

APPENDIX B-5

TRANSPORTATION EMISSION CALCULATIONS

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Appendix B-5
Tesoro Integration and Compliance Project
Operational Transportation Emissions
Emissions Summary

Peak Daily Emissions Inside SCAQMD (lb/day)

Scenario	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e
Truck Emissions	0.0	0.2	0.7	0.0	0.2	0.1	179.3
Rail Emissions	1.2	7.6	25.8	0.0	0.7	0.6	2081.5
Total	1.2	7.8	26.6	0.0	0.9	0.7	2260.8

Annual Emissions Inside SCAQMD (lb/yr)

Scenario	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Truck Emissions	8.7	61.2	219.4	0.5	62.1	16.1	24.3
Rail Emissions	438.8	2783.1	9431.9	7.0	248.6	228.7	260.2
Total	447.6	2844.3	9651.3	7.5	310.7	244.8	284.5

Peak Daily Emissions Outside SCAQMD (lb/day)

Scenario	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e
Truck Emissions	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rail Emissions	4.2	26.5	89.7	0.1	2.4	2.2	6258.5
Total	4.2	26.5	89.7	0.1	2.4	2.2	6258.5

Annual Emissions Outside SCAQMD (lb/yr)

Scenario	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Truck Emissions	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rail Emissions	1523.6	9662.2	32745.6	24.4	863.1	794.0	1026.3
Total	1523.6	9662.2	32745.6	24.4	863.1	794.0	1026.3

Appendix B-5
Tesoro Integration and Compliance Project
Operational Onroad Emissions
Onroad Summary

Parameters

Scenario	Baseline		Project		Incremental Change		
	Miles/Trip	Trucks/day	Miles/Trip	Trucks/day	Miles/day	Trucks/day	Miles/day
SARP	5.4	6.0	1.9	8.0	-3.5	2.0	-17.4
Spent Caustic	0.0	0.0	5.0	3.0	5.0	3.0	15.0
Fresh Caustic	0.0	0.0	10.0	3.0	10.0	3.0	30.0
Misc	0.0	0.0	20.0	1.0	20.0	1.0	20.0
Total							47.6

Emission Factors (lb/mi) ⁽¹⁾⁽²⁾⁽³⁾

Vehicle Category	VOC	CO	NOx	SOx	PM10 Exhaust	PM10 Fugitive	PM10 Total	PM2.5	CO2e
T7 Trucks	6.13E-04	4.30E-03	1.54E-02	3.59E-05	4.73E-04	3.90E-03	4.37E-03	1.14E-03	3.77E+00

Peak Daily Emissions (lb/day)

Scenario	VOC	CO	NOx	SOx	PM10 Exhaust	PM10 Fugitive	PM10 Total	PM2.5	CO2e
SARP	-0.01	-0.07	-0.27	0.00	-0.01	-0.07	-0.08	-0.02	-65.64
Spent Caustic	0.01	0.06	0.23	0.00	0.01	0.06	0.07	0.02	56.52
Fresh Caustic	0.02	0.13	0.46	0.00	0.01	0.12	0.13	0.03	113.03
Misc	0.01	0.09	0.31	0.00	0.01	0.08	0.09	0.02	75.36
Total	0.03	0.20	0.73	0.00	0.02	0.19	0.21	0.05	179.26

Annual Emissions (lb/yr)

Scenario	VOC	CO	NOx	SOx	PM10 Exhaust	PM10 Fugitive	PM10 Total	PM2.5	CO2e (MT/yr)
SARP	-3.90	-27.37	-98.14	-0.23	-3.01	-24.78	-27.79	-7.22	-10.87
Spent Caustic	3.36	23.57	84.49	0.20	2.59	21.33	23.92	6.21	9.36
Fresh Caustic	4.78	33.58	120.38	0.28	3.69	30.39	34.08	8.85	13.33
Misc	4.48	31.42	112.66	0.26	3.45	28.45	31.90	8.29	12.48
Total	8.72	61.20	219.39	0.51	6.72	55.40	62.12	16.14	24.30

(1) Emfac2011 emission factors for the South Coast Air District.

(2) Emission Calculations for travel on paved roads from EPA AP-42 Section 13.2.1, January 2011

$$E = k(\text{sl})^{0.91} \times (W)^{1.02}$$

Where: k = 0.0022 lb/VMT for PM10, sl = road silt loading (gms/m²)

(0.03 for major/collector roads), W = weight of vehicles is 40 tons

(3) Carbon Dioxide Equivalence (CO₂) = CO₂ + CH₄ * 21 + N₂O*310where CO₂ emissions factors are from Emfac2011. CH₄ and N₂O emissions factors are from Direct Emissions from Mobile Combustion Sources, EPA 2008.

where light vehicle are gasoline light duty trucks.

where medium/heavy duty vehicle are diesel heavy duty trucks.

Chemical	2015
CO ₂ (lb/mi)	3.7642
CH ₄ (g/mi)	0.0051
N ₂ O (g/mi)	0.0048
CO ₂ e (lb/mi)	3.768

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Tesoro Integration and Compliance Project

Operational Locomotive Emissions

Emission Summary

Scenario	Peak Daily Criteria Pollutant Emissions (lb/day)					
	VOC	CO	NOx	SOx	PM10	PM2.5
SCAQMD ⁽¹⁾	1.20	7.62	25.84	0.02	0.68	0.63
BAAQMD ⁽²⁾	0.47	2.95	10.01	0.01	0.26	0.24
SJVAPCD ⁽²⁾	1.78	11.27	38.20	0.03	1.01	0.93
EKAPCD ⁽²⁾	0.49	3.12	10.56	0.01	0.28	0.26
MDAQMD ⁽³⁾	0.82	5.21	17.65	0.01	0.47	0.43
ICAPCD ⁽¹⁾	0.62	3.92	13.30	0.01	0.35	0.32

(1) Assumes 10 LPG railcars from Arizona border and 4 caustic railcars.

(2) Assumes 10 LPG railcars from Martinez.

(3) Assumes 10 LPG railcars from Nevada border.

Scenario	Annual Criteria Pollutant Emissions (ton/yr)					
	VOC	CO	NOx	SOx	PM10	PM2.5
SCAQMD ⁽¹⁾	0.22	1.39	4.72	0.00	0.12	0.11
BAAQMD ⁽²⁾	0.08	0.54	1.83	0.00	0.05	0.04
SJVAPCD ⁽²⁾	0.32	2.06	6.97	0.01	0.18	0.17
EKAPCD ⁽²⁾	0.09	0.57	1.93	0.00	0.05	0.05
MDAQMD ⁽³⁾	0.15	0.95	3.22	0.00	0.08	0.08
ICAPCD ⁽¹⁾	0.11	0.72	2.43	0.00	0.06	0.06

(1) Assumes 10 LPG railcars per day for 365 days and 4 caustic railcars per week for 52 weeks from the Arizona border.

(2) Assumes 10 LPG railcars per day for 365 days from Martinez.

(3) Assumes 10 LPG railcars per day for 365 days from Nevada border.

Scenario	GHG Emissions (MT/yr)			
	CO2	CH4	N2O	CO2e
SCAQMD ⁽¹⁾	255.83	0.03	0.01	260.19
BAAQMD ⁽²⁾	131.21	0.01	0.01	133.44
SJVAPCD ⁽²⁾	500.85	0.05	0.02	509.39
EKAPCD ⁽²⁾	138.53	0.01	0.01	140.89
MDAQMD ⁽³⁾	198.41	0.02	0.01	235.39
ICAPCD ⁽¹⁾	7.10	0.00	0.00	7.22
In California ⁽⁴⁾	1180.11	0.13	0.06	1200.22

(1) Assumes 10 LPG railcars per day for 365 days and 4 caustic railcars per week for 52 weeks from the Arizona border.

(2) Assumes 10 LPG railcars per day for 365 days from Martinez.

(3) Assumes 10 LPG railcars per day for 365 days from Nevada border.

(4) Assumes 10 LPG railcars per day for 365 days from Martinez and 4 caustic railcars per week for 52 weeks from the Arizona Boarder.

Appendix B-5
Tesoro Integration and Compliance Project
Operational Locomotive Emissions
Locomotive Distance and Time

TRAVEL FROM MARTINEZ⁽¹⁾

Rail Segment	Distance (one-way miles)	Average Speed (mph)	Travel time (hours)
BAAQMD	53.8	27	1.97
SJVAPCD	277.7	37	7.52
EKAPCD	54.2	26	2.08
MDAQMD to Daggett	33	20	1.67
Daggett to SCAQMD Border	58.9	45	1.31
SCAQMD Border to Redondo	98.4	52	1.89
Redondo to Dolores	14.4	39	0.37
Dolores to Refinery	15	25	0.60
Total Travel Time			17.41
Total Travel Time In SCAQMD			2.86
Total Travel Time In California ⁽²⁾			14.55

TRAVEL FROM NEVADA BORDER⁽¹⁾

Rail Segment	Distance (one-way miles)	Average Speed (mph)	Travel time (hours)
NV Border to Yermo	126.8	61	2.09
Yermo to SCAQMD Border	62	45	1.39
SCAQMD Border to Redondo	98.4	52	1.89
Redondo to Dolores	14.4	39	0.37
Dolores to Refinery	15	25	0.60
Total Travel Time			6.33
Total Travel Time In SCAQMD			2.86
Total Travel Time In California(MDAQMD) ⁽²⁾			3.48

TRAVEL FROM ARIZONA BORDER⁽¹⁾

Rail Segment	Distance (one-way miles)	Average Speed (mph)	Travel time (hours)
Arizona Boarder to SCAQMD Border	112.3	60	1.87
SCAQMD Border to Rancho	81.6	48	1.71
Rancho to Redondo	54.1	56	0.96
Redondo to Dolores	14.4	39	0.37
Dolores to Refinery	15	25	0.60
Total Travel Time			5.50
Total Travel Time In SCAQMD			3.63
Total Travel Time In California (ICAPCD) ⁽²⁾			1.87

(1) Travel distance based milepost markers from Union Pacific or review of maps.

(2) Travel inside California but outside SCAQMD.

Appendix B-5
Tesoro Integration and Compliance Project
Operational Locomotive Emissions
Travel from the Arizona Border

Parameters	GE Dash 9
Locomotive	4400 bhp
Engine Size	4
Number of Engines	T2
Engine Tier	27.4%
Average Load Factor (See Below)	7.7%
Railcar Utilization ⁽¹⁾	3.63 hour/day
Operating Hours Inside SCAQMD	1.87 hour/day
Operating Hours Inside ICPCD	1350.0 bhp-hr/day
Daily Work in SCAQMD	694.7 bhp-hr/day
Daily Work in ICAPCD	20.8 bhp-hr/gal
Brake Specific Fuel Consumption ⁽²⁾	64.9 gal/day
Fuel Usage in SCAQMD	33.4 gal/day
Fuel Usage in ICAPCD	

(1) Assumes 10 LFC tanker cars in a 130 unit line-haul train on a peak day, Port of Long Beach (POLB), 2013 Air Emissions Inventory, 2014.
(2) EPA, Emission Factors for Locomotives, 2009.

Typical Power Distribution by Notch ⁽³⁾	Idle ⁽³⁾	DB ⁽³⁾	1	2	3	4	5	6	7	8
Notch	0.6%	2.7%	4.5%	11.5%	23.5%	35.0%	48.5%	64.0%	85.0%	100.0%
Percent of Rated Power	38.0%	12.5%	6.5%	6.5%	5.2%	4.4%	3.8%	3.9%	3.0%	16.2%
Average Percentage of Time in Notch										27.4%
Average Load Factor										

(3) Notch distribution and power rating from EPA, Locomotive Emissions Standard Regulatory Support Document, April 1998.

Criteria Pollutant Emissions ⁽⁴⁾

	HC	VOC ⁽⁵⁾	CO	NOx	SOx ⁽⁶⁾	PM10	PM2.5 ⁽⁷⁾
Emission Factors (g/bhp-hr)	0.27	0.29	1.83	6.20	0.00	0.16	0.15
Emission Factors (g/gal)	5.70	6.00	38.06	129.00	0.10	3.40	3.13
Emission Factors (lb/gal)	0.01	0.01	0.08	0.28	0.00	0.01	0.01
Daily Emissions in SCAQMD (lb/day)	0.82	0.86	5.45	18.46	0.01	0.49	0.45
Daily Emissions in ICAPCD (lb/day)	0.42	0.44	2.80	9.50	0.01	0.25	0.23
Annual Emissions in SCAQMD (tons/yr) ⁽⁸⁾	0.15	0.16	0.99	3.37	0.00	0.09	0.08
Annual Emissions in ICAPCD (tons/yr) ⁽⁸⁾	0.08	0.08	0.51	1.73	0.00	0.05	0.04

(4) Emission Factors from the EPA Emission Factors for Locomotive Document, 2009.
(5) VOC emissions scaled from HC emission factors. EPA, Emission Factors for Locomotives, 2009.
(6) Based on 15 ppm S.
(7) PM2.5 emissions scaled from PM10 emissions. POLB, 2013 Air Emissions Inventory, 2014.
(8) Based on 365 days of operations.

GHG Emissions ⁽⁹⁾

	CO2	CH4	N2O	CO2e ⁽¹⁰⁾
Emission Factors (g/bhp-hr)	491	0.05	0.02	499.57
Emission Factors (g/gal)	1021.7	1.10	0.49	10391.09
Emission Factors (lb/gal)	22.52	0.00	0.00	22.91
Daily Emissions in SCAQMD (lb/day)	1461.89	0.16	0.07	1486.80
Daily Emissions in ICAPCD (lb/day)	752.27	0.08	0.04	765.08
Annual Emissions in SCAQMD (lb/yr) ⁽⁸⁾	533589.25	57.25	25.45	542681.34
Annual Emissions in ICAPCD (lb/yr) ⁽⁸⁾	274576.75	29.46	13.10	279255.40
Annual Emissions in SCAQMD (MT/yr) ⁽⁸⁾	242.03	0.03	0.01	246.16
Annual Emissions in ICAPCD (MT/yr) ⁽⁸⁾	124.55	0.01	0.01	126.67

(9) CO2 emission factor from Emission Factors for Locomotives, 2009. CH4 and N2O emissions scaled up from HC and NOx emissions in the POLB 2013 Air Emissions Inventory, 2014.
(10) Based on State global warming potentials.

Appendix B-5
Tesoro Integration and Compliance Project
Operational Locomotive Emissions
Travel from the Nevada Border

Parameters	GE Dash 9
Locomotive	4400 bhp
Engine Size	4
Number of Engines	T2
Engine Tier	27.4%
Average Load Factor (See Below)	7.7%
Railcar Utilization ⁽¹⁾	2.86 hour/day
Operating Hours Inside SCAQMD	3.48 hour/day
Operating Hours Inside MDAQMD	1061.0 bhp-hr/day
Daily Work in SCAQMD	1290.9 bhp-hr/day
Daily Work in MDAQMD	20.8 bhp-hr/gal
Brake Specific Fuel Consumption ⁽²⁾	51.0 gal/day
Fuel Usage in SCAQMD	62.1 gal/day
Fuel Usage in MDAQMD	

(1) Assumes 10 LFC tanker cars in a 130 unit line-haul train on a peak day, Port of Long Beach (POLB), 2013 Air Emissions Inventory, 2014.
(2) EPA, Emission Factors for Locomotives, 2009.

Typical Power Distribution by Notch ⁽³⁾	Idle ⁽³⁾	DB ⁽³⁾	1	2	3	4	5	6	7	8
Notch	0.6%	2.7%	4.5%	11.5%	23.5%	35.0%	48.5%	64.0%	85.0%	100.0%
Percent of Rated Power	38.0%	12.5%	6.5%	6.5%	5.2%	4.4%	3.8%	3.9%	3.0%	16.2%
Average Percentage of Time in Notch										27.4%
Average Load Factor										

(3) Notch distribution and power rating from EPA, Locomotive Emissions Standard Regulatory Support Document, April 1998.

Criteria Pollutant Emissions ⁽⁴⁾

	HC	VOC ⁽⁵⁾	CO	NOx	SOx ⁽⁶⁾	PM10	PM2.5 ⁽⁷⁾
Emission Factors (g/bhp-hr)	0.27	0.29	1.83	6.20	0.00	0.16	0.15
Emission Factors (g/gal)	5.70	6.00	38.06	129.00	0.10	3.40	3.13
Emission Factors (lb/gal)	0.01	0.01	0.08	0.28	0.00	0.01	0.01
Daily Emissions in SCAQMD (lb/day)	0.64	0.67	4.28	14.51	0.01	0.38	0.35
Daily Emissions in MDAQMD (lb/day)	0.78	0.82	5.21	17.65	0.01	0.47	0.43
Annual Emissions in SCAQMD (tons/yr) ⁽⁸⁾	0.12	0.12	0.78	2.65	0.00	0.07	0.06
Annual Emissions in MDAQMD (tons/yr) ⁽⁸⁾	0.14	0.15	0.95	3.22	0.00	0.08	0.08

(4) Emission factors from the EPA Emission Factors for Locomotive Document, 2009.
(5) VOC emissions scaled from HC emission factors. EPA, Emission Factors for Locomotives, 2009.
(6) Based on 15 ppm S.
(7) PM2.5 emissions scaled from PM10 emissions. POLB, 2013 Air Emissions Inventory, 2014.
(8) Based on 365 days of operations.

GHG Emissions ⁽⁹⁾

	CO2	CH4	N2O	CO2e ⁽¹⁰⁾
Emission Factors (g/bhp-hr)	491	0.05	0.02	499.57
Emission Factors (g/gal)	1021.7	1.10	0.49	10391.09
Emission Factors (lb/gal)	22.52	0.00	0.00	22.91
Daily Emissions in SCAQMD (lb/day)	1148.91	0.12	0.05	1168.49
Daily Emissions in MDAQMD (lb/day)	1397.93	0.15	0.07	1421.75
Annual Emissions in SCAQMD (lb/yr) ⁽⁸⁾	419353.58	44.99	20.00	426499.15
Annual Emissions in MDAQMD (lb/yr) ⁽⁸⁾	510242.88	54.74	24.34	518937.17
Annual Emissions in SCAQMD (MT/yr) ⁽⁸⁾	190.22	0.02	0.01	193.46
Annual Emissions in MDAQMD (MT/yr) ⁽⁸⁾	231.44	0.02	0.01	235.39

(9) CO2 emission factor from Emission Factors for Locomotives, 2009. CH4 and N2O emissions scaled up from HC and NOx emissions in the POLB 2013 Air Emissions Inventory, 2014.
(10) Based on State global warming potentials.

Appendix B-5

Appendix B-5 Tesoro Integration and Compliance Project Operational Locomotive Emissions Travel from Martinez, California

Parameters

Locomotive	GE Dash 9
Engine Size	4400 bhp
Number of Engines	4
Engine Tier	T2
Average Load Factor (See Below)	27.4%
Railcar Utilization ⁽¹⁾	7.7%
Operating Hours Inside SCAQMD	2.86 hour/day
Operating Hours Inside BAAQMD	1.97
Operating Hours Inside SJVAPCD	7.52
Operating Hours Inside EKAPCD	2.08
Operating Hours Inside MDAQMD	2.98 hour/day
Daily Work in SCAQMD	1061.0 bhp-hr/day
Daily Work in BAAQMD	731.8
Daily Work in SJVAPCD	2793.6
Daily Work in EKAPCD	772.7
Daily Work in MDAQMD	1106.7 bhp-hr/day
Brake Specific Fuel Consumption ⁽²⁾	20.8 bhp-hr/gal
Fuel Usage in SCAQMD	51.0 gal/day
Fuel Usage in BAAQMD	35.2
Fuel Usage in SJVAPCD	134.3
Fuel Usage in EKAPCD	37.1
Fuel Usage in MDAQMD	53.2 gal/day

(1) Assumes 10 LPG tanker cars in a 130 unit line-haul train on a peak day. Port of Long Beach (POLB), 2013 Air Emissions Inventory, 2014.

(2) EPA, Emission Factors for Locomotives, 2009.

Typical Power Distribution by Notch ⁽³⁾

Notch	Idle ⁽³⁾	DB ⁽³⁾	1	2	3	4	5	6	7	8
Percent of Rated Power	0.6%	2.7%	4.5%	11.5%	23.5%	35.0%	48.5%	64.0%	85.0%	100.0%
Average Percentage of Time in Notch	38.0%	12.5%	6.5%	6.5%	5.2%	4.4%	3.8%	3.9%	3.0%	16.2%
Average Load Factor										27.4%

(3) Notch distribution and power rating from EPA, Locomotive Emissions Standard Regulatory Support Document, April 1998.

Criteria Pollutant Emissions ⁽⁴⁾

	HC	VOC ⁽⁵⁾	CO	NOx	SOx ⁽⁶⁾	PM10	PM2.5 ⁽⁷⁾
Emission Factors (g/bhp-hr)	0.27	0.29	1.83	6.20	0.00	0.16	0.15
Emission Factors (g/gal)	5.70	6.00	38.06	129.00	0.10	3.40	3.13
Emission Factors (lb/gal)	0.01	0.01	0.08	0.28	0.00	0.01	0.01
Daily Emissions in SCAQMD (lb/day)	0.64	0.67	4.28	14.51	0.01	0.38	0.35
Daily Emissions in BAAQMD (lb/day)	0.44	0.47	2.95	10.01	0.01	0.26	0.24
Daily Emissions in SJVAPCD (lb/day)	1.69	1.78	11.27	38.20	0.03	1.01	0.93
Daily Emissions in EKAPCD (lb/day)	0.47	0.49	3.12	10.56	0.01	0.28	0.26
Daily Emissions in MDAQMD (lb/day)	0.67	0.70	4.46	15.13	0.01	0.40	0.37
Annual Emissions in SCAQMD (tons/yr) ⁽⁸⁾	0.12	0.12	0.78	2.65	0.00	0.07	0.06
Annual Emissions in BAAQMD (tons/yr) ⁽⁸⁾	0.08	0.08	0.54	1.83	0.00	0.05	0.04
Annual Emissions in SJVAPCD (tons/yr) ⁽⁸⁾	0.31	0.32	2.06	6.97	0.01	0.18	0.17
Annual Emissions in EKAPCD (tons/yr) ⁽⁸⁾	0.09	0.09	0.57	1.93	0.00	0.05	0.05
Annual Emissions in MDAQMD (tons/yr) ⁽⁸⁾	0.12	0.13	0.81	2.76	0.00	0.07	0.07

(4) Emission factors from the EPA Emission Factors for Locomotive Document, 2009.

(5) VOC emissions scaled from HC emission factors. EPA, Emission Factors for Locomotives, 2009.

(6) Based on 15 ppm S.

(7) PM2.5 emissions scaled from PM10 emissions. POLB, 2013 Air Emissions Inventory, 2014.

(8) Based on 365 days of operations.

GHG Emissions ⁽⁹⁾

	CO2	CH4	N2O	CO2e ⁽¹⁰⁾
Emission Factors (g/bhp-hr)	491	0.05	0.02	499.57
Emission Factors (g/gal)	10217	1.10	0.49	10391.09
Emission Factors (lb/gal)	22.52	0.00	0.00	22.91
Daily Emissions in SCAQMD (lb/day)	1148.91	0.12	0.05	1168.49
Daily Emissions in BAAQMD (lb/day)	792.49	0.09	0.04	806.00
Daily Emissions in SJVAPCD (lb/day)	3025.15	0.32	0.14	3076.70
Daily Emissions in EKAPCD (lb/day)	836.74	0.09	0.04	851.00
Daily Emissions in MDAQMD (lb/day)	1198.39	0.13	0.06	1218.81
Annual Emissions in SCAQMD (lb/yr) ⁽⁸⁾	419353.58	44.99	20.00	426499.15
Annual Emissions in BAAQMD (lb/yr) ⁽⁸⁾	289260.00	31.03	13.80	294188.84
Annual Emissions in SJVAPCD (lb/yr) ⁽⁸⁾	#####	118.46	52.67	#####
Annual Emissions in EKAPCD (lb/yr) ⁽⁸⁾	305411.57	32.77	14.57	310615.63
Annual Emissions in MDAQMD (lb/yr) ⁽⁸⁾	437413.97	46.93	20.86	444867.29
Annual Emissions in SCAQMD (MT/yr) ⁽⁸⁾	190.22	0.02	0.01	193.46
Annual Emissions in BAAQMD (MT/yr) ⁽⁸⁾	131.21	0.01	0.01	133.44
Annual Emissions in SJVAPCD (MT/yr) ⁽⁸⁾	500.85	0.05	0.02	509.39
Annual Emissions in EKAPCD (MT/yr) ⁽⁸⁾	138.53	0.01	0.01	140.89
Annual Emissions in MDAQMD (MT/yr) ⁽⁸⁾	198.41	0.02	0.01	201.79

(9) CO2 emission factor from Emission Factors for Locomotives, 2009. CH4 and N2O emissions scaled up from HC and NOx emissions in the POLB 2013 Air Emissions Inventory, 2014.

(10) Based on State global warming potentials.

Appendix B-5
Tesoro Integration and Compliance Project
Operational Locomotive Emissions
Travel of Spent Caustic (via Arizona Border)

Parameters									
Locomotive	GE Dash 9								
Engine Size	4400 bhp								
Number of Engines	4								
Engine Tier	T2								
Average Load Factor (See Below)	27.4%								
Railcar Utilization ⁽¹⁾	3.1%								
Operating Hours Inside SCAQMD	3.63 hour/day								
Operating Hours Inside ICPCD	1.87 hour/day								
Daily Work in SCAQMD	540.0 bhp-hr/day								
Daily Work in ICAPCD	277.9 bhp-hr/day								
Brake Specific Fuel Consumption ⁽²⁾	20.8 bhp-hr/gal								
Fuel Usage in SCAQMD	26.0 gal/day								
Fuel Usage in ICAPCD	13.4 gal/day								
(1) Assumes 4 spent caustic tanker cars in a 130 unit line-haul train on a peak day, Port of Long Beach (POLB), 2013 Air Emissions Inventory, 2014.									
(2) EPA, Emission Factors for Locomotives, 2009.									
Typical Power Distribution by Notch ^(a)									
Notch	Idle ⁽³⁾	1	2	3	4	5	6	7	8
Percent of Rated Power	0.6%	4.5%	11.5%	23.5%	35.0%	48.5%	64.0%	85.0%	100.0%
Average Percentage of Time in Notch	38.0%	6.5%	6.5%	5.2%	4.4%	3.8%	3.9%	3.0%	16.2%
Average Load Factor	27.4%								

Typical Power Distribution by Notch ⁽³⁾

	Idle ⁽³⁾	DB ⁽³⁾	1	2	3	4	5	6	7	8
Notch										
Percent of Rated Power	0.6%	2.7%	4.5%	11.5%	23.5%	35.0%	48.5%	64.0%	85.0%	100.0%
Average Percentage of Time in Notch	38.0%	12.5%	6.5%	6.5%	5.2%	4.4%	3.8%	3.9%	3.0%	16.2%
Average Load Factor										27.4%

(3) Notch distribution and power rating from EPA, Locomotive Emissions Standard Regulatory Support Document, April 1998.

Criteria Pollutant Emissions ⁽⁴⁾

	HC	VOC ⁽⁵⁾	CO	NOx	SOx ⁽⁶⁾	PM10	PM2.5 ⁽⁷⁾
Emission Factors (g/bhp-hr)	0.27	0.29	1.83	6.20	0.00	0.16	0.15
Emission Factors (g/gal)	5.70	6.00	38.06	129.00	0.10	3.40	3.13
Emission Factors (lb/gal)	0.01	0.01	0.08	0.28	0.00	0.01	0.01
Daily Emissions in SCAQMD (lb/day)	0.33	0.34	2.18	7.38	0.01	0.19	0.18
Daily Emissions in ICAPCD (lb/day)	0.17	0.18	1.12	3.80	0.00	0.10	0.09
Annual Emissions in SCAQMD (tons/yr) ⁽⁸⁾	0.06	0.06	0.40	1.35	0.00	0.04	0.03
Annual Emissions in ICAPCD (tons/yr) ⁽⁸⁾	0.03	0.03	0.20	0.69	0.00	0.02	0.02

(4) Emission Factors from the EPA Emission Factors for Locomotive Document, 2009.

(5) VOC emissions scaled from HC emission factors. EPA, Emission Factors for Locomotives, 2009.

(6) Based on 15 ppm S.

(7) PM2.5 emissions scaled from PM10 emissions. POLB, 2013 Air Emissions Inventory, 2014.

(8) Based on 4 railcars per week and 52 weeks of operations.

GHG Emissions ⁽⁹⁾

	CO2	CH4	N2O	CO2e ⁽¹⁰⁾
Emission Factors (g/bhp-hr)	491	0.05	0.02	499.57
Emission Factors (g/gal)	1021.7	1.10	0.49	10391.09
Emission Factors (lb/gal)	22.52	0.00	0.00	22.91
Daily Emissions in SCAQMD (lb/day)	584.76	0.06	0.03	594.72
Daily Emissions in ICAPCD (lb/day)	300.91	0.03	0.01	306.03
Annual Emissions in SCAQMD (lb/yr) ⁽⁸⁾	30407.28	3.26	1.45	30925.40
Annual Emissions in ICAPCD (lb/yr) ⁽⁸⁾	15647.11	1.68	0.75	15913.73
Annual Emissions in SCAQMD (MT/yr) ⁽⁸⁾	13.79	0.00	0.00	14.03
Annual Emissions in ICAPCD (MT/yr) ⁽⁸⁾	7.10	0.00	0.00	7.22

(9) CO2 emission factor from Emission Factors for Locomotives, 2009. CH4 and N2O emissions scaled up from HC and NOx emissions in the POLB 2013 Air Emissions Inventory, 2014.

(10) Based on State global warming potentials.

Appendix B-5

Tesoro Integration and Compliance Project

Operational Marine Vessel Emissions

Emissions Summary

Emission per Barrel (lb/1000 bbl delivered) - Panamax

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project Unload Rate	0.9	2.1	23.8	0.8	0.11	0.09	0.5
Existing Unload Rate	1.0	2.4	27.1	1.3	0.15	0.12	0.9
Delta	(0.1)	(0.3)	(3.3)	(0.5)	(0.03)	(0.03)	(0.3)

Emission per Barrel (lb/1000 bbl delivered) - Aframax

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project Unload Rate	0.6	1.5	16.7	0.7	0.09	0.07	0.5
Existing Unload Rate	0.7	1.8	19.9	1.2	0.12	0.10	0.8
Delta	(0.1)	(0.2)	(3.2)	(0.6)	(0.04)	(0.03)	(0.4)

Emission per Barrel (lb/yr-1000 bbl delivered) - Panamax

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project	9.6	23.1	260.8	8.5	1.2	1.0	6.0
Existing	13.2	31.8	356.1	16.5	1.9	1.6	11.4
Delta	(3.6)	(8.6)	(95.3)	(8.0)	(0.7)	(0.6)	(5.4)

Emission per Barrel (lb/yr-1000 bbl delivered) - Aframax

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project	6.9	16.9	182.3	7.1	1.0	0.8	5.1
Existing	9.8	23.3	261.0	16.1	1.6	1.3	11.1
Delta	(2.9)	(6.5)	(78.6)	(9.0)	(0.7)	(0.6)	(6.0)

Appendix B-5
Tesoro Integration and Compliance Project
Operational Marine Vessel Emissions
Panamax Parameters

OGV Main Engine Usage per One-Way Transit

Activity	Propulsion Max kW ⁽¹⁾	Speed (Kts) ⁽¹⁾	Load Factor ⁽²⁾	Distance (nm/trip) ⁽³⁾	Duration (hr/trip)	Energy Consumed (kW-hr/trip)
California to AQMD Overwater Boundary ⁽⁴⁾	11,390	14.8	1.00	110.0	7.43	84,655
Fairway: AQMD Overwater Boundary to 20-Mile ⁽⁵⁾	11,390	12.0	0.53	22.9	1.90	11,561
Fairway: 20-Mile to Precautionary Zone ⁽⁵⁾	11,390	12.0	0.53	20.0	1.67	10,119
Precautionary Zone ^(6,7)	11,390	9.0	0.22	8.1	0.90	2,305
Harbor Transit Inbound ⁽⁸⁾	11,390	5.0	0.04	3.5	0.70	307
Harbor Transit Outbound ⁽⁸⁾	11,390	8.0	0.16	3.5	0.44	787
Turning ⁽⁸⁾	11,390	n/a	0.02	n/a	0.25	57
Docking ⁽⁸⁾	11,390	n/a	0.02	n/a	0.25	57
Existing - Hoteling ⁽⁹⁾	11,390	n/a	-	n/a	62.15	-
Project - Hoteling ⁽¹⁰⁾	11,390	n/a	-	n/a	21.33	-

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table A.3 (Starcrest 2014)

(2) Load factor = (speed/max speed)³. Load factor of 0.02 represents minimum load factor for propulsion engines.

(3) Distances from Starcrest (2010), except for California to AQMD and harbor, which were measured from a map. Assumes northern route.

Average One-Way Transit Distances	n miles
California to AQMD Boundary	110.0
Fairway 1-way nm	42.9
20nm 1-way Distance within Fairway	20.0
PZ to Breakwater 1-way nm	8.1

(4) Assume no Vessel Speed Reduction (VSR).

(5) Assume VSR to 12 knots.

(6) Portion of transit that occurs from PZ boundary to the breakwater.

(7) Average speeds in the precautionary zone are from POLB Air Emissions Inventory 2013 - Table 2.4 (Starcrest 2014)

(8) In harbor transit times and load factors from POLB Air Emissions Inventory 2005 - pg.67 (Starcrest 2007)

(9) Assumes 320,000 barrels unloaded at 5,149 barrels per hour. Unload rate based on average unload rate in 2012.

(10) Assumes 320,000 barrels unloaded at 15,000 barrels per hour.

OGV Auxiliary Generator Usage per One-Way Transit

Activity	Auxiliary kW per Vessel ⁽¹⁾	Hours/ Transit	kW-Hrs/ Transit
Point Conception to AQMD Overwater Boundary	630	7.43	4,682
Fairway: AQMD Overwater Boundary to 20-Mile	630	1.90	1,200
Fairway: 20-Mile to Precautionary Zone	630	1.67	1,050
Precautionary Zone	630	0.90	567
Harbor Transit Inbound	867	0.70	607
Harbor Transit Outbound	867	0.44	379
Turning	867	0.25	217
Docking	867	0.25	217
Existing - Hoteling	683	62.1	42,447
Project - Hoteling	683	21.3	14,571

Notes: (1) Port of Long Beach Air Emissions Inventory - 2011 - Table 2.12 (Starcrest 2012)

OGV Auxiliary Boiler Usage per One-Way Transit

Activity	Boiler kW per Vessel ⁽¹⁾	Hours/ Transit	kW-Hrs/ Transit
Point Conception to AQMD Overwater Boundary	-	7.43	-
Fairway: AQMD Overwater Boundary to 20-Mile	-	1.90	-
Fairway: 20-Mile to Precautionary Zone	-	1.67	-
Precautionary Zone	-	0.90	-
Harbor Transit Inbound	371	0.70	259.700
Harbor Transit Outbound	371	0.44	162.313
Turning	371	0.25	92.750
Docking	371	0.25	92.750
Existing - Hoteling	3,000	62.1	186,443.970
Project - Hoteling	3,000	21.3	64,000.000

Notes: (1) Port of Long Beach Air Emissions Inventory - 2011 - Table 2.16 (Starcrest 2012)

Tugboat Usage during Assists

Engine Type	Tugboat Max Hp ⁽¹⁾	Load Factor ⁽²⁾	Hours/ Assist ⁽³⁾	Tugboats per Assist	kW-Hrs/ Assist
Main Engine	6,770	0.31	3.28	2	10,255
Auxiliary Generator	850	0.43	3.28	2	1,786

Notes: (1) Based on 2 engines per vessel. Port of Long Beach Air Emissions Inventory - 2011 - Table 3.1, 3.2 (Starcrest 2012)

(2) Port of Long Beach Air Emissions Inventory - 2011 - Table 3.4 (Starcrest 2012)

(3) Time spent operating per vessel trip. Assumed to be equal to vessel "Harbor" transit times 2 to account for tug movement and assist time.

Appendix B-5
Tesoro Integration and Compliance Project
Operational Marine Vessel Emissions
Aframax Parameters

OGV Main Engine Usage per One-Way Transit

Activity	Propulsion Max kW ⁽¹⁾	Speed (Kts) ⁽¹⁾	Load Factor ⁽²⁾	Distance (nm/trip) ⁽³⁾	Duration (hr/trip)	Energy Consumed (kW-hr/trip)
California to AQMD Overwater Boundary ⁽⁴⁾	13,589	15.2	1.00	110.0	7.24	98,341
Fairway: AQMD Overwater Boundary to 20-Mile ⁽⁵⁾	13,589	12.0	0.49	22.9	1.90	12,732
Fairway: 20-Mile to Precautionary Zone ⁽⁵⁾	13,589	12.0	0.49	20.0	1.67	11,144
Precautionary Zone ^(6,7)	13,589	9.0	0.21	8.1	0.90	2,539
Harbor Transit Inbound ⁽⁸⁾	13,589	5.0	0.04	3.5	0.70	339
Harbor Transit Outbound ⁽⁸⁾	13,589	8.0	0.15	3.5	0.44	867
Turning ⁽⁹⁾	13,589	n/a	0.02	n/a	0.25	68
Docking ⁽⁹⁾	13,589	n/a	0.02	n/a	0.25	68
Existing - Hoteling ⁽⁹⁾	13,589	n/a	-	n/a	139.83	-
Project - Hoteling ⁽¹⁰⁾	13,589	n/a	-	n/a	48.00	-

Notes: (1) Port of Long Beach Air Emissions Inventory - 2011 - Table A.3 (Starcrest 2012)

(2) Load factor = (speed/max speed)³. Load factor of 0.02 represents minimum load factor for propulsion engines.

(3) Distances from Starcrest (2010), except for California to AQMD and harbor, which were measured from a map. Assumes northern route.

Average One-Way Transit Distances	n miles
California to AQMD Boundary	110.0
Fairway 1-way nm	42.9
20nm 1-way Distance within Fairway	20.0
PZ to Breakwater 1-way nm	8.1

(4) Assume no Vessel Speed Reduction (VSR).

(5) Assume VSR to 12 knots.

(6) Portion of transit that occurs from PZ boundary to the breakwater.

(7) Average speeds in the precautionary zone are from POLB Air Emissions Inventory 2011 - Table 2.4 (Starcrest 2012)

(8) In harbor transit times and load factors from POLB Air Emissions Inventory 2005 - pg.67 (Starcrest 2007)

(9) Assumes 720,000 barrels unloaded at 5,149 barrels per hour. Unload rate based on average unload rate in 2012.

(10) Assumes 720,000 barrels unloaded at 15,000 barrels per hour.

OGV Auxiliary Generator Usage per One-Way Transit

Activity	Auxiliary kW per Vessel ⁽¹⁾	Hours/ Transit	kW-Hrs/ Transit
Point Conception to AQMD Overwater Boundary	584	7.24	4,226
Fairway: AQMD Overwater Boundary to 20-Mile	584	1.90	1,112
Fairway: 20-Mile to Precautionary Zone	584	1.67	973
Precautionary Zone	584	0.90	526
Harbor Transit Inbound	803	0.70	562
Harbor Transit Outbound	803	0.44	351
Turning	803	0.25	201
Docking	803	0.25	201
Existing - Hoteling	632	139.8	88,374
Project - Hoteling	632	48.0	30,336

Notes: (1) Port of Long Beach Air Emissions Inventory - 2011 - Table 2.12 (Starcrest 2012)

OGV Auxiliary Boiler Usage per One-Way Transit

Activity	Boiler kW per Vessel ⁽¹⁾	Hours/ Transit	kW-Hrs/ Transit
Point Conception to AQMD Overwater Boundary	-	7.24	-
Fairway: AQMD Overwater Boundary to 20-Mile	-	1.90	-
Fairway: 20-Mile to Precautionary Zone	-	1.67	-
Precautionary Zone	-	0.90	-
Harbor Transit Inbound	371	0.70	259.700
Harbor Transit Outbound	371	0.44	162.313
Turning	371	0.25	92.750
Docking	371	0.25	92.750
Existing - Hoteling	3,000	139.8	419,498.932
Project - Hoteling	3,000	48.0	144,000.000

Notes: (1) Port of Long Beach Air Emissions Inventory - 2011 - Table 2.16 (Starcrest 2012)

Tugboat Usage during Assists

Engine Type	Tugboat Max Hp ⁽¹⁾	Load Factor ⁽²⁾	Hours/ Assist ⁽³⁾	Tugboats per Assist	kW-Hrs/ Assist
Main Engine	6,770	0.31	3.28	2	10,255
Auxiliary Generator	850	0.43	3.28	2	1,786

Notes: (1) Based on 2 engines per vessel. Port of Long Beach Air Emissions Inventory - 2011 - Table 3.1, 3.2 (Starcrest 2012)

(2) Port of Long Beach Air Emissions Inventory - 2011 - Table 3.4 (Starcrest 2012)

(3) Time spent operating per vessel trip. Assumed to be equal to vessel "Harbor" transit times 2 to account for tug movement and assist time.

Appendix B-5

Tesoro Integration and Compliance Project

Operational Marine Vessel Emissions

Marine Vessel Emission Factors

Emission Factors for OGV

Engine Type	Assumed Fuel Type	Assumed Fuel Use Application	VOC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O	Source
Main Propulsion Engine (g/kW-hr)												
OGV Main Engines	MGO (0.1% S)	All (current in-use fuel)	0.60	1.40	17.01	0.40	0.07	0.05	589	0.0120	0.02914	(1.2)
Tugboat Main Engines	CARB (500 ppm S)	2006	0.68	1.97	7.31	0.18	0.36	0.29	683	0.0040	0.03100	(3)
(Medium Speed Diesel)	CARB (15 ppm S)	2007+ Tier 4	0.49	1.97	5.80	0.01	0.11	0.09	683	0.0029	0.02939	(3.4)
Auxiliary Engine (g/kW-hr)												
OGV Auxiliary Engines	MGO (0.1% S)	All (current in-use fuel)	0.40	1.10	12.97	0.47	0.07	0.05	683	0.0080	0.02914	(2.5)
Tugboat Auxiliary Engines	CARB (500 ppm S)	2006	0.81	3.73	5.10	0.18	0.15	0.12	722	0.0100	0.03100	(3)
(High Speed Diesel)	CARB (15 ppm S)	2007+ Tier 4	0.58	3.73	5.60	0.01	0.11	0.09	722	0.0072	0.02939	(3.4)
Auxiliary Boiler (g/kW-hr)												
OGV Auxiliary Boilers	MGO (0.1% S)	All (current in-use fuel)	0.10	0.20	1.88	0.60	0.04	0.03	876	0.002	0.0705	(2.6)

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 2.5, 2.6. (Starcrest 2014)

(2) Fuel emission factors were adjusted in accordance with lower sulfur fuels. Port of Long Beach Air Emissions Inventory - 2013 - Table 2.17. (Starcrest 2014)

(3) Emission Estimation Methodology for Commercial Harbor Craft Operating in California. (CARB 2007)

(4) Port of Long Beach Air Emissions Inventory - 2013 - Table 3.7. (Starcrest 2014)

(5) Port of Long Beach Air Emissions Inventory - 2013 - Table 2.10, 2.11. (Starcrest 2014)

(6) Port of Long Beach Air Emissions Inventory - 2013 - Table 2.14, 2.15. (Starcrest 2014)

Load Emission Factor Adjustments for OGV Main Propulsion Engines

Activity	Load Factor	VOC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O
Point Conception to AQMD Overwater Boundary	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fairway: AQMD Overwater Boundary to 20-Mile	0.49	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fairway: 20-Mile to Precautionary Zone	0.49	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Precautionary Zone	0.21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Harbor Transit Inbound	0.04	9.12	5.46	2.46	1.00	3.53	1.00	9.12	2.46	2.46
Harbor Transit Outbound	0.15	1.40	1.36	1.07	1.00	1.12	1.00	1.40	1.07	1.07
Turning	0.02	21.18	9.70	4.63	1.00	7.29	1.00	21.18	4.63	4.63
Docking	0.02	21.18	9.70	4.63	1.00	7.29	1.00	21.18	4.63	4.63
Exiting - Hoteling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Project - Hoteling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: (1) Port of Long Beach Air Emissions Inventory - 2013 - Table 2.7. (Starcrest 2014)

Low-Load Emission Factor Regression Factors for OGV Main Propulsion Engines

Variable	VOC	CO	NOx	SOx	PM10	PM2.5	CO2	CH4	N2O
Exponent	1.5	1	1.5	0	1.5	1.5	0	1.5	1.5
Intercept	0.3859	0.1458	10.4496	0	0.2551	0.2551	0	0.3859	10.4496
Coefficient	0.0667	0.8378	0.1255	1	0.0059	0.0059	1	0.0667	0.1255
Ref. EF @ 20% Load	1.132	4.335	11.853	1	0.321	0.321	1	1.132	11.853

Appendix B-5

Tesoro Integration and Compliance Project

Operational Marine Vessel Emissions

Panamax Emissions

Total Emissions per Delivery (lb/visit) - Existing

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Marine Vessels - Point Conception to AQMD x 2	232.2	545.3	6,618.5	158.9	26.5	21.2	107.8
Marine Vessels - AQMD to 20 mile x 2	32.7	77.2	935.9	22.9	3.8	3.0	15.5
Marine Vessels - 20 mile to PZ x 2	28.6	67.6	819.1	20.0	3.3	2.6	13.6
Marine Vessels - PZ x 2	7.1	17.0	205.4	5.2	0.9	0.7	3.5
Marine Vessels - Harbor Transit Inbound	4.3	6.8	46.8	1.2	0.3	0.2	0.8
Marine Vessels - Harbor Transit Outbound	1.8	4.3	43.2	1.3	0.2	0.2	0.9
Marine Vessels - Turning	1.8	2.3	16.5	0.4	0.1	0.1	0.3
Marine Vessels - Docking	1.8	2.3	16.5	0.4	0.1	0.1	0.3
Marine Vessels - Hoteling	78.5	185.1	1,986.6	290.3	21.0	18.0	196.8
Tugboats	13.4	59.2	153.2	0.1	2.9	2.3	8.4
Total	402.28	966.96	10,841.52	500.80	58.97	48.39	347.81

Total Emissions per Delivery (lb/visit) - Project

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Marine Vessels - Point Conception to AQMD x 2	232.2	545.3	6,618.5	158.9	26.5	21.2	107.8
Marine Vessels - AQMD to 20 mile x 2	32.7	77.2	935.9	22.9	3.8	3.0	15.5
Marine Vessels - 20 mile to PZ x 2	28.6	67.6	819.1	20.0	3.3	2.6	13.6
Marine Vessels - PZ x 4	7.1	17.0	205.4	5.2	0.9	0.7	3.5
Marine Vessels - Harbor Transit Inbound x 2	4.3	6.8	46.8	1.2	0.3	0.2	0.8
Marine Vessels - Harbor Transit Outbound x 2	1.8	4.3	43.2	1.3	0.2	0.2	0.9
Marine Vessels - Turning x 2	1.8	2.3	16.5	0.4	0.1	0.1	0.3
Marine Vessels - Docking x 2	1.8	2.3	16.5	0.4	0.1	0.1	0.3
Marine Vessels - Hoteling	27.0	63.6	681.9	99.6	7.2	6.2	67.5
Tugboats x 2	13.4	59.2	153.2	0.1	2.9	2.3	8.4
Total	350.70	845.37	9,536.83	310.16	45.20	36.58	218.59

Emission per Barrel (lb/1000 bbl delivered)

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project	0.9	2.1	23.8	0.8	0.1	0.1	0.5
Existing	1.0	2.4	27.1	1.3	0.1	0.1	0.9
Delta	(0.1)	(0.3)	(3.3)	(0.5)	(0.0)	(0.0)	(0.3)

Emission per Barrel (lb/yr-1000 bbl delivered)

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project	9.6	23.1	260.8	8.5	1.2	1.0	6.0
Existing	13.2	31.8	356.1	16.5	1.9	1.6	11.4
Delta	(3.6)	(8.6)	(95.3)	(8.0)	(0.7)	(0.6)	(5.4)

Appendix B-5

Tesoro Integration and Compliance Project

Operational Marine Vessel Emissions

Aframax Emissions

Total Emissions per Delivery (lb/visit) - Existing

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Marine Vessels - Point Conception to AQMD x 2	267.6	627.5	7,619.1	182.1	30.4	24.3	123.5
Marine Vessels - AQMD to 20 mile x 2	35.6	84.0	1,018.7	24.7	4.1	3.3	16.8
Marine Vessels - 20 mile to PZ x 2	31.2	73.5	891.7	21.7	3.6	2.9	14.7
Marine Vessels - PZ x 2	7.6	18.2	220.5	5.6	0.9	0.7	3.8
Marine Vessels - Harbor Transit Inbound	4.6	7.2	48.4	1.2	0.3	0.2	0.8
Marine Vessels - Harbor Transit Outbound	2.0	4.6	45.6	1.3	0.2	0.2	0.9
Marine Vessels - Turning	2.1	2.6	17.9	0.4	0.1	0.1	0.3
Marine Vessels - Docking	2.1	2.6	17.9	0.4	0.1	0.1	0.3
Marine Vessels - Hoteling	170.4	399.3	4,266.0	645.8	46.1	39.6	437.8
Tugboats	13.4	59.2	153.2	0.1	2.9	2.3	8.4
Total	536.67	1,278.63	14,298.94	883.40	88.73	73.71	607.21

Total Emissions per Delivery (lb/visit) - Project

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Marine Vessels - Point Conception to AQMD x 2	267.6	627.5	7,619.1	182.1	30.4	24.3	123.5
Marine Vessels - AQMD to 20 mile x 2	35.6	84.0	1,018.7	24.7	4.1	3.3	16.8
Marine Vessels - 20 mile to PZ x 2	31.2	73.5	891.7	21.7	3.6	2.9	14.7
Marine Vessels - PZ x 4	15.3	36.4	441.0	11.1	1.8	1.5	7.5
Marine Vessels - Harbor Transit Inbound x 2	9.3	14.4	96.7	2.4	0.6	0.5	1.7
Marine Vessels - Harbor Transit Outbound x 2	3.9	9.1	91.1	2.7	0.4	0.3	1.8
Marine Vessels - Turning x 2	4.2	5.1	35.8	0.8	0.2	0.2	0.5
Marine Vessels - Docking x 2	4.2	5.1	35.8	0.8	0.2	0.2	0.5
Marine Vessels - Hoteling	58.5	137.1	1,464.4	221.7	15.8	13.6	150.3
Tugboats x 2	26.7	118.4	306.3	0.3	5.8	4.7	16.8
Total	456.55	1,110.73	12,000.78	468.31	62.99	51.33	334.14

Emission per Barrel (lb/1000 bbl delivered)

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project	0.6	1.5	16.7	0.7	0.1	0.1	0.5
Existing	0.7	1.8	19.9	1.2	0.1	0.1	0.8
Delta	(0.1)	(0.2)	(3.2)	(0.6)	(0.0)	(0.0)	(0.4)

Emission per Barrel (lb/yr-1000 bbl delivered)

Project Scenario/Activity	VOC	CO	NOx	SOx	PM10	PM2.5	CO2e (MT)
Project	6.9	16.9	182.3	7.1	1.0	0.8	5.1
Existing	9.8	23.3	261.0	16.1	1.6	1.3	11.1
Delta	(2.9)	(6.5)	(78.6)	(9.0)	(0.7)	(0.6)	(6.0)