APPENDIX B

REVISED AIR QUALITY

TABLE OF CONTENTS

Page

LIST OF TABLES

REVISED
APPENDIX B
AIR QUALITY AND GREENHOUSE GASES

This appendix describes the methodology and assumptions used to estimate emissions and health risks associated with the construction and operation of the No Action Alternative and the proposed project. Data sources are also provided. This technical appendix supports and supplements the analysis presented in the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Downtown San Francisco Ferry Terminal Expansion Project.

This analysis was first developed in 2012-2013 and published in the Draft EIS/EIR in May 2013. Based on comments received on the Draft EIS/EIR, portions of the health risk assessment were revised as described in detail in Appendix F, Response to Comments.

1.0 CONSTRUCTION EMISSIONS

The No Action Alternative does not include any construction activities. Thus, the construction equipment, activity assumptions, and emission discussions below are only related to the proposed project.

1.1 CONSTRUCTION EQUIPMENT

Details of the construction equipment associated with the North Basin and South Basin activities of the proposed project are provided in Tables AIR-1 and AIR-2. Construction phases for each basin and equipment types for each activity were based on the descriptions in Chapter 2.0 *Alternatives*. Equipment quantities for each phase were not detailed in Chapter 2.0 *Alternatives*. Thus, for the purposes of the air quality/greenhouse gas (GHG) analysis, equipment quantities were assigned as follows: two of a particular equipment type if Chapter 2.0 *Alternatives* used the plural form of that equipment type (e.g., cherry pickers), and one of an equipment type if the singular equipment name (e.g., cherry picker) was provided. Equipment horsepower and duty cycles were based on the Sacramento Metropolitan Air Quality Management District's Road Construction model's (Version 6.3.2, July 2009) default horsepower and duty-cycle values for various equipment types. Tables AIR-1 and AIR-2 include major equipment expected for each phase; in addition, a variety of tools such as table saws, welders, and drills would be used for most phases of construction.

The duration of each phase was generally based on the estimated construction schedule provided in Chapter 2.0 *Alternatives* (Figure 2-10). This analysis assumed that construction would begin in January 2014. However, if Chapter 2.0 *Alternatives* grouped a basin's construction activity descriptions (e.g., the South Basin's Embarcadero Plaza and East Bayside Promenade activities), then it was assumed that the construction period for these activities would extend from the beginning of the earliest activity to the end of the latest activity, with no additional time required for concurrent/overlapping activities shown on Figure 2-10. It was assumed that there would be approximately 30 construction workdays in each month, and that construction activities would occur for 8 hours each day.

Table AIR-1 Proposed Project's North Basin Major Construction Equipment List and Construction Activity Assumptions					
Activity	**Number of Pieces of Equipment**	**Engine Horsepower (HP)**	**Days** **(Assume 30 work-days/month)**	**Hours per Day**	**Duty Cycle**
Dredging (1 Month) (January 2014)					**2014**
Off-Road Equipment					
Dredging (1 month)					
Clamshell Dredge (assume crane)	1	399	30	8	43%
Boats (for dredging)					
Survey Boat (assume diesel-powered)	1	100	30	8	45%
On-Road Equipment					
Worker Vehicles	6	—	30	—	—
Gate A Pier (February–May 2014 for Structural Work); (June – November 2014 for Surface Improvements and Gate B Canopy)					**2014**
Off-Road Equipment					
Vibratory Hammer on a barge	1	75	300	8	62%
Concrete Pumpers	2	75	300	8	62%
Diesel Scissors Lifts	2	60	300	8	46%
Diesel Cherry Pickers	2	60	300	8	46%
Diesel Forklifts	2	145	300	8	30%
Diesel Generators	2	549	300	8	74%
Welders	2	45	300	8	45%
Boats					
Gasoline Utility Boats	2	100	300	8	45%
Diesel Tugboat	1	400	300	8	45%

Table AIR-1 Proposed Project's North Basin Major Construction Equipment List and Construction Activity Assumptions (Continued)					
Activity	**Number of Pieces of Equipment**	**Engine Horsepower (HP)**	**Days (Assume 30 work-days/month)**	**Hours per Day**	**Duty Cycle**
On-Road Equipment/Vehicles					
Worker Vehicles	25	—	300	—	—
Concrete Trucks (one-way truckloads; not trips)	62	—	14	—	—
Marginal Wharf Improvements (4 Months) (February –May 2014)					**2014**
Off-Road Equipment					
Concrete Pumpers	2	75	120	8	62%
Boats					
Diesel Tugboat	1	400	120	8	45%
On-Road Equipment/Vehicles					
Worker Vehicles	25	—	120	—	—
Concrete Trucks (one-way truckloads; not trips)	15	—	14	—	—
Gate A Berth (3 Months) (November 2014-January 2015)					**2014-2015**
Vibratory Hammer on a Barge	1	75	90	8	62%
Boats					
Diesel Tugboat	1	400	90	8	45%
Gasoline Utility Boats	2	100	90	8	45%
On-Road Equipment/Vehicles					
Worker Vehicles	25	—	90	—	—
Testing and Closeout (2 Months) (January–February 2015)					**2015**
On-Road Equipment/Vehicles					
Worker Vehicles	6	—	60	—	—

Table AIR-2 Proposed Project's South Basin Major Construction Equipment List and Construction Activity Assumptions					
Activity	Number of Pieces of Equipment	Engine Horsepower (HP)	Days (Assume 30 work-days/month)	Hours per Day	Duty Cycle
Demolition and Dredging (4 months) (January 2014–April 2014)					**2014**
Off-Road Equipment					
Demolition (2 months)					
Crane w/Clamshell Bucket	1	399	60	8	43%
Excavator with Jaws	1	168	60	8	57%
Dredging (2 months)					
Clamshell Dredge (assume crane)	1	399	60	8	43%
Boats (for dredging)					
Survey Boat (assume diesel powered; HP assumption from Tim Rimpo)	1	100	60	8	45%
On-Road Equipment					
Worker Vehicles	6	—	120	—	—
Embarcadero Plaza, East Bayside Promenade, South Apron (Total 18 months) (May 2014–October 2015)					**2014-2015**
Off-Road Equipment					
Vibratory Hammer On A Barge	1	75	540	8	62%
Concrete Pumpers	2	75	540	8	62%
Diesel Scissors Lifts	2	60	540	8	46%
Diesel Cherry Pickers	2	60	540	8	46%
Diesel Forklifts	2	145	540	8	30%
Diesel Generators	2	549	540	8	74%
Welders	2	45	540	8	45%
Boats					
Gasoline Utility Boats	2	100	540	8	45%
Diesel Tugboat	1	400	540	8	45%

Table AIR-2 Proposed Project's South Basin Major Construction Equipment List and Construction Activity Assumptions (Continued)					
Activity	**Number of Pieces of Equipment**	**Engine Horsepower (HP)**	**Days** **(Assume 30 work-days/month)**	**Hours per Day**	**Duty Cycle**
On-Road Equipment/Vehicles					
Worker Vehicles	25	—	540	—	—
Concrete Trucks (one-way truckloads; not trips)	200	—	14	—	—
Lowboy Truck for granite delivery (one-way truckload not truck trips)	1	—	1	—	—
Gate F Berth (2 Months) (May–June 2015)					**2015**
Vibratory Hammer on a Barge	1	75	60	8	62%
Boats					
Diesel Tugboat	1	400	60	8	45%
Gasoline Utility Boats	2	100	60	8	45%
On-Road Equipment/Vehicles					
Worker Vehicles	25	—	60	—	—
Gate G Berth (3 Months) (September– November 2015)					**2015**
Vibratory Hammer on a Barge	1	75	90	8	62%
Boats					
Diesel Tugboat	1	400	90	8	45%
Gasoline Utility Boats	2	100	90	8	45%
On-Road Equipment/Vehicles					
Worker Vehicles	25	—	90	—	—
Testing and Closeout (2 Months) (November–December 2015)					**2015**
On-Road Equipment/Vehicles					
Worker Vehicles	6	—	60	—	—

The number of construction workers for each construction activity was assumed to be the maximum quantity (25 workers) provided in Chapter 2.0 *Alternatives*, except for certain activities (e.g., demolition and dredging) that were specifically referenced as requiring less workers (up to 6). Concrete truckload quantities were taken from Chapter 2.0 *Alternatives*, and assumed to occur within a 14-day period.

The California Air Resources Board's (CARB) Commercial Harbor Craft Emissions Model – California Barge and Dredge Emissions Inventory Database model's data for harbor craft were used for the marine vessel horsepower assumptions (CARB, 2011).

1.2 CONSTRUCTION EMISSION SUMMARY

Construction emission sources were grouped into three categories: on-road vehicles, off-road equipment, and marine vessels. Tables AIR-3 and AIR-4 provide summaries of construction-related emissions in tons per year (tons/year) and pounds per day (lbs/day), and the corresponding Bay Area Air Quality Management District (BAAQMD) thresholds. Construction emissions of toxic air contaminants (TACs) and particulate matter 2.5 microns in diameter or less ($PM_{2.5}$) are described in Section 3.1.

1.2.1 On-Road Emissions

The on-road emissions included emissions from construction-worker vehicles, concrete trucks, and lowboy trucks (Tables AIR-5 through AIR-7). It was assumed that approximately half of the construction-worker vehicles were light-duty automobiles, and half were light-duty trucks. An average vehicle miles traveled of 10.8 miles was assumed based on URBEMIS' default values for San Francisco County (Jones & Stokes Associates, 2007). EMFAC 2007 v.3's emission factors (at an assumed speed of 25 miles per hour) were used to calculate the exhaust emissions of each criteria pollutant during each year of construction (CARB, 2006a). The number of construction truckloads for a particular phase was divided by the number of days that truck was used (e.g., 14 days for concrete trucks) as shown in Tables AIR-1 and AIR-2. The number of vehicles was multiplied by two to account for daily round-trips. The equations below were used to calculate the on-road construction worker and truck emissions.

> Construction Worker Vehicle Daily Emissions (lbs/day): # of construction workers * 2 trips/day * average vehicle miles traveled (10.8 miles) * [(Emission Factor for Light-Duty Automobiles (grams/mile) + Emission Factor for Light-Duty Trucks (grams/mile)/2]/conversion factor (454 grams/lbs)

> Concrete or Lowboy Trucks: # of construction truckloads for a particular phase/day * 2 trips/day * average vehicle miles traveled (10.8 miles) * (Emission Factor for Light-Duty Trucks (grams/mile)/conversion factor (454 grams/lbs)

1.2.2 Off-Road Emissions

The CARB's OFFROAD2007 emission factors (CARB, 2006b) were used to calculate the emissions generated from the project's construction equipment during each construction phase (Table AIR-8).[1]

[1] OFFROAD2007 was used because the newer OFFROAD2011 does not yet allow the user to estimate emissions for ROG or CO_2.

Table AIR-3 Annual Unmitigated Construction-Related Emissions for the Proposed Project					
	Emissions (tons/year)				
Emission Category	**ROG**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
2014 Calculations					
On-Road Emissions	0.03	0.15	0.003	0.003	188
Off-Road Emissions	1.58	15.37	0.65	0.65	2,235
Marine Emissions	0.28	7.14	0.23	0.23	940
Total 2014:	**1.90**	**22.66**	**0.88**	**0.88**	**3,364**
2015 Calculations					
On-Road Emissions	0.021	0.069	0.001	0.001	143
Off-Road Emissions	0.78	7.51	0.31	0.31	1,203
Marine Emissions	0.20	5.00	0.17	0.17	649
Total 2015:	**1.00**	**12.58**	**0.48**	**0.48**	**1,996**

Notes:

CO_2e = carbon dioxide equivalent
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Table AIR-4 Average Daily Construction-Related Emissions for the Proposed Project					
Mitigation Level	**Emissions (lbs/day)**				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Estimated Unmitigated Average Total Emissions	8.1	98	3.8	3.8	14,888
Estimated Emissions after implementation of Mitigation Measure AQ-1: Construction Phasing (mitigated)	5.1	62	2.4	2.4	9,403
Estimated emissions after implementation of Mitigation Measure AQ-1 and Mitigation Measure AQ-2: Best Management Practices (mitigated)	5.1	50	1.3	1.3	9,403
BAAQMD Threshold	**54**	**54**	**82**	**54**	**N/A**
Exceeds Threshold:	**N**	**N**	**N**	**N**	**N/A**

Notes:

BAAQMD = Bay Area Air Quality Management District
CO_2e = carbon dioxide equivalent
lbs/day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

* Unmitigated average total construction-related emissions from the proposed project were calculated by dividing the total combined North Basin and South Basin 2014 and 2015 emissions (tons/year) by a 24-month, 30-day/month construction period and applying a conversion factor to obtain average daily emissions in lbs/day. These unmitigated total emissions were assumed to: 1) occur during an overlapping 24-month construction period; and 2) be emitted daily from 8 hours of active construction activities.

Mitigated emissions shown above indicate the emissions reduction from implementation of Mitigation Measure AQ-1, and an additional reduction from implementation of Mitigation Measure AQ-2. Mitigation measures are detailed below.

The BAAQMD thresholds are from the BAAQMD's CEQA Air Quality Guidelines (BAAQMD, 2011).

Table AIR-5 North Basin Daily Unmitigated On-Road Vehicle Exhaust Emissions					
North Basin	**Emissions (lbs/day)**				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
2014 Calculations					
Dredging					
Passenger Vehicles	0.020	0.060	0.001	0.001	114
Gate A Pier and Gate B Canopy					
Passenger Vehicles	0.082	0.252	0.004	0.004	477
Concrete Trucks	0.058	1.686	0.032	0.032	252
Total for Gate A	**0.140**	**1.938**	**0.037**	**0.037**	**729**
Marginal Wharf Improvements					
Passenger Vehicles	0.082	0.252	0.004	0.004	477
Concrete Trucks	0.014	0.408	0.008	0.008	61
Total for Wharf	**0.096**	**0.660**	**0.012**	**0.012**	**538**
2015 Calculations					
Gate A Berth					
Passenger Vehicles	0.070	0.229	0.004	0.004	477
Testing and Closeout					
Passenger Vehicles	0.070	0.229	0.004	0.004	477

Notes:

CO_2e = carbon dioxide equivalent
lbs/day = pounds per day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Table AIR-6 South Basin Daily Unmitigated On-Road Vehicle Exhaust Emissions					
	Emissions (lbs/day)				
South Basin	**ROG**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
2014 Calculations					
Demolition and Dredging					
Passenger Vehicles	0.020	0.060	0.001	0.001	114
Embarcadero Plaza, East Bayside Promenade, South Apron					
Passenger Vehicles	0.082	0.25	0.0042	0.0042	477
Concrete Trucks	0.2	5.4	0.10	0.10	814
Lowboy Truck	0.013	0.38	0.0073	0.0073	57
Total for EP, EBP, SA	**0.28**	**6.1**	**0.12**	**0.12**	**1,348**
2015 Calculations					
Embarcadero Plaza, East Bayside Promenade, South Apron					
Passenger Vehicles	0.070	0.23	0.004	0.004	477
No Concrete Trucks in 2015					
No Lowboys in 2015					
Total for EP, EBP, SA	**0.070**	**0.23**	**0.004**	**0.004**	**477**
Gate F Berth					
Passenger Vehicles	0.07	0.23	0.004	0.004	477
Gate G Berth					
Passenger Vehicles	0.07	0.23	0.004	0.004	477
Testing and Closeout					
Passenger Vehicles	0.07	0.23	0.004	0.004	477

Notes:

CO_2e = carbon dioxide equivalent
lbs/day = pounds per day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas
EB = Embarcadero Plaza
EBP = East Bayside Promenade
SA = South Apron

Table AIR-7 Proposed Project's Annual Unmitigated On-Road Vehicle Exhaust Emissions					
Combined Years and Basin Tasks	**Emissions (tons/year)**				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
2014 Calculations					
NB Dredging	0.00030	0.00091	0.000015	0.000015	1.7
SB Demo and Dredging	0.0012	0.0036	0.000061	0.000061	6.9
NB Gate A Pier and B Canopy	0.013	0.050	0.00086	0.00086	73
NB Marginal Wharf	0.0050	0.018	0.00031	0.00031	29
NB Gate A Berth	0.0021	0.007	0.00012	0.00012	14
SB Circulation Improvements	0.011	0.069	0.0012	0.0012	63
Total 2014:	**0.032**	**0.15**	**0.0026**	**0.0026**	**188**
2015 Calculations					
NB Gate A Berth	0.0011	0.0034	0.000059	0.000059	7.2
NB Testing and Closeout	0.0021	0.0069	0.00012	0.00012	14.3
SB Circulation Improvements	0.011	0.034	0.00059	0.00059	71.6
SB Gate F Berth	0.0021	0.0069	0.00012	0.00012	14.3
SB Gate G Berth	0.0032	0.010	0.00018	0.00018	21.5
SB Testing and Closeout	0.0021	0.0069	0.00012	0.00012	14.3
Total 2015:	**0.021**	**0.069**	**0.0012**	**0.0012**	**143**

Notes:

CO_2e = carbon dioxide equivalent
NB = northbound
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas
SB = southbound

Table AIR-8 Annual Unmitigated Emissions from Off-Road Construction Equipment for the Proposed Project					
Combined Years and Basin Tasks	**Emissions (tons/year)**				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
2014 Calculations					
NB Dredging	0.010	0.084	0.003	0.003	12
SB Demo and Dredging	0.053	0.442	0.018	0.018	61
NB Gate A Berth	0.010	0.070	0.005	0.005	9
NB Gate A Pier and B Canopy	0.817	8.029	0.333	0.333	1,178
NB Marginal Wharf	0.035	0.257	0.019	0.019	35
SB Circulation Improvements	0.659	6.486	0.269	0.269	942
Total 2014:	**1.58**	**15.37**	**0.65**	**0.65**	**2,235**
2015 Calculations					
NB Gate A Berth	0.004	0.032	0.002	0.002	4
SB Circulation Improvements	0.75	7.32	0.30	0.30	1,178
SB Gate F Berth	0.009	0.064	0.005	0.005	9
SB Gate G Berth	0.012	0.088	0.006	0.006	13
Total 2015:	**0.78**	**7.51**	**0.31**	**0.31**	**1,203**

Notes:

CO_2e = carbon dioxide equivalent
NB = northbound
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas
SB = southbound

Fugitive-dust–related particulate matter emissions were assumed to be negligible because the proposed project's construction area overlies water. The model's default horsepower and load factors for each equipment type were used, and it was assumed that active construction would occur for 8 hours each day. Based on the construction equipment detail tables (Tables AIR-1 and AIR-2), equipment types and quantities were input into the model for each construction phase for each year of construction. If a particular type of construction equipment was not included in the model's list of equipment types, a similar equipment type was selected, or the "other construction equipment" category was used.

The model provided daily pollutant emissions (lbs/day) for each construction phase. As shown in the equation below, these daily emissions were multiplied by the number of construction days for a particular phase, and divided by a conversion factor (2,000 lbs/ton) to calculate annual emissions for each construction phase (tons/year).

> Annual Emissions by Construction Phase = Daily Emissions from Off-Road Model Results (lbs/day) * # of construction days for that phase in a given year/conversion factor (2,000 lbs/ton)

1.2.3 Marine Emissions

Daily emission rates (in lbs/day) were calculated for construction-related marine vessels using the formula below (Table AIR-9). It was assumed that the project's marine vessels would be 2008 models. The CARB's Commercial Harbor Craft Emissions Model – California Barge and Dredge Emissions Inventory Database 2011 model was used to determine appropriate marine vessel emission factors (Table AIR-10). The appropriate emission factor for each vessel was selected from the corresponding horsepower range for model year 2008. The deterioration rates used in the equations below were selected based on each vessel's horsepower range, and were adjusted to consider the age of the vessel at the time of use/total lifespan of the vessel (vessel lifespan assumed to equal 20 years). Fuel correction factors were 0.948 and 0.8 (unit less) for oxides of nitrogen (NO_X) and particulate matter (PM), respectively, and were taken from CARB's Appendix B of the Commercial Harbor Craft Emissions Model, *Emissions Estimation Methodology for Commercial Harbor Craft Operating in California* (CARB, 2012).

> Daily emission rate (lbs/day) = emission factor (grams/horsepower-hour) * marine vessel's horsepower * vessel load factor × conversion factor (1 lb/453.6 grams) * vessel operation period (hours/day) * fuel correction factor (for NO_X and PM only) * (1 + (deterioration rate * adjustment of deterioration rate for consideration of age of vessel))

Annual emissions (tons/year) associated with each construction phase were determined by multiplying the daily emission rate (lbs/day) for the applicable marine vessel(s) by the number of work days for that construction phase in a given year by the number of vessels of that type, and dividing by a conversion factor of 2,000 lbs/ton (Table AIR-11).

1.2.4 Mitigated Emissions Calculations

As shown in Table AIR-4, the proposed project's construction-related unmitigated emissions would exceed the applicable BAAQMD average daily emission threshold for NO_X. Therefore, the proposed project would include the mitigation measures identified below, and would result in the construction-

Table AIR-9 Daily Emission Summary for Marine Vessels (Model Year 2008) Used for Construction of the Proposed Project							
Equipment Type by Construction Year	**Horsepower (HP)**	**Emissions (lbs/day)**					
		ROG	**CO**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
2014							
Survey Boat	100	0.198	2.57	3.93	0.17	0.17	451.03
Diesel Tugboat	400	0.435	3.14	12.80	0.34	0.34	1804.13
Gasoline Utility Boat	100	0.198	2.57	3.93	0.17	0.17	451.03
2015							
Survey Boat	100	0.200	2.59	3.95	0.18	0.18	451.03
Diesel Tugboat	400	0.443	3.18	12.92	0.34	0.34	1804.13
Gasoline Utility Boat	100	0.200	2.59	3.95	0.18	0.18	451.03

Notes:

CO = carbon dioxide
CO_2e = carbon dioxide equivalent
lbs/day = pounds per day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Table AIR-10
Emission Factors and Deterioration Rates Used in Proposed Project's Construction-Related Marine Vessel Emissions

Equipment Horsepower Range	Max Horsepower	Vessel Model Year	Emission Factors (grams/horsepower-hour)			
			ROG	CO	NO_X	PM
50 to <=120	120	2008	0.23	3.09	5.01	0.24
250 to <=500	500	2008	0.12	0.92	4.0	0.11

Deterioration Rates (percent/100)

Equipment Horsepower Range	ROG	CO	NO_X	PM	
51 to 120	0.28	0.16	0.14	0.44	N/A
251-500	0.44	0.25	0.21	0.67	

Notes:

CO = carbon dioxide
CO_2e = carbon dioxide equivalent
N/A = not applicable
NO_X = nitrogen oxide
PM= particulate matter
ROG = reactive organic gas

Emission factors are from the California Air Resources Board's Barge and Dredge Emissions 2011 model and are based on main engine emission rates.
Deterioration rates are also based on California Air Resources Board's Appendix B Emissions Estimation Methodology for Commercial Harbor Craft Operating in California. These rates are the assumed deterioration rates for engines at the end of their useful life. For example, the ROG emissions from a 100-horsepower engine are assumed to be 28 percent higher after 20 years (the engine's useful life), as compared to the engine's new emission rate.

Table AIR-11 Annual Unmitigated Marine Vessel Emissions for the Proposed Project's Construction Phases					
Combined Years and Basin Tasks	**Emissions (tons/year)**				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
2014 Calculations					
NB Dredging	0.00	0.06	0.003	0.003	6.77
NB Gate A Berth	0.02	0.62	0.02	0.02	81.19
SB Demo and Dredging	0.01	0.12	0.01	0.01	13.53
NB Gate A Pier and B Canopy	0.12	3.10	0.10	0.10	405.93
NB Marginal Wharf	0.03	0.77	0.02	0.02	108.25
SB Circulation Improvements	0.10	2.48	0.08	0.08	324.74
Total 2014:	**0.28**	**7.14**	**0.23**	**0.23**	**940.40**
2015 Calculations					
NB Gate A Berth	0.01	0.31	0.01	0.01	40.59
SB Circulation Improvements	0.13	3.12	0.10	0.10	405.93
SB Gate F Berth	0.03	0.62	0.02	0.02	81.19
SB Gate G Berth	0.04	0.94	0.03	0.03	121.78
Total 2015:	**0.20**	**5.00**	**0.17**	**0.17**	**649.49**

Notes:

CO_2e = carbon dioxide equivalent
NB = northbound
NO_X = nitrogen oxide
PM= particulate matter
ROG = reactive organic gas
SB = southbound

related emissions following mitigation shown in Table AIR-4. Mitigation measures for the proposed project's construction activities include:

- **Mitigation Measure AQ-1: Construction Phasing**. The Water Emergency Transportation Authority will phase construction activities in such a way that onsite emission-generating construction activities for the North Basin and South Basin improvements do not overlap.

- **Mitigation Measure AQ-2: Implement BAAQMD-Recommended Best Management Practices**. The following BAAQMD-recommended best management practices will be implemented to reduce exhaust emissions:

- Minimize the idling time of diesel-powered construction equipment to 2 minutes.

- The contractor will demonstrate at various phases of construction (e.g., 25 percent, 50 percent, and completion) that the off-road equipment (more than 50 horsepower) and marine vessels to be used during construction (i.e., owned, leased, and subcontractor vehicles) would achieve a project-wide fleet-average 20 percent NO_X reduction, and a 45 percent PM reduction, compared to the most recent CARB fleet average to the extent feasible. Acceptable options for reducing emissions include the use of late-model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, add-on devices such as particulate filters, and/or other options that may become available. The contractor will document efforts taken to achieve the specified goals, explain why meeting the goals was not feasible (if applicable), and indicate what emissions reduction and equipment use goals were achieved.

- Require that all construction equipment, diesel trucks, and generators be equipped with Best Available Control Technology for emission reductions of NO_X and PM.

- Require all contractors use equipment that meets CARB's most recent certification standard for off-road heavy-duty diesel engines.

Table AIR-4 shows mitigated emissions associated with Mitigation Measures AQ-1 and AQ-2. Whereas unmitigated emissions assume that the North Basin and South Basin construction activities would overlap, Mitigation Measure AQ-1 assumes no overlap of emission-generating activities. Without any overlap of emission-generating construction activities, the total construction period would increase from 24 to 38 months. With implementation of Mitigation Measure AQ-1, average daily NO_X emissions would be reduced from 99.8 to 63.0 pounds per day, which still exceeds the BAAQMD's 54-pounds-per-day significance threshold.

Mitigation Measure AQ-2 would further reduce emissions from 63.0 pounds of NO_X per day to 50.7 pounds per day (see Table AIR-4). With implementation of Mitigation Measures AQ-1 and AQ-2, the project's emissions would be less than BAAQMD's 54-pounds-per-day threshold.

2.0 OPERATION EMISSIONS

The No Action Alternative and the proposed project would result in direct and indirect operational-related emissions. For the No Action Alternative, vessel idling would generate exhaust emissions. The proposed project would generate exhaust emissions from several sources, including idling vessels, operation and periodic testing of an emergency generator, and a survey boat used for maintenance dredging. Maintenance dredging and the operation of an emergency generator would occur infrequently, but were included in the emission calculations to determine the most conservative (i.e., highest emissions) scenario. For both the No Action Alternative and the proposed project, vessels were assumed to be evenly composed of large (7,657 horsepower) and small (2,198 horsepower) vessels. Vessel types assumed in this analysis were based on vessel information provided in the Program EIR's Technical Appendix AIR-C Emissions for Alternatives 1 through 4's *Summary of Marine Emissions for the No Project and "Reduced" Alternative 2 Project Scenarios Assuming EPA Tier 2 Emissions Standards for Diesel Engines* table (WETA, 2003).

2.1 NO ACTION OPERATION EMISSIONS

Similar to the construction-related marine vessel calculations, maximum daily emission rates (lbs/day) were calculated for the No Action Alternative's large and small vessels (Table AIR-12). The vessels were assumed to be 2010 models, with the horsepower described above. The marine vessels for the No Action and proposed project's services would use U.S. Environmental Protection Agency (U.S. EPA) and CARB Tier 2–compliant clean diesel engines, which emit approximately 25 to 30 percent less reactive organic gas (ROG), NO_X, and particulate matter 10 microns in diameter or less (PM_{10}) than current diesel engines. In addition, add-on control devices such as selective catalytic reduction and particulate traps would further reduce NO_X and PM_{10} emissions to 10 percent and 5 percent, respectively, of U.S. EPA Tier 2 levels. For ROG, NO_X, PM_{10}, and $PM_{2.5}$, the U.S. EPA's Marine Compression-Ignition Engines Exhaust Emission Standards for Tier 2 commercial (C1) engines were used (Table AIR-13). As described above, additional emission reductions from the add-on control devices were applied for NO_X and PM_{10} (Table AIR-13).

The CARB's Commercial Harbor Craft Emissions Model – California Barge and Dredge Emissions Inventory Database 2011 model was used to determine appropriate marine vessel emission factors for carbon dioxide equivalent (CO_2e) emissions for both alternatives. The appropriate emission factor for each vessel was selected from the corresponding horsepower range for the corresponding model year. The vessels were assumed to be 2010 models, with the horsepower described above. Based on Chapter 2.0 *Alternatives*, under the No Action Alternative, vessel arrivals could increase to a total of 65 vessels/day.

The equation used to estimate vessel idling emissions is as follows:

> **Daily emission rate (lbs/day) for idling small or large vessels** = emission factor (grams/horsepower-hour) * marine vessel's horsepower * vessel load factor (of 0.01) * conversion factor (1 lb/453.6 grams) * number of total vessels/day * 1/2 the vessels (one-half of total vessels are small vessels and one-half are large) * 20 idling minutes/vessel * 1 hour/60 min

Annual vessel idling exhaust emissions (tons/year) were calculated as shown in Table AIR-14. To calculate vessel idling emissions, daily emission rates for each vessel type was multiplied by 365 days/year and multiplied by a conversion factor (1 ton/2,000 lbs). Average daily emissions for the No Action Alternative (Table AIR-15) were calculated by dividing the total annual emissions (tons/year) for each pollutant by 365 days/year and multiplying by a conversion factor (1 ton/2,000 lbs).

Table AIR-12 Operation Emissions for the No Action Alternative – Maximum Daily Emission Rates							
Equipment Type	**Equipment Horsepower**	**Emissions (lbs/day)**					
		ROG	**CO**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Large Vessel	7,657	4.9	6.8	0.5	0.014	0.014	1,039
Small Vessel	2,198	1.4	2.0	0.1	0.004	0.004	298

Notes:

Maximum Daily Emission Rates are the emissions that would be generated during an assumed 24 hours of operation.

CO = carbon dioxide
CO_2e = carbon dioxide equivalent
lbs/day = pounds per day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Table AIR-13 Marine Vessel Emission Rates for the No Action and Proposed Project's Operation Phases			
Criteria Pollutants	**Tier 2 Emission Rate (grams/kw-hr)**	**Reduction by Add-on Control Devices (percent)**	**Adjusted Emission Rate (grams/kw-hr)**
PM_{10} and $PM_{2.5}$	0.2	95	0.01
CO	5	0	5
ROG	3.6	0	3.6
NO_X	3.6	90	0.36

Notes:

Tier 2 emission rates for ROG and NO_X are a combined 7.2 grams/kw-hr. These rates were split evenly between ROG and NO_X for the purposes of these calculations. Because the Tier 2 standards do not include an emission rate for CO_2, CO_2 emission rates were estimated using California Air Resources Board rates.

Source: U.S. EPA 2012a

CO = carbon monoxide
CO_2 = carbon dioxide
grams/kw-hr. = grams per kilowatt-hour
NO_X = nitrogen oxide
PM = particulate matter
ROG = reactive organic gas

Table AIR-14 Annual Operation-Related Emissions for the No Action Alternative					
	Emissions (tons/year)				
Operation Activity	**ROG**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e[1]**
Large Vessel Idling	0.90	0.09	0.0025	0.0025	190
Small Vessel Idling	0.26	0.03	0.0007	0.0007	54
Total:	**1.15**	**0.12**	**0.0032**	**0.0032**	**244**
BAAQMD Annual Emission Thresholds	10	10	15	10	1,212.54

Notes:

Net difference values may slightly vary due to rounding.

[1] BAAQMD's maximum annual emissions threshold for CO_2e can also be expressed as 1,100 metric tons per year (2,204.62 pounds per metric ton).

BAAQMD = Bay Area Air Quality Management District
CO_2e = carbon dioxide equivalent
N/A = not applicable
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Table AIR-15 Average Daily Operation-Related Emissions for the No Action Alternative					
	Emissions (lbs/day)				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Total	6.32	0.63	0.018	0.018	1,338
BAAQMD Threshold	54	54	82	54	N/A
Exceeds Threshold	No	No	No	No	N/A

Notes:

Emissions are averaged from the total annual emissions (tons/year) for this alternative.

BAAQMD = Bay Area Air Quality Management District
CO_2e = carbon dioxide equivalent
N/A = not applicable
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

2.2 PROPOSED PROJECT OPERATION EMISSIONS

Similar to the construction-related marine vessel calculations and the No Action Alternative's operation emission calculations, maximum daily emission rates (lbs/day) were calculated for the proposed project's maintenance dredging activities (survey boat), and large and small vessels (Table AIR-16). Based on Chapter 2.0 *Alternatives*, the proposed project would support and increase in vessel arrivals to a total of 181 vessels arrivals/day. CARB's Commercial Harbor Craft Emissions Model – California Barge and Dredge Emissions Inventory Database 2011 model was used to determine appropriate marine vessel emission factors for CO_2e. For ROG, NO_X, PM_{10}, and $PM_{2.5}$, the U.S. EPA's Marine Compression-Ignition Engines Exhaust Emission Standards for Tier 2 commercial (C1) engines were used (Table AIR-13).

Table AIR-16
Operation Emissions for the Proposed Project – Maximum Daily Emission Rates

Equipment Type	Equipment Horsepower	Emissions (lbs/day)					
		ROG	CO	NO_X	PM_{10}	$PM_{2.5}$	CO_2e
Survey Boat (Maintenance Dredging)	100	0.2	2.6	4.0	0.2	0.2	451
Emergency Generator	549	4.0	16.9	47.2	1.4	1.3	9,043
Large Vessel	7,657	13.7	19.0	1.4	0.04	0.04	2,894
Small Vessel	2,198	3.9	5.5	0.4	0.01	0.01	831

Notes:

Maximum Daily Emission Rates are the emissions that would be generated during an assumed 24 hours of operation.

CO = carbon dioxide
CO_2e = carbon dioxide equivalent
lbs/day = pounds per day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

The deterioration rates used in the equation below were selected based on each vessel's horsepower and were adjusted for the age of the vessel at the time of use/total lifespan of the vessel (assumed 20 years). It was assumed the first year that maintenance dredging occurring under the proposed project would be 3 years after completion of project construction (assumed to be year 2018), and that the survey boat would be 10 years old out of its 20-year lifespan (a deterioration rate adjustment of 10/20).

Daily emission rate (lbs/day) for survey boat = emission factor (grams/horsepower-hour) * marine vessel's horsepower * vessel load factor * conversion factor (1 lb/453.6 grams) * vessel operation period (hours/day) * fuel correction factor (for NO_X and PM only) * (1 + (deterioration rate × adjustment of deterioration rate for consideration of age of boat))

Daily emission rate (lbs/day) for idling small or large vessels = emission factor (grams/horsepower-hour) * marine vessel's horsepower * vessel load factor (of 0.01) * conversion factor (1 lb/453.6 grams) * number of total vessels/day * 1/2 the vessels * 20 idling minutes/vessel * 1 hour/60 min

Annual emissions (tons/year) from each activity were calculated as shown in Table AIR-17. To calculate the vessel idling emissions, the daily emission rates for each vessel type were multiplied by 365 days/year, and multiplied by a conversion factor (1 ton/2,000 lbs).

Table AIR-17
Annual Operation-Related Emissions for the Proposed Project

Combined Operational Activities	Emissions (tons/year)				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Operational Emissions Calculations					
Large Vessel Idling	2.5	0.25	0.007	0.007	528
Small Vessel Idling	0.72	0.072	0.0020	0.0020	152
Emergency Generator	0.01	0.12	0.003	0.003	23
Maintenance Dredging	0.0010	0.020	0.0009	0.0009	2
Total:	**3.22**	**0.46**	**0.01**	**0.01**	**705**

Notes:
CO_2e = carbon dioxide equivalent
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Maintenance dredging emissions were assumed to occur over a 10-day period; thus, the equation used to calculate maintenance dredging emissions was daily emission rate for the survey boat * 10 days/year * a conversion factor (1 ton/2,000 lbs). Average daily emissions for the proposed project (Table AIR-18) were calculated by dividing the total annual emissions (tons/year) for each pollutant by 365 days/year, and multiplying by a conversion factor (1 ton/2,000 lbs).

Table AIR-18
Average Daily Operation-Related Emissions for the Proposed Project

	Emissions (lbs/day)				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
Total Average Emissions	17.7	2.5	0.073	0.071	3,865
BAAQMD Threshold	54	54	82	54	N/A

Notes:
BAAQMD = Bay Area Air Quality Management District
CO_2e = carbon dioxide equivalent
GHG = greenhouse gas
lbs/day = pounds per day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Daily emissions from the operation and periodic testing of an emergency generator under the proposed project were calculated using the Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model, Version 6.3.2. In the model, it was assumed that one 549-horsepower generator (default generator size and load factor used) would operate 24 hours per day. As shown in the following equation, annual emissions (Table AIR-17) were calculated by using these maximum daily emission rates (Table AIR-16), and assuming that the generator would be operated up to a maximum of 124 hours annually (2 hours/month for periodic testing, and up to 100 hours of use):

Annual emissions (tons/year) from the emergency generator = daily emission rates (lbs/day) × 1 day/24 hours × 124 hours/year × conversion factor (1 ton/2,000 lbs)

2.3 NET OPERATION EMISSIONS

As shown in Tables AIR-19 and AIR–20, net proposed project emissions were calculated by determining the total increase in the proposed project's emissions, compared to the No Action Alternative's emissions. For operational emissions, there are four emission categories for the proposed project: large-vessel idling, small-vessel idling, emergency generator, and maintenance dredging. However, for the No Action Alternative, there are only two emission categories: large-vessel idling and small-vessel idling. Consequently, the net emission increases for the emergency generator and maintenance dredging shown in Table AIR-19 are identical to the proposed project emissions for these categories shown in Table AIR-17. The net emission increases for the large- and small-vessel idling categories shown in Table AIR-19 are the net change in emissions from these categories shown for the proposed project in Table AIR-17, minus the emissions shown for the No Action Alternative shown in Table AIR-14.

Table AIR-19
Net Increase in Annual Operational Emissions from the Proposed Project as Compared to the No-Action Alternative

Combined Operational Activities	Emissions (tons/year)				
	ROG	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e[1]**
Operational Emissions Calculations					
Large-Vessel Idling	1.60	0.16	0.004	0.004	338
Small-Vessel Idling	0.46	0.05	0.001	0.001	97
Emergency Generator	0.01	0.12	0.003	0.003	23
Maintenance Dredging	0.001	0.02	0.0009	0.0009	2
Total:	**2.07**	**0.34**	**0.010**	**0.010**	**461**
BAAQMD Maximum Annual Emissions Threshold (tons/year)	10	10	15	10	1,212.54

Notes:
[1] BAAQMD's maximum annual emissions threshold for CO_2e can also be expressed as 1,100 metric tons per year (2,204.62 pounds per metric ton).
BAAQMD = Bay Area Air Quality Management District
CO_2e = carbon dioxide equivalent
lbs/day = pounds per day
N/A = Not available
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

Table AIR-20 Net Increase in Daily Operational Emissions of the Proposed Project as Compared to the No Action Alternative					
	Emissions (lbs/day)				
Alternative	**ROG**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**CO_2e**
No Action	6.32	0.63	0.018	0.018	1,338
Proposed Project	17.7	2.5	0.073	0.071	3,865
Net Increase (Proposed Project minus No Action)	**11.3**	**1.87**	**0.055**	**0.053**	**2,527**
BAAQMD Daily Emission Thresholds *	54	54	82	54	N/A

Notes:
Emissions are averaged from the total emissions (tons/1 year of operation [365 days]) for each alternative.
Net difference values may vary slightly due to rounding.
* The BAAQMD thresholds are from the BAAQMD's CEQA Air Quality Guidelines (2011).
BAAQMD = Bay Area Air Quality Management District
CEQA = California Environmental Quality Act
CO_2e = carbon dioxide equivalent
GHG = greenhouse gas
lbs/day = pounds per day
NO_X = nitrogen oxide
PM_{10} = particulate matter 10 microns in diameter or less
$PM_{2.5}$= particulate matter 2.5 microns in diameter or less
ROG = reactive organic gas

3.0 TOXIC AIR CONTAMINANTS AND HEALTH RISK ANALYSIS

3.1 TOXIC AIR CONTAMINANTS

In addition to the criteria air pollutants listed above, TACs or hazardous air pollutants are air pollutants that may lead to serious illness or increased mortality, even when present in relatively low concentrations. There are hundreds of different types of TACs with varying degrees of toxicity. Many TACs are confirmed or suspected carcinogens, or are known or suspected to cause birth defects or neurological damage. Secondly, many TACs can be toxic at very low concentrations. For some chemicals, such as carcinogens, there are no thresholds below which exposure can be considered risk-free.

Industrial facilities and mobile sources are significant sources of TACs. Automobile exhaust also contains TACs such as benzene and 1,3-butadiene. Most recently, diesel particulate matter (DPM) was identified as a TAC by CARB. DPM differs from other TACs in that it is not a single substance but rather a complex mixture of hundreds of substances. BAAQMD research indicates that mobile-source emissions of DPM, benzene, and 1,3-butadiene represent a substantial portion of the ambient background risk from TACs in the San Francisco Bay Area Air Basin. For the proposed project, the TACs of concern are DPM and $PM_{2.5}$, which would be emitted by heavy construction equipment and by marine vessels during project operation.

3.2 HEALTH RISK ANALYSIS

The proposed project's construction and operational activities could affect local air quality. The primary sources of health risks from construction equipment are DPM, which is produced by diesel engine exhaust;

and $PM_{2.5}$. As shown in Tables AIR-17 and AIR-19, emissions of PM_{10} and $PM_{2.5}$ in equipment exhaust would not exceed the significance criteria for regional emissions of criteria pollutants. However, localized $PM_{2.5}$ and DPM emissions could expose sensitive receptors to substantial concentrations, resulting in health risks. These pollutants were evaluated to identify potential cancer risk and chronic noncancer hazards.

The construction and operational health risk analysis evaluated the potential risk to existing sensitive receptors in the vicinity of the proposed project areas. Risk characterization and model results are discussed in this section.

The thresholds for individual project risks and hazards are:

- An excess lifetime cancer risk level of more than 10 in one million;
- A noncancer (chronic) risk greater than 1.0; and
- An incremental increase in the annual average $PM_{2.5}$ concentration greater than 0.3 microgram per cubic meter ($\mu g/m^3$).

A health risk assessment, consistent with the BAAQMD's "Recommended Methods for Screening and Modeling Local Risks and Hazards," was performed for the proposed project. First, consistent with the BAAQMD's Tier 1 modeling recommendation, a conservative screening-level risk assessment was conducted, using the U.S. EPA's SCREEN3 model, to evaluate the potential risk to existing sensitive receptors in the vicinity of the proposed project's construction and operation areas. For all risks that were below thresholds using the screening modeling approach, no further analysis was performed. If the screening assessment indicated that risks for a sensitive receptor could exceed a threshold, a more detailed analysis was performed consistent with BAAQMD's Tier 2 and 3 modeling recommendations. In this case, the risks for that receptor were modeled using, U.S. EPA's AERMOD, which incorporates more site-specific detail than the screening level method, such as hourly wind data, locations of emissions sources, locations of receptors, terrain data, and nearby building dimensions.

3.2.1 Sensitive Receptors

To assess the health risks on sensitive receptors from the project's construction and operation, residential, school (including day cares), medical, and commercial sensitive receptors were identified. The distance between the nearest residential-zoned property and the project area is approximately 300 feet. The nearest existing residence is approximately 700 feet (213.4 meters) from the project area, the nearest school is approximately 293 feet (89.3 meters) from the project area, and a medical facility is approximately 4,168 feet (1,270 meters) from the project area. A commercial property is within the project area.

It was conservatively assumed that the closest residential receptor was 300 feet to northwest (91.4 meters); this is the boundary of the nearest residentially zoned property, which currently does not contain residential structures. The closest current residential structure is 700 feet (213.4 meters) to the northwest of the project area. However, a new residential development, 8 Washington, is proposed on the portion of this property where there are currently tennis courts (i.e., 300 feet from the proposed project). The 8 Washington Final EIR indicates that air filtration systems will be incorporated into the design, so that at least 80 percent of fine particulates would be removed from the air in the habitable areas (City and

County of San Francisco, 2012).[2] Because the risks calculated in the sections below are driven by DPM, the filtration is reasonably assumed to decrease calculated risk by 80 percent. This was incorporated into the analysis for the receptors at the 8 Washington site, but not at other residential locations where it is unknown if there is filtration.

To assess the health risks on sensitive receptors from the project's construction and operation, the nearest residential, school (including day cares), medical, and commercial sensitive receptors were identified. The distance between the nearest residential-zoned property and the project area is approximately 300 feet (91.4 meters). The nearest school is approximately 293 feet (89.3 meters) from the project area. A medical facility is located approximately 4,168 feet (1,270 meters) from the project area. A commercial property is within the project area and was considered to be 0 feet from the project area.

3.2.2 Screening-Level Health Risk Assessment

3.2.2.1 SCREEN3 Model and Model Inputs

The U.S. EPA's SCREEN3 model was used to perform a screening-level analysis of the potential health risks of the proposed project. The SCREEN3 model is a "single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources" (U.S. EPA, 2012b). The model was used to identify a maximum ground-level concentration near the project area, and the concentrations at the nearest four sensitive receptor types described above. As detailed below, these concentrations were then converted into chronic and carcinogenic risks for the screening health risk analysis.

Inputs required for the model include source type, receptor, and source heights; project area dimensions; emission rates (in grams/second*square meters); and distances to the nearest sensitive receptors. For this analysis, the following model inputs were used:

- Source type = Area source;
- Receptor and source heights = 1.8 meters;
- Project area dimensions = 1,543 feet by 829 feet (or approximately 470 meters by 253 meters), or a total project area of 1,279,147 square feet; and
- Project's emission rates (discussed further below).

Total PM_{10} emission rates for each of the project's construction years (Table AIR-3) and the project's operational PM_{10} emissions (Tables AIR-17 and AIR-19) were converted from tons/year to grams/(second*square meters). The converted project emission rates are provided in Table AIR-21. PM_{10} emissions were used as a surrogate for DPM emissions.

[2] "Mitigation M-AQ-7: Building Design and Ventilation Requirements. The project sponsor shall submit a ventilation plan for the proposed buildings. The ventilation plan shall show that the building ventilation systems remove at least 80 percent of the $PM_{2.5}$ pollutants from habitable areas. The ventilation system shall be designed by an engineer certified by ASHRAE, who shall provide a written report documenting that the system offers the best available technology to minimize outdoor-to-indoor transmission of air pollution. In addition to installation of an air filtration system, the project sponsor shall present a plan that ensures ongoing maintenance for the ventilation and filtration systems. The project sponsor shall also ensure the disclosure to buyers and renters regarding the findings of the analysis and inform occupant's proper use of any installed air filtration system."

Table AIR-21 Summary of Proposed Project PM_{10} Emission Rates and Rate Conversions for the SCREEN3 Modeling		
	Total Emissions (Tons/Year)	**Total Emissions (grams/[second*square meters])**
Construction		
2014	0.88	2.14E-07
2015	0.48	1.17E-07
Proposed Project Operation (2018)	0.01	3.2E-09
Net Project Operation (2018)	0.01	2.43E-09

Notes:
1 ton = 907,184.74 grams
1 year = 31,536,000 seconds
Project area = approximately 118,836.65 square meters
PM_{10} = particulate matter 10 microns in diameter or less
Net Project Operation is the increase in emissions for the proposed project as compared to the No Action Alternative

3.2.2.2 SCREEN3 Model Results

Table AIR-22 provides the conservative SCREEN3-modeled ground-level DPM concentrations (in μg/m^3) at the nearest sensitive receptors to the project's construction and operational activities. Per BAAQMD recommendations, worst-hour SCREEN3 results were multiplied by a factor of 0.1 to determine annual concentrations. The 2014 and 2015 annualized construction emissions were averaged for use in the chronic and carcinogenic risk calculations.

Table AIR-22 SCREEN3 Results – Unmitigated Ground-Level Concentrations of DPM at Nearest Sensitive Receptors to Project Area					
Sensitive Receptor Type	**Construction Concentrations (μg/m^3)**			**Operational Concentrations (2018) (μg/m^3)**	**Net Operational Concentrations (2018) (μg/m^3)**
	2014	**2015**	**Average**		
Residence	0.65	0.356	0.503	9.76E-03	7.39E-03
School	0.563	0.308	0.435	8.44E-03	6.40E-03
Commercial Building	0.710	0.389	0.550	1.07E-02	8.08E-03
Medical	0.097	0.053	0.075	1.46E-03	1.11E-03

Notes:
Distances to nearest sensitive receptors are provided previously in text above.
Net Operational Concentrations are the increase in emissions for the proposed project as compared to the No Action Alternative

3.2.2.3 Screening-Level Ambient $PM_{2.5}$ Concentrations

The $PM_{2.5}$ ground-level concentrations were modeled in SCREEN3 using the $PM_{2.5}$ emissions from the project's construction and operation activities. Results of the analysis indicate that unmitigated $PM_{2.5}$ construction-related concentrations at three of the nearest sensitive receptors would be greater than the BAAQMD significance threshold of 0.3 $\mu g/m^3$ (see Table AIR-23). However, implementation of Mitigation Measures AQ-1 and AQ-2 would reduce the $PM_{2.5}$ concentrations to levels less than the BAAQMD's significance health risk threshold.

Table AIR-23
Summary of the Project's $PM_{2.5}$ Concentrations at the Nearest Sensitive Receptors

	Construction Concentrations		Operational Concentrations	Net Operational Concentrations
Sensitive Receptor Type[1]	**$PM_{2.5}$ (unmitigated)**	**$PM_{2.5}$ (mitigated)[2]**	**$PM_{2.5}$ (unmitigated)**	**$PM_{2.5}$ (unmitigated)**
Residence	0.50	0.17	0.010	0.007
School	0.44	0.15	0.008	0.006
Commercial Building	0.55	0.19	0.011	0.008
Medical	0.08	0.03	0.001	0.001
BAAQMD Significance Level	**0.3**	**0.3**	**0.3**	**0.3**

Notes:

Net Operational Concentrations are the increase in emissions for the proposed project as compared to the No Action Alternative

1 Distances to nearest sensitive receptors are provided previously in text above.

2 Mitigated emissions assume the implementation of Mitigation Measures AQ-1: Construction Phasing, and AQ-2: Implement BAAQMD-Recommended Best Management Practices, described in more detail in Section 1.2.4.

3.2.2.4 Exposure Assumptions

The exposure assessment estimates human exposure to substances that can increase cancer risk or cause chronic noncancer health risks. The primary exposure pathway for DPM is through inhalation.

Dose-response assessment is the process of characterizing the relationship between exposure to an agent and incidence of an adverse health effect in exposed populations. In quantitative carcinogenic risk assessments, the dose-response relationship is expressed in terms of a potency slope that is used to calculate the probability or risk of cancer associated with an estimated exposure. Cancer potency factor is expressed as the 95th percent upper confidence limit of the slope of the dose response curve, and assumes continuous lifetime exposure to a substance at a dose of 1 milligram per kilogram of body weight-day, commonly expressed in units of inverse dose, i.e., (milligrams per kilogram per day [mg/kg-day])-1. It is assumed in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis. The California Office of Environmental Health Hazard Assessment (OEHHA) has compiled cancer potency factors, which are used in risk assessments (OEHHA, 2011). The methodologies for calculating cancer risks from the BAAQMD's "Recommended Methods for Screening and Modeling Local Risks and Hazards" were used for calculating risk (BAAQMD 2012a). The BAAQMD methodologies incorporate values and methodologies from OEHHA.

For noncarcinogenic effects, dose-response data developed from animal or human studies are used to develop chronic noncancer reference exposure levels (RELs). The chronic RELs are defined as the concentration at which no adverse noncancer health effects are anticipated. The most sensitive health effect is chosen to determine the REL if the chemical affects multiple organ systems. Unlike cancer health effects, noncancer chronic health effects are generally assumed to have thresholds for adverse effects. In other words, chronic injury from a pollutant will not occur until exposure to that pollutant has reached or exceeded a certain concentration (i.e., threshold). The chronic RELs are intended to be below the threshold for health effects for the general population.

3.2.2.5 Screening-Level Chronic Noncancer Hazard Index

The potential for exposure to result in chronic noncancer effects is evaluated by comparing the estimated annual average air concentration (which is equivalent to the average daily air concentration) to the chemical-specific noncancer chronic RELs. The chronic REL is the inhalation exposure concentration at which no adverse chronic health effects would be anticipated following exposure. When calculated for a single chemical, the comparison yields a ratio termed a hazard quotient.

The chronic risk level is calculated as follows:

Inhalation chronic risk = Cair/cREL, where:

Cair = annual concentration ($\mu g/m^3$)

cREL = Chronic noncancer REL ($\mu g/m^3$)

For this analysis, the SCREEN3 model results were converted using an adjustment factor of 0.1 from 1-hour concentrations ($\mu g/m^3$) to annual concentrations ($\mu g/m^3$). A REL of 5 was used for mercury, as recommended by OEHHA (2011).

3.2.2.6 Assessment of Cancer Risk

The maximum incremental cancer risk from exposure to DPM was calculated by estimating exposure to carcinogenic chemicals, and multiplying the dose times the cancer potency factor and an age sensitivity factor (ASF). Because the ASF changes with the age of the exposed individual, incremental cancer risks were calculated for each phase of construction or operation as appropriate, and then summed. The following equation was used to determine cancer risk for each time period assessed:

Cancer Risk = (Dose * CRAF * cancer potency factor), where:

Cancer Risk = risk (potential chances per million)

Dose = dose through inhalation (mg/kg-day)

CRAF = Cancer risk adjustment factor (exposure period for project activity [time period of assessment])/total exposure period (70 years) * ASF

Dose is estimated using the following equation:

Dose = (Cair * DBR * EF * ED * CF)/AT, where:

Dose = dose through inhalation (mg/kg-day)

Cair = annual air concentration (μg/m^3) from the model at each sensitive receptor location; this value changes over time and is paired with the ASF discussed below

DBR = daily breathing rate (581 liters per kilogram [L/kg] body weight-day for a child during construction; 302 for a 70-year exposure duration)

EF = exposure frequency (350 days/year, recommended default value for residents; 180 days/year for school children; conservatively used 350 days/year for both commercial and medical)

ED = exposure duration (70 years, recommended default value for operation; adjusted as appropriate for construction exposure)

CF = conversion factor (10-6 ([mg/μg] * [m^3/L])

Slope Factor or Cancer Potency Factor = the OEHHA-established cancer potency slope factor of 1.1 (mg/kg-day)-1 for DPM.

ASF = Age Sensitivity Factor (accounts for the increased susceptibility of infants and children to carcinogens, in comparison to adults—used 10 for first trimester until the age of two; 3 for children over the age of two; 1 for ages over 16; and 1.7 for a lifetime exposure)

AT = averaging time (25,550 days or 70 years)

For the cancer risk analysis, the dose was calculated using the values provided above and the concentrations at each sensitive receptor location from the air dispersion model. Default values were based on the guidance provided by BAAQMD (2012a), as well as OEHHA (2003). In addition, the methodology used here uses the recommended hourly-to-annual conversion factor, child daily breathing rate, and infant ASF recommended by the BAAQMD comment letter (BAAQMD, 2013). To determine incremental cancer risk, the estimated dose through inhalation was multiplied by the OEHHA-established cancer potency slope factor of 1.1 (mg/kg-day)-1 for DPM.

3.2.2.7 Screening-Level Health Risk Assessment Results

For construction impacts on residential receptors, a conservative ASF of 10 was used. For construction impacts on school receptors, a conservative ASF of 3 was used. For construction impacts on commercial and medical land uses, an ASF of 1 was applied. For all operational impacts on residential and school receptors, a weighted ASF of 1.7 was used, as recommended by BAAQMD (2012).[3] For operational impacts on commercial and medical receptors, an ASF of 1 was applied to assess risks.

Results for cancer risk and chronic noncancer hazard impacts are provided in Table AIR-24 for each of the nearest sensitive receptor types. The conservative screening-level assessment indicates that risks for nearby commercial uses and the nearest medical facility would be less than significant. However, the screening-level assessment results for residences and schools indicate that more detailed assessment is required for these receptors, to determine risks. Refer to Section 3.2.3 for the detailed health risk assessment for these receptors.

Table AIR-24
Summary of the Project's Screening-Level Carcinogenic and Chronic Health Risks at Nearest Sensitive Receptors to Project Area

Sensitive Receptor Type	Construction Risks		Operational Risks		Net Operational Risks	
	Chronic Risk (unitless)	**Carcinogenic Risk (per million)**	**Chronic Risk (unitless)**	**Carcinogenic Risk (per million)**	**Chronic Risk (unitless)**	**Carcinogenic Risk (per million)**
Residence	0.10	88	0.0020	5.3	0.0015	4.0
School	0.09	23	0.0017	4.6	0.0013	3.5
Commercial Building	0.11	6.5	0.0021	5.8	0.0016	4.4
Medical	0.02	0.9	0.0003	0.8	0.0002	0.6
BAAQMD Significance Level	**1**	**10**	**1**	**10**	**1**	**10**

Notes:

Distances to nearest sensitive receptors are provided previously in text above.

The risks presented here are unmitigated; i.e., the screening-level health risk assessment did not assume implementation of Mitigation Measures AQ-1 and AQ-2.

Net Operational Risks are the risks for the proposed project as compared to the No Action Alternative

3.2.3 Detailed Health Risk Assessment

The screening assessment indicated that a more detailed analysis should be conducted for the sensitive receptors (residences and schools) that were not below the thresholds shown in Table AIR-24. Therefore, a more detailed assessment of carcinogenic risks was conducted for these sensitive receptors for construction and operation. The refined assessment accounted for (1) actual wind direction, which is primarily away from the receptors; (2) ASFs over longer averaging times, because project construction was assumed to be 38 months in duration; (3) implementation of proposed project mitigation (i.e., Mitigation Measures AQ-1 and AQ-2); and (4) air filtration controls for the new residential development approximately 300 feet from the project area.

[3] Page 66 of the guidance states "For estimating cancer risk where the emissions do not vary by year, concentrations can simply be multiplied by a cumulative ASF of 1.7 that incorporates the overall variations in ASFs."

The U.S. EPA's AERMOD model was used to perform the detailed analysis of certain potential health risks of the proposed project. The AERMOD model is a "A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain" (U.S. EPA, 2012b). The model was used to identify refined maximum concentrations at certain sensitive receptors. As detailed in Section 3.2.3.1, these concentrations were then converted into carcinogenic risks for the health risk analysis.

Refer to Figure 3.6-1 of the EIS/EIR for the location of the nearest sensitive receptors, Figure 2-9 of the EIS/EIR for the location of the construction zone (where construction emissions would be generated), and Figure 2-1 of the EIS/EIR for the location of the new water transit gates (where the operational emissions would be generated).

3.2.3.1 AERMOD Input and Assumptions

Inputs required for the model include source information,[4] receptor locations, meteorological data, terrain data, and nearby building dimensions. AERMOD-ready meteorological data from Mission Bay (2007 and 2008) were provided by the BAAQMD. The 2008 meteorological data were used because they gave more conservative results.

For the residential receptors, because an ASF of 10 is applied to the third trimester until 2 years of age, the first 27 months of construction was assessed with an ASF of 10. After 27 months, an ASF of 3 was used. Because Mitigation Measure AQ-1 requires that construction be phased so that emission-generating construction activities in the North Basin and South Basin do not overlap, it was assumed that the total duration of construction would be 38 months. Figure 2-10 was used to determine which phases occur before and after the 27th month of construction, assuming the North Basin construction would occur first. Therefore, all North Basin construction activities (Table AIR-1), as well as the demolition and dredging in the South Basin, were assumed to occur before 27 months; and therefore, an ASF of 10 was applied for these construction phases. For the construction of the circulation improvements in the South Basin (i.e., Embarcadero Plaza, East Bayside Promenade, South Apron of the Agriculture Building Improvements), it was assumed that half of the construction would occur in the first 27 months of construction, and half of the construction would occur after the 27th month of construction. Therefore, half of these emissions were assessed with an ASF of 10, and half were assessed with an ASF of 3. The construction of Gate F and Gate G would occur after the 27th month, and were therefore assessed with an ASF of 3.

For construction impacts on school receptors, an ASF of 3 was used for all phases. School children were assumed to be at the school 180 days of the year, 8 hours per day.

[4] Source parameters are as follows: The North and South Basin construction area was modeled as a series of volume sources, with a release height of 5 meters, a length of 10 meters, and an initial vertical dimension of 1.4 meters. North and South Basin construction was modeled as occurring from 6 a.m. through 7 p.m. The generator was modeled as a point source with a release height of 2.92 meters, an exit temperature of 756.18 Kelvin, an exit velocity of 62.93 meters per second, and an inner diameter of 0.09 meter. Dredging was modeled with all of the same parameters as the North and South basins, but occurring 24 hours per day. The ferries were modeled as several point sources with a release height of 10 meters, an exit temperature of 550 Kelvin, an exit velocity of 23 meters per second, and an inner diameter of 0.07 meter. The ferries were modeled as having emissions from 6 a.m. through 9 p.m.

For all operational impacts, a weighted ASF of 1.7 was used, as recommended by BAAQMD (2012).[5] A daily breathing rate of 581 L/kg per day was used for construction impacts, and a daily breathing rate of 302 L/kg per day for operational impacts.

The detailed health risk assessment also assumed that Mitigation Measure AQ-2 would be implemented, thereby reducing construction emissions, as described in Section 1.2.4.

In addition, as described in Section 3.2.1, there are two types of residences near the project area. The existing residences are approximately 700 feet to the northwest, and a proposed new residential development—8 Washington—would be approximately 300 feet from the project area to the northwest. The 8 Washington Final EIR includes a mitigation measure that requires the removal of 80 percent of particulate matter from habitable areas through an air filtration system. Therefore, the detailed health risk assessment assumed that the residents at this future development would be exposed to a concentration 80 percent less than the DPM concentration calculated by the AERMOD model. It was assumed that the existing residences 700 feet from the project area do not have an air filtration system.

The proposed project emissions for construction from Section 1.2 were used, and Mitigation Measure AQ-2 was subsequently applied. The proposed project emissions from Table AIR-20 were used for operational emissions.

3.2.3.2 Detailed Health Risk Analysis Results

The health risks were calculated using the assumptions and methods described in Section 3.2.2.6 and Section 3.2.3.1. The results of the detailed health risk assessment are shown in Table AIR-25.

Table AIR-25
Summary of the Project's Carcinogenic Risks from the Detailed Health Risk Assessment (per million)

	Carcinogenic Risks from Construction (per million)	Carcinogenic Risks from Operation (per million)
Existing Residences (700 feet from project area)	9.26	0.6
School	4.9	2.4
BAAQMD Significance Level	**10**	**10**

Notes:
The results presented here are from a more detailed analysis that was conducted to assess risks for these sensitive receptors. The detailed assessment considered hourly wind data, locations of emissions sources, locations of receptors, terrain data, and nearby building dimensions, implementation of Mitigation Measures AQ-1 and AQ-2, and more detailed information on the residential receptors.
The estimated risks for the existing residential area were higher than the risks for the proposed residential area, and are therefore the results presented here.
The operation risks shown are for the proposed project (not the net increase in risk as compared to the No Action Alternative).

[5] Page 66 of the guidance states "For estimating cancer risk where the emissions do not vary by year, concentrations can simply be multiplied by a cumulative age sensitivity factor of 1.7 that incorporates the overall variations in age sensitivity factors."

3.2.4 Cumulative Health Risk

The cumulative health risk analysis is conducted for the project, and results are compared to the BAAQMD's thresholds for cumulative effects:

- An excess lifetime cancer risk level of more than 100 in one million;
- A chronic noncancer HI greater than 10; and
- An incremental increase in the annual average $PM_{2.5}$ of greater than 0.8 μg/m^3.

The incremental increase in $PM_{2.5}$ concentrations, incremental cancer risk, and chronic HI from all past, present, and foreseeable future sources (including stationary sources) within a 1,000-foot radius from the project area, plus the contribution from the project, are analyzed for the cumulative health risk assessment. Sources within 1,000 feet of the project area are presented in Table AIR-26.

Table AIR-26
Summary of the Project's Cumulative Health Risks for Maximally Impacted Receptor (Residential)

Emission Sources	Carcinogenic Risk (per million)	Chronic Hazard Index (unitless)	$PM_{2.5}$ Concentration (μg/m^3)
Proposed Project Construction	9.3	0.1	0.17
Proposed Project Operation	0.6	0.0015	0.007
AMB Property	9.29	0.00328	0.00214
Paramount One	0.09	0.001	0.176
Hotel Vitale	2.79	0.01067	0.00289
Davis Cleaners	7.49	0	0
Equity Office/Ferry Building[1]	34.5	0.012	0.061
The Embarcadero[2,3]	6.59	< 0.02	0.276
Market Street[2,4]	0.51	< 0.02	0.016
Mission Street [2,4]	0.51	< 0.02	0.016
Total	71.7	0.19	0.73
BAAQMD Significance Level	**100 per million**	**10**	**0.8 μg/m^3**
Exceed Significance?	No	No	No

Source: BAAQMD 2012b.

1 Ferry Building risk is scaled using BAAQMD "Diesel Internal Combustion (IC) Engine Distance Multiplier Tool," and assuming the residences are more than 164 feet from the Ferry Building.

2 Roadway volumes are estimated as recommended by BAAQMD from: http://www.ehib.org/traffic_tool.jsp.

3 It is assumed that The Embarcadero is a north-south roadway, and more than 10 feet from the residences northwest of the project area.

4 It is assumed that Market Street and Mission Street are north-south roadways, and more than 700 feet from the residences northwest of the project area.

μg/m_3 = micrograms per cubic meter

$PM_{2.5}$ = particulate matter equal to or less than 2.5 micrometers in diameter

The screening $PM_{2.5}$ concentration, cancer risks, and chronic hazards values for permitted stationary sources were obtained from the BAAQMD county-specific kml files for Google EarthTM (BAAQMD, 2012b); values for roadway sources were obtained from the BAAQMD-recommended roadway volumes tool and risk tables. These data included $PM_{2.5}$ concentrations, cancer risks, and hazards values. Table AIR-26 shows these cumulative values from all sources within a 1,000-foot buffer zone of the project area. The cumulative values include the maximum project $PM_{2.5}$, chronic, and carcinogenic risk operational values.

As shown in the table, the maximum project cumulative operational values would result in a $PM_{2.5}$ concentration of 0.72 $\mu g/m^3$, a cancer risk of 72 in one million, and a chronic hazard index of 0.13.

4.0 REFERENCES

BAAQMD (Bay Area Air Quality Management District), 2013. Letter to Michael Gougherty, WETA Project Manager. Subject: Downtown San Francisco Ferry Terminal Expansion Project Draft Environmental Impact Statement/Environmental Impact Report. July 30.

BAAQMD (Bay Area Air Quality Management District), 2012a. Recommended Methods for Screening and Modeling Local Risks and Hazards. Available online at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/Risk%20Modeling%20Approach%20May%202012.ashx?la=en. Accessed September 2013.

BAAQMD (Bay Area Air Quality Management District), 2012b. Stationary Source and Highways Screening Analysis Tool. Available: Available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Accessed October 2012.

BAAQMD (Bay Area Air Quality Management District), 2011. CEQA Air Quality Guidelines. Update May 2011. Available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Updated-CEQA-Guidelines.aspx.

CARB (California Air Resources Board), 2012. Appendix B of the Commercial Harbor Craft Emissions Model, *Emissions Estimation Methodology for Commercial Harbor Craft Operating in California*. Available online at: http://www.arb.ca.gov/msei/categories.htm#chc_category. Revised: February 2012.

CARB (California Air Resources Board), 2011. Commercial Harbor Craft Emissions Model - California Barge and Dredge Emissions Inventory Database. Available online at: http://www.arb.ca.gov/msei/categories.htm#chc_category.

CARB (California Air Resources Board), 2006a. EMFAC2007 Model. Available online at: http://www.arb.ca.gov/msei/onroad/latest_version.htm. Accessed June 15, 2012.

CARB (California Air Resources Board), 2006b. OFFROAD2007 Model. Available online at: http://www.arb.ca.gov/msei/offroad/offroad.htm. December 15, 2006. Accessed June 15, 2012.

City and County of San Francisco, 2012. 8 Washington Street/Seawall Lot 351 Project Final EIR. January. Available online at: http://www.sf-planning.org/modules/ShowDocument.aspx?documentid=8540.

Jones & Stokes Associates, 2007. Software User's Guide: URBEMIS2007 for Windows, Version 9.2 Emissions Estimation for Land Use Development Projects. Prepared for: South Coast Air Quality Management District. Available online at: http://www.urbemis.com/software/download.html. Accessed July 15, 2012.

OEHHA (California Office of Environmental Health Hazard Assessment), 2003. Air Toxics Hot Spots Program Risk Assessment Guidelines. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Oakland, CA.

OEHHA (California Office of Environmental Health Hazard Assessment), 2011. Consolidated Table of OEHHA/ARB-Approved Risk Assessment Health Values. February 14.

U.S. EPA (U.S. Environmental Protection Agency), 2012a. Marine Compression-Ignition (CI) Engines – Exhaust Emission Standards. Available online at: http://www.epa.gov/otaq/standards/nonroad/marineci.htm. Accessed October 24, 2012.

U.S. EPA (U.S. Environmental Protection Agency), 2012b. Screening Models. Available online at: http://www.epa.gov/ttn/scram/dispersion_screening.htm#screen3. Accessed October 25, 2012.

WETA (Water Emergency Transportation Authority), 2003. Final Program Environmental Impact Report Expansion of Vessel Transit Service in the San Francisco Bay Area. Prepared by URS Corporation.