Appendix C

HEALTH RISK ASSESSMENT

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HEALTH RISK ASSESSMENT

Dispersion is the process by which atmospheric pollutants disseminate due to wind and vertical stability. The results of a dispersion analysis are used to assess pollutant concentrations at or near an emission source. Pollutant concentrations are then used to determine receptor exposure to toxic air contaminants (TACs) and associated risk.

Approach

The proposed Project includes a lease renewal that would allow the Project Applicants to continue sand mining in the San Francisco Bay and western Sacramento-San Joaquin Delta for an additional 10 years. Tugboats and dredge barge engines used for sand mining would emit diesel particulate matter (DPM), a known TAC. This study focuses on two different activities associated with sand mining: (1) sand mining events and (2) offloading events.

Generally emissions from mining events would occur offshore and would not impact a significant number of sensitive receptors. The mining parcel located near the most sensitive receptors is PRC 709.1 (South) (part of lease parcel PRC 709.1 [Presidio, Alcatraz North, and Point Knox North Shoals]). Therefore, mining operations on this parcel were modeled in order to capture the worst case risk to sensitive receptors that would occur from mining events.

Offloading events at Jerico offloading facilities were not modeled since Jerico would plug into shore electricity during offloading events, and therefore DPM emissions from engine operations would not be expected. However, Hanson would not utilize shore electricity; therefore, as described in more detail below, emissions from Hanson offloading events were modeled to determine worst case risk to receptors located near offloading facilities.

Emissions Estimates

Emissions from tug and barge engines were estimated based on data from the California Air Resources Board (CARB, 2007) as well as data provided by Project Applicants. Based on engine specifications provided, worst case emissions from mining would occur from use of Hanson's TS&G 230 dredge barge and the San Joaquin River Tug. This tugboat-dredge combination would emit up to 1.3 pounds of particulate matter per hour during mining events (see Appendix D, Air Quality for emissions calculations). It was assumed that all 1.3 pounds of particulate matter would be DPM as all engines would be diesel fueled.

For offloading events worst case emission would occur from use of Hanson's DS-10 dredge barge and American River Tug. During offloading events, the DS-10 would run all engines resulting in up to 0.7 pounds of DPM emissions per hour.

Dispersion Modeling Approach

The AERMOD dispersion model (Version 07026) was used for the modeling analysis. AERMOD is the USEPA preferred dispersion model for general industrial purposes. The AERMOD model is the appropriate model for this analysis based on the coverage of simple, intermediate, and complex terrain. It also predicts both short-term and long-term (annual) average concentrations.

The model was executed using the regulatory default options, default wind speed profile categories, default potential temperature gradients, and no pollutant decay.

As discussed previously, this study focuses on emissions from mining events and offloading events. Five different modeling scenarios were evaluated (one for mining in PRC 709 [South] and one for each of Hanson's offloading locations). Details on modeling assumptions for each scenario are described in more detail below.

Mining Events (PRC 709 [South])

Sand mining events generally last between three and 5.5 hours. Therefore to be conservative, emissions were modeled assuming that each mining event would last six hours. A single location was chosen and emissions were modeled assuming that one six-hour mining event would take place everyday in the same location for the entire year, which represents a conservative analysis. Since meteorology varies throughout the day, four scenarios were evaluated to determine maximum annual average onshore DPM concentrations (12 am to 6 am; 6 am to 12 pm; 12 pm to 6 pm; and 6 pm to 12 am).

Mining emissions were modeled as a single point source based on the assumption that once a suitable location is found that the barge would remain relatively stationary throughout the mining event. Table 1 below shows stack parameter assumptions used to model mining events in AERMOD.

Table C-1
Source Parameters for Mining Event

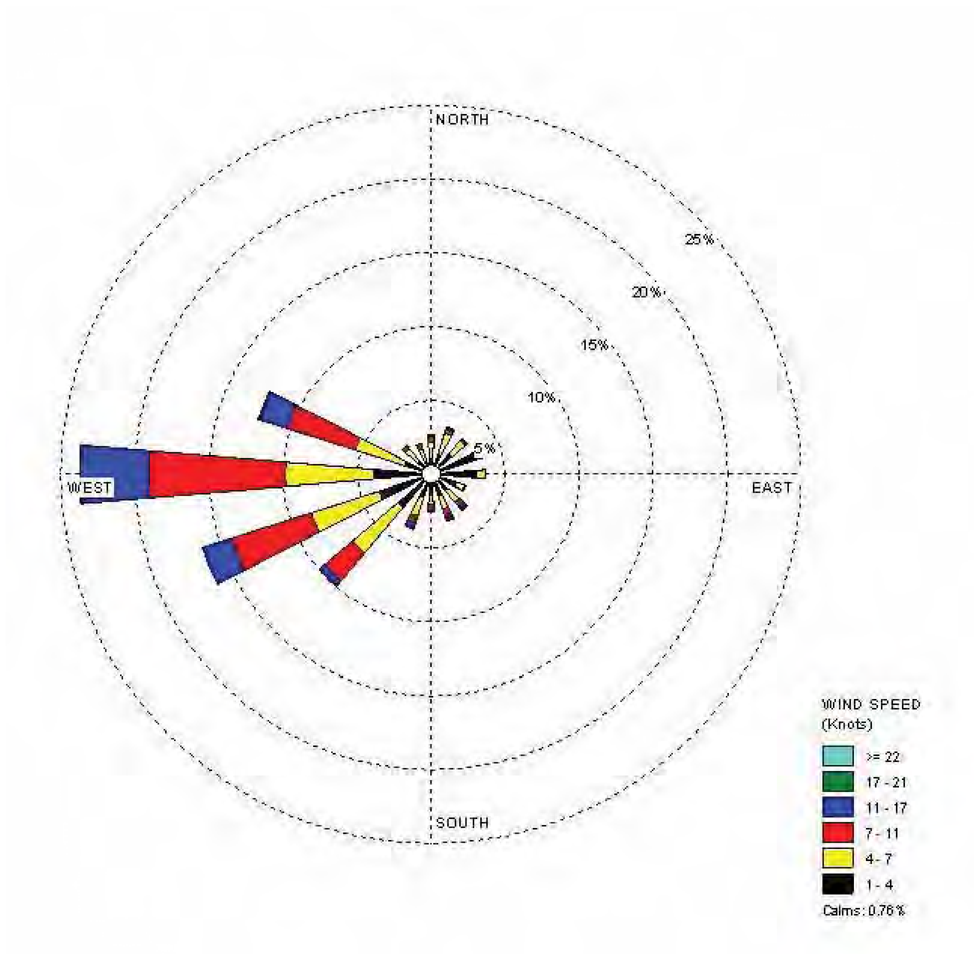
Source Type	Release Height	Gas Exit Temperature	Gas Exit Velocity	Stack Diameter
Point	10 meters	618 Kelvin	16 meters/second	0.5 meters

Source: CARB, 2006.

A uniform Cartesian receptor grid with 100 meter by 100 meter spacing was used to model pollutant concentrations at and near the source. Receptors were modeled at ground level breathing height. Terrain elevations for receptor locations were determined based on data from the USGS 7.5 minute San Francisco North digital elevation model (DEM).

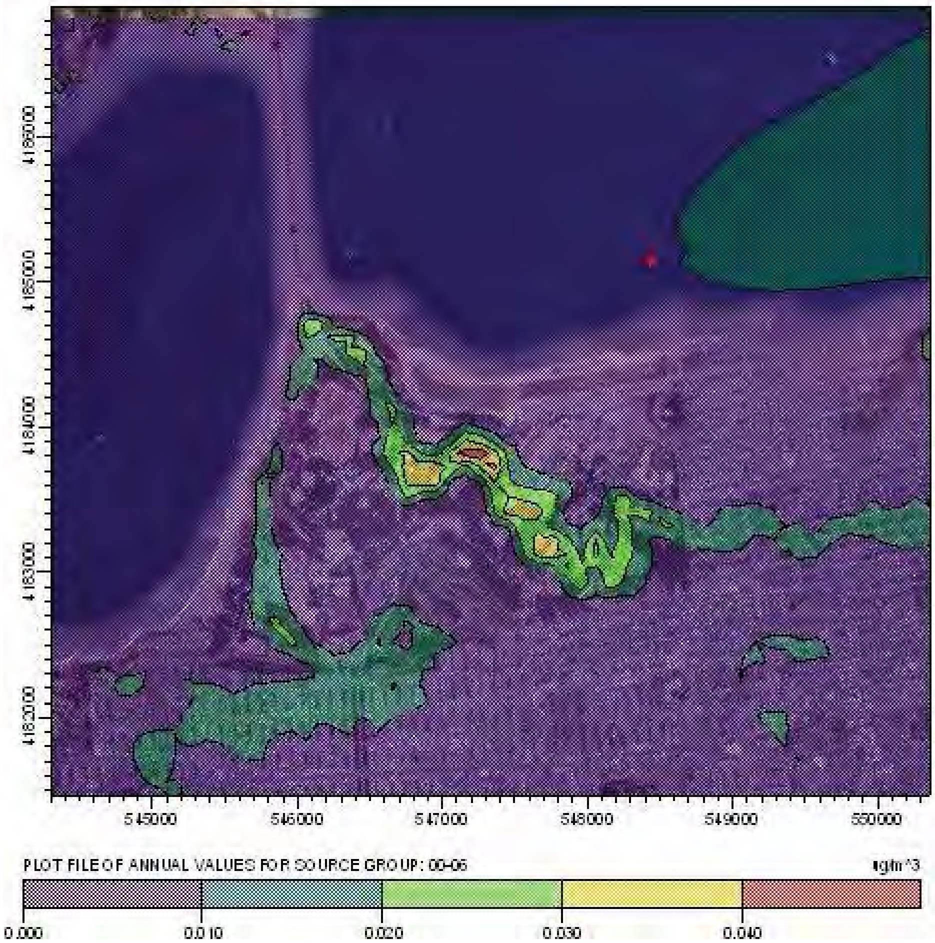
Surface meteorological data from BAAQMD's Mission Bay meteorological station was used along with upper air meteorological data from the Oakland Airport for the modeling analysis. Figure 1 presents the annual wind rose for the Mission Bay meteorological station for the year 2004.

Figure C-1
Mission Bay Wind Rose – Wind Direction Blowing From



Based on the modeling output, the maximum onshore annual average DPM concentrations would result from mining events occurring between 12 am and 6 am. Figure 2 demonstrates annual average concentrations of DPM expressed in micrograms per cubic meter (µg/m^3). As shown, annual average DPM concentrations onshore could be up to 0.05 µg/m^3. It should be noted that this represents a worst case analysis which assumes that mining would occur in the same location over the duration of the Project when in fact mining events would occur at various locations throughout the Bay over the life of the project.

Figure C-2
Mining Events in Parcel PRC 709.1 South – DPM Concentrations



Offloading Events

Hanson's offloading events generally last four hours. Since meteorology varies throughout the day, six scenarios were evaluated to determine maximum annual average DPM concentrations at and near Hanson's offloading locations (12 am to 4 am; 4 am to 8 am; 8 am to 12 pm; 12 pm to 4 pm; 4 pm to 8 pm; and 8 pm to 12 am). It was assumed that one mining event would occur per day at each location for the entire year. This represents a conservative analysis.

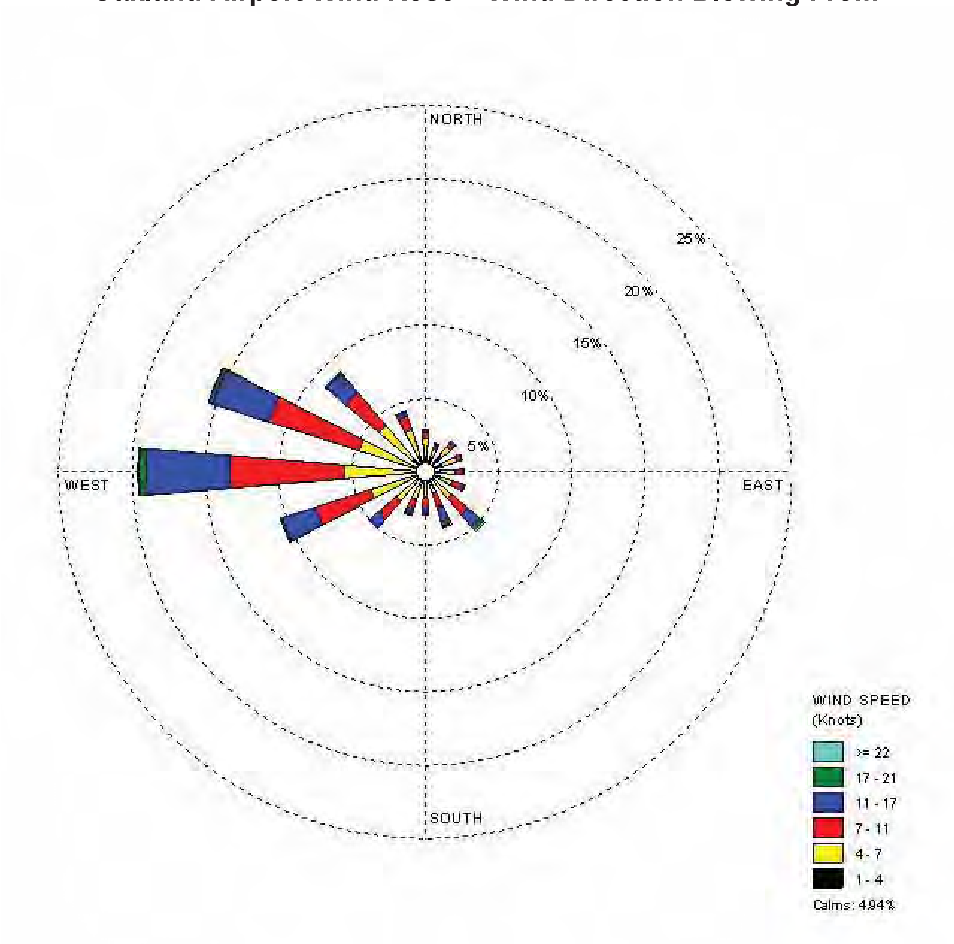
Offloading emissions were modeled as a single point source using the same source parameters as listed above in Table 1. Receptors were modeled using a uniform Cartesian receptor grid with 100 meter by 100 meter spacing. Emissions at each of the four offloading locations were modeled using representative meteorological data. Detailed information on offloading locations, meteorological data used and model output for each location is provided below.

Oakland Facility

The Oakland offloading facility is located at 4501 Tidewater Avenue in Oakland, California. Receptor heights were obtained from the USGS 7.5 minute Oakland East and Oakland West DEMs as well as the USGS 1 degree San Francisco DEM.

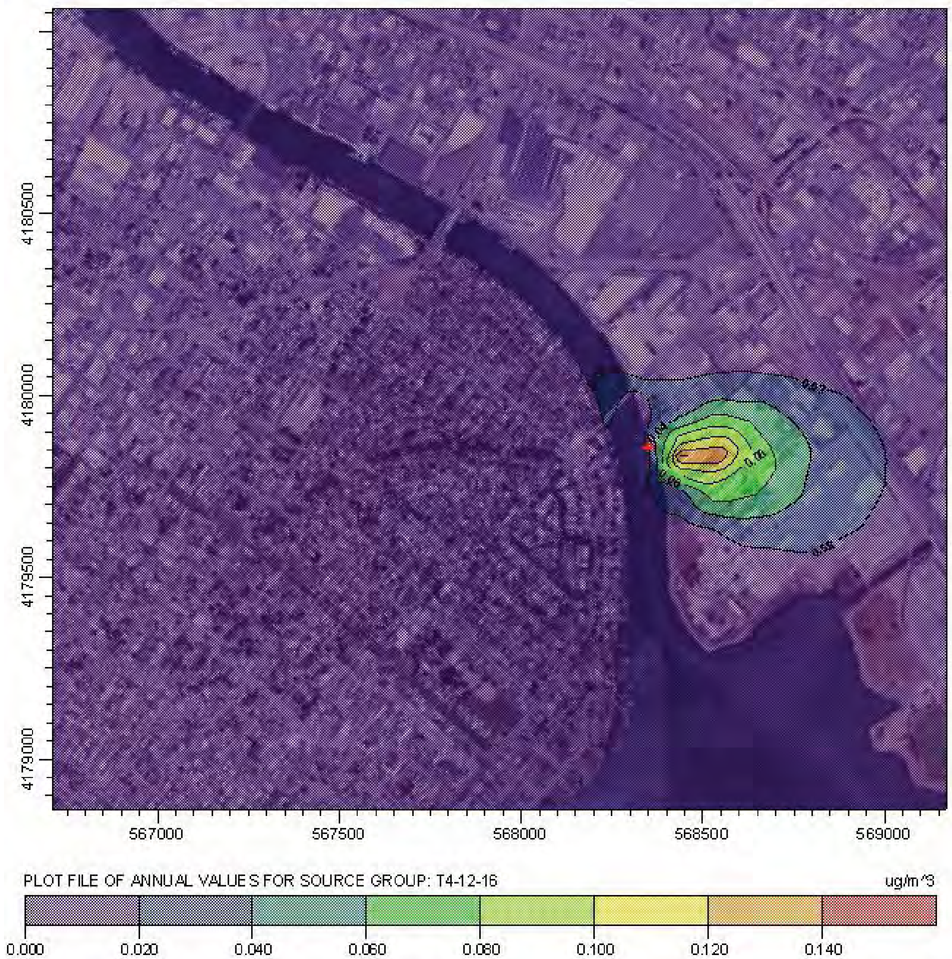
Surface and upper air meteorological data from the Oakland Airport meteorological station was used to model emissions at the Oakland facility. Figure 3 presents the annual wind rose for the Oakland Airport from 1998 through 2001.

Figure C-3
Oakland Airport Wind Rose – Wind Direction Blowing From



Based on modeling output, the maximum annual average concentrations of DPM would result from offloading events taking place between 12 pm and 4 pm. Figure 4 demonstrates the maximum concentrations from this scenario. As shown in the figure, concentrations at the maximum exposed receptors would be approximately 0.14 $\mu g/m^3$. The receptors affected by this concentration were assumed to be worker receptors due to the industrial nature of the affected area.

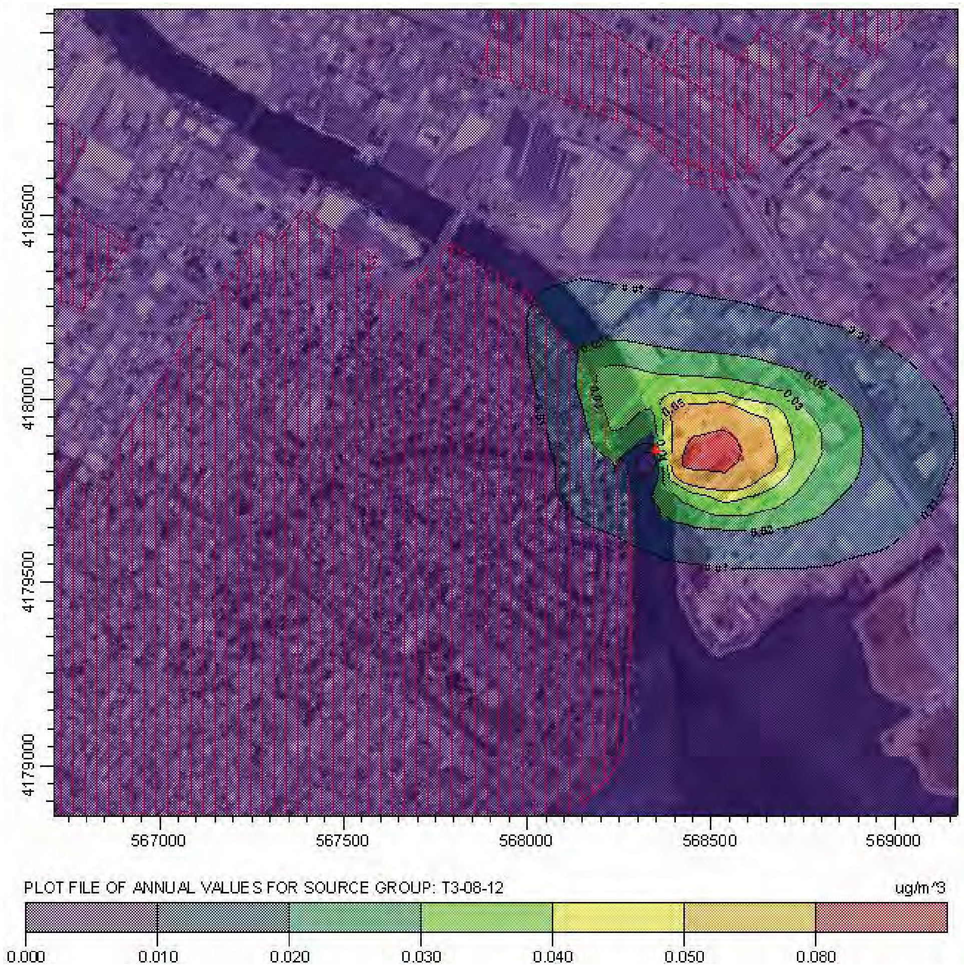
Figure C-4
Oakland Offloading Facility – DPM Concentrations (Maximum)



While the overall maximum concentration would occur at worker receptors as a result of activities between 12 pm and 4 pm, the maximum concentration at a residential receptor would result from activities between 8 am and 12 pm. Figure 5 shows concentrations at the maximum exposed residents. As shown, the maximum exposed resident would be exposed to an annual average DPM concentration of up to 0.4 $\mu g/m^3$.

Hanson also has another off-loading facility on the Oakland estuary, at 5th and Embarcadero. This facility is currently closed, but Hanson may reopen it in the future. Based on the lack of sensitive receptors within close proximity to this facility (the nearest residential receptors downwind of the facility are about ½ mile away, on the opposite side of the I-880 freeway), and the similarity of the meteorology and topography to the Tidewater facility, residential exposures from offloading activities at the 5th and Embarcadero facility, should it be re-opened, can be expected to be lower than those from the Tidewater facility.

Figure C-5
Oakland Offloading Facility – DPM Concentrations (Resident)



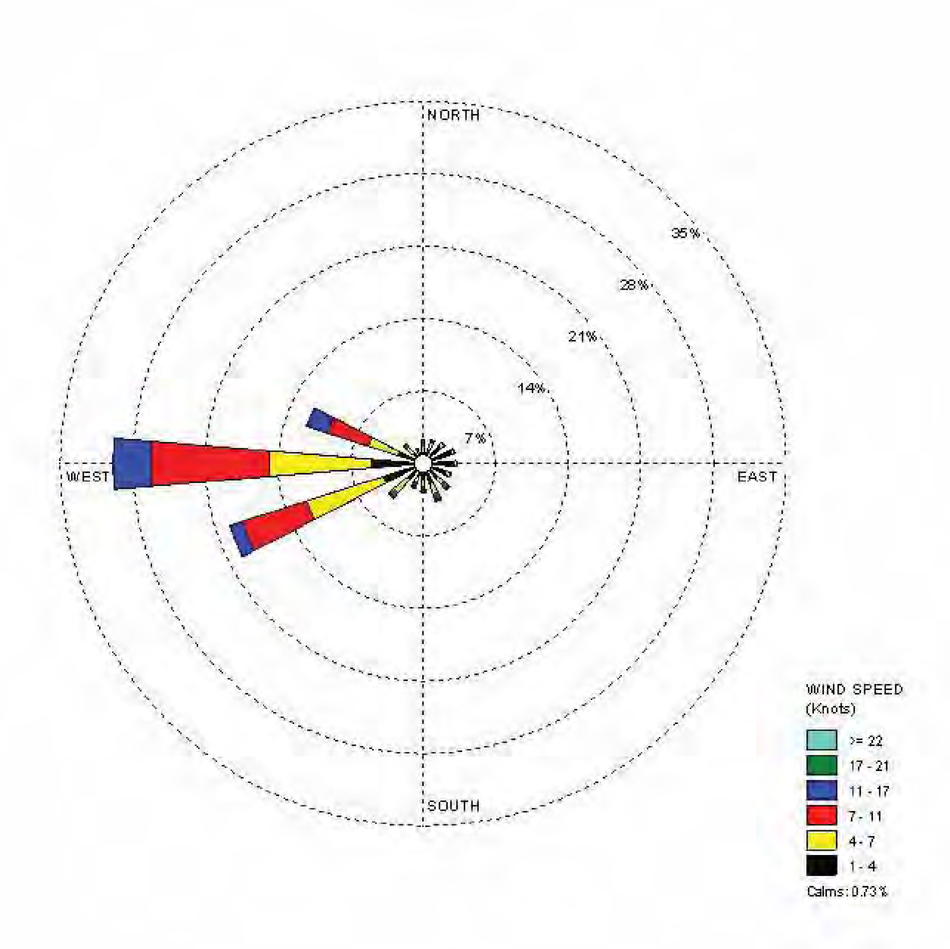
Note: Vertical red lines represent areas with residential uses.

San Francisco Facility

The San Francisco facility is located at 480 Amador Street in San Francisco, California. Receptor heights for this facility were obtained from the USGS 1 degree San Francisco DEM.

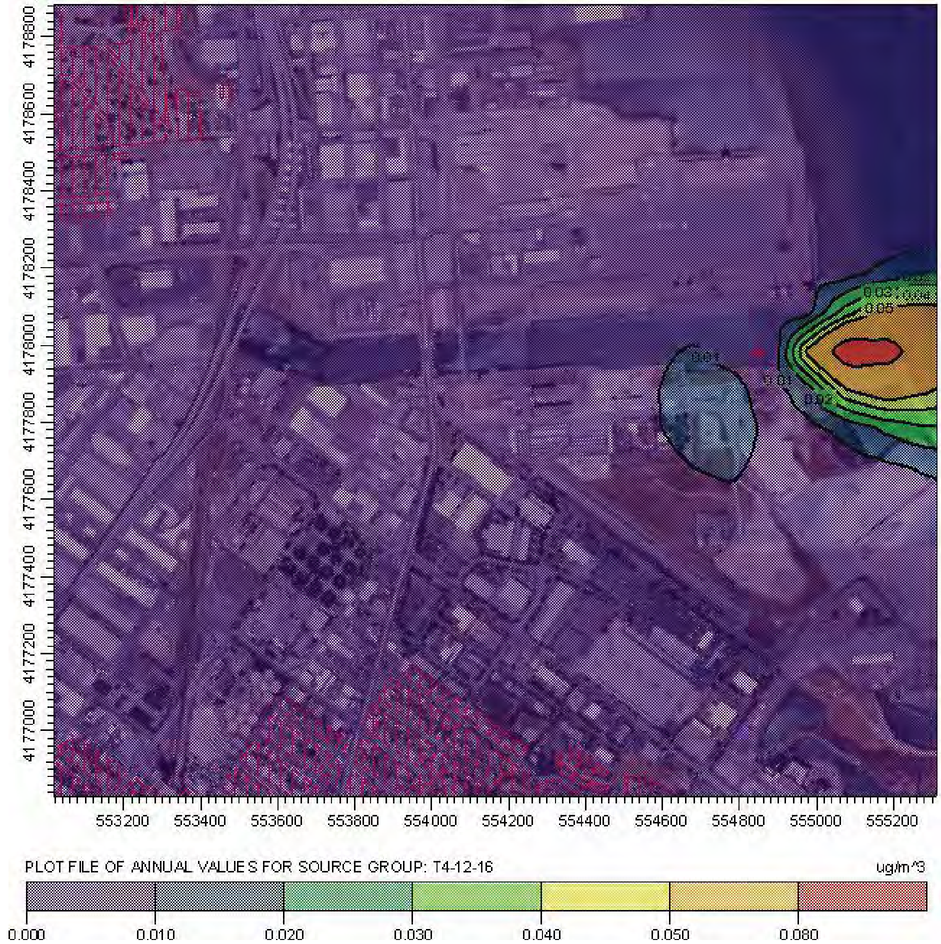
Surface meteorological data from BAAQMD's meteorological station at the San Francisco Sewage Treatment Plant and upper air meteorological data from the Oakland Airport meteorological station were used to model emissions at the San Francisco offloading facility. Figure 6 presents the annual wind rose for the San Francisco Sewage Treatment Plant for the year 2004.

Figure C-6
San Francisco Sewage Treatment Plant Wind Rose – Wind Direction Blowing From



Based on modeling output, the maximum onshore annual average concentrations of DPM would result from activities taking place between 12 pm and 4 pm. Figure 7 demonstrates the maximum concentrations from this scenario. As shown in the figure, annual average concentrations of DPM at the maximum exposed receptor would be approximately 0.05 $\mu g/m^3$ and the nearest residents would be exposed to concentrations of 0.01 $\mu g/m^3$ or less.

Figure C-7
San Francisco Offloading Facility – DPM Concentrations



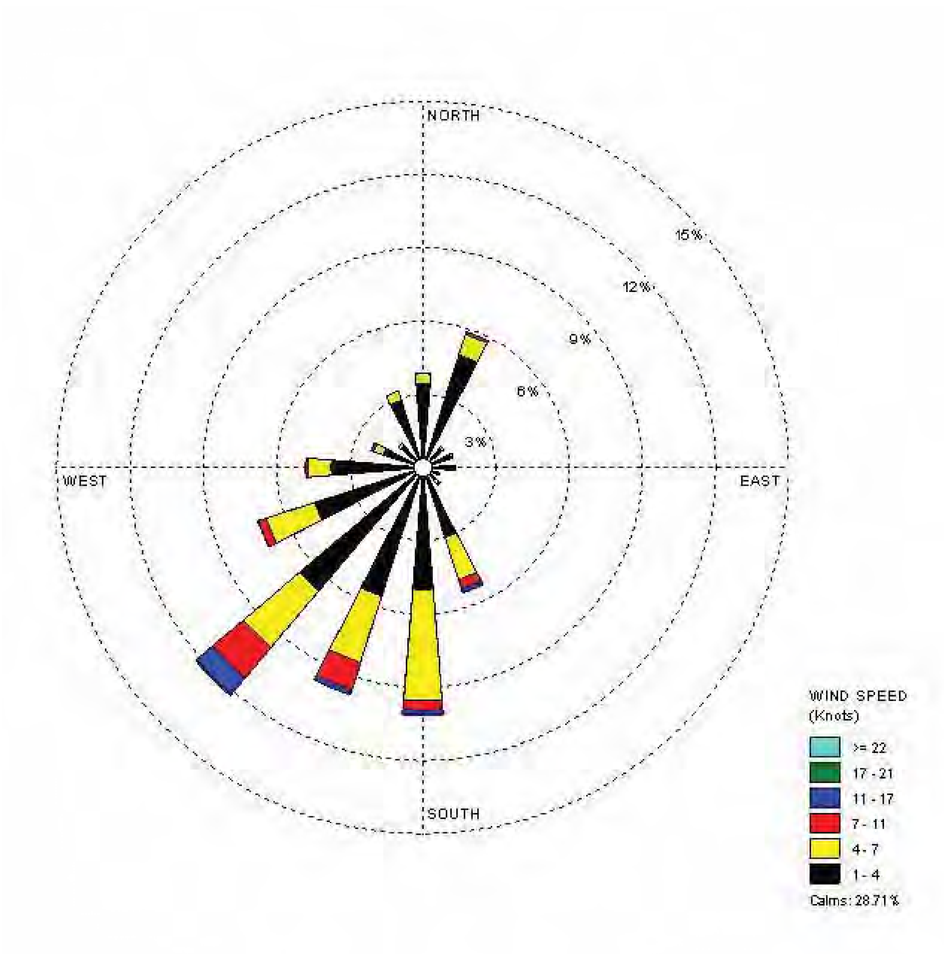
Note: Vertical red lines represent areas with residential uses.

San Rafael Facility

The San Rafael offloading facility is located near the San Rafael Rock Quarry at 1000 Point San Pedro Road in San Rafael, California. Receptor heights for this facility were obtained from the USGS 1 degree San Francisco DEM and the 1 degree Santa Rosa DEM.

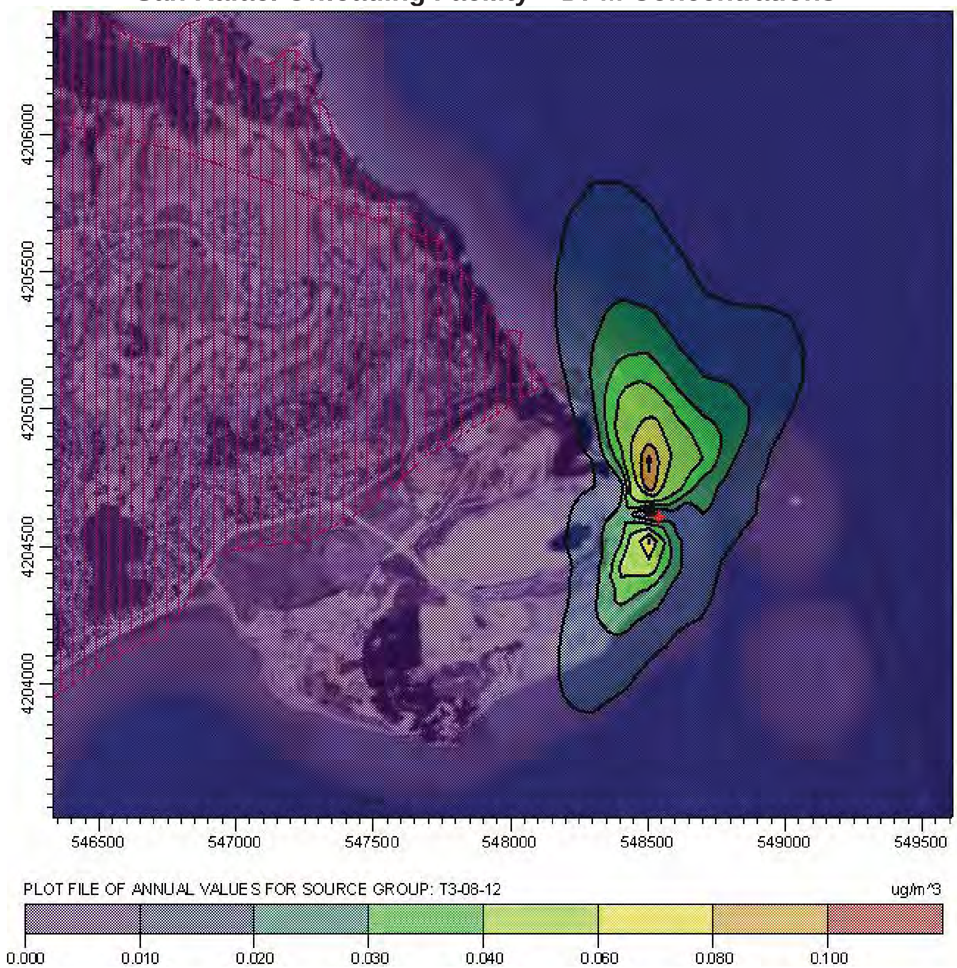
Surface meteorological data from the San Rafael Rock Quarry and upper air meteorological data from the Oakland Airport meteorological station were used to model emissions at the San Rafael facility. Figure 8 presents the annual wind rose for the San Rafael Rock Quarry from April 2004 through June 2005.

Figure C-8
San Rafael Rock Quarry Wind Rose – Wind Direction Blowing From



Based on modeling output, the maximum onshore annual average concentrations of DPM would result from offloading events taking place between 12 pm and 4 pm. Figure 9 demonstrates the maximum annual average DPM concentrations from this scenario. As shown in the figure, concentrations at the maximum exposed receptor would be approximately 0.10 $\mu g/m^3$ and the nearest residents would be exposed to concentrations of 0.01 $\mu g/m^3$ or less.

Figure C-9
San Rafael Offloading Facility – DPM Concentrations



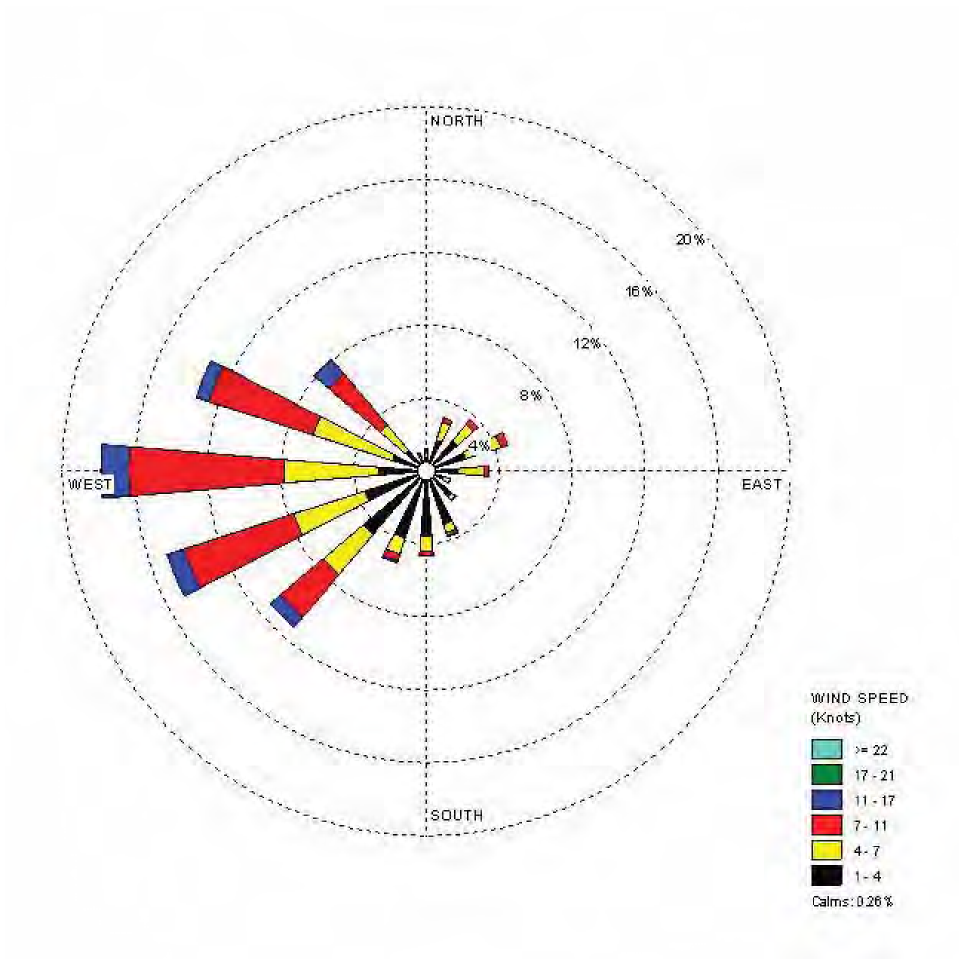
Note: Vertical red lines represent areas with residential uses.

Martinez Facility

The Martinez offloading facility is located at 1725 Marina Vista Avenue in Martinez, California. Receptor heights were obtained from the USGS 7.5 degree Benicia and Vine Hill DEMs.

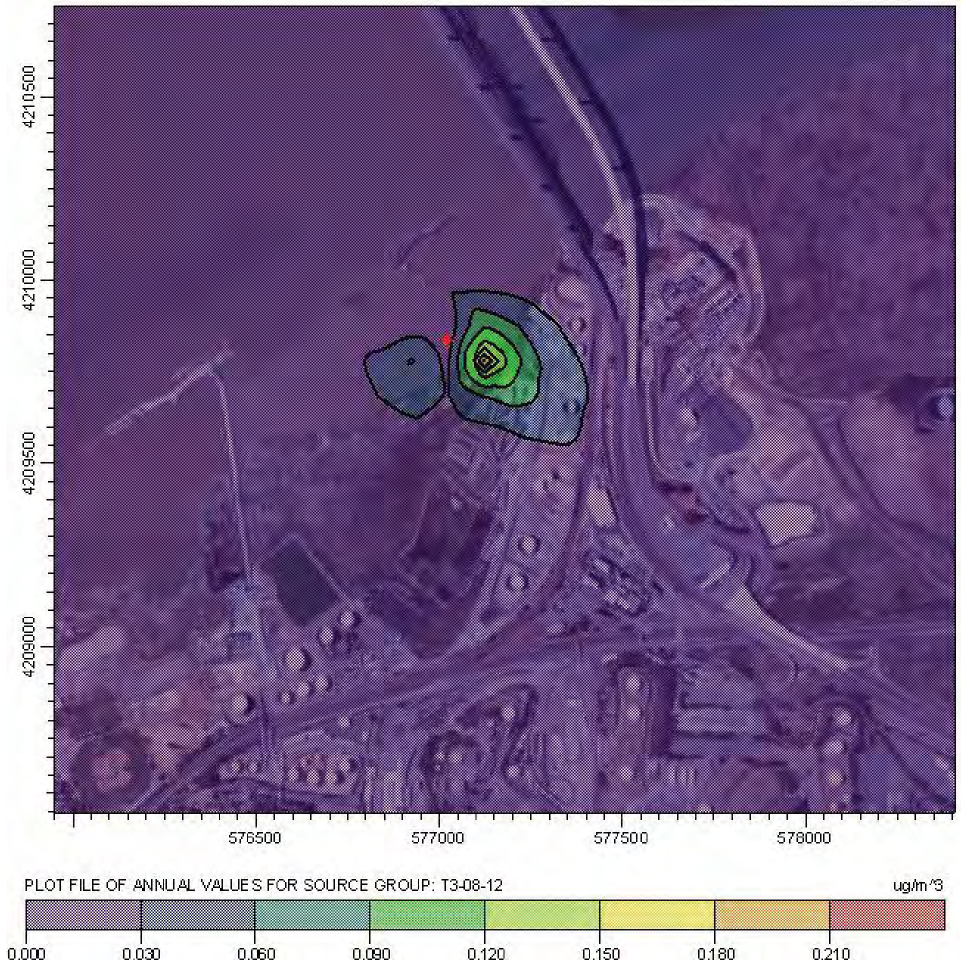
Surface meteorological data from BAAQMD's Shell West meteorological station and upper air meteorological data from the Oakland Airport meteorological station were used to model emissions at the Martinez offloading facility. Figure 10 presents the annual wind rose for the Shell West Station for the year 2004.

Figure C-10
Shell West Wind Rose – Wind Direction Blowing From



Based on modeling output, the maximum onshore concentrations of DPM would result from offloading events taking place between 8 am and 12 pm. Figure 11 demonstrates the maximum concentrations from this scenario. As shown in the figure, concentrations at the maximum exposed receptor would be approximately 0.21 $\mu g/m^3$. No residences have been identified in the vicinity of the Martinez offloading facility.

Figure C-11
Martinez Offloading Facility – DPM Concentrations



RISK CHARACTERIZATION

The maximum incremental cancer risk from exposure to DPM was calculated following the guidelines established by California Office of Environmental Health Hazard Assessment (OEHHA, 2003). The equation used to determine exposure to DPM through inhalation is demonstrated below:

$$\text{Dose-inhalation} = \frac{C_{air} * \{DBR\} * A * EF * ED * 10^{-6}}{AT}$$

Where:

Dose-inh = Dose of the toxic substance through inhalation in milligrams per kilogram of body weight per day (mg/kg-day)

10^{-6} = Micrograms to milligrams conversion, Liters to cubic meters conversion

C_{air} = Concentration in air ($\mu g/m^3$)

{DBR} = Daily breathing rate (L/kg body weight – day)

A	= Inhalation absorption factor
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
AT	= Averaging time period over which exposure is averaged in days (25,550 days for a 70 year cancer risk)

The dose through inhalation calculation shown above yields a value that represents the quantity of a substance inhaled by an individual expressed in milligrams per kilogram of body weight per day (mg/kg-day). To determine cancer risk, the dose through inhalation is multiplied by a cancer potency slope factor of the particular TAC which has the unit $(mg/kg\text{-}day)^{-1}$. Therefore, multiplying the estimated dose by the cancer potency slope factor yields a unitless value that represents chances per million of an individual developing cancer from exposure to a given TAC.

Concentrations at maximum exposed residents and workers described previously were used to determine incremental cancer risk from the proposed Project. The exposure duration was assumed to be 10 years as the proposed Project includes a 10 year permit renewal. OEHHA recommends that for 9-year residential exposure durations that the 95th percentile child breathing rate of 581 L/kg-day be used to determine risk. Therefore, risk at residential receptors was analyzed using both the high-end child breathing rate as well as the 80th percentile adult breathing rate of 302 L/kg-day. Exposure frequency for residents was assumed to be 350 days per year. For worker receptors, the OEHHA recommended breathing rate of 149 L/kg-day and the recommended exposure frequency of 245 days per year (49 weeks per year, 5 days per week) were assumed. The OEHHA recommended cancer potency slope of 1.1 (mg/kg-day)$^{-}$1 for DPM was used to determine risk. Table 2 presents estimated risk based on these assumptions. As shown in the table, risk would not exceed the BAAQMD recommended significance threshold of 10 in one million. Thus, the impacts would be less than significant at all locations.

Table C-2
Cancer Risk from Exposure to DPM

Location	DPM Concentration		Residential Risk [a]		Worker Risk
	Resident	Worker	High End	Average	
Mining (PRC 709.1 South)	0.05 μg/m^3	0.05 μg/m^3	4.4	2.3	0.8
Oakland	0.04 μg/m^3	0.14 μg/m^3	3.5	1.8	2.2
San Francisco	0.01 μg/m^3	0.06 μg/m^3	0.9	0.5	0.9
San Rafael	0.01 μg/m^3	0.10 μg/m^3	0.9	0.5	1.6
Martinez	NA	0.21 μg/m^3	NA	NA	3.3

[a] High end risk assumes the 95th percentile child breathing rate of 581 L/kg-day while average risk assumes the 80th percentile adult breathing rate of 302 L/kg-day.

References

California Air Resources Board (CARB), 2006. *Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach*. April 2006.

CARB, 2007. *Technical Support Document: Initial Statement of Reason for Proposed Rule Making, Proposed Regulation for Commercial Harbor Crafts, Appendix B*, September 2007.

Office of Environmental Health Hazards Assessment (OEHHA), 2003. *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments,* available online at: http://www.oehha.org/air/hot_spots/pdf/HRAguidefinal.pdf, August 2003.