APPENDIX A

EMISSION CALCULATIONS

Table A-1
Truck Emissions Increase

On Road Mobile Emission Factors from California ARB EMFAC2007 Scenario Year 2007 (Model Years 2002 to 2007)

Vehicle Type	CO Emissions Factor (lb/mile)	VOC Emission Factor (lb/mile)	NOx Emissions Factor (lb/mile)	SOx Emissions Factor (lb/mile)	PM10 Emissions Factor (lb/mile)	PM2.5 Emissions Factor (lb/mile)	CO_2 Emissions Factor (lb/mile)
Delivery Trucks	0.005109	0.001108	0.025305	0.00003799	0.001304	0.00127792	4.14055081

Source	Parameters				Peak Day Emissions, lbs/day						
	Number of Vehicles per Day	Trips per Day per Vehicle	Distance Traveled per Trip	Distance Traveled per Day	CO Emissions	VOC Emissions	NOx Emissions	SOx Emissions	PM10 Emissions	PM2.5 Emissions	CO_2 Emissions
Delivery Trucks	30	2	30	1800	9.20	1.99	45.55	0.07	2.35	2.30	7452.99
Totals					9.20	1.99	45.55	0.07	2.35	2.30	7452.99

Based on California ARB EMFAC2007 model years 2002-2007, South Coast AQMD Average Annual for Heavy Heavy-Duty Trucks

Peak Day Emissions = Emission Factor x Distance Travelled per Day

Evaluation of Ship Emissions for the PetroDiamond Terminal
- Ship Equivalence -
(Per Visit Basis)

Emissions from One Currently Permitted Ship (pounds)

Activity	NOx	CO	HC	PM10	PM2.5	SOx
Main Propulsion						
Cruising	25969.66	2008.70	860.87	2754.79	2209.57	15065.27
Maneuvering	577.48	96.47	130.73	96.45	75.51	72.35
Hotelling	0.00	0.00	0.00	0.00	0.00	0.00
Total	26547.14	2105.18	991.61	2851.24	2285.08	15137.63
Auxiliary						
Cruising	85.31	6.75	2.45	1.84	1.47	26.39
Maneuvering	43.80	3.47	1.26	0.95	0.76	13.55
Hotelling	1137.73	90.04	32.74	24.56	19.64	351.96
Total	1266.84	100.25	36.46	27.34	21.87	391.90
Totals						
Cruising	26054.97	2015.45	863.33	2756.63	2211.05	15091.67
Maneuvering	621.28	99.94	132.00	97.40	76.26	85.90
Hotelling	1137.73	90.04	32.74	24.56	19.64	351.96
Grand Total	27813.99	2205.43	1028.06	2878.59	2306.95	15529.53

Emissions from One Barge (pounds)

Activity	NOx	CO	HC	PM10	PM2.5	SOx
Main Propulsion						
Cruising	890.79	69.99	31.81	45.81	36.90	731.72
Maneuvering	890.79	69.99	31.81	45.81	36.90	731.72
Hotelling	0.00	0.00	0.00	0.00	0.00	0.00
Total	1781.58	139.98	63.63	91.62	73.81	1463.44
Auxiliary						
Cruising	23.43	1.93	0.86	0.64	0.52	9.24
Maneuvering	54.07	4.46	1.98	1.49	1.19	21.33
Hotelling	26.43	2.18	0.97	0.73	0.58	10.43
Total	103.93	8.58	3.81	2.86	2.29	41.00
Totals						
Cruising	914.22	71.93	32.67	46.46	37.42	740.96
Maneuvering	944.86	74.45	33.80	47.30	38.09	753.05
Hotelling	26.43	2.18	0.97	0.73	0.58	10.43
Grand Total	1885.51	148.56	67.44	94.48	76.10	1504.44

Ship Equivalence (pounds)

	NOx	CO	HC	PM10	PM2.5	SOx
Ship Totals	27813.99	2205.43	1028.06	2878.59	2306.95	15529.53
Barge Totals	1885.51	148.56	67.44	94.48	76.10	1504.44
Equivalence	14	14	15	30	30	10

(1) PM2.5 is ratioed from PM10 using the SCAQMD PM2.5 ratio for Ships, Liquid Fuel, http://www.aqmd.gov/ceqa/handbook/PM2_5/finalAppA.doc

Evaluation of Ship Emissions for the PetroDiamond Terminal
- Ship Parameters -

Ship Parameters

Size	Avg Main Power (kW)[1]	Avg Max Speed (knots)[1]	Avg Number of Aux Engines[2]	Avg Aux Power/Engine (kW)[2]	Avg Total Aux Power (kW)[2]	Max Capacity (bbls)	Unloading Rate (bbl/hour)
25K-50K DWT Tankers	97679	14.75	2.94	675	1985	350000	6000
Barges/Ocean-going Tugs	3356	-	2	125	250	100000	6000

Average Barrels of Fuel Unloaded

	Currently Permitted	2000	2001	2002	2003	2004
Barges	-	-	59,622	46,488	52,108	30,924
Tankers	167,500	-	-	-	-	-

Activity Log

Activity	Currently Permitted Time for Peak 24-Hour Day (Hours)[3]	Currently Permitted Avg Time per Visit (Hours)	Proposed Time for Peak 24-Hour Day (Hours)	Proposed Avg Time per Visit (Hours)	Main Engine Load Factor[4]	Aux Engine Load Factor[5]
25-50 DWT Tankers						
Cruising[6]	4.25	8.50			0.78	0.17
Maneuvering[7]	0.75	1.60			0.02	0.45
Hotelling[8]	19.00	27.92			0.00	0.67
Total	24.00	38.02				
Barges/Ocean-going Tugs						
Cruising[6]			12	12	0.43	0.20
Maneuvering[7]			1.60	1.60	0.43	0.45
Hotelling[8]			9.94	9.94	0.00	0.22
Total			23.54	23.54		

All Tables and Figures are referenced from *The Port of Los Angeles - Port-wide Baseline Air Emissions Inventory*. July 2005

(1) Table 2.26 for Tankers; Barges are considered Line Haul Towboats (pg.151), 1 Horsepower = .75 kiloWatts.

(2) Table 2.27

(3) Hotelling for the current permit conditions exceeds 24 hours. Peak day consists of entry cruising, entry maneuvering, and 19 hours of hotelling.

(4) Load Factor = (Speed/Max Speed)^3 ; Maneuvering Load Factor is taken at 2% minimum. Table 3.9 for Barges.

(5) Table 2.19; Cruising Load Factor is 75% Fairway and 25% Precautionary Zone Loading Factors.

(6) Cruising Time is time required to travel through the Fairway and Precautionary Zone (66 miles one way) at 13.6 knots for Tankers and 9.4 knots for Barges.

(7) Arrival is depicted in Figure 2.28. Departure is depicted in Figure 2.29.

(8) Hotelling = Maximum Average Fuel Unloaded (bbl) / Unloading Rate (bbl/hr)

Evaluation of Ship Emissions for the PetroDiamond Terminal
- Currently Permitted 25,000-50,000 DWT Ships Per Visit -

Emission Factors

Engine Type	NOx (g/kW-hr)	CO (g/kW-hr)	HC (g/kW-hr)	PM10 (g/kW-hr)	PM2.5 (g/kW-hr)	SOx (g/kW-hr)
Main Propulsion(1)	18.10	1.40	0.60	1.92	1.54	10.50
Auxiliary(2)	13.90	1.10	0.40	0.30	0.24	4.30

Low-Loading Factor Emission Adjustment Factors(3)

Loading Factor	NOx	CO	HC	PM10	PM2.5	SOx
2%	4.63	10.00	31.62	7.29	7.12	1.00

25K-50K DWT Ship Emissions (grams)(4)

Activity	NOx	CO	HC	PM10	PM2.5	SOx
Main Propulsion						
Cruising	11779839.40	911147.80	390491.91	1249574.12	1002262.58	6833608.49
Maneuvering	261945.38	43760.19	59301.31	43750.19	34249.11	32820.14
Hotelling	0.00	0.00	0.00	0.00	0.00	0.00
Total	12041784.78	954907.99	449793.23	1293324.31	1036511.69	6866428.64
Auxiliary						
Cruising	38697.08	3062.36	1113.59	835.19	668.15	11971.04
Maneuvering	19865.88	1572.12	571.68	428.76	343.01	6145.56
Hotelling	516076.01	40840.55	14851.11	11138.33	8910.67	159649.41
Total	574638.97	45475.03	16536.37	12402.28	9921.82	177766.01
Totals						
Cruising	11818536.48	914210.16	391605.50	1250409.31	1002930.73	6845579.53
Maneuvering	281811.26	45332.31	59872.99	44178.95	34592.11	38965.70
Hotelling	516076.01	40840.55	14851.11	11138.33	8910.67	159649.41
Grand Total	12616423.76	1000383.02	466329.60	1305726.59	1046433.51	7044194.65

25K-50K DWT Ship Emissions (pounds)(5)

Activity	NOx	CO	HC	PM10	PM2.5	SOx
Main Propulsion						
Cruising	25969.66	2008.70	860.87	2754.79	2209.57	15065.27
Maneuvering	577.48	96.47	130.73	96.45	75.51	72.35
Hotelling	0.00	0.00	0.00	0.00	0.00	0.00
Total	26547.14	2105.18	991.61	2851.24	2285.08	15137.63
Auxiliary						
Cruising	85.31	6.75	2.45	1.84	1.47	26.39
Maneuvering	43.80	3.47	1.26	0.95	0.76	13.55
Hotelling	1137.73	90.04	32.74	24.56	19.64	351.96
Total	1266.84	100.25	36.46	27.34	21.87	391.90
Totals						
Cruising	26054.97	2015.45	863.33	2756.63	2211.05	15091.67
Maneuvering	621.28	99.94	132.00	97.40	76.26	85.90
Hotelling	1137.73	90.04	32.74	24.56	19.64	351.96
Grand Total	27813.99	2205.43	1028.06	2878.59	2306.95	15529.53

All Tables are referenced from *The Port of Los Angeles - Port-wide Baseline Air Emissions Inventory* . July 2005

(1) Table 2.20

(2) Table 2.22

(3) Table 2.21, Except for PM2.5 which is based on the PM10 to PM2.5 ratio from SCAQMD PM2.5 ratio for Ships, Liquid Fuel, http://www.aqmd.gov/ceqa/handbook/PM2_5/finalAppA.doc

(4) Emissions = Emission Factor * Engine Power * Time * Loading Factor * Adjustment Factor

(5) 1 pound = 453.6 grams

Evaluation of Ship Emissions for the PetroDiamond Terminal
- Full Barges/Ocean-going Tugs -

Emission Factors

Engine Type	NOx (g/kW-hr)	CO (g/kW-hr)	HC (g/kW-hr)	PM10 (g/kW-hr)	PM2.5 (g/kW-hr)	SOx (g/kW-hr)
Main Propulsion(1)	14.00	1.10	0.50	0.72	0.58	11.50
Auxiliary(2)	10.90	0.90	0.40	0.30	0.24	4.30

Barge Emissions (grams)(3)

Activity	NOx	CO	HC	PM10	PM2.5	SOx
Main Propulsion						
Cruising	242437.44	19048.66	8658.48	12468.21	10043.84	199145.04
Maneuvering	32324.99	2539.82	1154.46	1662.43	1339.18	26552.67
Hotelling	0.00	0.00	0.00	0.00	0.00	0.00
Total	274762.43	21588.48	9812.94	14130.64	11383.02	225697.71
Auxiliary						
Cruising	6376.50	526.50	234.00	175.50	140.40	2515.50
Maneuvering	1962.00	162.00	72.00	54.00	43.20	774.00
Hotelling	5957.21	491.88	218.61	163.96	131.17	2350.09
Total	14295.71	1180.38	524.61	393.46	314.77	5639.59
Totals						
Cruising	248813.94	19575.16	8892.48	12643.71	10184.24	201660.54
Maneuvering	34286.99	2701.82	1226.46	1716.43	1382.38	27326.67
Hotelling	5957.21	491.88	218.61	163.96	131.17	2350.09
Grand Total	289058.14	22768.86	10337.56	14524.10	11697.78	231337.30

Barge Emissions (pounds)(4)

Activity	NOx	CO	HC	PM10	PM2.5	SOx
Main Propulsion						
Cruising	534.47	41.99	19.09	27.49	22.14	439.03
Maneuvering	71.26	5.60	2.55	3.66	2.95	58.54
Hotelling	0.00	0.00	0.00	0.00	0.00	0.00
Total	605.74	47.59	21.63	31.15	25.09	497.57
Auxiliary						
Cruising	14.06	1.16	0.52	0.39	0.31	5.55
Maneuvering	4.33	0.36	0.16	0.12	0.10	1.71
Hotelling	13.13	1.08	0.48	0.36	0.29	5.18
Total	31.52	2.60	1.16	0.87	0.69	12.43
Totals						
Cruising	548.53	43.16	19.60	27.87	22.45	444.58
Maneuvering	75.59	5.96	2.70	3.78	3.05	60.24
Hotelling	13.13	1.08	0.48	0.36	0.29	5.18
Grand Total	637.25	50.20	22.79	32.02	25.79	510.00

All Tables are referenced from *The Port of Los Angeles - Port-wide Baseline Air Emissions Inventory* . July 2005

(1) Table 2.20

(2) Table 2.22

(3) Emissions = Emission Factor * Engine Power * Time * Loading Factor

(4) 1 pound = 453.6 grams

Sample Calculation for Ship and Barge Emissions

Equation

Emissions (lbs/visit) = Emission Factor * Engine Power * Time * Loading Factor/ (453.6 g/lb)

Sample Calculation for NOx Emissions from a Barge

Engine Type	NOx (g/kW-hr)
Main Propulsion(1)	14.00
Auxiliary(2)	10.90

Engine Size(3)	Avg Main Power (kW)	Avg Max Speed (knots)	Avg Number of Aux Engines	Avg Aux Power/ Engine (kW)	Avg Total Aux Power (kW)
Barges/Ocean-going Tugs	3356	-	2	125	250

Activity	Main Engine Load Factor(4)	Aux Engine Load Factor(5)	Proposed Avg Time per Visit (Hours)
Cruising(6)	0.43	0.20	12
Maneuvering(7)	0.43	0.45	1.60
Hotelling(8)	0.00	0.22	9.94
			23.54

Main Engines

Cruising	E = 14 g/kW-hr * 3356 kW * 12 hrs/visit * 0.43 / 453.6 g/lb =	534.47
Maneuvering	E = 14 g/kW-hr * 3356 kW * 1.6 hrs/visit * 0.43 / 453.6 g/lb =	71.26
Hotelling	E = 0	
Total Main Engines (lbs/visit)		**605.74**

Auxiliary Engines

Cruising	E = 10.9 g/kW-hr * 250 kW * 12 hrs/visit * 0.2 / 453.6 g/lb =	14.06
Maneuvering	E = 10.9 g/kW-hr * 250 kW * 1.6 hrs/visit * 0.45 / 453.6 g/lb =	4.33
Hotelling	E = 10.9 g/kW-hr * 250 kW * 9.94 hrs/visit * 0.22 / 453.6 g/lb =	13.13
Total Auxiliary Engines (lbs/visit)		**31.52**

All Tables are referenced from *The Port of Los Angeles - Port-wide Baseline Air Emissions Inventory* . July 2005

(1) Table 2.20

(2) Table 2.22

(3) See Parameters on page A-3.

(4) Load Factor = (Speed/Max Speed)^3 ; Maneuvering Load Factor is taken at 2% minimum. Table 3.9 for Barges.

(5) Table 2.19; Cruising Load Factor is 75% Fairway and 25% Precautionary Zone Loading Factors.

(6) Cruising Time is time required to travel through the Fairway and Precautionary Zone (66 miles one way) at 13.6 knots for Tankers and 9.4 knots for Barges.

(7) Arrival is depicted in Figure 2.28. Departure is depicted in Figure 2.29.

Fuel Use Estimation

Formula

Fuel Use =

Engine Size (KW) * Fuel Rate (grams/kW-hr) * Hours * Load Factor * Number of Ships per year / 453.6 g/lb

Fuel Use Calculations

Ship		lbs fuel / yr
Cruising	= 97679 kW * 195 g/kW-hr * 8.5 hrs * 0.78 * 24 / 453.6 g/lb =	6681709
Maneuvering	= 97679 kW * 195 g/kW-hr * 1.6 hrs * 0.02 * 24 / 453.6 g/lb =	32250
Hotelling	= 1985 kW * 227 g/kW-hr * 28 hrs * 0.67 * 24 / 453.6 g/lb =	447257
Total		7161216

Barge		lbs fuel / yr
Cruising	= 3356 kW * 195 g/kW-hr * 12 hrs * 0.43 * 240 /453.6 g/lb =	1786670
Maneuvering	= 3356 kW * 195 g/kW-hr * 1.6 hrs * 0.43 * 240 /453.6 g/lb =	238223
Hotelling	= 250 kW * 227 g/kW-hr * 10 hrs * 0.22 * 240 /453.6 g/lb =	66058
		2090951

Reduction in fuel use	lbs fuel / yr	
Heavy Fuel Oil	4689065	70%
Diesel	381199	85%

Fuel Rates		
Heavy Fuel Oil	195	grams fuel/kW-hr
Diesel	227	grams fuel/kW-hr

Assumptions:
Fuel rate is the same for both types of engines.
Both vessels are using heavy fuel oil in the main engines.
Both vessels are using diesel fuel in the auxiliary engines.