APPENDIX C
EMISSION ESTIMATION AND MODELING PROTOCOL

INTRODUCTION

This air emission estimation and modeling protocol has been prepared for the proposed Wespac Pittsburg Energy Infrastructure Project (project). As described in Chapter 2 of the WesPac Pittsburg Energy Infrastructure Project Draft Environmental Impact Report (DEIR), the project would receive crude oil and partially refined crude oil from marine vessels or pipelines via the nearby Rail Transload Facility, store the oil in the retrofitted existing and newly built storage tanks, and then transfer the oil to nearby refineries. The project alternatives considered for the proposed project will include a no-project alternative and a reduced footprint alternative (Alternative 1), which is similar to the proposed project but reduces the onshore storage working capacity by approximately 22 percent.

This protocol document presents additional details regarding the analysis methodologies discussed in Chapter 4 – Air Quality and Chapter 5 – Greenhouse Gas of the DEIR. Provided below is a description of the emissions estimation and modeling methodologies behind the impact analysis performed on air quality and greenhouse gases for the proposed project. This document has been broken into two parts. Part A focuses on the procedures used to estimate air quality impacts. Part B focuses on the procedures related to greenhouse gas (GHG) calculations. The impact analysis for Alternative 1 was performed in a similar manner to that of the proposed project.

PART A – AIR QUALITY

This part describes the assumptions and methods for emission calculations, dispersion modeling, and Health Risk Assessment (HRA) that evaluated potential air quality impacts and public health effects attributed to the construction and operations of the proposed project and Alternative 1.

Emission from various project related sources were quantified using project-specific information and general industry estimation methods. Emission sources associated with construction activities as well as project operations were both considered in the emission estimates for the proposed project and Alternative 1. Emissions from construction activities included sources such as off-road construction equipment, on-road trucks, dredge equipment, tugboats, and other material movement activities. Emissions calculations for operational activities considered sources such as marine vessels, tugboats, rail locomotives, storage tanks, a vapor destruction unit (thermal oxidizer), and crude oil heaters.

Based on the results of emission estimates for both construction and operational emissions for the proposed project and Alternative 1, air dispersion modeling was performed to predict off-site ground-level concentrations of $PM_{2.5}$, diesel particulate matter (DPM), and toxic air contaminants (TACs) from the proposed project construction, as well as $PM_{2.5}$, DPM, TACs, and the 1-hour and 8-hour CO for the proposed project operations.

To evaluate the potential air quality and health risk impacts attributed to the proposed project and Alternative 1, the following four general steps were performed: (1) quantified emissions of precursor organic compounds (POCs), CO, NO_x, SO_x, PM_{10}, and $PM_{2.5}$ for both the construction and operations of the proposed project and Alternative 1; (2) identified ground-level receptor locations that may be affected by the emissions (including both a regular grid of receptors and any special sensitive receptor locations such as schools, hospitals, convalescent homes, and/or daycare centers); (3) performed dispersion modeling analyses using the project's construction and operational emissions estimates to predict the maximum offsite ambient concentrations of $PM_{2.5}$, DPM (in the form of PM_{10}), and other TACs at each receptor location; (4) estimated the maximum offsite 1-hour and 8-hour CO concentrations attributed to the project operations in the dispersion modeling to assess the associated air quality impacts (in terms of CO) to the local residential area in proximity to the project site; (5) performed a HRA using a risk characterization model along with the outputs from the dispersion modeling analysis to evaluate the potential public health impacts (at each receptor location) associated with the TAC emissions from the construction and operations of the proposed project and Alternative 1.

A - 1 Emission Estimates

This section provides a brief summary of the emission scenarios, assumptions, emission factor references, and calculation methods used for the emission estimates for the construction and operations of the proposed project and project Alternative 1.

A - 1.1 Construction Emissions

Project construction activities would involve the use of off-road construction equipment, on-road trucks, dredge equipment, and tugboats. Exhaust emissions in the form of NO_x, PM_{10}, $PM_{2.5}$, POC, CO, and SOx would be generated from the combustion of diesel fuel in this equipment. In addition, fugitive dust emissions in the form of PM_{10} and $PM_{2.5}$ would result from vehicle traffic and other earth moving activities associated with the construction. As recommended by BAAQMD (A. Kirk, personal communication, February 25, 2013), the California Emissions Estimator Model (CalEEMod) (version 2011.1) was used to quantify the construction emissions associated with the proposed project and Alternative 1.

As indicated in Chapter 2 of the DEIR, construction of the proposed project would be divided into two major phases, which would consist of a total of five main construction work scopes. The first major construction phase is associated with construction of facilities required to support receipt of product by rail and pipeline. This construction phase is estimated to take approximately 16 months and would include two main scopes of construction: 1) construction of Rail Transload Facility, storage tanks replacement, and other onshore modification and 2) pipeline construction. The first major construction phase is proposed to begin in October 2013 and be completed in January 2015. The second major construction phase is associated construction of the facility required to support marine terminal operations. It would consist of three main scopes of construction work: marine work, storage tank retrofit, and other storage terminal construction. The second major construction phase is estimated to take approximately 19 months and would begin in April 2014 and be completed in October 2015.

For Alternative 1, the six 162 kbbl internal floating roof tanks in the east tank farm would not be reactivated for operation. The Alternative 1 storage tank retrofit construction duration was estimated to be reduced by 28 percent. This reduction ratio is calculated based on working capacity reduction of all the existing storage tanks for tank retrofit work. Detailed calculations of the reduction ratio are presented in Table 1 below. Except where noted otherwise, the remainder of construction activities for Alternative 1 were assumed to be the same as for the proposed project.

Table 1 - Reduction Ratio of Construction Activities for Alternative 1

	Product Storage Tanks	**Norminal Capacity (kbbl)**	**Number of Tanks**	**Working Capacity (kbbl)**	**Total Working Capacity (kbbl)**	**% of Total Retrofitted Tanks Working Capacity[1]**	**% of All Tanks Working Capacity[2]**
East Tank Farm	Internal Floating Roof Tanks **(Not Included in Alternative 1)**	162	6	146	876	28%	22%
South Tank Farm	Internal Floating Roof Tanks	500	5	450	2250	71%	58%
	External Floating Roof Tanks	54	1	48.6	48.6	2%	1%
	Internal Floating Roof Tanks (New Tanks to be Constructed)	200	4	184	736	0%	19%
Sum of working capacity for all tanks (kbbl)					3910.6	-	100%
Sum of working capacity of all tanks for retrofit (kbbl)					3174.6	100%	-
Ratio of Tank Working Capacity for Alternative 1 (Excluding Tanks in the East Tank Farm)						**72%**	**78%**

Notes:

[1] The percentages in this column were calculated based on the total working capacity of all existing tanks that would be retrofitted.

[2] The percentages in this column were calculated based on the total working capacity of all product storage tanks in the storage terminal, including the existing tanks that would be retrofitted and the new tanks that would be constructed.

Based on the construction scope, various types of construction activity are expected to occur during each construction phase. Because CalEEMod utilizes different emission calculation methodologies for difference types of construction activity, the construction for the proposed project and Alternative 1 was further broken down into twenty-seven subphases in CalEEMod based on the construction activity types. Construction activities are expected to vary substantially from day to day. For the analysis of the maximum impacts to air quality and public health risk, certain construction subphases were modeled to overlap with each other based on worst case emission scenario assumptions during construction. Table 2 and Table 3 below list the construction subphases and the corresponding construction schedules that were used for the emission estimates of the proposed project and Alternative 1 respectively.

Table 2 – Proposed Project Construction Schedule

Construction Phase	Approx. Length	SubPhase Name	SubPhase Type	Approx. Duration	Approx. Start Date	Approx. Completion
Phase 1A: Rail Transload Facility, Storage Tank Replacements and Other Onshore Modifications	16 months (Oct. 2013- Jan. 2015)	Phase 1A-1a: Transloading Platform & Facility Construction (Demolition)	Demolition	1 weeks	2013/10/21	2013/10/25
		Phase 1A-1b: Transloading Platform & Facility Construction (Grading)	Grading	3 weeks	2013/11/10	2013/11/29
		Phase 1A-1c: Transloading Platform & Facility Construction (Trenching_Utility)	Trenching	1 week	2013/11/25	2013/11/29
		Phase 1A-1d: Transloading Platform & Facility Construction: General Construction (Utilities,	Building Construction	35 weeks	2013/11/29	2014/07/31
		Phase 1A-1e: Transloading Platform & Facility Construction (Paving)	Paving	1 week	2014/07/31	2014/08/06
		Phase 1A-2a: Rail/Bridge Construction (Demolition)	Demolition	1 weeks	2013/10/26	2013/11/01
		Phase 1A-2b: Transloading Platform & Facility Construction (General Construction_Bridge)	Building Construction	20 weeks	2013/11/01	2014/03/20
		Phase 1A-2c: Transloading Platform & Facility Construction (General Construction_Rail)	Building Construction	20 weeks	2014/03/20	2014/08/06
		Phase 1A-2d: Transloading Platform & Facility Construction (Grading)	Grading	3 weeks	2014/03/20	2014/04/09
		Phase 1A-3a: Storage Terminal Modification (Demolition)	Demolition	2 months	2013/10/21	2013/12/19
		Phase 1A-3b: Storage Terminal Modification (Grading)	Grading	1 month	2013/12/30	2014/01/28
		Phase 1A-3c: Storage Terminal Modification (Trenching)	Trenching	1 month	2014/02/10	2014/03/11
		Phase 1A-3d: Storage Terminal Modification (Building Construction)	Building Construction	10 months	2014/03/17	2015/01/13
		Phase 1A-3e: Storage Terminal Modification (Architectural Coating2)	Architectural Coating	5 weeks	2014/09/10	2014/10/14

Construction Phase	Approx. Length	SubPhase Name	SubPhase Type	Approx. Duration	Approx. Start Date	Approx. Completion
Phase 1B: Pipeline construction	4 months (May. 2014 - Aug. 2014)	Phase 1B-1: Pipeline Construction: (Grading)	Grading	2 weeks	2014/05/01	2014/05/14
		Phase 1B-2: Pipeline Construction: (Trenching)	Trenching	3 months	2014/05/12	2014/08/08
		Phase 1B-3: Pipeline Construction: (Paving)	Paving	2 weeks	2014/08/11	2014/08/22
Phase 2A: Marine Terminal Construction	10 months (Jul.2014 - April 2015)	Phase 2A-1: Marine Work (Demolition)	Demolition	1 month	2014/07/07	2014/08/05
		Phase 2A-2 Marine Work (Berth Construction)	Building Construction	4 months	2014/08/05	2014/12/03
		Phase 2A-3 Marine Work (Dredging)	Building Construction	4 months	2014/08/05	2014/12/03
		Phase 2A-4 Marine Work (Other Construction)	Building Construction	4 months	2014/12/08	2015/04/07
Phase 2B: Storage Tank Retrofit	19 months (Apr. 2014 - Oct. 2015)	Phase 2B-1: Storage Terminal Retrofit (Building Construction)	Building Construction	16 months	2014/04/15	2015/08/12
		Phase 2B-2: Storage Terminal Retrofit (Architectural Coatings)	Architectural Coating	2 months	2015/08/15	2015/10/14
Phase 2C: Storage Terminal construction	19 months (Apr. 2014 - Oct. 2015)	Phase 2C-1: Storage Terminal Construction (Grading)	Grading	1 month	2014/04/10	2014/05/10
		Phase 2C-2: Storage Terminal Construction (Trenching)	Trenching	1 month	2014/05/10	2014/06/10
		Phase 2C-3: Storage Terminal Construction (Building Construction)	Building Construction	15 months	2014/06/15	2015/09/11
		Phase 2C-4: Storage Terminal Construction (Paving)	Paving	1 month	2015/09/15	2015/10/14

Table 3 – Alternative 1 Construction Schedule

Construction Phase	Approx. Length	SubPhase Name	SubPhase Type	Approx. Duration	Approx. Start Date	Approx. Completion
Phase 1A: Rail Transload Facility, Storage Tank Replacements and Other Onshore Modifications	16 months (Oct. 2013- Jan. 2015)	Phase 1A-1a: Transloading Platform & Facility Construction (Demolition)	Demolition	1 weeks	2013/10/21	2013/10/25
		Phase 1A-1b: Transloading Platform & Facility Construction (Grading)	Grading	3 weeks	2013/11/10	2013/11/29
		Phase 1A-1c: Transloading Platform & Facility Construction (Trenching_Utility)	Trenching	1 week	2013/11/25	2013/11/29
		Phase 1A-1d: Transloading Platform & Facility Construction: General Construction (Utilities,	Building Construction	35 weeks	2013/11/29	2014/07/31
		Phase 1A-1e: Transloading Platform & Facility Construction (Paving)	Paving	1 week	2014/07/31	2014/08/06
		Phase 1A-2a: Rail/Bridge Construction (Demolition)	Demolition	1 weeks	2013/10/26	2013/11/01
		Phase 1A-2b: Transloading Platform & Facility Construction (General Construction_Bridge)	Building Construction	20 weeks	2013/11/01	2014/03/20
		Phase 1A-2c: Transloading Platform & Facility Construction (General Construction_Rail)	Building Construction	20 weeks	2014/03/20	2014/08/06
		Phase 1A-2d: Transloading Platform & Facility Construction (Grading)	Grading	3 weeks	2014/03/20	2014/04/09
		Phase 1A-3a: Storage Terminal Modification (Demolition)	Demolition	2 months	2013/10/21	2013/12/19
		Phase 1A-3b: Storage Terminal Modification (Grading)	Grading	1 month	2013/12/30	2014/01/28
		Phase 1A-3c: Storage Terminal Modification (Trenching)	Trenching	1 month	2014/02/10	2014/03/11
		Phase 1A-3d: Storage Terminal Modification (Building Construction)	Building Construction	10 months	2014/03/17	2015/01/13
		Phase 1A-3e: Storage Terminal Modification (Architectural Coating2)	Architectural Coating	5 weeks	2014/09/10	2014/10/14

Construction Phase	Approx. Length	SubPhase Name	SubPhase Type	Approx. Duration	Approx. Start Date	Approx. Completion
Phase 1B: Pipeline construction	4 months (May. 2014 - Aug. 2014)	Phase 1B-1: Pipeline Construction: (Grading)	Grading	2 weeks	2014/05/01	2014/05/14
		Phase 1B-2: Pipeline Construction: (Trenching)	Trenching	3 months	2014/05/12	2014/08/08
		Phase 1B-3: Pipeline Construction: (Paving)	Paving	2 weeks	2014/08/11	2014/08/22
Phase 2A: Marine Terminal Construction	10 months (Jul.2014 - April 2015)	Phase 2A-1: Marine Work (Demolition)	Demolition	1 month	2014/07/07	2014/08/05
		Phase 2A-2 Marine Work (Berth Construction)	Building Construction	4 months	2014/08/05	2014/12/03
		Phase 2A-3 Marine Work (Dredging)	Building Construction	4 months	2014/08/05	2014/12/03
		Phase 2A-4 Marine Work (Other Construction)	Building Construction	4 months	2014/12/08	2015/04/07
Phase 2B: Storage Tank Retrofit	13.5 months (Apr. 2014 - May. 2015)	Phase 2B-1: Storage Terminal Retrofit (Building Construction)	Building Construction	11.5 months	2014/04/15	2015/03/30
		Phase 2B-2: Storage Terminal Retrofit (Architectural Coatings)	Architectural Coating	1.5 months	4/15/2015	5/27/2015
Phase 2C: Storage Terminal construction	19 months (Apr. 2014 - Oct. 2015)	Phase 2C-1: Storage Terminal Construction (Grading)	Grading	1 month	2014/04/10	2014/05/10
		Phase 2C-2: Storage Terminal Construction (Trenching)	Trenching	1 month	2014/05/10	2014/06/10
		Phase 2C-3: Storage Terminal Construction (Building Construction)	Building Construction	15 months	2014/06/15	2015/09/11
		Phase 2C-4: Storage Terminal Construction (Paving)	Paving	1 month	2015/09/15	2015/10/14

Various construction emission sources were considered in CalEEMod for emission calculations. The major emission sources that were modeled in CalEEMod for the construction of the proposed project and Alternative 1 include the following:

- Off-road construction equipment
- On-road vehicles and mobile equipment associated with worker commute trips, vendor commute trips, and hauling trips
- Fugitive emissions from grading, demolition, truck loading, and paved and unpaved roads
- POC emissions from architectural coating and asphalt paving

A - 1.1.1 Off-Road Construction Equipment

Emissions of NO_x, PM_{10}, $PM_{2.5}$, POC, CO, and SO_x from off-road construction equipment were quantified in CalEEMod using emission factors derived from the OFFROAD 2007 air quality model for off-road equipment based on the equipment type, equipment horsepower rating, and the selected emission tier standard of the equipment. Table 4 below summarizes the construction equipment list that was utilized in the CalEEMod model to quantify emissions from off-road construction equipment. During the marine terminal construction activities, tugboats would be used to haul dredge sediment in barges offsite for proper disposal. For the consistency of emission estimation methodology, this equipment was also modeled as construction equipment in CalEEMod, and emissions from this equipment were calculated using model default emission factors corresponding to the equipment power ratings and selected tier standard. Due to the limitation of available equipment types listed in CalEEMod and the available horsepower ratings listed for certain construction equipment in the model, tugboats used during construction were modeled as other material handling in the model.

Table 4 – Construction Equipment for the Proposed Project Construction

Construction Equipment	Use	Qty	Avg. Hour/day	Hp	Days/Wk
Phase 1A-1a & 1A-2a	**Demolition**				
front loader (CAT 966)		1	4	220	5
truck and trailer		1	4	150	5
Backhoe (Case 580 or CAT446)		1	8	100	5
Water truck (2,500 gal)		1	8	150	5
Phase 1A-1b & 1A-2d	**Grading**				
Motor Grader (CAT 16G)		2	4	275	5
track-type tractors (CAT D9)		2	4	370	2
compactors (CS583)		2	4	145	5
scrapers (CAT627)		6	4	555	1
excavator (CAT 320)		1	8	128	2
front loader (CAT 966)		1	8	220	5
truck and trailer		4	4	150	5

Construction Equipment	**Use**	**Qty**	**Avg. Hour/day**	**Hp**	**Days/Wk**
water trucks (1 – 5,000 gal, 1 – 2,500 gal)		1	4	400	5
Phase 1A-1c	**Trenching**				
Backhoe (Case 580 or CAT446)		1	8	100	5
Water truck (2,500 gal)		1	8	150	5
Phase 1A-1d	**Building Construction**				
truck and trailer		2	8	150	5
Boom truck (Terex 25T)		1	4	300	5
Backhoe (Case 580 or CAT446)		1	4	100	5
Water truck (2,500 gal)		1	2	150	5
Phase 1A-1e	**Paving**				
compactors (CS583)		1	8	145	2
front loader (CAT 966)		1	8	220	2
Water truck (2,500 gal)		1	8	150	2
Phase 1A-2b	**Building Construction**				
truck and trailer		1	8	150	5
Hydraulic Crane (RT875)		1	2	235	5
Boom truck (Terex 25T)		1	2	300	5
Backhoe (Case 580 or CAT446)		1	2	100	5
Water truck (2,500 gal)		1	2	150	5
Phase 1A-2c	**Building Construction**				
front loader (CAT 966)		1	8	220	5
truck and trailer		1	8	150	5
Backhoe (Case 580 or CAT446)		1	2	100	5
Water truck (2,500 gal)		1	6	150	5
Phase 1A-3a:	**Demolition**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Crane	Cranes	1	4	365	5
Forklift	Forklifts	1	4	105	5
Manlift	Other Construction Equip.	1	8	160	5
Weld Rig	Welders	1	8	160	5
Vacuum Truck	Utility Location	1	4	479	5
1 Ton Flatbed	Pipe Delivery Trucks	1	4	479	3
Semi Truck with Trailer	Pipe Equipment Delivery	1	4	479	5
Phase 1A-3b:	**Grading**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Dozer	Soil excavation, grading	1	8	160	5
Water Truck	Dust Control	1	8	175	5

Construction Equipment	Use	Qty	Avg. Hour/day	Hp	Days/Wk
Phase 1A-3c	**Trenching**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Backhoe	Excavation	2	8	160	5
Trackhoe	Excavation	1	8	160	5
Water Truck	Dust Control	1	8	175	5
Phase 1A-3d	**Building Construction**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Crane	Cranes	1	4	365	3
Dump Truck	Soil Transport	1	8	479	3
Trackhoe	Excavation	1	8	160	3
Backhoe	Excavation	2	8	160	3
Dozer	Soil excavation, grading	1	8	160	3
Compactor	Soil Compaction	1	8	160	3
Loader	Excavation	1	8	215	3
Boom-Truck	Pipe/Equipment Transport	1	8	479	5
Water Truck	Dust Control	1	2	175	5
Man-Lift	Other Construction Equip.	2	4	160	5
Fork Lift	Forklifts	2	4	105	5
Welding Rigs	Welding Equipment	2	8	160	5
Air Compressor	Other Construction Equip.	1	8	112	5
Fill/Hydrotest Pump	Other Construction Equipment	1	1	160	1
Phase 1A-3e	**Architectural Coating**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Manlift	Other Construction Equip.	2	8	160	5
Air Compressor	Other Construction Equip.	2	8	112	5
Fork Lift	Forklifts	1	1	105	1
Phase 1B-1:	**Grading**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Dozer	Soil excavation, grading	1	8	160	2
Water Truck	Dust Control	1	4	175	5
Phase 1B-2	**Trenching**				
1 Ton Flatbed	Pipe Delivery Trucks	1	4	479	1
Semi Truck with Trailer	Pipe Equipment Delivery	1	4	479	1
Water Truck	Dust Control	1	4	175	5
Dump Truck	Soil Transport	2	8	479	2
Vacuum Truck	Utility Location	1	8	479	2
Backhoe (Rubber Tired)	Tractors/Loaders/Backhoes	2	8	160	5
Bending Machine	Construction Equipment	1	4	160	2
Truck Crane	Set Bore Machine	1	1	365	1
Sideboom	Construction Equipment	2	8	160	4
Loader Rubber Tired	Loaders	1	8	215	5
Forklift	Forklifts	1	4	105	2
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Weld Rig	Weldering Equipment	2	8	160	5
Fill/Hydrotest Pump	Other Construction	1	1	160	1

Construction Equipment	Use	Qty	Avg. Hour/day	Hp	Days/Wk
	Equipment				
Boring Machine	Bore/Drill Rigs	1	8	160	2
Phase 1B-3	**Paving**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Dump Truck	Soil Transport	1	8	479	2
Compactor	Soil Compaction	1	8	160	5
Asphalt Rollers	Construction Equipment	1	8	160	1
Phase 2A-1	**Demolition**				
Derrick	Demolition	2	10	600	6
Phase 2A-2	**Building Construction**				
Derrick	Construction	2	10	600	6
Tugboat	Move barge	1	10	1500	6
Phase 2A-3	**Building Construction**				
Dredge derrick	Dredging	1	24	1200	6
Tugboat	Move dredge derrick	1	24	1500	6
Phase 2A-4	**Building Construction**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Crane	Cranes	1	4	365	2
Cement Truck	Foundations	1	4	479	2
Boom-Truck	Pipe/Equipment Transport	1	4	479	2
Man-Lift	Other Construction Equip.	2	4	160	5
Fork Lift	Forklifts	2	4	105	5
Welding Rigs	Welding Equipment	2	8	160	5
Air Compressor	Other Construction Equip.	1	8	112	5
Fill/Hydrotest Pump	Other Construction Equipment	1	1	160	1
Derrick	Hoisting materials	1	8	600	2
Tugboat	Moving barges	1	8	1500	2
Phase 2B-1	**Building Construction**				
Diesel Generator (200 KW)	Other Construction Equip.	1	8	45	5
Crane	Cranes	1	8	365	5
Forklift	Forklifts	1	8	105	5
Manlift	Other Construction Equip.	1	8	160	5
Weld Rig	Welders	2	8	160	5
Fill Pump	Other Construction Equipment	1	8	160	1
Air Compressor	Other Construction Equip.	1	8	112	5
Phase 2B-2	**Architectural Coating**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Manlift	Other Construction Equip.	2	8	160	5
Air Compressor	Other Construction Equip.	2	8	112	5
Fork Lift	Forklifts	1	8	105	1

Construction Equipment	Use	Qty	Avg. Hour/day	Hp	Days/Wk
Phase 2C-1:	**Grading**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Dozer	Soil excavation, grading	1	8	160	5
Water Truck	Dust Control	1	4	175	5
Phase 2C-2	**Trenching**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Backhoe	Excavation	2	8	160	5
Trackhoe	Excavation	1	8	160	5
Water Truck	Dust Control	1	4	175	5
Phase 2C-3	**Building Construction**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Crane	Cranes	1	4	365	2
Dump Truck	Soil Transport	1	8	479	3
Trackhoe	Excavation	1	8	160	3
Backhoe	Excavation	2	8	160	3
Dozer	Soil excavation, grading	1	8	160	3
Compactor	Soil Compaction	1	8	160	3
Loader	Excavation	1	8	215	3
Boom-Truck	Pipe/Equipment Transport	1	8	479	5
Water Truck	Dust Control	1	2	175	5
Man-Lift	Other Construction Equip.	2	4	160	5
Fork Lift	Forklifts	2	4	105	5
Welding Rigs	Welding Equipment	2	8	160	5
Air Compressor	Other Construction Equip.	1	8	112	5
Fill/Hydrotest Pump	Other Construction Equipment	1	1	160	1
Phase 2C-4	**Paving**				
Diesel Generator (200 KW)	Temporary Power	1	8	45	5
Dump Truck	Soil Transport	1	8	479	2
Compactor	Soil Compaction	1	8	160	5
Asphalt Rollers	Construction Equipment	1	8	160	1

Two equipment emission standards were analyzed in CalEEMod for the proposed project and Alternative 1. All construction equipment was assumed to be at a minimum meet the EPA Tier 1 engine standard for the unmitigated project option and meet the EPA Tier 2 engine standard for mitigated project option, as indicated below.

- Proposed Project Unmitigated (EPA Tier I engines)
- Proposed Project Mitigated (EPA Tier II engines)
- Alternative 1 Unmitigated (EPA Tier I engines)
- Alternative 1 Mitigated (EPA Tier II engines)

The emissions from off-road construction equipment were calculated in CalEEMod using equipment emission factors, engine load factors in combination with estimations regarding daily hour usage for each piece of equipment, and the duration and number of work days of the construction subphase during which the equipment would be operated. Engine load factor impacts the fuel consumption of the off-road construction equipment, which in turn affects the emission levels of the equipment. To account for the overestimation of default load factors in OFFROAD 2007, as acknowledged by CARB (CARB, 2010), all model default engine load factors used for emissions estimates of off-road equipment (except for tugboats) were reduced by 33% in CalEEMod before being applied in the emission calculations in the model. To conservatively quantify the emissions from tugboats, model default load factors without further adjustment were used in calculating the emissions from tugboats used during construction. As indicated in Table 4, certain construction equipment is not expected to be operated every day throughout the corresponding construction phases and thus, the total annual emissions calculated in CalEEMod for off-road construction equipment are likely to be more than the emissions that would be generated during actual construction.

A - 1.1.2 On-Road Vehicle Exhaust Emissions

Exhaust emissions associated with on-road vehicles were quantified in CalEEMod using the model default vehicle fleet mixes, the emission factors derived from the EMFAC2007 on-road mobile source emission factor model together with project estimates regarding the number and length of on-road vehicle trips for workers, vendors and hauling. The estimated vehicle trips and trip length for both the proposed project and Alternative 1 are summarized in Table 5 below. On-road mobile equipment, such as haul trucks, that will be used during construction, were first modeled as off-highway trucks using the same calculation method for off-road equipment to quantify the emissions generated on-site. To account for the emissions that would be generated from the on-road mobile equipment during off-site transport, additional vendor trips and vehicle miles traveled were added in the on-road vehicle emission estimates.

Table 5 – Estimated Construction Vehicle Trips and Trip Length for the Proposed Project and Alternative 1[1]

PhaseName	Worker Trip (trips/day)	Vendor Trip (trips/day)	Hauling Trip (trips/day)	Worker Trip Length (mile)	Vendor Trip Length (mile)	Hauling Trip Length (mile)
Phase 1A-1a: Transloading Platform & Facility Construction (Demolition)	15	1	1	25	25	25
Phase 1A-1b: Transloading Platform & Facility Construction (Grading)	15	1	1	25	25	25
Phase 1A-1c: Transloading Platform & Facility Construction (Trenching_Utility)	15	1	1	25	25	25
Phase 1A-1d: Transloading Platform & Facility Construction: General Construction (Utilities, Platform and Faclities)	15	1	1	25	25	25

PhaseName	Worker Trip (trips/day)	Vendor Trip (trips/day)	Hauling Trip (trips/day)	Worker Trip Length (mile)	Vendor Trip Length (mile)	Hauling Trip Length (mile)
Phase 1A-1e: Transloading Platform & Facility Construction (Paving)	15	1	1	25	25	25
Phase 1A-2a: Rail/Bridge Construction (Demolition)	5	0.25	0.25	25	25	25
Phase 1A-2b: Transloading Platform & Facility Construction (General Construction_Bridge)	5	0.25	0.25	25	25	25
Phase 1A-2c: Transloading Platform & Facility Construction (General Construction_Rail)	5	0.25	0.25	25	25	25
Phase 1A-2d: Transloading Platform & Facility Construction (Grading)	5	0.25	0.25	25	25	25
Phase 1A-3a: Storage Terminal Modification (Demolition)	15	3	3	25	25	30
Phase 1A-3b: Storage Terminal Modification (Grading)	15	3	0	25	25	30
Phase 1A-3c: Storage Terminal Modification (Trenching)	15	3	3	25	25	30
Phase 1A-3d: Storage Terminal Modification (Building Construction)	15	3	0	25	25	30
Phase 1A-3e: Storage Terminal Modification (Architectural Coating)	15	3	0	25	25	30
Phase 1B-1: Pipeline Construction: (Grading)	6	2	2	25	25	30
Phase 1B-2: Pipeline Construction: (Trenching)	8	0	0	25	25	30
Phase 1B-3: Pipeline Construction: (Paving)	8	0	0	25	25	30
Phase 2A-1: Marine Work (Demolition)	10	2	1	25	25	30
Phase 2A-2 Marine Work (Building Construction)	10	2	0	25	25	30
Phase 2A-3: Marine Work (Dredging)	10	2	0	25	25	30
Phase 2A-4: Marine Work (Other Building Construction)	10	2	0	25	25	30
Phase 2B-1: Storage Terminal Retrofit (Building Construction)	15	3	5	25	25	30
Phase 2B-2: Storage Terminal Retrofit (Architectural Coatings)	15	3	0	25	25	30
Phase 2C-1: Storage Terminal Construction (Grading)	15	0	0	25	25	30
Phase 2C-2: Storage Terminal Construction (Trenching)	15	0	3	25	25	30
Phase 2C-3: Storage Terminal Construction (Building Construction)	15	3	0	25	25	30
Phase 2C-4: Storage Terminal Construction (Paving)	15	0	0	25	25	30

[1] Because the construction duration for Phase 2B had been reduced accordingly for Alternative 1, the number of daily vehicle trips during construction was assumed to be the same as the proposed project.

A - 1.1.3 Fugitive Dust Emissions

Fugitive dust emissions in the form of PM_{10} and $PM_{2.5}$ would be generated by various source activities occurring at the project construction site. The evaluation of fugitive emissions during construction incorporated emissions sources such as dust from material movement, demolition activities, and vehicle traffic resulting from construction. Material movement during construction is mostly associated with the grading phases, which consists of three major activities: grading equipment passes, earth bulldozing, and truck loading. Within CalEEMod, the three primary operations that would generate dust emissions during the demolition phases are mechanical or explosive dismemberment, site removal of debris, and on-site truck traffic on paved and unpaved roads. Fugitive emissions from material movement and demolition activities were quantified in CalEEMod based on model defaults assumptions along with additional project specific engineering estimates, which are summarized in Table 6 through Table 8. Fugitive dust emissions associated with vehicle traffic such as worker and vendor commute trips and hauling trips were calculated in the model based on emission factors from EMFAC2007 along with the estimated number of trips and vehicle miles traveled, which is summarized in Table 5 above.

Table 6 – Material Movement Estimates for the Proposed Project

Phase Name	Material Import (yrd^3)	Material Export (yrd^3)	Mean Vehicle Speed (mph)	Total Acres Disturbed
Phase 1A-1b: Transloading Platform & Facility Construction (Grading)		9000	15	4
Phase 1A-2d: Transloading Platform & Facility Construction (Grading)	16000		15	7.5
Phase 1A-3b: Storage Terminal Modification (Grading)	0	0	7.1	1
Phase 1B-1: Pipeline Construction: (Grading)	0	0	7.1	0.5
Phase 2C-1: Storage Terminal Construction (Grading)	0	0	7.1	1.5

Table 7 – Material Movement Estimates for Alternative 1

Phase Name	Material Import (yrd3)	Material Export (yrd3)	Mean Vehicle Speed (mph)	Total Acres Disturbed[1]
'Phase 1A-1b: Transloading Platform & Facility Construction (Grading)		9000	15	4
Phase 1A-2d: Transloading Platform & Facility Construction (Grading)	16000		15	7.5
Phase 1A-3b: Storage Terminal Modification (Grading)	0	0	7.1	1
Phase 1B-1: Pipeline Construction: (Grading)	0	0	7.1	0.5
Phase 2C-1: Storage Terminal	0	0	7.1	1.1

Construction (Grading)					

[1] Total acre disturbed for Phase 2C-1 was assumed to be reduced from that of the proposed project by approximately 28 percent.

Table 8 – Project Demolition Estimates for the Proposed Project and Alternative 1

Phase Name	Unit Amount	Size Metric
Phase 1A-1a: Transloading Platform & Facility Construction (Demolition)	25	tons of debris
Phase 1A-2a: Rail/Bridge Construction (Demolition)	25	tons of debris
Phase 1A-3a: Storage Terminal Modification (Demolition)	2,900	tons of debris
Phase 2A-1: Marine Work (Demolition)	825	tons of debris

A - 1.1.4 POC Emissions from Architectural Coating and Asphalt Paving

POC off-gassing emissions would be generated by architectural coating and asphalt paving activities. POC off-gassing emissions associated with architectural coating activities are the result of evaporation of solvents contained in surface coatings. The evaluation of POC emissions generated during architectural coatings for the proposed project and Alternative 1 incorporated emissions from interior and exterior surface area coating of the storage tanks and other project structures. POC emissions from the architectural coatings were calculated by multiplying the coating area with the emission factors associated with the surface coating. The POC emissions factors were determined by the POC content in the paint in grams per liter and the default paint usage per coating area. In CalEEMod,,the model default coating area is less than the estimated coating area proposed for the project. Because of a model limitation that does not allow end users to override the coating area, but does allow the user to adjust the POC content, the POC contents for interior and exterior architectural coating were proportionally scaled up from the model default values (250 gram per liter) to account for the larger project coating area estimates and to avoid underestimation of POC emissions in the model. Table 9 and Table 10 below list the estimated architectural coating area for the proposed project and Alternative 1 and the adjusted POC content that were used in the model for emission calculations.

Table 9 – Architectural Coating Estimates for the Proposed Project

Phase Name	Estimated Interior Area[1] (ft^2)	Adjusted POC Content[2] (g/L)	Estimated Exterior Area[1] (ft^2)	Adjusted POC Content[2](g/L)
Phase 1A-3e: Storage Terminal Modification (Architectural Coating)	133,400	2,576	299,100	17,328
Phase 2B-2: Storage Terminal Retrofit (Architectural Coatings)	464,800	8,976	46,800	2,711

[1] Model default areas for coating: 12,945 ft^2 for interior area, and 4,315 ft^2 for exterior area for both phases.

[2] POC emission factors were adjusted based on model default emission factor of 250 g/L.

Table 10 – Architectural Coating Estimates for the Alternative 1

Phase Name	Estimated Interior Area[1] (ft^2)	Adjusted POC Emission Factor[2] (g/L)	Estimated Exterior Area[1] (ft^2)	Adjusted POC Emission Factor[2] (g/L)
Phase 1A-3e: Storage Terminal Modification (Architectural Coating)	133,400	3,163	299,100	21,273
Phase 2B-2: Storage Terminal Retrofit (Architectural Coatings)[3]	335,160	7,946	34,200	2,432

[1] Model default areas for coating: 10,540 ft^2 for interior area, and 3,515 ft^2 for exterior area for both phases.

[2] POC emission factors were adjusted based on model default emission factor of 250 g/L.

[3] Storage tank coating area for Phase 2B-2 was estimated to be reduced by approximately 28% from that of the proposed project.

POC off-gassing emissions would also be generated from the asphalt paving of the project parking lots, and were calculated using the model default POC emissions rate and the project assumptions regarding the parking lot size. It is estimated that approximately 6,786 square feet of project land would be paved for parking spaces for the project.

A - 1.1.5 Annual and Daily Construction Emissions

As indicated in Chapter 2 of the EIR, the Rail Transload Facility and portions of the tank farm would be in operation while the rest of the marine terminal are being constructed during the period from October 2014 to October 2015. As recommended by BAAQMD (V. Lau, personal communication, March 13, 2013), the construction emissions associated with the proposed project and project alternatives were broken into two construction scenarios (Scenario 1 and Scenario 2) for separate air quality impact analysis and health risk assessment. Scenario 1 only considers emissions associated with construction activities that would occur before the rail operations begin in October 2014. Scenario 2 incorporates all emissions associated with construction activities that would occur after the rail operations begins, in addition to the operating emissions that would occur simultaneously with the remaining construction activities.

Emissions associated with the proposed construction activities were quantified in the CalEEMod model. The CalEEMod model calculates maximum daily and annual on-site and off-site emissions for each construction subphase. In addition, the model also calculates maximum daily emissions for each construction year by selecting the highest total maximum daily emissions of the overlapping construction subphases. Likewise, total annual emissions for each construction year were quantified in the model by summing the annual emissions from individual construction phases occurring during the same year.

For consistency with the air quality impact and health risk analysis associated with project construction emissions, total project construction emissions calculated in CalEEMod were broken down into the two scenario construction emissions using October 2014 as the cutoff timeline. Total construction emissions for each scenario were then divided by the total numbers of calendar days in each scenario construction period to estimate average daily construction emissions for comparison to the BAAQMD construction emission thresholds of significance.

A - 1.2 Operational Emissions

The operational emissions associated with the marine terminal proposed project include both on-site and off-site emission sources including marine vessels, assist tugboats, rail locomotives, storage tanks, terminal equipment (crude oil heaters and a thermal oxidizer), and fugitives.

The determination of health risks associated with the proposed project and Alternative 1 requires the calculation of 70-year average emission rates. Unlike project construction that is only expected to last for approximately 25 months for both the proposed project and Alternative 1, the extended period for operational emissions require wide ranging predictions for future operations of the proposed emission sources. The major factors that would affect future emissions from the proposed project are reductions in emission factors due to (a) the incidental phase-in of cleaner vehicles or equipment due to normal fleet turnover; (b) the future phase-in of cleaner fuels as required by existing regulations or agreements; and (c) the future phase-in of cleaner engines as required by existing regulations or agreements.

Activity level for each year of the 70-year analysis period is one of the parameters needed to calculate source category emission rates. The emission levels of the proposed project operations are significantly impacted by the activity levels related to vessel calls and tugboat operations. The projected monthly activity levels of vessel calls from 2015 to 2084 are presented in Table 11 for the proposed project and Alternative 1.

Table 11: Monthly Vessel Activity for Proposed Project and Alternative 1

Calendar Year	Tugboat Engine Year	Number of Years	Proposed Project - Number of Monthly Vessel Calls	Alternative 1 - Number of Monthly Vessel Calls
2015 to 2026	2007	12	18	15
2027 to 2085	2016	58	18	15

As the operations of the proposed project and Alternative 1 involve various scenarios of marine vessels and tugboats over the 70-year period, respective emissions factors were derived according to the proposed vessel and tugboat engine year and power ratings. For conservative analysis of vessel emissions, constant emission levels were assumed for marine vessels over the 70-year period, although NOx emission levels from vessel main engines is expected to be reduced over time when the International Maritime Organization (IMO) Tier III engine standard goes into effect in 2016 inside Emission Control Areas (ECA) for new vessels. Because of tugboats' relatively shorter lifetime as compared to that of marine vessels, fleet turnover derived emission reductions were assumed for tugboats such that all tugboats serving the facility would meet the EPA 2016 emission level by 2027. This will provide ample time for the tug fleet operators to build new tugboats to call on this berth. Future turnover of other emissions sources were assumed to be replaced by those meeting the same or cleaner emission standards due to technology improvements to the exhaust emission controls. The land vehicle trip generation rates, and consequently the vehicle emissions, were conservatively held constant in the emissions calculations for the entire 70-year period. The actual emissions are expected to gradually decline over time due to vehicle fleet turnover and decreasing per vehicle emissions.

To evaluate the air quality impacts of project operations, peak operational emissions were calculated for each stationary and mobile source associated with the proposed project and Alternative 1. Operational emissions for the various modeled averaging times were derived as described below.

Marine vessels including tugboats would be one of the two major mobile emission sources associated with the proposed project. The maximum daily emission rates of marine vessels were calculated based on worst-case activity estimates that could occur during a day. The worst-case scenario assumed for the proposed project and Alternative 1 is that one marine vessel at maximum would call at the berth. Maximum daily marine vessel emissions include emissions during the transiting, maneuvering, and hoteling modes. For annual emissions, estimates of emission rates of marine vessels were based on the maximum daily vessel emissions and the projected number of ship calls during each year. Maximum 1-hour and 8-hour emission rate calculations assumed that vessels at berth would generate the highest emission rate.

Rail locomotives would be another major mobile source associated with the proposed project. Similar to the emissions estimates of marine vessels, the maximum daily emissions from rail locomotive were calculated based on the worst-case activities that could occur during a day, which assumes that one 100-car unit train with three locomotives at maximum will call at the rail transload facility for crude oil offloading and will later depart from this facility during a 24-hour period. Maximum daily emissions from the rail include locomotive emissions upon arrival and departure from the rail transload facility and idling emissions. Annual emissions from rail locomotives will be calculated based on the maximum daily rail emissions and the projected number of train calls during each year. Maximum 1-hour and 8-hour emissions from locomotives will be based on the maximum daily usage during which the rail locomotives are operating at the highest duty cycle (highest throttle position) while at the rail facility.

The stationary sources such as heaters, a thermal oxidizer, and storage tanks were assumed to emit air contaminants at a constant rate. Thus, a constant 1-hour (heaters and storage tanks) and 8-hour emission rate (heaters and thermal oxidizer) were used for emission estimates of all stationary sources.

The maximum daily emission rates and the maximum annual emission rate are equal to the hourly emission rate times the daily or annual operating hours of each aforementioned stationary source.

A - 1.2.1 Vessel Emissions

The CARB document, Emissions Estimation Methodology for Ocean-Going Vessels (CARB, 2008) was used for the emission factors for the main and auxiliary engines on the vessels. The EPA document, AP-42 Chapter 1 – External Combustion, May 2010 were used for the emission factors for the offloading boilers on the vessels because these vessels utilize large utility-type boilers for steam power to offload the crude. These are not typical marine boilers found on other ocean going vessels.

Vessel emissions included emissions from main engines, auxiliary engines, and boilers during different legs of tanker route. Each vessel has only one boiler, two propulsion main engines, and two auxiliary generators, which would emit an equal quantity of emissions[1]. It is anticipated that a variety of Panamax vessels, Aframax vessels, and barges would service the facility during operation. Analysis indicates that the most conservative vessel emissions scenario is to include Panamaxes only for all vessel calls since much of vessel emissions are expected to come from vessel cruising, maneuvering, and tugboats. The offloading emissions on a per barrel basis are similar between the Panamax and Aframax. If an Aframax were to be used instead of a Panamax, the number of annual vessel calls and tugboats for the proposed project would be decreased by 1.4 times as well as the emissions decreased by approximately 30 percent. Furthermore, if barges were to be loaded at the berth, Panamax vessels would not be able to call at berth, which also significantly lowers vessel boiler emissions at berth since barges do not require any vessel steam power. Assumptions on vessel characteristics of Panamaxes are summarized in Table 12.

Table 12 – Tanker Parameter Assumptions

Given:	Value	Units
Panamax Cargo Size	32,5000	bbl/call (partially loaded with 35 ft draft)
Panamax Max Speed	15.8	Knots
Panamax MCR	10,300	kW
Aux Engine Max MCR	2,145	kW
Boiler Pumping Rate	33,340	bbl/hr
Panamax Boiler Fuel Consumption	78.5	lb/10^3 bbl offloaded
Boiler Inerting Savings (Hotelling)	28.06	lb/10^3 bbl offloaded
Fuel density	7.1	lb/gal
Note: All tanker assumptions were provided by project proponent and Capt. Jerry Aspland.		

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[1] In actuality, vessels usually will have three auxiliary generators but only two are operated at a time.

The vessel route was divided into 10 different legs with different speed, distance, engine loads, and boiler loads, as summarized in Table 13 below.

Table 13 - Tanker Route Assumptions

Tanker Route								
Tanker Route[1]	**distance[2] (nm)**	**Speed (knots)**	**Time (hrs)**	**Panamax**		**Tugboat[3,4]**		**Boiler Load[6] %**
				Main Engine Load[5] %	**Auxiliary Engine Load %**	**Main Engine Load %**	**Auxiliary Engine Load %**	
Leg 1 = Transit from Bar Pilot Station to tug pick up	24	14.5	1.7	77%	28%	N/A	N/A	N/A
Leg 2 = Transit	14	13.5	1.0	62%	28%	30%	31%	N/A
Leg 3 = Transit	10	10	1.0	25%	28%	30%	31%	N/A
Leg 4 = Maneuvering	6	6	1.0	5%	28%	50%	31%	30%
Leg 5 = Vessel Turn Around (once per call)	N/A	N/A	0.5	5%	28%	50%	31%	30%
Leg 6 = Mooring	N/A	N/A	1.0	N/A	28%	50%	31%	30%
Leg 7 = Arrival/Inspections	N/A	N/A	2.5	N/A	28%	N/A	N/A	30%
Leg 8 = Hotelling[6]	N/A	N/A	10.7	N/A	55%	N/A	N/A	N/A
Leg 9 = Departure Prep	N/A	N/A	1.0	N/A	28%	N/A	N/A	N/A
Leg10 = Unmooring	N/A	N/A	0.5	N/A	28%	60%	31%	N/A

Notes:

1. Outbound route same as inbound (Legs 1-4)
2. Assumptions on distance, speed, time, and auxiliary engine load factors are based on information provided by Capt. Jerry Aspland.
3. One Tug Required for Legs 2, 3, 4, 5, 6, 10, 4, 3, 2
4. Additional Tug Required for Legs 4, 5, 6
5. Main engine load factors are calculated directly from the propeller curve based upon the cube of actual speed divided by maximum speed (at 100% maximum continuous rating [MCR]).
6. Boiler load information was provided by a marine engineer (Karl Briers of Herbert Engineering Corporation).
7. One hour is added for hoteling for the engine to ramp up the speed and get to the full emission rate.

With reference to the emission calculation methods from the EPA document, Proposal to Designate an Emission Control Area for Nitrogen Oxides, Sulfur Oxides and Particulate Matter, Technical Support Document, Chapter 2 Emission Inventory, EPA-420-R-09-007 (EPA, 2009), vessel engine emissions were calculated by multiplying engine power (maximum continuous rating (MCR)), engine load factor, running time, emission factors (Table 14), and low load adjustment factor (Table 15).

Table 14 – Vessel Emission Factors

Vessel Emission Sources	**Emission Factors (g/kW-hr)**								
	CO	**NO_x**	**SO_2**	**HC**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**
Main Engine (current)	1.10	17.0	0.36	0.78	0.25	0.25	588	0.07	0.008
Auxiliary Engine	1.10	13.9	0.40	0.52	0.25	0.25	690	0.09	0.008

Notes:

1. Criteria pollutant and CO_2 and CH_4 emission factors source: http://www.arb.ca.gov/regact/2008/fuelogv08/appdfuel.pdf; Fuel type: marine distillate, 0.1%S.
2. N_2O emission factor source: CCAR general reporting protocols, v.3.1. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35; Page 53 for distillate fuel)

Vessel Emission Sources	**Emission Factors (lb/1000 gal)**								
	CO	**NO_x**	**SO_2**	**HC**	**PM_{10}[3]**	**$PM_{2.5}$[3]**	**CO_2**	**CH_4**	**N_2O**
Boilers	5	20	14.2	0.2	2.3	1.55	22,388	3.307	0.22

Notes:

1. Criteria pollutant emission factors were obtained from EPA AP-42 fuel oil combustions (industrial boilers and distillate oil fired for CO, NO_x, SO_2, HC, PM_{10}, and $PM_{2.5}$); http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf
2. Greenhouse gas emission factor source: CCAR general reporting protocols, v.3.1. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. (Page 35 and Page 53 for distillate fuel)
3. PM_{10} and $PM_{2.5}$ EFs for boiler emissions were obtained by each summing the corresponding condensable PM_{10} EF and $PM_{2.5}$ EF from AP42 Table 1.3-2 and the corresponding filterable PM_{10} EF and $PM_{2.5}$ EF from AP42 Table 1.3-6.

Table 15 - Low Load Adjustment Factors for Main Engines

EPA (2009) Low-Load Emission Adjustment Factors (Table 2.7)								
Load	**NO_x**	**HC**	**CO**	**PM**	**SO_2**	**CO_2**	**CH_4**	**N_2O**
1%	11.47	59.28	19.32	19.17	5.99	5.82	19.32	11.47
2%	4.63	21.18	9.68	7.29	3.36	3.28	9.68	4.63
3%	2.92	11.68	6.46	4.33	2.49	2.44	6.46	2.92
4%	2.21	7.71	4.86	3.09	2.05	2.01	4.86	2.21
5%	1.83	5.61	3.89	2.44	1.79	1.76	3.89	1.83
6%	1.60	4.35	3.25	2.04	1.61	1.59	3.25	1.60
7%	1.45	3.52	2.79	1.79	1.49	1.47	2.79	1.45
8%	1.35	2.95	2.45	1.61	1.39	1.38	2.45	1.35
9%	1.27	2.52	2.18	1.48	1.32	1.31	2.18	1.27
10%	1.22	2.20	1.96	1.38	1.26	1.25	1.96	1.22
11%	1.17	1.96	1.79	1.30	1.21	1.21	1.79	1.17
12%	1.14	1.76	1.64	1.24	1.18	1.17	1.64	1.14

EPA (2009) Low-Load Emission Adjustment Factors (Table 2.7)								
13%	1.11	1.60	1.52	1.19	1.14	1.14	1.52	1.11
14%	1.08	1.47	1.41	1.15	1.11	1.11	1.41	1.08
15%	1.06	1.36	1.32	1.11	1.09	1.08	1.32	1.06
16%	1.05	1.26	1.24	1.08	1.07	1.06	1.24	1.05
17%	1.03	1.18	1.17	1.06	1.05	1.04	1.17	1.03
18%	1.02	1.11	1.11	1.04	1.03	1.03	1.11	1.02
19%	1.01	1.05	1.05	1.02	1.01	1.01	1.05	1.01
20%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Low Load Adjustment Factor Calculations:

CO $y = 0.2026x^{-0.988}$

NO_x (4%-20%) $y = 8598.3x^4 - 4903.3x^3 + 1038.7x^2 - 99.238x + 4.7837$

SOx (4%-20%) $y = -519.87x^3 + 239.55x^2 - 38.161x + 3.1848$

HC $y = 0.1026x^{-1.354}$

PM (4%-20%) $y = 14359x^4 - 8221.7x^3 + 1750.2x^2 - 168.23x + 7.4638$

CO_2 (4%-20%) $y = -480.74x^3 + 223.25x^2 - 35.93x + 3.0789$

Notes:

1. Reference: EPA Proposal to Desigate an Emission Control Area for Nitrogen Oxides, Sulfur Oxides and Particulate Matters, 2009, Table 2.7, http://www.epa.gov/otaq/regs/nonroad/marine/ci/420r09007-chap2.pdf
2. x is the load factor, and y is the calculated low load adjustment factor.

Vessel boiler emissions were only calculated for leg 4 through leg 8, during which the boilers would be operating. Vessel boiler emissions during leg 4 through 7 were calculated by multiplying boiler fuel consumption, boiler load factor, pumping rate, and boiler emission factor. As mentioned in Chapter 2 of the DEIR, some boiler flue gas would be sent to the vessel cargo tank via an insert gas system during cargo unloading and would be contained in the vessel cargo tank until the vessel is loaded at the next port. Therefore, the emissions of boiler exhaust gases during hoteling would be reduced because of the inert gas saving practices. Vessel boiler emissions during leg 8 (hoteling) were calculated by multiplying the boiler emission factors, cargo size, and fuel density with the difference between boiler fuel consumption and inerting saving. A list of air pollutants and emission factors used for vessel boiler speciated emission calculations is included in Table 16.

Table 16 - Boiler Pollutant Emission Factors:

Pollutant	Emission Factor (lb/1000gal)
Benzene	2.14E-04
Ethylbenzene	6.36E-05
Formaldehyde	3.30E-02
Naphthalene	1.13E-03
1,1,1-Trichloroethane	2.36E-04
Toluene	6.20E-03

Pollutant	Emission Factor (lb/1000gal)
o-Xylene	1.09E-04
Acenaphthene	2.11E-05
Acenaphthylene	2.53E-07
Anthracene	1.22E-06
Benz(a)anthracene	4.01E-06
Benzo(b,k)fluoranthene	1.48E-06
Benzo(g,h,i)perylene	2.26E-06
Chrysene	2.38E-06
Dibenzo(a,h) anthracene	1.67E-06
Fluoranthene	4.84E-06
Fluorene	4.47E-06
Indo(1,2,3-cd)pyrene	2.14E-06
Phenanthrene	1.05E-05
Pyrene	4.25E-06
OCDD	3.10E-09
Antimony	5.25E-03
Arsenic	1.32E-03
Barium	2.57E-03
Beryllium	2.78E-05
Cadmium	3.98E-04
Chloride	3.47E-01
Chromium	8.45E-04
Chromium VI	2.48E-04
Cobalt	6.02E-03
Copper	1.76E-03
Fluoride	3.73E-02
Lead	1.51E-03
Manganese	3.00E-03
Mercury	1.13E-04
Molybdenum	7.87E-04
Nickel	8.45E-02
Phosphorous	9.46E-03
Selenium	6.83E-04
Vanadium	3.18E-02
Zinc	2.91E-02
Source: EPA AP42, 1.3 - Fuel Oil Combustion: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf.	

A - 1.2.2 Assist Tugboats

The California Air Resources Board (CARB) document, *Emissions Estimation Methodology for Commercial Harbor Craft Operating in California, Appendix B, 2007* was used for the main and auxiliary engine emission factors on the tugboats. Tugboat emissions are calculated for leg 2, 3, 4, 5, 6, and 10. Parameters used for calculations are summarized in Table 17. One escort tugboat was assumed from the Point Bonita Light/Mile Rock Light to berth and vice versa. During the docking operation, two tugboats were assumed; while during the undocking operation, only one tugboat was required. The tugboat route was divided into 10 different legs with different speed, distance, engine loads, as summarized in Table 13 above. Tugboat emissions during each leg are calculated by multiplying tugboat main/auxiliary engine power, load factor, and emissions factors (see Table 17 and Table 18). Annual emissions from tugboats were estimated based on the daily tugboat emissions and the number of annual vessel calls.

Table 17 – Tugboat Assumptions

Given:	Value	**Units**
Tugboat Main Engine Max MCR	5000	Hp
Tugboat Aux Engine Max MCR	520	Hp
Tugboat Fuel Consumption	184	g/hp-hr

Note: Tugboats assumptions are based on information provided by Captain Jerry Aspland.

Table 18 - Tugboat Emission Factors

Tugboat Operations	**Emission Factors**[1,2]								
	(g/hp-hr)		**(ppm)**	**(g/hp-hr)**					
	CO	**NO_x**	**SO_2**[3]	**HC**	**PM_{10}**	**$PM_{2.5}$**[4]	**CO_2**	**CH_4**	**N_2O**
Main Engine (2007)	3.73	5.53	15	0.68	0.2	0.2	580	0.09	0.006
Auxiliary Engine (2007)	3.73	5.10	15	0.81	0.15	0.15	580	0.09	0.006
Main Engine (2016)	3.73	1.30	15	0.18	0.03	0.03	580	0.09	0.006
Auxiliary Engine (2016)	3.73	3.99	15	0.81	0.08	0.08	580	0.09	0.006

Notes:

1. Source for criteria pollutant emission factors: Appendix B – Emissions Estimation Methodology for Commercial Harbor Craft Operating in California: www.arb.ca.gov/regact/2007/chc07/appb.pdf
2. Source for greenhouse gas emission factors: CCAR general reporting protocols, www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf
3. Emission factor for SO_2 is assumed to be 15 ppm based on current regulatory requirements for sulfur content in fuel.
4. Emission factors for PM_{10} and $PM_{2.5}$ are assumed to be the same.

A - 1.2.3 Rail Cars

A 100-unit rail car train with two head-end locomotives and one tail-end locomotive will be used to deliver crude oil to the project's rail transload facility using BNSF's existing main tracks. The train will arrive from the east on the BNSF main line onto the existing BNSF siding and then onto one of the facility's two dedicated landing tracks. The entire train of 100-unit tank cars will be then pushed by one of the two head-end locomotives to set on the unloading tracks for crude oil offloading from the bottom of each tank car through individual drain hoses. Meanwhile, the three locomotives (only one operating, the other two are in tow) will travel to the BNSF Richmond Facility for servicing (fueling, cleaning, etc) and return to the rail transload facility (two operating, the other one in tow). After the 100 tank cars are emptied and reassembled on the landing tracks, the three locomotives will reconnect the 100-unit empty tank cars for departure out of state (two locomotives will be operating and the other one in tow).

Emission estimates for rail locomotives will include emissions while the locomotives are within Contra Costa County and therefore, BAAQMD jurisdiction. The rail locomotives would stay on site for approximately 2.25 hours over the entire unloading event. The remaining time will be spent in transit to and from and servicing at the BNSF Richmond Facility. It is assumed that the locomotives would be moving during 30 percent of the time on-site, and would idle on-site for the rest of the time. Each locomotive is assumed to have only one ES44 Model engine. Railcar assumptions came from email communication (6/7/13 and 6/20/13) with Mike Stanfill of BNSF and are summarized in Tables 19 and 20 below.

Table 19 – Percent Time in Notch Locomotive Assumptions

Throttle Position	Percent Time in Notch Inbound to Pittsburg	Percent Time in Notch Outbound from Pittsburg
Idle	8.5%	4.4%
DB	11.0%	7.8%
1	8.3%	2.2%
2	6.1%	1.9%
3	8.3%	1.8%
4	10.4%	24.2%
5	3.5%	35.0%
6	3.2%	14.0%
7	5.0%	2.5%
8	35.7%	6.2%

Table 20 – Percent Time in Notch Locomotive Servicing Assumptions

Throttle Position	Percent Time in Notch Outbound to Richmond	Percent Time in Notch Inbound from Richmond
Idle	8.9%	25.3%
DB	33.0%	20.4%
1	10.6%	12.2%
2	11.0%	12.4%
3	5.2%	5.9%

4	13.8%	3.5%
5	12.0%	7.4%
6	0.2%	10.9%
7	0.2%	1.9%
8	5.1%	0.1%

Rail locomotive emissions would be calculated based on the engine throttle position, duty cycles (percent time in each notch) and the emission factors at each throttle position. The locomotives that would be serving the Rail Transload Facility were assumed to at least meet the EPA Tier 2 exhaust emission standards from 2014 to 2026, and would meet the EPA Tier 4 exhaust emission standards by 2027. Tier 2 emission factors utilized for locomotive emission estimates were obtained from the revised Port of Oakland 2005 Seaport Air Emissions Inventory (2008). Tier 4 emission factors were obtained by adjusting the Tier 2 emissions factors obtained from the Port of Oakland publication with the reduction ratio of EPA emission standards from Tier 2 to Tier 4. It was assumed that Tier 4 emission levels of the locomotives serving the Rail Transload Facility would be reduced from Tier 2 emission levels by approximately 76% for NOx, 0% for CO, 53% for POC, and 70% for PM (EPA, 2012). GHG emission factors were obtained from the Port of Long Beach 2011 Air Emission Inventory (2012), and the GHG emission levels of Tier 2 and Tier 4 locomotive engines were assumed to be the same. Tables 21 and 22 below list the Tier 2 and Tier 4 emissions factors, respectively, that will be used for locomotive emission estimates.

Table 21 – Tier 2 Locomotive Emission Factors

Throttle Position	**Emission Factors (g/hr)**					**Emission Factors[4] (g/hp-hr)**		
	NOx	**CO**	**POC**	**PM**	**SO2**	**CO_2**	**CH_4**	**N_2O**
Idle	329	30	24	7.7	0.44	494	0.040	0.013
DB	657	120	65	42.0	1.40	494	0.040	0.013
1	1,135	142	62	69.3	0.75	494	0.040	0.013
2	2,730	239	120	145.8	1.87	494	0.040	0.013
3	5,310	607	220	304.3	3.08	494	0.040	0.013
4	7,246	806	224	365.0	4.51	494	0.040	0.013
5	9,612	479	311	405.2	6.02	494	0.040	0.013
6	13,455	537	408	418.4	7.72	494	0.040	0.013
7	16,005	790	488	513.5	9.67	494	0.040	0.013
8	18,566	1,034	619	607.5	11.63	494	0.040	0.013

Table 22 – Tier 4 Locomotive Emission Factors

Throttle Position	**Emission Factors (g/hr)**					**Emission Factors[4] (g/hp-hr)**		
	NOx	**CO**	**POC**	**PM**	**SO2**	**CO_2**	**CH_4**	**N_2O**
Idle	79	30	11	2.3	0.44	494	0.040	0.013

DB	158	120	31	12.6	1.40	494	0.040	0.013
1	272	142	29	20.8	0.75	494	0.040	0.013
2	655	239	56	43.7	1.87	494	0.040	0.013
3	1,274	607	103	91.3	3.08	494	0.040	0.013
4	1,739	806	105	109.5	4.51	494	0.040	0.013
5	2,307	479	146	121.6	6.02	494	0.040	0.013
6	3,229	537	192	125.5	7.72	494	0.040	0.013
7	3,841	790	229	154.1	9.67	494	0.040	0.013
8	4,456	1,034	291	182.3	11.63	494	0.040	0.013

A - 1.2.4 Storage Tanks

EPA TANKS modeling software (version 4.0.9d) was used to calculate the annual POC and toxic emissions from the storage tanks. Tables 23 and 24 contain the basic inputs provided by the project design team for the emission model.

Table 23 – Storage Tank Assumptions

Given:		**Units**
Maximum Reid Vapor of Crude Oil	11	psia
Benzene Concentration	3	wt %
Toluene Concentration	1.54	wt %
Hexane Concentration	1.38	wt %
Xylene Concentration	1.43	wt %
East Tank Farm	6	Internal Floating Roof
Nominal Capacity	162,000	bbl
Working Capacity	146,000	bbl
Diameter	160	ft
Height	48	ft
Throughput	2,078,000	bbl/yr/tank
South Tank Farm	5	Internal Floating Roof
Nominal Capacity	500,000	bbl
Working Capacity	450,000	bbl
Diameter	273	ft
Height	48	ft
Throughput	6,414,000	bbl/yr/tank
South Tank Farm	4	Internal Floating Roof
Nominal Capacity	200,000	bbl
Working Capacity	180,000	bbl
Diameter	175	ft
Height	48	ft
Throughput (3 tanks)	8,517,000	bbl/yr/tank

Throughput (1 tank)	18,250,000	bbl/yr
South Tank Farm	1	External Floating Roof
Nominal Capacity	54,000	bbl
Working Capacity	48,600	bbl
Diameter	120	ft
Height	50	ft
Throughput	600,000	bbl/yr

Table 24 – Tank Fitting Count Assumptions

Deck Fittings/Instrumentation	162 kbbl IFR Tank	500 kbbl IFR Tank	200 kbbl IFR Tank	54 kbbl EFR Tank
Access Hatch (24-in. Diam.)/Bolted Cover, Gasketed	1	1	1	1
Automatic Gauge Float Well/Bolted Cover, Gasketed	1	1	1	1
Roof Leg or Hanger Well/Fixed	71	185	80	23
Slotted Guide-Pole/Sample Well/Gasketed. Sliding Cover, w. Float, Wiper	1	1	1	1
Vacuum Breaker (10-in. Diam.)/Weighted Mech. Actuation, Gasketed	1	5	1	2
Gauge-Hatch/Sample Well (8-in. Diam.)/Weighted Mech. Actuation, Gasketed	1	1	1	1
Column Well (24-in. Diam.)/Pipe Col.-Flex. Fabric Sleeve Seal	16	53	20	N/A

A - 1.2.5 Terminal Equipment

Terminal equipment for the operations of the proposed project and Alternative 1 would include crude oil heaters for the storage tanks and a thermal oxidizer. The heaters would operate on natural gas only, while the thermal oxidizer would burn any excess crude vapors with natural gas makeup gas to achieve proper destruction efficiency.

Thermal Oxidizer - Natural Gas Combustion

The emissions factors for natural gas combustion (except for NO_x and CO, which were based on BAAQMD requirements) were obtained from the EPA document, AP-42 Chapter 1 – External Combustion, May 2010. Table 25 summarizes the emissions factors used for emission estimates for natural gas combustion from terminal equipment. Emissions were calculated by multiplying the corresponding emission factors with natural gas usage, and the size of the unit.

Table 25 – Natural Gas Emission Factors

Natural Gas Combustion Emissions		
Criteria pollutants	**EF[1] (ppmv at 3% O2)**	**EF[2] (lb/MMBtu at 21% O_2)**
NO_x	15	1.82E-02
CO	400	2.96E-01
Criteria and Greenhouse Gas Pollutants	**EF[3] (lb/10^6 scf)**	**EF (lb/MMBtu)**
POC	5.5	5.39E-03
SO_2	0.6	5.88E-04
PM_{10}	7.6	7.45E-03
$PM_{2.5}$[4]	7.6	7.45E-03
CO_2	120000	1.18E+02
CH_4	2.3	2.25E-03
N_2O	2.2	2.16E-03
Speciated Organic Compounds	**EF[3] (lb/10^6 scf)**	**EF (lb/MMBtu)**
2-Methylnaphthalene	2.40E-05	2.35E-08
3-Methylchloranthrene	1.80E-06	1.76E-09
7,12-Dimethylbenz(a)anthracene	1.60E-05	1.57E-08
Acenaphthene	1.80E-06	1.76E-09
Acenaphthylene	1.80E-06	1.76E-09
Anthracene	2.40E-06	2.35E-09
Benz(a)anthracene	1.80E-06	1.76E-09
Benzene	2.10E-03	2.06E-06
Benzo(a)pyrene	1.20E-06	1.18E-09
Benzo(b)fluoranthene	1.80E-06	1.76E-09
Benzo(g,h,i)perylene	1.20E-06	1.18E-09
Benzo(k)fluoranthene	1.80E-06	1.76E-09
Butane	2.10E+00	2.06E-03
Chrysene	1.80E-06	1.76E-09
Dibenzo(a,h)anthracene	1.20E-06	1.18E-09
Dichlorobenzene	1.20E-03	1.18E-06
Ethane	3.10E+00	3.04E-03
Fluoranthene	3.00E-06	2.94E-09
Fluorene	2.80E-06	2.75E-09
Formaldehyde	7.50E-02	7.35E-05
Hexane	1.80E+00	1.76E-03
Indeno(1,2,3-cd)pyrene	1.80E-06	1.76E-09
Naphthalene	6.10E-04	5.98E-07
Pentane	2.60E+00	2.55E-03
Phenanathrene	1.70E-05	1.67E-08

Natural Gas Combustion Emissions		
Propane	1.60E+00	1.57E-03
Pyrene	5.00E-06	4.90E-09
Toluene	3.40E-03	3.33E-06
Metals	**EF^3 (lb/10^6 scf)**	**EF (lb/MMBtu)**
Arsenic	2.00E-04	1.96E-07
Barium	4.40E-03	4.31E-06
Beryllium	1.20E-05	1.20E-08
Cadmium	1.10E-03	1.08E-06
Chromium	1.40E-03	1.37E-06
Cobalt	8.40E-05	8.24E-08
Copper	8.50E-04	8.33E-07
Manganese	3.80E-04	3.73E-07
Mercury	2.60E-04	2.55E-07
Molybdenum	1.10E-03	1.08E-06
Nickel	2.10E-03	2.06E-06
Selenium	2.40E-05	2.35E-08
Vanadium	2.30E-03	2.25E-06
Zinc	2.90E-02	2.84E-05
Notes:		
1. EF source*:* BAAQMD Rule 9-7-307.3		
2. Converted using equation lb/MMBTU = ppmv$_{measured}$/10^6*[(21-0)/(21-%O2 $_{measured}$)] *(MW)* Fd /VM. ppmv: parts per million by volume		
3. EF Source: EPA AP 42 Chapter 1.4 – Natural Gas Combustion: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf *4.* It was assumed that the emission factor for PM_{10}=$PM_{2.5}$		

Thermal Oxidizer - Crude Vapor from Loading Events

The proposed project and alternative project would include operations of crude oil offloading from vessel and occasional crude oil loading onto vessels, which is subject to BAAQMD Regulation 8 Rule 44 “Organic Compounds: Marine Tank Vessel Operations”. The proposed project and Alternative 1 would include a thermal oxidizer, which would be connected to the vessel to combust crude vapors from loading events with makeup natural gas added. The criteria pollutant emissions factors for crude vapor combustion were based on the natural gas emission factors for PM_{10} and SO_2 and the BAAQMD requirements (BAAQMD Rule 9-7-307.3) for NO_x and CO. Although hydrogen sulfide (H_2S) is found in crude oil, an initial calculation indicates that the loading loss H_2S emissions are negligible and thus, were not included in the project emissions analysis.

Annual PM_{10} and SO_2 emissions were calculated by multiplying the corresponding emission factors listed in Table 26 with the annual crude vapor volume to be combusted in the thermal oxidizer, which was first calculated by dividing the mass of annual crude vapor loss by the calculated crude vapor density based on the loading loss equation 1 from AP-42 Chapter 5.2. Total NO_x and CO emissions from combustion of crude vapor and natural gas in the thermal oxidizer were calculated by multiplying the corresponding emission factors as listed in Table 26 with thermal oxidizer usage, and the size of the unit.

The emission factor of POC from loading loss (in unit of lb/10^3 bbls loaded) was calculated based on the loading loss equation 1 from AP-42 Chapter 5.2. The projected POC emissions from crude vapor loading events after control were then calculated based on the POC loading loss emission factor, the projected loading volume of crude oil, and the proposed control efficiency of the thermal oxidizer. For the toxic components in the crude oil, emissions after control were calculated based on the vapor mass fraction listed in Table 26 and the calculated loading loss POC emissions after treatment control.

Table 26 – Crude Vapor Emission Factors

Emissions from Crude Vapors		
POC from loading loss		
Component	**Vapor Mass Fraction[1]**	**Molecular Weight**
benzene	0.0177	78.11
hexane	0.0134	86.17
toluene	0.0026	92.13
xylene	0.0007	106.17
Criteria Pollutants (from combustion of crude vapor and natural gas in thermal oxidizer)		
Pollutants	**EF[2] (ppmv at 3% O2)**	**EF[3] (lb/MMBtu at 21% O2)**
NO_x (total)	15	1.92E-02
CO (total)	400	3.12E-01
Criteria Pollutants from Crude Vapor Combustion		
Pollutants	**EF[4] (lb/10^6 scf)**	
PM_{10}	7.6	
SO_2	0.6	

Notes:

1. Vapor mass fraction is obtained from crude oil MSDS, and the higher benzene concentration is based on ANS crude.
2. NOx and CO emission factors were based on BAAQMD Rule 9-7-307.3
3. Converted using equation $\text{lb/MMBTU} = \text{ppmv}_{\text{measured}}/10^6*[(21-0)/(21-\%O2_{\text{measured}})] * (MW)* Fd /VM$.
4. Assumed the same emission factors as natural gas; EF Source: EPA AP 42 Chapter 1.4 – Natural Gas Combustion: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf

Crude Oil Heaters

The proposed project would include three identical small and two identical large crude oil heaters. Alternative 1 would include only the two identical large crude oil heaters. All of these heaters would be operating on natural gas. Each heater was estimated to operate approximately 4,400 hours per year (50 percent usage). The heater parameters are presented in Table 27.

Table 27 – Heater Parameters and Assumptions

Parameter	Large	Small	units
No. of crude oil heater	2	3	
Size	12	3.4	MMBtu/hr
Usage	4400	4400	hr/yr
NO_x EF	15	15	ppmv at 3%O2
CO EF	400	400	ppmv at 3%O2
VM = molar volume	385	385	dscf/mole
NO2 molecular weight	46	46	lb/lbmol
CO molecular weight	28	28	lb/lbmol
Fd	8710	8710	dscf/MMBtu
stack diameter	2	1.17	ft
stack height	15.75	15.75	ft
stack velocity	35	35	ft/s
stack temp	430	430	F
Note:			
1. Fd – Dry volumes of combustion components per unit of heat content			

Thermal Oxidizer

The proposed project and Alternative 1 would include a thermal oxidizer, which would be connected to the vessel to combust crude vapors from loading events. Emissions from the thermal oxidizer would include combustion of natural gas and crude vapor from loading loss. Based on the engineering estimates provided by the project design team, the thermal oxidizer would operate at a firing rate of 67 MMBtu/hr with a destruction efficiency of 99.5%. As mentioned in Chapter 2 – Proposed Project and Alternatives of the DEIR, approximately 187 scfm of natural gas would be added to the crude vapor for consumption in the burner. The potential to emit from the thermal oxidizer is based upon 440 hours per year (based on 2 loading events per month for 18 hours each). The thermal oxidizer parameters are summarized in Table 28.

Table 28 – Thermal Oxidizer Assumptions

Parameter		Units
Size	67	MMBtu/hr
Usage	440	hr/yr

Parameter		**Units**
Fd[1]	9190	dscf/MMBtu
stack diameter	2.48	ft
stack height	23.17	ft
stack velocity	98	ft/s
stack temp	2100	F
natural gas supplement	187	scfm
thermal oxidizer destruction efficiency	99.5	%
no. of loading events	2	per month
size of loaded vessel	325000	bbl
Calculated Parameter		
Stack cross-section	4.75	ft^2
Flow Rate (ft3/hr)	1674557.24	ft^3/hr
Stack Temp	1422	K
Oxygen Correction	3.03E+00	
POC Loading Loss	1.76	lb/1000gal
POC Loading Loss after control	0.37	lb/1000bbl loaded
Note:		
1. Fd – Dry volumes of combustion components per unit of heat content		

A – 1.2.6 Fugitive Emissions

Fugitive emissions from miscellaneous sources (piping, flanges, connectors, etc.) from the marine terminal and Rail Transload Facility were calculated using component count estimates and standard (non-leaking) emission factors from USEPA Protocol for Equipment Leak Emission Estimates. The component count estimates and the emissions factors used for fugitive emission calculations are presented in Table 29 and Table 30. The TAC emissions were based on the POC emissions calculated and crude oil vapor concentrations, which are summarized in Table 31.

Table 29 – Fugitive Emission Sources – Marine Terminal

Component	**No. of Components**	**Component Type**	**Service Type**	**Emission Factor[1] (kg/hr/source)**
Flanged Valves (10" and above)	195	Valves	Light liquid	1.50E-05
Process pumps	20	Pump seals	Light liquid	2.40E-04
Meters & Other	3	Others (compressors and others)	Light liquid	2.40E-05
Fittings (flanges)	478	Fittings (connectors and flanges)	Light liquid	7.20E-06

Source: http://www.epa.gov/ttnchie1/efdocs/equiplks.pdf

Table 30 – Fugitive Emission Sources – Rail Transload Facility

No. of Components	Component Type	Service Type	Emission Factor[1] (kg/hr/source)
104	Valves	Light liquid	1.50E-05
1	Pump seals	Light liquid	2.40E-04
0	Others (compressors and others)	Light liquid	2.40E-05
664	Fittings (connectors and flanges)	Light liquid	7.20E-06
			TOTAL POC EMISSIONS
Notes: 1. Emission factor source: http://www.epa.gov/ttnchie1/efdocs/equiplks.pdf, Table 2-7, <10,000 ppmv THC (no leaking) 2. Emissions = NO. of Component * Emission Factor * Time			

Table 31– Estimated Percent by Weight of TAC Fugitive Emissions in Crude Oil Vapor

TAC in Crude Oil	Percent by Weight (%)
Benzene	3.00%
Toluene	1.54%
Hexane	1.38%
Xylene	1.43%

A – 1.2.7 Vehicle Emissions

Project operation would generate very little vehicular traffic from personally owned vehicle (POV) commuter trips, company-owned vehicles, and vendor/delivery vehicles. All crude oil would leave the project facility via pipelines with no over land trucking required such that minimal truck traffic is expected to result from project operations. As indicated in Chapter 2 of the DEIR, a fleet mix that primarily consists of POV and light-medium duty truck, was assumed in assessing the vehicle emissions from the proposed project. Based on the engineering estimates provided by the project design team, there would be approximately fifteen offsite worker commute trips per day with an average travel distance of 30 miles per trip when the proposed project becomes fully operational. In addition, it was estimated that fifteen on-site worker trips per day with an average distance traveled of 10 miles per trip would also occur. Worker trip frequency and length associated with Alternative 1 were estimated to be the same as those of the proposed project. CalEEMod 2011.1 was used to estimate air emissions from vehicles using the BAAQMD default assumptions on average travel speeds.

A - 2 Air Dispersion Model

Based on the results of emission estimates for both construction and operational emissions from the proposed project and Alternative 1, air dispersion modeling was performed to predict off-site ground-level concentrations of $PM_{2.5}$, diesel particulate matter (DPM), toxic air contaminants (TACs) from the proposed project and Alternative 1 construction, and $PM_{2.5}$, DPM, TACs, and CO from the proposed project and Alternative 1 operations.

AERMOD model (version 12345) was used to model the dispersion and impact of air pollutants generated from the proposed project. The selection of the AERMOD model was based on (1) the general acceptance by the modeling community and regulatory agencies of its ability to provide reasonable results for large industrial complexes with multiple emission sources, (2) a consideration of the availability of an annual set of hourly meteorological data for use by AERMOD, and (3) the model's ability to handle the various physical characteristics of project emission sources, including "point," "area," and "volume" source types. AERMOD is an USEPA-approved refined dispersion model and recommended by the BAAQMD.

The AERMOD air dispersion model is a mathematical estimation of pollutant impacts from emissions sources within a project radius. The 'default' model settings were used which includes the following options: stack-tip downwash, buoyancy-induced dispersion, final plume rise, a routine for processing averages when calm winds occur, and default values for wind profile exponents and for the vertical potential temperature gradients. A land use designation of 'rural', as defined by the BAAQMD, was used based upon surrounding population density indicated by aerial photographs of the area surrounding the site. Ground-level receptor locations that may be affected by the emissions (including both a regular grid of receptors and any sensitive receptor locations such as schools, hospitals, convalescent homes, and/or daycare centers) were first identified in the dispersion modeling. Dispersion modeling requires a coordinate system to be defined in order to assess the relative distances from sources to receptors and, where necessary, to consider other geographical features. The location of all emission sources and the grid receptors in the analysis were positioned by using the UTM coordinate system referenced to topographic data obtained from the Google Earth mapping application. The UTM system uses meters as its basic unit of measurement and allows for a more precise definition of specific locations than latitude/longitude. The receptor grid identifies a series of receptor locations at which the model will estimate air concentrations. The grid does not necessarily correspond to actual home locations, but is a means of developing isopleths to illustrate the dispersion pattern of the source emissions and the anticipated downwind concentration in the community or off-site areas. Based on an initial dispersion model conducted with an evenly spaced receptor grid, it is indicated that the dispersion of air pollutants associated with the proposed project is more centralized near and around the project site. Therefore, finer receptor grids near the project site were utilized for more representative modeling results. The following receptor grids were utilized in the AERMOD modeling analyses:

- A fine grid of 25-meter spacing extending 300 meters (1000 feet) beyond the project fenceline.
- A medium grid of 100-meter spacing extending between 300 and 1000 meters beyond the project fenceline.
- A coarse grid of 250-meter spacing extending between 1000 and 2500 meters beyond the project fenceline.
- Boundary receptors placed every 25 meters along the property boundary of the project site.
- Several points were chosen to represent the local sensitive receptors. These include the former Marina Park (597121.61E, 4210285.33N), Riverview Park (597463.76E, 4210954.89N), the new park on the corner of Herb White Way and 8th Street (597247.73E, 4209912.67N), and St. Peter Martyr school (597277.19E, 4210165.75N) which are all within 1000 feet.

Meteorological conditions directly impact the fate and transport of pollutants in the atmosphere. The AERMOD model used the AERMOD-ready hourly surface meteorological data obtained from the BAAQMD for dispersion calculations. The meteorological data consists of parameters such as wind direction, wind speed, temperature, cloud cover, and upper-air meteorological temperature data. The meteorological data was collected at the Pittsburg Power Plant (PPP) site formerly owned by the Pacific Gas and Electric Company, which is now owned and operated by GenOn Corporation. Because both the proposed project and the meteorological station are located on the southern bank of Suisun Bay within the boundary of the former PPP site, the selected meteorological data was assumed to be representative of conditions affecting the transport and dispersion of pollutants from the proposed project site. The Pittsburg AERMOD surface and profile meteorological data files for years 2002, 2003, 2004, and 2005 were obtained from the BAAQMD. The provided four years of meteorological data were used in the model.

The AERMOD modeling analysis simulated the proposed emission sources, taking into consideration physical characteristics, activity levels, and operational locations of the sources. The following section discusses the major model inputs used in the dispersion modeling analysis for the construction and the operations of the proposed project and Alternative 1.

A – 2.1 Construction Dispersion Model Input

The construction emission sources in AERMOD were determined based on the size of the construction areas. As recommended in the BAAQMD document Screening Tables for Air Toxics Evaluation during Construction, 2010, the on-site construction activities were simulated as area sources, and their emissions were distributed throughout these construction areas. Construction sites are assumed to be 134.8 acres for the proposed project and approximately 109.8 acres Alternative 1. Several polygon area sources were used to represent each construction activity and locations. Emissions associated with construction equipment were assumed to have an initial dispersion of 3 meters to represent the height of the engine exhaust. Most construction sources were modeled with emissions occurring 10 hours per day, 5 days per week except for the dredging activity (Phase 2A) which were 24 hours per day, 6 days per week. For risk modeling, the average annual on-site emissions and maximum hourly on-site emissions were used. The maximum hourly onsite emissions were calculated by dividing the maximum daily onsite emissions by the daily construction hours.

A – 2.2 Operational Dispersion Model Input

Project-related operational emission sources including marine vessels (tankers) and assist tugboats, storage tanks, crude oil heaters, and a thermal oxidizer were evaluated in the AERMOD modeling analysis. These emission sources were modeled as different types of sources according to the sources' operational characteristics. The following sections discuss the major model inputs that were used in the operational dispersion modeling analysis for the proposed project and Alternative 1. All operational sources were modeled with emissions occurring 24 hours per day.

A – 2.2.1 Marine Terminal/Vessel

Emissions from the movement of vessels in the shipping lanes were simulated and modeled as a series of separated volume sources. Volume sources are three-dimensional sources of diffused air pollutant emissions; emissions from such emission sources are simulated by AERMOD as being released and mixed vertically and horizontally within a volume of air prior to being dispersed downwind. Stationary emissions from vessel hoteling and offloading were modeled as point sources with upward plume velocity and buoyancy.

Vessel Emissions Near-Berth

Vessels will travel parallel to the shoreline in Suisan Bay to the project berth in Pittsburg. The vessel was modeled as a series of elevated-release volume sources approximately every 100 meters extending out to 1600 meters (1 mile) from the berth. Since the vessel will parallel the shore, the length of a vessel was used as the lateral dimension. The release height was assumed to be two times the stack height.

Turning in the vicinity of berth is only required once per vessel call when leaving the berth to exit the harbor. Vessels docking at berth are positioned head-in, with the starboard side against the breasting dolphins. While the vessel is turning, it is considered as one volume source located in the area immediately north of the berth. It was assumed that a typical vessel was 700 feet long and 100 feet wide. The modeling point location map that indicates the exact location of the volume sources (including vessels and tugboats) with respect to the berth is presented in Appendix D.

It was assumed that the vessel transiting and vessel turning volume sources have identical source characteristics as indicated in the following table except for the coordinates. The initial lateral dimension, or sigma Y, is based on the vessel length in meters divided by 2.15 and the initial vertical dimension, or sigma Z, is based on the vessel stack height in meters divided by 2.15. Vessel source parameters are summarized in Table 32.

Table 32 - Vessel Source Parameters

Source	Release Height (m)	Sigma Y (=length/2.154.3)	Sigma Z (=stack height/2.15)
Vessel transiting	68.3	99	15.9
Vessel turning	68.3	99	15.9

Vessel Mooring/Hotelling/Offloading

It takes approximately one hour to moor/tie the vessel to the dock and make it secure. Since the vessels are relatively stationary while this is occurring, the emissions during this period were modeled as a point source. Similarly, vessels are stationary while hoteling and offloading and therefore, these emissions were modeled as point sources with upward plume velocity and buoyancy. During the vessel mooring/hotelling/offloading activities, auxiliary engines and boiler on the vessels are the only emission sources since the vessel's main engine is shut off while at berth.

Specific stack parameters (stack height, stack diameter, exhaust gas temperature, and exit velocity) for tanker hoteling/offloading emissions were obtained from Herbert Engineering Corporation, and are listed in Table 33. These parameters are reflective of the sizes of vessels that would be used in the proposed project and are shown below.

Table 33 - Boilers and Auxiliary Engines Source Parameters

Source Description	Stack Height (ft)	Exhaust Temperature (F)	Stack Exit Velocity (ft/sec)	Stack Diameter (ft)
Boiler	112	800	100	3.0
Auxiliary Generator 1	112	700	113	0.83
Auxiliary Generator 2	112	700	113	0.83

A – 2.2.2 Tugboats

Tugboats will be needed to assist a vessel to and from the dock, approximately 30 nautical miles each way. It is expected that two tugboats would be required during the vessel docking operations, and only one tugboat would be required during the vessel undocking operations. Tugboat emissions (from main propulsion engines and auxiliary engines) during vessel maneuvering, vessel turning, and vessel mooring were calculated and represented in the dispersion modeling as a series of volume sources located on either side of the vessel volume sources. The tugboat volume sources were positioned in the model approximately every 100 meters out to 1600 meters (approx. 1 mile) from the berth. The location of the tugboat was approximately 15 meters (50 feet) on either side of the vessel, near the middle of the vessel. The tugboat emissions would have the same plume as the vessel. It was assumed that a typical tugboat was 120 feet long and 30 feet wide. The following table lists additional parameters used in the air dispersion modeling for tugboat.

Table 34 - Tugboat Source Parameters

Source	Release Height (m)	Sigma Y (=length/2.15)	Sigma Z (=stack height/2.15)
tugboat	68.3	17	15.9

A – 2.2.3 Rail Cars

Railcars will travel from out of state to the facility. However, the maximum impact will occur when in close proximity to the other facility sources. A 100-unit train would be approximately 6,570 feet in length including rail tank cars, buffer cars, and locomotives. The three locomotives were modeled as a series of volume sources approximately every 25 meters to 1600 meters (1 mile) out from the rail facility along the BNSF main line and the rail facility's landing tracks. The release height was taken to be the top of the locomotive stack approximately 16 feet. It was assumed that the locomotive rail car engine is approximately 22 meters long and 10 feet wide (Diesel Shop, 2007).

It was assumed that these volume sources have identical source characteristics except for the coordinates. The following table lists additional parameters used in the dispersion modeling for railcars.

Table 35 - Railcar Source Parameters

Source	Release Height (m)	Sigma Y (length/2.15)	Sigma Z (stack height/2.15)
Railcar	4.9	10.2	2.3

A – 2.2.4 Storage Tanks

The storage tanks fugitive emissions were modeled as volume sources. Tank center-points were used as the tank location. The initial lateral dimension, or sigma Y, is based on the tank diameter in meters divided by 4.3 and the initial vertical dimension, or sigma Z, is based on the height in meters divided by 2.15. Below is a table showing the source modeling parameters.

Table 36 - Storage Tank Source Parameters

Tank Size (kbbl)	No. of Tanks	Height (m)	Diameter (m)	Sigma Y (diameter/4.3)	Sigma Z (height/2.15)
200 IFR	4	14.63	53.35	12.41	6.81
500 IFR	5	14.63	83.21	19.36	6.81
162 IFR	6	14.63	48.77	11.34	6.81
54 IFR	1	14.63	36.59	6.37	6.81

A – 2.2.5 Heaters

The natural gas-fired heaters would be installed at the storage terminal to heat the stored product. Buildings and other structures near a relatively short stack can have an effect on plume transport and dispersion, and on the resulting ground-level concentrations that are observed. Because the heaters would be located in close proximity to the tank farm tanks, adjustments for building downwash effects were included in the modeling. Building downwash was performed using EPA's Building Profile Input Program (BPIP) –PRIME model. The BPIP model calculates direction-specific structure widths and heights for use with the AERMOD model in downwash analyses for heaters. The heaters were modeled as point sources with the source modeling parameters listed in Table 37 below.

Table 37 - Heater Source Parameters

Parameters	Large Heater	Small Heater	Units
Stack Height	15.75	15.75	ft
Exhaust Temperature	430	430	F
Stack Exit Velocity	35	35	ft/sec
Stack Diameter	2	1.17	ft

A – 2.2.6 Thermal Oxidizer

A thermal oxidizer, also known as a vapor destruction unit (VDU), would be connected to the vessel tank to destroy crude vapors that would otherwise be released from the vessel tank during loading events. The amount of crude vapor that would be incinerated in the thermal oxidizer was based on the BAAQMD maximum allowable crude vapor loss ratio during loading events as well as operational assumptions. The thermal oxidizer was modeled as point source with the following source modeling parameters listed in Table 38.

Table 38 - Thermal Oxidizer Source Parameters

Given	Value	Units
Stack Height	23.17	Ft
Exhaust Temperature	2100	F
Stack Exit Velocity	98	ft/sec
Stack Diameter	2.48	Ft

A – 2.2.7 Fugitive Components

The miscellaneous fugitive emissions were modeled as four area sources (series of polygons) over the rail facility, East Tank Farms, and the South Tank Farm, which was split into two areas to represent the containment structures/wall. The fugitive emissions were modeled to have an initial release height of 3 meters.

A - 3 Risk Calculation

To evaluate potential health effects attributed to the construction and operation of the proposed project and Alternative 1, the potential carcinogenic effects and non-carcinogenic effects associated with the air contaminants emitted from the proposed project and Alternative 1 were considered in the HRA. The HRA were performed using the CARB Hotspots Analysis and Reporting Program (HARP) model and the HARP on-ramp model.

Based on the project-generated emissions calculated for each emission scenario and the off-site ground-level concentrations of $PM_{2.5}$, DPM, and other TACs estimated at each grid receptor, the cancer and non-carcinogenic chronic and acute hazards were estimated in the risk analysis model to assess the potential health effects from the proposed project and Alternative 1. The results of the air dispersion modeling (off-site ground-level concentrations at each grid receptor location) represent an intermediate product in the HRA process. These results were first converted to a HARP readable format by the HARP on-ramp model and subsequently input into the HARP risk module to determine the cancer risk and non-cancer health effects.

The HRA was conducted in accordance with the OEHHA, Air Toxics Hot Spots Program Risk Assessment Guidelines, and the BAAQMD Recommended Methods for Screening and Modeling Local Risk and Hazards. The evaluated length of exposure time varied from one hour for acute hazard evaluation, one year for $PM_{2.5}$ exposure and chronic non-cancer hazard evaluation, and 70 years for cancer risk.

As the operation of the proposed project involves a ramp-up of annual vessel calls and tugboat engine years over the 70-year period, the maximum annual emission rates in each year were used to conservatively determine the respective off-site $PM_{2.5}$ concentrations and individual lifetime cancer risks associated with each year. The overall cancer risk associated with the proposed project and Alternative 1 is estimated by summing up the cancer risks for each year [accounting for the results of each year over the 70-year period and age sensitivity factors (ASFs) (discussed below)]. By comparison, the non-carcinogenic chronic and acute hazards associated with the project operations were determined based on the vessel calls and tugboat year that yields the highest raw risk. The following sections describe the methods used to develop the risk assessment step of the HRA. The methods and assumptions described here also apply to the HRA for Alternative 1 unless noted otherwise.

A - 3.1 TAC Emission Sources

TACs are compounds that are known or suspected to cause adverse health effects via both short term (acute) and/or long-term (chronic) exposures. Emissions from the diesel internal combustion engines on marine vessels, tugboats, and locomotives represent the majority of emissions from the proposed project operations. For these emission sources, DPM is the only pollutant needed for the cancer risk analysis because the unit risk factor established by Office of Environmental Health Hazard

Assessment (OEHHA) for the assessment of DPM cancer risk includes consideration of all of the individual toxic species that could be adsorbed onto the DPM particles. For other combustion source types (vessel boilers, heaters, and a thermal oxidizer), speciation of combustion emissions into individual TAC compounds were necessary for the health risk analysis modeling. Speciated emissions are the amounts of various organic compounds that make up toxic organic gases (TOG), and various metals and particulate compounds that make up PM. For the storage tanks and fugitives sources, the TAC (benzene, hexane, toluene, and xylenes) composition of the crude oil was used.

A - 3.2 Exposure Scenarios for Individual Health Risk

The frequency and duration of exposure to TACs are assumed to be directly proportional to the adverse health impacts. The BAAQMD has defined different thresholds depending on the health effects and time of exposure. Cancer risks associated with the proposed project were assessed for long term exposures of 70 years in the HRA process. For the calculation of cancer risk, the duration of exposure to project emissions were assumed to be 24 hours per day, 350 days per year, for 70 years, at all receptors. Acute non-carcinogenic health effects were assessed based on the maximum one-hour exposure. $PM_{2.5}$ concentrations and chronic non-carcinogenic health effects are based on annual average exposures.

Different HARP assessment methods were used to estimate the potential health impacts from the proposed project and Alternative 1. The maximum cancer risks for residential receptors were calculated using the HARP's 80th percentile point estimate analysis method, which incorporates an 80th percentile breathing rate of 302 liters per kilogram of body weight per day (L/kg BW-day) for the operational analysis. However, for the construction analysis, the maximum cancer risks for residential receptors were calculated using a child's breathing rate of 581 L/kg BW-day. The maximum chronic non-carcinogenic hazard associated with the proposed project and Alternative 1 was assessed in the HARP modeling using the HARP's built-in high point estimate method. The maximum acute non-carcinogenic hazard associated with the proposed project and Alternative 1 was assessed in the HARP modeling using the HARP's simple estimate method.

A - 3.3 Toxicity Factors

The HARP modeling assessed health effects by combining pollutant concentrations with pollutant-specific cancer potency values and chronic/acute Referenced Exposure Levels (RELs) obtained from OEHHA. In accordance with OEHHA's revised health risk assessment guidelines (specifically, OEHHA's Technical Support Document (TSD) for Cancer Potency Factors, May 2009), calculation of cancer risk estimates should incorporate age sensitivity factors (ASFs). The revised TSD for Cancer Potency Factors provides updated calculation procedures used to consider the increased susceptibility of infants and children to carcinogens, as compared to adults. The updated calculation procedure includes the use of age-specific weighting factors (including age specific breathing rates) in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. As per BAAQMD guidelines ASFs were applied to all carcinogens in estimating cancer risks related to the proposed project construction and operations. For estimating cancer risk associated with operational emissions for residential receptors, the incorporation of ASFs over 70 years results in an average cancer risk adjustment factor (CRAF) of 1.7, as shown in Table 39. The ASF per risk year is also provided below. Because the construction emissions were broken down into two scenarios for risk analysis as recommended by BAAQMD, different ASFs were used for risk estimates. Scenario 1 (from October 2013 to September 2014) project construction is only expected to last for 12 months, so only an ASF of 10 for the entire 12-month construction period were chosen for risk estimates for the proposed project and Alternative 1. Because the construction duration of Scenario 2 (from October 2014 to October 2015) is expected to last approximately 13 months for the proposed project and Alternative 1, an ASF of 10 was also assumed in estimating the health risks associated with Scenario 2 construction. During Scenario 2 construction, the Rail Transload Facility and oil storage tanks constructed during Scenario 1 are expected to become operational, while the rest of the marine terminal was being constructed during Scenario 2. Therefore, the 70-year cancer risks associated with the operation of the four new tanks were added to the Scenario 2 risk analysis, and an ASF of 1.7 was assumed for the entire 70-year analysis period..

Table 39 - Age Sensitivity Factor

Risk Year (Age)	Age Sensitivity Factor
1 to 2	10
3	4.75
4 to16	3
17	1.5
18 to 70	1
Average	**1.7**

A - 3.4 Chronic and Acute Non-Carcinogenic Factors

The potential for chronic non-cancer hazards were evaluated by comparing the long-term exposure level to a chronic REL. An REL is a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect sensitive individuals within the population. The chronic REL is an estimate of the continuous inhalation concentration to which the human population (including sensitive subgroups) can be exposed without appreciable risk of experiencing deleterious non-cancer effects.

The potential for acute non-cancer hazards is evaluated by comparing the maximum short-term exposure level to an acute REL. In accordance with OEHHA's risk assessment guidelines, acute non-cancer hazards should only be assessed for the inhalation exposure pathway. No exposure period adjustments are necessary for acute health impact calculations.

The various exposure parameters and settings used in this approach are equivalent to the HARP methodology and are consistent with BAAQMD's Recommended Methods for Screening and Modeling Risks and Hazards (Screening Methods).

A - 3.5 Cumulative Methodology

As recommended by the BAAQMD, besides the individual impact from the project-related emission sources, the cumulative impacts of the proposed project in combination with existing emission sources near the proposed project site were also evaluated. The cumulative impacts are the summation of the cancer risks, hazards, and $PM_{2.5}$ concentrations from the proposed project-related sources in combination with all TAC and $PM_{2.5}$ sources identified within 1,000 foot (ft) radius of the project.

The BAAQMD permitted sources near the proposed project site were identified through the Contra Costa County source location file, which was generated by the BAAQMD with the Google Earth Mapping Software. Three permitted sources (Delta Diablo Sanitation, PG&E, Stripping Workshop) and a major roadway was identified to be within the 1,000 ft radius of the proposed project, and information for these sources was obtained from the BAAQMD.

The cumulative modeling analysis was performed by summing the project-related $PM_{2.5}$, and risks and hazards values with the corresponding values from the identified nearby emission sources. The estimated cumulative $PM_{2.5}$ concentrations and the cancer risks and hazards at the maximally exposed receptor locations were then compared to the cumulative thresholds of significance developed by the BAAQMD under the CEQA guidelines. (version May, 2011).

Part B – Greenhouse Gas Emissions

The proposed project and Alternative 1 would generate GHG emissions from various sources. The primary GHG emissions generated by the project would be CO_2, which is mainly attributed to the exhaust emissions from marine vessels, and tugboats. Emissions of methane (CH_4) and nitrous oxide (N_2O) generated by the project would be relatively small in comparison to CO_2. However, due to the global warming potential (GWP) of CH_4 (21 with respect to CO_2) and N_2O (310 with respect to CO_2), these two GHG components would also contribute to the total global warming potential of the project-generated GHG emissions. Therefore, GHG emissions associated with the proposed project and Alternative 1 were estimated for CO_2, CH_4 and N_2O. Carbon dioxide equivalent (CO_2e), which is a unit of measurement that uses CO_2 as a standard unit for reference, was quantified to characterize the contributions of all GHG emissions from the proposed project and Alternative 1.

Project-generated GHG emission estimates were developed based on methodologies and emission factors recommended by the CCAR and other government agencies. Project-specific information was used to determine the total GHG emissions associated with the proposed project construction and operations. The following sections provide a description of the methodologies that were used to perform GHG emission estimates for various emissions sources associated with the proposed project and Alternative 1.

B – 1 Construction emissions

Construction activities for the proposed project and Alternative 1 would require the use of various types of heavy construction equipment that would generate GHG emissions. The project-related construction sources from which GHG emissions were generated include:

- Off-road diesel construction equipment at the proposed project site
- On-road trucks associated with project construction activities
- Harbor craft (tugs, dredging equipment) used for dredging activities
- Worker, vendor commute vehicles and hauling trucks

As recommended by BAAQMD (V. Lau, personal communication, March 20, 2013), the CalEEMod air quality model was used to quantify GHG emissions associated with proposed project construction following the same estimation methodology and assumptions specified in Section A – 1.1 Construction Emissions. Within CalEEMod, CO_2, CH_4, and N_2O emissions factor data for construction equipment and motor vehicles are derived from the OFFROAD2007 and Emission Factors 2007 (EMFAC2007) models. CO_2, CH_4, and N_2O emission factors were selected for calculations based on the equipment type, horsepower rating, and corresponding equipment tier standards. Maximum daily and annual CO_2, CH_4, N_2O, and CO_2e emissions from the proposed construction-related activities were quantified by the CalEEMod model for each construction year. Construction-generated GHG emissions were also calculated by CalEEMod for Alternative 1 with the assumption that construction duration and certain associated construction activities of the storage tank retrofit construction phases (2B-1 and 2B-2 in the model) would be proportionally reduced. Detailed project-specific assumptions utilized for emission estimates for the construction of the proposed project and Alternative 1 in CalEEMod are presented in Section A-1 above.

The CalEEMod model does not analyze emissions from construction-related electricity consumption, natural gas consumption, water use, or wastewater treatment. Construction-related emissions from the use of these utilities vary based on the amount of power and water used during construction and other unknown factors that render them too uncertain to quantify. In addition, they are typically small contributors to construction GHG emissions. As such, these sources of GHG were not included in the quantification.

B – 2 Operational Emissions

GHG emissions associated with project operation can be divided into two categories: direct and indirect emissions. Emissions from sources owned or operated by WesPac Energy–Pittsburg LLC (WesPac) as part of the WesPac Energy-Pittsburg Terminal (Terminal), or from sources owned or operated by others but directly involved in activities at the Terminal, would be considered direct emissions. GHG emission sources related to project operation for which direct emissions are anticipated include:

- Marine vessels (main engines, auxiliary engines, and boilers);
- Tug boats (main engines and auxiliary engines);
- Rail locomotives
- Vapor Destruction Units (Thermal Oxidizer); and
- Crude oil heaters

Indirect emissions occur as a consequence of the project operation activities, but occur at sources owned or controlled by other entities. Indirect GHG emissions associated with the proposed project include:

- Electricity and water consumption from project terminal operation.
- Waste generated from project terminal operation
- Employee motor vehicle commute trips

The direct and indirect GHG emissions attributed to the operations of the proposed project and Alternative 1 were quantified in the form of CO_2, CH_4, and N_2O. To compare the effect of different GHG components based upon their global warming potential, CO_2e was quantified for each project-related GHG emission source. CO_2e refers to the amount of CO_2 that would give the same warming effect as the effect of other GHG components, and it is derived by multiplying the amount of the GHG species by the associated GWP.

The operational GHG emission estimates were prepared based on a worst-case scenario. For example, the analysis assumes that all emissions from the project would be new, in the sense that, absent the development of the proposed project, these emissions would not occur. In practice, the regional demand for imported crude oil would be met by one of the many facilities in the Bay Area and the related GHG emissions will occur at these facilities. Additionally, these emissions are estimated assuming that there would be no reductions in GHG-generating activities over time. This would be unlikely, and presents a conservative analysis, given the expected reductions in GHG emissions from most activities that would take place over the years due to future regulations, development and advancement of technologies, and the likely increasing costs of energy.

The following sections provide a brief description of the methodologies and assumptions that were used to estimate the direct and indirect emissions attributed to the operation of the proposed project and Alternative 1.

B - 2.1 Direct Emissions

GHG emissions attributed to the various emission sources were calculated in the form of CO_2, CH_4 and N_2O, following the same assumptions and estimation methodology as described in ***Part A*** of this protocol. GHG emission factors for vessel engines (N_2O only), vessel boilers, and tugboats were obtained from California Climate Action Registry (CCAR) general reporting protocols. CO_2 and CH_4 emission factor associated with vessel engines were obtained from the CARB's Emissions Estimation Methodology for Ocean-Going Vessels (2008). GHG emissions factors for heaters and thermal oxidizer were obtained from the EPA document, AP-42 Chapter 1 – External Combustion, May 2010 (EPA, 2010). GHG emission factors that were used for the project GHG emission estimates are summarized in ***Part A*** of this protocol and listed in tables corresponding to each project-related emission sources.

B - 2.2 Indirect Emissions

As recommended by BAAQMD (V. Lau, personal communication, March 20, 2013), the CalEEMod air quality model was used to calculate indirect GHG emissions associated with the operation of the proposed project and alternatives. The CalEEMod model quantifies operational GHG emissions from land development projects based upon GHG sources, including electricity use, water use, waste disposal, transportation, and other area sources, if applicable. Model default assumptions along with project-specific land use data for the proposed project and Alternative 1 were used to calculate the indirect emissions from different sources of GHG emissions.

B – 2.2.1 Electricity Emissions

The consumption of fossil fuels to generate electricity and to provide heating and hot water generates CO_2, CH_4, and N_2O emissions. A major source of indirect emissions associated with the proposed project operation would occur indirectly through the use of purchased electricity. Therefore, the indirect GHG emissions from electricity consumption would depend on the amount of electricity use (energy intensity) and the mix of fuel that combusted to produce this electricity.

Energy use in buildings is divided into energy consumed by the built environment and energy consumed by uses that are independent of the construction of the building such as plug-in appliances. In California, Title 24 governs energy consumed by the built environment, mechanical systems, and some types of fixed lighting. The CalEEMod model was used to quantify the indirect GHG emissions from the electricity consumption for the proposed project operations based on the projected annual energy consumptions in terms of Title 24 electricity, non-Title 24 electricity, and the lighting energy, along with the model default emission calculation parameters for CO_2, CH_4, and N_2O. Table 40 below listed the estimated energy use that was used for emission estimates in the model. As indicated in Table 40, the annual energy consumptions for Alternative 1 were reduced from the proposed project by approximately 22 percent, which equals the reduction ratio of total tank working capacity in the marine terminal for Alternative 1.

Table 40 – Estimated Energy Consumption for the Proposed Project and Alternative 1

Project	Title -24 Electricity Energy Intensity (KWhr/yr)	Non-Title -24 Electricity Energy Intensity (KWhr/yr)	Lighting Energy Intensity (KWhr/yr)
Proposed Project	48,000	7,620,000	142,000
Alternative 1	44,040	6,454,000	127,260

B – 2.2.2 Water Use Emissions

Water use for the operation of the proposed project and Alternative 1 would cause indirect GHG emissions related to the electricity used to power systems that pump, treat, and distribute water and wastewater. In addition to the indirect GHG emissions associated with electricity use, CH_4 and N_2O emissions could be generated from the decomposition of organic matter during wastewater treatment. The CalEEMod model was used to quantify the indirect GHG emissions associated with project water use based on the amount of electricity required to supply, convey, treat, and distribute water for indoor and outdoor use. In addition, the indirect GHG emissions associated with the electricity needed to process the resulting wastewater from project indoor water uses were also quantified in the CalEEMod model. The indirect GHG emissions from project water use were calculated in CalEEMod using the annual indoor and outdoor water consumption rate along with the model default emission parameters corresponding to the project's regional location. The estimated annual water consumption rate provided by the project engineering design team for the proposed project and Alternative 1 are listed in Table 41 below. As indicated in Table 41. Indirect water usage associated with Alternative 1 was estimated to be the same as that of the proposed project.

Table 41 – Estimated Water Consumption for the Proposed Project and Alternative 1

Indoor Water Use (gals/year)	**Outdoor Water Use (gals/year)**
675,000	5,000

B – 2.2.3 Waste Disposal Emissions

Indirect GHG emissions would also result from solid waste generated from the proposed project operations. This is because municipal solid waste that is disposed of by land filling would generate GHG emissions in the form of CO_2 or CH_4 from the decomposition of the waste. CalEEMod was used to quantify the indirect GHG emissions associated with the solid waste generation for the operation of the proposed project and project alternatives. GHG emissions associated with the solid waste generation were estimated in CalEEMod using model default assumptions regarding CH_4 and CO_2 emission parameters along with the project-specific annual waste generation rate. As the magnitude and nature of waste generated during the operational phase of the proposed project is estimated to be minimal and of a household/commercial nature, it was assumed that approximately 24 tons per year of solid waste would be generated from project operation. Solid waste generation associated with Alternative 1 was estimated to be the same as that of the proposed project.

B – 2.2.4 Transportation Emissions

Vehicular traffic generated by the proposed project operation would result in GHG emissions associated with the vehicle exhaust. Both on-site and off-site worker trips associated with project operation were used to quantify the GHG emissions related to project-generated transportation. Following the same estimation methodology and assumptions described in Section A – 1.2.7 Vehicle Emissions above, CalEEMod was used to quantify the GHG emissions related to the vehicle traffic generated by the operation of the proposed project and Alternative 1.

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