0	100.312
600	0	0	0	103.258	0	0	103.258
660	0	0	0	106.284	0	0	106.284
720	0	0	0	109.388	0	0	109.388

Pollutant Name: Oxides of Nitrogen Temperature: 50F Relative Humidity: ALL

Time min	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	0	0	0	2.404	0	0	2.404
10	0	0	0	3.622	0	0	3.622
20	0	0	0	5.762	0	0	5.762
30	0	0	0	7.505	0	0	7.505
40	0	0	0	8.852	0	0	8.852

50	0	0	0	9.803	0	0	9.803
60	0	0	0	10.358	0	0	10.358
120	0	0	0	10.594	0	0	10.594
180	0	0	0	10.555	0	0	10.555
240	0	0	0	10.495	0	0	10.495
300	0	0	0	10.415	0	0	10.415
360	0	0	0	10.315	0	0	10.315
420	0	0	0	10.194	0	0	10.194
480	0	0	0	10.052	0	0	10.052
540	0	0	0	9.89	0	0	9.89
600	0	0	0	9.707	0	0	9.707
660	0	0	0	9.504	0	0	9.504
720	0	0	0	9.28	0	0	9.28

Pollutant Name: Carbon Dioxide Temperature: 50F Relative Humidity: ALL

Time min	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	0	0	0	4.412	0	0	4.412
10	0	0	0	8.801	0	0	8.801
20	0	0	0	17.503	0	0	17.503
30	0	0	0	26.109	0	0	26.109
40	0	0	0	34.616	0	0	34.616
50	0	0	0	43.026	0	0	43.026
60	0	0	0	51.338	0	0	51.338
120	0	0	0	87.318	0	0	87.318
180	0	0	0	103.159	0	0	103.159
240	0	0	0	118.066	0	0	118.066
300	0	0	0	132.038	0	0	132.038
360	0	0	0	145.074	0	0	145.074
420	0	0	0	157.176	0	0	157.176
480	0	0	0	168.342	0	0	168.342
540	0	0	0	178.574	0	0	178.574
600	0	0	0	187.87	0	0	187.87
660	0	0	0	196.232	0	0	196.232
720	0	0	0	203.659	0	0	203.659

Pollutant Name: Sulfur Dioxide Temperature: 50F Relative Humidity: ALL

Time min	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	0	0	0	0	0	0	0
10	0	0	0	0.001	0	0	0.001
20	0	0	0	0.001	0	0	0.001
30	0	0	0	0.002	0	0	0.002
40	0	0	0	0.002	0	0	0.002

50	0	0	0	0.002	0	0	0.002
60	0	0	0	0.003	0	0	0.003
120	0	0	0	0.002	0	0	0.002
180	0	0	0	0.002	0	0	0.002
240	0	0	0	0.003	0	0	0.003
300	0	0	0	0.003	0	0	0.003
360	0	0	0	0.003	0	0	0.003
420	0	0	0	0.003	0	0	0.003
480	0	0	0	0.003	0	0	0.003
540	0	0	0	0.003	0	0	0.003
600	0	0	0	0.004	0	0	0.004
660	0	0	0	0.004	0	0	0.004
720	0	0	0	0.004	0	0	0.004

Pollutant Name: PM10 Temperature: 50F Relative Humidity: ALL

Time min	LDA	LDT	MDT	HDT	UBUS	MCY	ALL
5	0	0	0	0.001	0	0	0.001
10	0	0	0	0.002	0	0	0.002
20	0	0	0	0.003	0	0	0.003
30	0	0	0	0.004	0	0	0.004
40	0	0	0	0.006	0	0	0.006
50	0	0	0	0.007	0	0	0.007
60	0	0	0	0.008	0	0	0.008
120	0	0	0	0.011	0	0	0.011
180	0	0	0	0.011	0	0	0.011
240	0	0	0	0.011	0	0	0.011
300	0	0	0	0.012	0	0	0.012
360	0	0	0	0.012	0	0	0.012
420	0	0	0	0.012	0	0	0.012
480	0	0	0	0.013	0	0	0.013
540	0	0	0	0.013	0	0	0.013
600	0	0	0	0.013	0	0	0.013
660	0	0	0	0.014	0	0	0.014
720	0	0	0	0.014	0	0	0.014

Table D17. Unit Production Emissions for the San Rafael Rock Quarry

Quarry Name	Production rate cubic yards	Emissions NOx	PM10	CO2e	Emmission per 1,000 cy produced Nox (tons)	PM10 (Tons)	CO2e (Mg)
San Rafael Rock Quar	1,131,200.00	19.18	56.59	3,424.66	0.0170	0.0500	3.0275

Nox (lbs)	PM10 (lbs)	CO2e (Mg)
34	100	3.0275

Source: San Rafael Rock Quarry Final EIR, Marin County, 2008.

Notes
Does not include haul truck emissions. Emissions are baseline (controlled). PM10 and NOx are based on daily emissions (5 days a week with 15 Saturdays

Table D18. Sand Mining Emissions per Unit Mined

	NOx	PM10	CO2e (metric tons)
Total annual emissions (~~2012~~ 2014) (Tons)*	97	5	8,247
Emissions per 1,000 Cubic Yards (Tons)	0.05	0.00	4.04
Emission per 1,000 Cubic Yards (pounds)	94.82	4.85	n.a.

*Based on annual production rate of 2,040,000 cubic yards See Table ~~D8~~ D14

Table D19. GHG emissions for Ocean Transport of Aggregate from British Columbia to the Bay Area

Factors for Ocean Transport	Value	Source
Ship Capacity (dwt)	71,000	see 1, below
Ship Capacity (cy)	62,480	conversion
No Project volume (cy)	1,020,000	Half of PP volume
Reduced Project volume (cy)	347,000	[PP volume - baseline (w/o CEMEX)]/2
Trips under the No Project Alternative	16.33	calculated
Trips under the Reduced Project Alt.	5.55	calculated
Total Roundtrip Distance (km)	3,700.00	measured (Google Earth)
Roundtrip Distance in the SFAB (km)	200.00	measured (Google Earth)
Percent of trips in SFAB (%)	5.41	calculated
Short tons per cubic yard	1.25	conversion factor
Metric tons per short ton	1.10	conversion factor
Metric tons per cubic yard	1.14	conversion

Source
1. Gerwick, Inc. website (http://www.gerwick.com/pdf/03_210e%20pacific%20atlantic%20terminal%20review.pdf)

Emission Factors and Rates

Type	KW	Load Factor	Emission Factors (g/kW-hr)				Emission Rate (lb/hr)				
			NOx	PM10	CO2	CH4	NOx	PM10	CO2	CH4	CO2e
Bulk Carrier Vessel - Main Engine	7,803.00	0.83	13.20	0.38	645.00	0.08	187.34	5.39	9,154.02	1.14	9,177.86
Bulk Carrier Vessel - Auxiliary Engine	2,459.00	0.10	13.90	0.38	690.00	0.09	7.54	0.21	374.06	0.05	375.09

Ocean Transport Emissions - metric tons/1,000 CY

Type	Speed	Speed	Distance	Time	Emissions (metric tons/1,000 CY		
	(knots)	(km/hour)	(km)	(hours/trip)	NOx	PM10	CO2e
Bulk Carrier Vessel - Main Engine	15.00	27.78	3,700.00	133.19	0.18	0.01	8.87
Bulk Carrier Vessel - Auxiliary Engine	NA	NA	NA	124.96	0.01	0.00	0.34
			total (metric tons/1,000 CY)		0.19	0.01	9.21
			total (pounds/1,000 CY)		414.42	11.91	20,314.73

Ocean Transport Emissions - No Project Alternative

No Project Ocean Trans. Emissions	NOx	PM10	CO2e
No Project Total Metric tons/year	191.74	5.51	9,398.99
Metric tons/year in BAAQMD	16.96	0.48	836.37

Ocean Transport Emissions - Reduced Project Alternative

No Project Ocean Trans. Emissions	NOx	PM10	CO2e
Reduced Project Total Metric tons/year	65.23	1.87	3,197.50
Metric tons/year in BAAQMD	5.77	0.16	284.53

It is assumed that it would take 4 hours to unload 2,000 cubic yards.

Kilowatts are averages for bulk carrier vessels obtained from CARB, 2008; page D-18. Load factors obtained from CARB, 2008; pages D-18 and D-19.

Emission factors are for marine distillate fuel with at or below 0.5% sulfur content and medium engine speed, obtained from CARB, 2008; page D-20.
California Air Resources Board (CARB). 2008. Emissions Estimation Methodology for Ocean-Going Vessels, May 2008.

Table D20. Comparison of Life Cycle Emissions for Mining and Delivery to Market of Sand

Figures are per 1,000 Cubic Yards of Sand*

	NOx (lbs)	PM10 (lbs)	CO2e (mt)
Bay Area Land-Based Quarry			
Material extraction and processing	34	100	3.0
Ground Transportation (40 mile avg RT)	76	3.4	3.77
TOTAL	110	103	6.79
Bay and Delta Sand Mining			
Mining and delivery to off-loading location	95	5	4.04
Ground Transportation (10 mile avg RT)	20	1	1.01
TOTAL	114.87	5.66	5.06
Import from Canada			
Material extraction and processing	34	100	3.0
Ocean Transportation, British Columbia - Bay Area	414.42	11.91	9.21
Ground Transportation in BC (10 mile avg RT)	20	1	1.01
TOTAL	468	113	13.3

Source: ESA

Notes:

*Sand assumed to have a bulk density of 1.25 short tons/cubic yard

Comparision of Project to Alternatives

1a. Total No Project: Assumes 1/2 of sand from BC, 1/2 from Bay Area Quarries, total 2,040,000 CY/year

	NOx (tons)	PM10 (tons)	CO2e (Mg)
Bay Area Land-Based Quarry	56	53	6,930
Import from Canada	239	57.5	13,522
Total: No Project Alternative	295	110	20,451
Total: Project as Proposed	117	6	10,316
Difference	178	104	10,135
Percent Difference	152%	1810%	98%

1b. No Project in SFAB: Assumes 5.4% of ocean travel emissions would occur in the SFAB.

	NOx (tons)	PM10 (tons)	CO2e (Mg)
Bay Area Land-Based Quarry	56	53	NA
Ocean Transport and Vessel Hoteling (see Table D19)	17	6	NA
Total: No Project Alternative	73	59	-
Total: Project as Proposed	117	6	NA
Difference	(44)	53	NA
Percent Difference	-38%	919%	NA

2a. Reduced Project: Assumes 694,000 CY per year of sand from BC and Bay Area Quarries, 1,346,267CY per year from Bay and Delta, total 2,040,000 CY/year

	NOx (tons)	PM10 (tons)	CO2e (Mg)

Bay Area Land-Based Quarry (347,000 CY/year)	19	18	2,358
Import from Canada (347,000 CY/year)	81	19.6	4,600
Sand Mining from the Bay and Delta (1,346,267 CY/year)	77	4	6,807
Total: Reduced Project Alternative	178	41	13,764
Project as Proposed	117	6	10,316
Difference	61	36	3,448
Percent Difference	52%	616%	33%

2b. Reduced Project in SFAB: Assumes 5.4% of ocean travel emissions would occur in the SFAB.

	NOx (tons)	PM10 (tons)	CO2e (Mg)
Bay Area Land-Based Quarry	19	20	NA
Ocean Transport and Vessel Hoteling (see Table D19)	6	0.2	NA
Sand Mining from the Bay and Delta (1,346,267 CY/year)	77	1	NA
Total: No Project Alternative	102	21	-
Total: Project as Proposed	117	6	NA
Difference	(15)	15	NA
Percent Difference	-13%	256%	NA

Source: ESA

Reduced Project: Quantities from Different Sources

	cy/year *10^--3
BC, Bay Area Quarries	347
Bay and Delta	1,346