APPENDIX E
Health Risk Assessment

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Permanente Quarry Health Risk Assessment

A health risk assessment (HRA) is accomplished in four steps; hazards identification, exposure assessment, toxicity assessment, and risk characterization. These steps cover the estimation of air emissions, the estimation of the air concentrations resulting from a dispersion analysis, the incorporation of the toxicity of the pollutants emitted, and the characterization of the risk based on exposure parameters such as breathing rate, age adjustment factors, and exposure duration; each depending on receptor type.

The HRA was conducted in accordance with technical guidelines developed by federal, state, and regional agencies, including US Environmental Protection Agency (USEPA), California Environmental Protection Agency (CalEPA), California Office of Environmental Health Hazard Assessment (OEHHA) *Air Toxics Hot Spots Program Guidance*[1], and the BAAQMD's *Health Risk Screening Analysis Guidelines*.[2]

TERMS AND DEFINITIONS

As the practice of conducting a HRA is particularly complex and involves concepts that are not altogether familiar to most people, several terms and definitions are provided that are considered essential to the understanding of the approach, methodology and results:

Acute effect – a health effect (non-cancer) produced within a short period of time (few minutes to several days) following an exposure to toxic air contaminants (TAC).

Cancer risk – the probability of an individual contracting cancer from a lifetime (i.e., 70 year) exposure to TAC in the ambient air.

Chronic effect – a health effect (non-cancer) produced from a continuous exposure occurring over an extended period of time (weeks, months, years).

Hazard Index (HI) – the unitless ratio of an exposure level over the acceptable reference dose (RfC). The HI can be applied to multiple compounds in an additive manner.

Hazard Quotient (HQ) – the unitless ratio of an exposure level over the acceptable reference dose (RfC). The HQ is applied to individual compounds.

Toxic air contaminants (TAC) – any air pollutant that is capable of causing short-term (acute) and/or long-term (chronic or carcinogenic, i.e., cancer causing) adverse human health effects (i.e., injury or illness). The current California list of TAC lists approximately 200 compounds, including particulate emissions from diesel-fueled engines.

Human Health Effects - comprise disorders such as eye watering, respiratory or heart ailments, and other (i.e., non-cancer) related diseases.

Health Risk Assessment (HRA) – an analysis designed to predict the generation and dispersion of TAC in the outdoor environment, evaluate the potential for exposure of

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[1] Office of Environmental Health Hazard Assessment (OEHHA), 2003. *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, http://www.oehha.org/air/hot_spots/pdf/HRAguidefinal.pdf

[2] Bay Area Air Quality Management District (BAAQMD), 2005. *BAAQMD Health Risk Screening Analysis Guidelines (http://www.baaqmd.gov/pmt/air_toxics/risk_procedures_policies/hrsa_guidelines.pdf)*, June 2005.

human populations, and to assess and quantify both the individual and population-wide health risks associated with those levels of exposure.

Incremental – under CEQA, the net difference (or change) in conditions or impacts when comparing the baseline to future year project conditions.

Maximum exposed individual (MEI) – an individual assumed to be located at the point where the highest concentrations of TAC, and therefore, health risks are predicted to occur.

Non-cancer risks – health risks such as eye watering, respiratory or heart ailments, and other non-cancer related diseases.

Receptors – the locations where potential health impacts or risks are predicted (schools, residences and work-sites).

LIMITATIONS AND UNCERTAINTIES

There are a number of important limitations and uncertainties commonly associated with a HRA due to the wide variability of human exposures to TACs, the extended timeframes over which the exposures are evaluated and the inability to verify the results. Among these challenges are the following:

- The current guidance and methodologies for modeling TACs and conducting a HRA are principally intended and designed to assess “stationary point” (i.e., smokestack) sources of air emissions. By comparison, this quarry is an assemblage of stationary sources, moving (or “mobile”) “line” sources (i.e., roadways) and “area” sources (i.e., quarry onsite mobile equipment).

- TAC speciation profile data are based upon limited sampling test data. Therefore, the TAC emissions and the predicted ambient concentrations of these pollutants from emission sources are not entirely reliable.

- The HRA exposure estimates do not take into account that people do not usually reside at the same location for 70 years and that other exposures (i.e., school children) are also of much shorter durations than was assumed in this analysis. Therefore, the results of the HRA are highly overstated for those cases.

- Other limitations and uncertainties associated with HRA and identified by the CalEPA include: (a.) lack of reliable monitoring data; (b.) extrapolation of toxicity data in animals to humans; (c.) estimation errors in calculating TACs emissions; (d.) concentration prediction errors with dispersion models; and (e.) the variability in lifestyles, fitness and other confounding factors of the human population.

HAZARDS IDENTIFICATION

TAC emissions associated with the Project would occur from the following project activities:

- Fugitive dust emissions from drilling, blasting, and grading/loading activities
- Fugitive dust emissions from traffic on unpaved roads and wind erosion
- Diesel particulate matter (DPM) emissions from off-road equipment exhaust

- DPM emissions from haul truck exhaust

The primary TAC of interest is DPM, which is described within the following section. However, additional air toxics such as crystalline silica and certain metals are also emitted by the Project and are included in the HRA.

Diesel Particulate Matter

Diesel exhaust is a complex mixture of thousands of individual gaseous and particulate compounds emitted from diesel-fueled combustion engines. DPM is formed primarily through the incomplete combustion of diesel fuel. Particulate matter in diesel exhaust can be emitted from on- and off-road vehicles, stationary area sources, and stationary point sources. DPM is removed from the atmosphere through physical processes including atmospheric fall-out and washout by rain. Humans can be exposed to airborne DPM or by deposition on water, soil, and vegetation. Acute inhalation exposure to elevated DPM has shown increased symptoms of irritation, cough, phlegm, chronic bronchitis, and inhibited pulmonary function. The USEPA has concluded that DPM is likely to be carcinogenic to humans by inhalation.

Diesel particulates, as defined by most emission standards, are sampled from diluted and cooled exhaust gases. This definition includes both solids and liquid material that condenses during the dilution process. The basic fractions of DPM are elemental carbon; heavy hydrocarbons derived from the fuel and lubricating oil and hydrated sulfuric acid derived from the fuel sulfur. Diesel particulates contain a large portion of the polycyclic aromatic hydrocarbons (PAH) found in diesel exhaust. Diesel particulates include small nuclei mode particles of diameters below 0.04 microns (µm) and their agglomerates of diameters up to 1 µm. Ambient exposures to diesel particulates in California are significant fractions of total TAC levels.

In August 1998, the California Air Resource Board (CARB) identified diesel PM as a TAC. The CARB developed *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles and Risk Management Guidance for the Permitting of New Stationary Diesel-Fueled Engines* and approved these documents on September 28, 2000. The documents represent proposals to reduce DPM emissions, with the goal of reducing emissions and the associated health risk by 75 percent in 2010 and by 85 percent in 2020. The program aims to require the use of state-of-the-art catalyzed DPM filters and ultra-low-sulfur diesel fuel.

In December 2000, the EPA promulgated regulations requiring that the sulfur content in motor vehicle diesel fuel be reduced to less than 15 parts per million (ppm) by June 1, 2006. Control of DPM emissions focuses on two strategies, reducing the amount of sulfur in diesel fuel and developing filters for operating diesel engines to reduce the amount of particulate matter that is emitted. The EPA also finalized a comprehensive national emissions control program which regulates highway heavy-duty vehicles and diesel fuel as a single system. Finally, the EPA established new motor-related emission standards that should significantly reduce PM and nitrogen oxides (NOx) from highway heavy-duty vehicles.

In 2001, CARB assessed the state-wide health risks from exposure to diesel exhaust and to other toxic air contaminants. It is difficult to distinguish the health risks of diesel emissions from those of other air toxics, since diesel exhaust contains approximately 40 different TACs. The CARB study detected diesel exhaust by using ambient air carbon soot measurements as a surrogate for diesel emissions. The study reported that in 2000, the state-wide cancer risk from exposure to diesel exhaust was about 540 per million population as compared to a total risk for exposure to all ambient air toxics of 760 per million. This estimate, which accounts for about 70 percent of the total risk from TACs, included both urban and rural areas in the state. The estimate can also be considered an average worst-case for the state, since it assumes constant exposure to outdoor concentrations of diesel exhaust and does not account for expected lower concentrations indoors, where most of time is spent.

Crystalline Silica

In 2005, the OEHHA added a chronic reference exposure level (REL) for crystalline silica. Silica is a hazardous substance when it is inhaled, and the airborne dust particles that are formed when the material containing the silica are broken, crushed, or sawn pose potential risks.

EXPOSURE ASSESSMENT

Dispersion is the process by which atmospheric pollutants circulate due to wind and vertical stability. The results of a dispersion analysis are used to assess pollutant concentrations at or near an emission source. The results of this analysis allow predicted concentrations of pollutants to be compared directly to air quality standards and other criteria such as health risks.

Dispersion Modeling Approach

This section presents the methodology used for the dispersion modeling analysis. This section addresses all of the fundamental components of an air dispersion modeling analysis including:

- Model selection and options
- Receptor locations
- Meteorological data
- Source release characteristics

Model Selection and Options

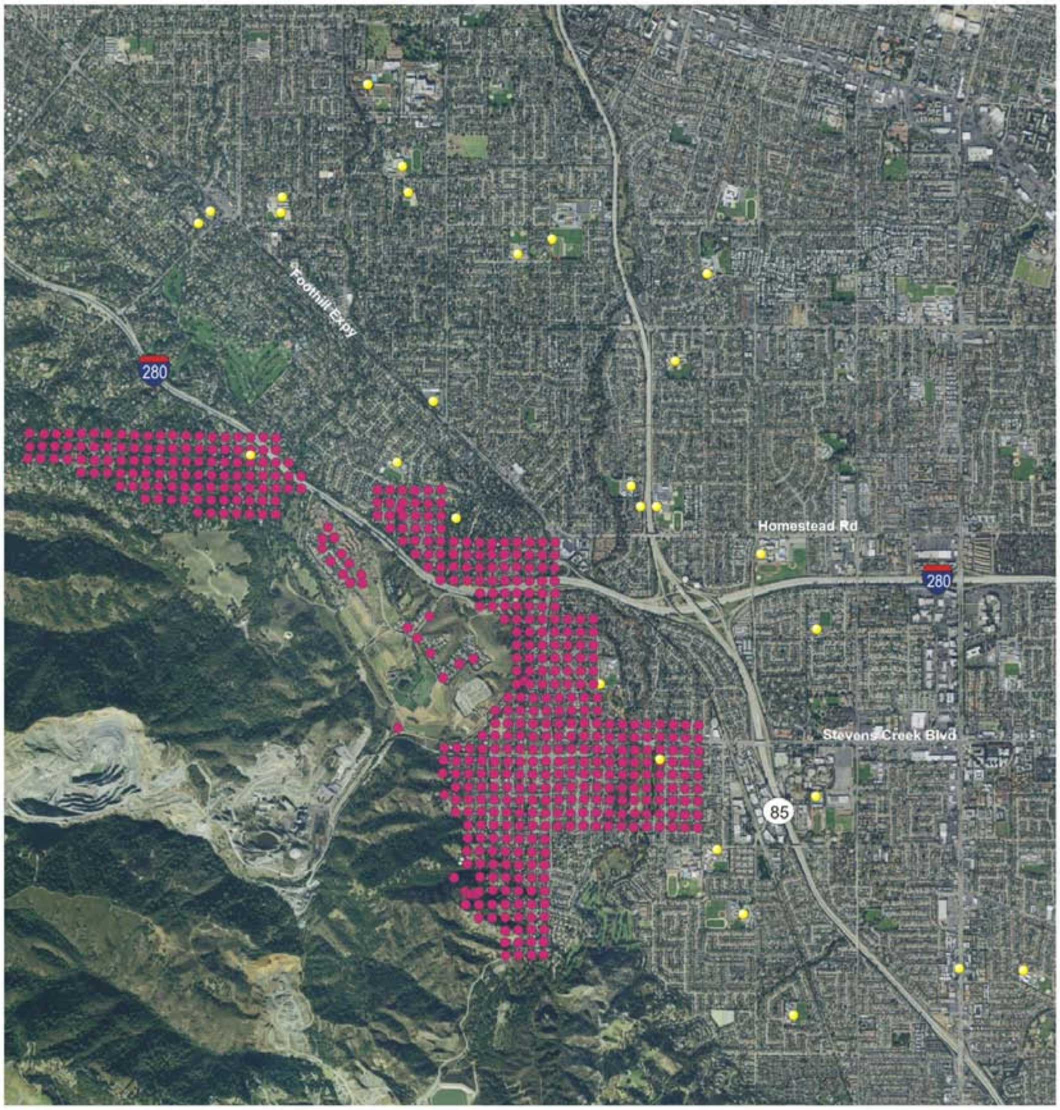
The AERMOD dispersion model (Version 11103) was used for the modeling analysis. AERMOD is the USEPA preferred dispersion model for general industrial sources. The model can simulate point, area, volume, and line sources. The AERMOD model is the appropriate model for this analysis based on the coverage 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 (stack-tip downwash, buoyancy-induced dispersion, and final plume rise), default wind speed profile categories, default potential temperature gradients, and no pollutant decay.

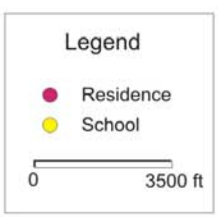
The selection of the appropriate dispersion coefficients depends on the land use within three kilometers (km) of the project site. The land use typing was based on the classification method defined by Auer (1978); using pertinent United States Geological Survey (USGS) 1:24,000 scale (7.5 minute) topographic maps of the area. If the Auer land use types of heavy industrial, light-to-moderate industrial, commercial, and compact residential account for 50 percent or more of the total area, the EPA *Guideline on Air Quality Models* recommends using urban dispersion coefficients; otherwise, the appropriate rural coefficients were used. Based on observation of the area surrounding the project site, rural dispersion coefficients were applied in the analysis.

Receptors

Some receptors are considered more sensitive to air pollutants than others, because of preexisting health problems, proximity to the emissions source, or duration of exposure to air pollutants. Land uses such as primary and secondary schools, hospitals, and convalescent homes are considered to be relatively sensitive to poor air quality because the very young, the old, and the infirm are more susceptible to respiratory infections and other air quality-related health problems than the general public. Residential areas are also considered sensitive to poor air quality because people in residential areas are often at home for extended periods. Recreational land uses are moderately sensitive to air pollution, because vigorous exercise associated with recreation places a high demand on respiratory system function.

Receptors were placed at a height of 1.8 meters (typical breathing height). Terrain elevations for receptor locations were used (i.e., complex terrain) based on available USGS information for the area. **Exhibit 1** displays the location of the receptors used in the HRA.





Permanente Quarry RPA Health Risk Assessment Receptors

EXHIBIT 1
HEALTH RISK ASSESSMENT RECEPTORS

Meteorological Data

Air quality is a function of both the rate and location of pollutant emissions under the influence of meteorological conditions and topographic features affecting pollutant movement and dispersal. Atmospheric conditions such as wind speed, wind direction, atmospheric stability, and air temperature gradients interact with the physical features of the landscape to determine the movement and dispersal of air pollutants, and consequently affect air quality.

Meteorological data from the Lehigh Cement Plant (formerly Kaiser Plant) (from 1999 and 2006) were used for the modeling analysis.[3] A screening analysis was conducted and determined that data from 1999 produced the maximum concentrations and this data were used of the HRA. **Exhibit 2** provides the wind roses for the Kaiser Plant meteorological station, showing the predominance of a wind from the north, west, and west-northwest.

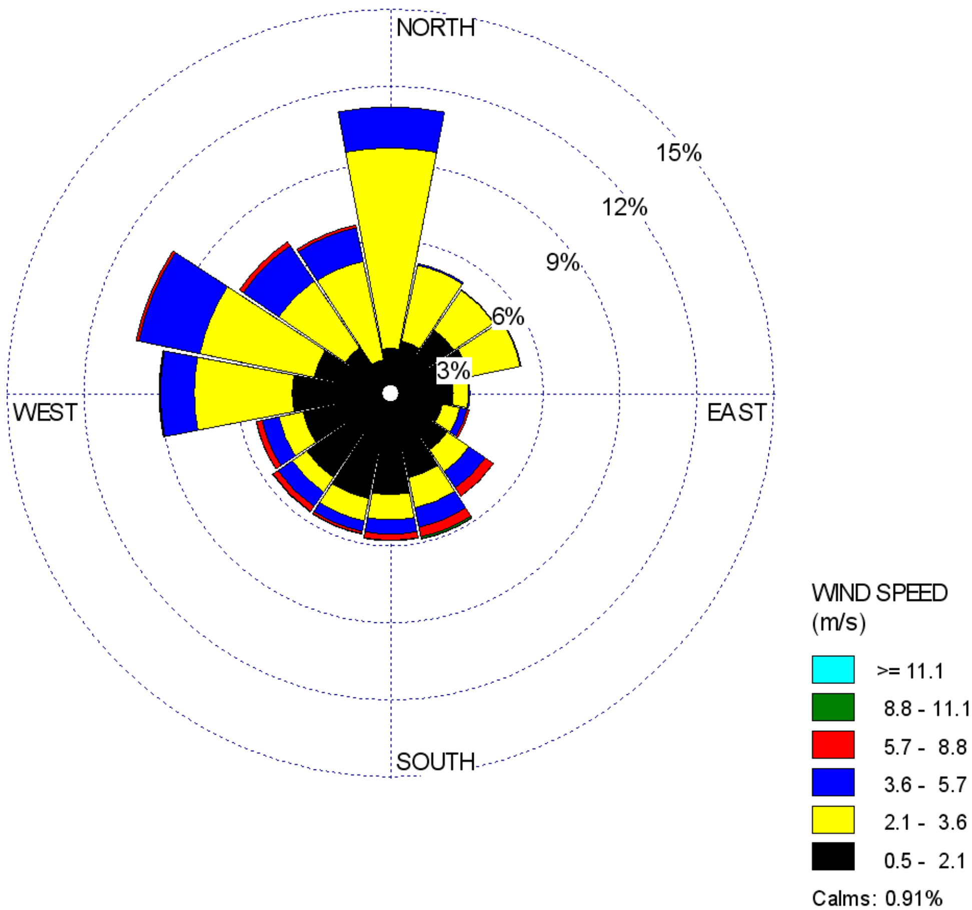


EXHIBIT 2
WINDROSE FOR LEHIGH PERMANENTE METEOROLOGICAL STATION

[3] Email from James Cordova at BAAQMD on September 23, 2010 Kaiser Cement Requested Met Data.

Emissions Estimates

The following describes the emission sources from quarrying and landfilling activities associated with the Proposed Project.

Quarry – This category encompasses the following emission sources associated with operation and reclamation of the North Quarry:

- Drilling of charge holes to allow placement of explosives for blasting
- Blasting to fracture and loosen ore, overburden and substrate through the use of explosives
- Bulldozing, scraping, and grading of topsoil, overburden, limestone, and waste material
- Loading and dumping of materials into and from transport trucks (referred to as material handling)
- Dust entrainment due to vehicle travel on unpaved roads in the vicinity of the North Quarry
- Wind erosion associated with actively disturbed unpaved areas, including unpaved roads in the vicinity of the North Quarry and active quarry operating, topsoil removal, and reclamation areas

Waste Rock Storage/Infill Areas – This category encompasses the following emission sources associated with operation of the East Material Storage Area (EMSA) and North Quarry Infill area:

- Material handling associated with waste rock from the North Quarry and reclamation of the EMSA and North Quarry Infill area
- Associated dust entrainment due to vehicle travel on unpaved roads in the vicinity of the EMSA and North Quarry Infill areas associated with transporting waste rock
- Wind erosion associated with actively disturbed unpaved areas, including unpaved roads in the vicinity of waste rock storage/infill areas and active waste rock storage/infill areas

Topsoil Storage Area – This category encompasses the following emission sources associated with operation and reclamation of the Topsoil Storage Area:

- Material handling
- Dust entrainment due to vehicle travel on unpaved roads in the vicinity of the Topsoil Storage Area

- Wind erosion associated with actively disturbed unpaved areas, including unpaved roads in the vicinity of the Topsoil Storage Area and active topsoil removal, operating, and reclamation areas

Combustion Sources – This category encompasses operation of the following equipment in conjunction with operation of Proposed Project:

- Portable diesel-fueled welders
- Off-road diesel equipment (bore/drill rigs, rubber-tired loaders, off-highway trucks, crawler-tractors, rubber-tired dozers, graders, water trucks, excavators, hydroseeders, and portable light towers)
- On-road, on-site vehicles (work trucks)
- On-road, off-site vehicles (fuel transport trucks and employee commute vehicles)

The No Project[4] and Project[5] emissions were based on information developed by ALG. The Phase 3 reclamation emissions were based on information developed by EnviroMine.[6]

Table 1 provides a key to the pertinent emission estimates. Emissions were estimated using OFFROAD2007 (for off-road equipment exhaust), EMFAC2007 (for on-road vehicle exhaust), and USEPA AP-42 emission factors or other appropriate references for fugitive dust sources. The calculations were based on the specific pieces of equipment and hours of operation for equipment to be used for the project. DPM emissions from off-road equipment were assumed to be 14 percent due to EMSA activities and the remaining 86 percent due to the North Quarry/WSMA activities.

TABLE 1
ESTIMATED EMISSIONS

	DPM Emissions (tons/year)	PM2.5 Emissions (tons/year)
No Project		
Existing	19.0	122
Phase 1A	7.0	111
Phase 1B	8.1	138
Phase 2	5.4	109
Phase 3	1.1	26.6
Project		
Existing	19.0	122
Phase 1A	12.6	43.1
Phase 1B	13.7	72.0
Phase 2	5.0	45.4
Phase 3	1.1	26.6

SOURCE: ALG, Air Quality Technical Analysis Permanente Quarry Revised Reclamation Plan Amendment, November 30, 2011
ALG, Air Quality Emission Calculation Worksheets Permanente Quarry No Project Alternative Emissions Analysis for Off-road Diesel Equipment, December 5, 2011.
EnviroMine, Financial Assurance Estimate for Permanente Quarry, April 2011

[4] ALG, Air Quality Emission Calculation Worksheets Permanente Quarry No Project Alternative Emissions Analysis for Off-road Diesel Equipment, December 5, 2011.

[5] ALG, Air Quality Technical Analysis Permanente Quarry Revised Reclamation Plan Amendment, November 30, 2011.

[6] EnviroMine, Financial Assurance Estimate for Permanente Quarry, April 2011.

The concentration of various TAC species within the fugitive dust was based on material sampling (McCampbell Analytical, October 4, 2010 and ALG, November 29, 2010). **Table 2** presents the soil sampling results which act as the basis for the emission estimates for fugitive dust activities.

TABLE 2
ESTIMATED AIR TOXICS CONTENT FOR FUGITIVE DUST SOURCES (MG/KG)

Inorganic Chemicals	Overburden	Unpaved Roads
Antimony	2.5	2.5
Arsenic	1.25	1.25
Barium	780	1000
Beryllium	0.75	0.75
Cadmium	1.25	1.25
Total Chromium	24	41
Cobalt	6.4	0.8
Copper	14	25
Lead	1.25	2.3
Mercury	0.2	0.14
Molybdenum	2.5	2.5
Nickel	23	54
Selenium	2.5	2.5
Silver	1.25	1.25
Thallium	1.25	1.25
Vanadium	19	83
Zinc	25	34
Chromium VI	0.1	1.9
Crystalline Silica	3712.8	7099.2

Source: McCampbell Analytical, Inc., October 4, 2010 and ALG, November 29, 2010.

The following describes the emission sources from reclamation activities associated with the Project.

Reclamation Activities – These activities encompass reclamation of the North Quarry and waste rock storage and infill areas, Topsoil Storage Area, and other disturbed areas as identified in the Proposed Project. Emissions associated with reclamation activities are included within the emission calculations for material handling, dust entrainment, wind erosion, and combustion sources for each of the different project areas. Activities related to reclamation include:

- Material handling associated with moving topsoil from the Topsoil Storage Area to each of the areas to be reclaimed

- Dust entrainment due to vehicle travel on unpaved roads associated with transporting topsoil from the Topsoil Storage Area

- Wind erosion associated with active reclamation within each of the areas to be reclaimed

- Combustion equipment operation due to topsoil transport for each of the reclamation areas, topsoil handling, topsoil mixing with the waste rock or other subsurface materials, and hydroseeding activities

Estimated emissions for the reclamation phases of the Proposed Project were based on information within the *Permanente Quarry Financial Assurance Estimate* (EnviroMine, 2011). **Table 3** provides the estimated annual equipment usage for the reclamation activities. **Table 4** provides the estimated annual onroad vehicle mileage for the reclamation activities. Fugitive dust emissions were estimated in a manner similar to the Phase 1 and 2 calculations.

TABLE 3
ESTIMATED OFFROAD EQUIPMENT USAGE FOR THE RECLAMATION ACTIVITIES

Subtask	Equipment	Hours	Horsepower	Load Factor
Overland Conveyor	Cat 330 w/ Steel Shear*	45	380	0.57
Overland Conveyor	Cat 330 w/ Grapple*	60	380	0.57
Overland Conveyor	Cat 966 Utility Loader	60	800	0.54
Overland Conveyor	Cat 330 w/ Breaker*	24	380	0.57
Overland Conveyor	Grove RT-635 40t Crane	60	208	0.78
Rock Plant	Cat 330 w/ Steel Shear*	48	380	0.57
Rock Plant	Cat 330 w/ Grapple*	48	380	0.57
Rock Plant	Cat 966 Utility Loader	48	800	0.54
Rock Plant	Cat 330 w/ Breaker*	80	380	0.57
Rock Plant	Cat 320 w/2.2 cy bucket	40	380	0.57
Rock Plant	Grove RT-635 40t Crane	48	208	0.78
Rough Grading	Hitachi EX1900-6	2,918	380	0.57
Rough Grading	Cat D9N Dozer	1,459	570	0.64
Rough Grading	Cat D8R Dozer	1,459	570	0.64
Rough Grading	12H Blade	1,459	327	0.57
Scarification	D8R Bulldozer	3.4	570	0.64
Finish Grading	D6R Bulldozer	393	570	0.64
EMSA Rough Grading	CAT D10 Dozer	28	570	0.64
EMSA Topsoil and Finish	CAT 330 Excavator	36	380	0.57
EMSA Topsoil and Finish	CATD6 Bulldozer	79	570	0.64
EMSA Topsoil and Finish	CAT 325 Excavator	45	380	0.57
EMSA Basin Removal	CATD8R Bulldozer	56	570	0.64
EMSA Basin Removal	CAT 446 w/ backhoe	56	800	0.54
EMSA SCARIFICATION	CAT D8R Bulldozer	2.7	570	0.64

Source: EnviroMine, *Permanente Quarry Financial Assurance Estimate, April 2011*.

TABLE 4
ESTIMATED ONROAD VEHICLE USAGE FOR THE RECLAMATION ACTIVITIES

Subtask	Equipment Category	EMFAC ID	Hours	VMT
Overland Conveyor	Truck w/low bed trailer	HDDV	70	2,450
Overland Conveyor	Truck w/Semi-End Dump	HDDV	36	1,260
Overland Conveyor	Welding Truck	MDV	60	2,100
Overland Conveyor	Pick up	LDA	120	4,200
Rock Plant	Truck w/low bed trailer	HDDV	48	1,680
Rock Plant	Truck w/Semi-End Dump	HDDV	48	1,680
Rock Plant	Welding Truck	MDV	60	2,100
Rock Plant	Pick up	LDA	80	2,800
Rough Grading	Cat 777 Haul Trucks	HDDV	20,424	134,798
Rough Grading	Water Truck	MDV	1,459	9,629
EMSA Topsoil and Finish	CAT 740 Haul Truck	HDDV	72	180
EMSA Basin Removal	Haul Truck	HDDV	25	62.5

Source: EnviroMine, *Permanente Quarry Financial Assurance Estimate, April 2011*.

Source Release Characteristics

Off-road equipment exhaust and fugitive dust from the blasting, drilling, grading/loading, wind erosion and other quarrying and landfilling activities were treated as separate area sources representing the North Quarry, EMSA, WMSA, and the PCRA. The release height of the off-road equipment exhaust was 3.05 meters, while the release height of the fugitive dust was at ground level. Haul trucks were treated as a line source (i.e., volume sources placed at regular intervals) located along the unpaved haul roads between the quarry and the storage infill areas. The haul trucks were assigned a release height of 3.05 meters and an initial vertical dimension of 4.15 meters, which accounts for dispersion from the movement of vehicles. The fugitive dust from unpaved roads was treated as a surface-based line source.

Terrain elevations for emission source locations were used (i.e., complex terrain) based on available USGS DEM for the area. AERMAP (Version 11103) was used to develop the terrain elevations, although the project site is generally flat.

Using AERMOD, the maximum 1-hour and average annual concentrations were determined for the emission sources of concern. These concentrations were estimated for a unit emission rate (1 gram per second) and adjusted based on the calculated project-related emission rate.

Table 5 displays the estimated haul truck trips associated with the Rock Plant and green waste. The cement plant trucks (approximately 45,112 per year) are a cumulative source and not directly associated with the Project.

TABLE 5
ESTIMATED ONROAD HAUL TRIPS

	No Project		Project	
Year	**Rock Plant**	**Green Waste**	**Rock Plant**	**Green Waste**
2008	43,490	-	43,490	-
2009	43,490	-	43,490	-
2010	43,490	-	43,490	-
2011	43,490	-	43,490	-
2012	43,490	-	77,800	-
2013	43,490	-	77,800	-
2014	43,490	-	77,800	-
2015	43,490	-	77,800	-
2016	43,490	-	77,800	-
2017	43,490	-	77,800	-
2018	43,490	-	77,800	-
2019	43,490	-	77,800	-
2020	43,490	-	77,800	-
2021	43,490	-	77,800	-
2022	43,490	-	77,800	-
2023	43,490	-	77,800	1,000
2024	43,490	-	77,800	1,000
2025	43,490	-	77,800	1,000
2026	43,490	-	-	-
2027	43,490	-	-	-
2028	43,490	-	-	-
2029	43,490	-	-	-
2030	43,490	1,000	-	-
2031	43,490	1,000		
2032	43,490	1,000		
2033	-	-		
2034	-	-		
2035	-	-		
2036	-	-		
2037	-	-		
Total	**1,000,270**	**3,000**	**1,263,160**	**3,000**

Source: Permanente Quarry, 2011.

TOXICITY ASSESSMENT

The HRA was conducted following methodologies in BAAQMD's *Health Risk Screening Analysis Guidelines*[7] and in the California Office of Environmental Health Hazard Assessment (OEHHA) *Air Toxics Hot Spots Program Guidance.*[8] This was accomplished by applying the highest estimated concentrations at the receptors analyzed to the established cancer risk estimates and acceptable reference concentrations (RfC) for non-cancer health effects.

The toxicity values used in this analysis were based on OEHHA guidance. These toxicity values are for carcinogenic effects and acute/chronic health impacts. The primary pathway for exposures was assumed to be inhalation and carcinogenic and non-carcinogenic effects were evaluated separately. The incremental risks were determined for each emission source of TAC and summed to obtain an estimated total incremental carcinogenic health risk.

The 80th percentile adult breathing rate of 302 L/kg-day was used to determine cancer risks to residents from exposure to TAC. The residential exposure frequency and duration was assumed to be 350 days per year and 70 years. For children, OEHHA recommends assuming a breathing rate of 581 L/kg-day to assess potential risk via the inhalation exposure pathway. This value represents the upper 95th percentile of daily breathing rates for children. The modeled TAC concentrations were used to represent the exposure concentrations in the air. The inhalation absorption factor was assumed to be 1.

Cancer risk estimates also incorporate age sensitivity factors (ASFs). This approach provides updated calculation procedures that factor in the increased susceptibility of infants and children to carcinogens as compared to adults. OEHHA recommends that cancer risks be weighted by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age, and by a factor of 3 for exposures from 2 years through 15 years of age. For estimating cancer risks for residential receptors over a 70 year lifetime, the incorporation of the ASFs results in a cancer risk adjustment factor (CRAF) of 1.7.

Based on OEHHA recommendations, the cancer risk to residential receptors assumes exposure occurs 24 hours per day for 350 days per year. For children at school sites, exposure is assumed to occur 10 hours per day for 180 days (or 36 weeks) per year. Cancer risk to residential receptors based on a 70-year lifetime exposure. Cancer risk estimates for children at school sites are calculated based on 9 year exposure duration.

Table 6 provides a summary of the risk assessment exposure parameters used in the analysis.

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[7] Bay Area Air Quality Management District (BAAQMD), 2005. *BAAQMD Health Risk Screening Analysis Guidelines (http://www.baaqmd.gov/pmt/air_toxics/risk_procedures_policies/hrsa_guidelines.pdf)*, June 2005.

[8] Office of Environmental Health Hazard Assessment (OEHHA), 2003. *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, http://www.oehha.org/air/hot_spots/pdf/HRAguidefinal.pdf

TABLE 6
HEALTH RISK ASSESSMENT EXPOSURE PARAMETERS

Receptor	Breathing Rate (DBR)	Cancer Risk Adjustment Factor (CRAF)	Daily Exposure	Annual Exposure	Exposure Duration (ED)
Adult	302	1.7	24 hours	350 days	70 years
Child	581	10	24 hours	350 days	3 years
School	581	3	10 hours	180 days	9 years

SOURCE: *BAAQMD Health Risk Screening Analysis Guidelines* (*http://www.baaqmd.gov/pmt/air_toxics/risk_procedures_policies/hrsa_guidelines.pdf*), June 2005

Table 7 provides the toxicity values for each of the pollutants associated with the proposed project. The chronic REL for DPM was established by the California OEHHA[9] as 5 μg/m^3. There is no acute REL for DPM. However, diesel exhaust does contain acrolein and other compounds, which do have an acute REL. BAAQMD's DPM speciation table (based on profile 4674 within the U.S. EPA Speciate 4.2)[10] was used to assess the acute impacts. Acrolein emissions are approximately 1.3 percent of the total emissions. The acute REL for acrolein was established by the California OEHHA[11] as 2.5 μg/m^3.

TABLE 7
TOXICITY VALUES

Pollutant	Slope Factor (mg/kg-day)	Acute REL (μg/m^3)	Chronic REL (μg/m^3)
Acrolein (with DPM)		2.5	
Arsenic	12.0	0.19	0.03
Beryllium	8.4		0.003
Cadmium			0.02
Chromium VI	510		0.2
Crystalline silica			3
DPM	1.1		5
Copper		100	
Cadmium	15.0		
Lead	0.04		
Mercury		1.8	0.09
Nickel	0.91	6.0	0.05
Selenium			20
Vanadium		30.0	

SOURCE: California Office of Environmental Health Hazards Assessment Toxicity Criteria Database, 2011. http://www.oehha.ca.gov/tcdb/

RISK CHARACTERIZATION

Cancer risk is defined as the lifetime probability of developing cancer from exposure to carcinogenic substances. Cancer risks are expressed as the chance in one million of getting cancer (i.e., number of cancer cases among one million people exposed). The cancer risks are assumed to occur exclusively through the inhalation pathway. The cancer risk can be estimated by using the cancer potency factor (milligrams per kilogram of body weight per day [mg/kg-day]), the 70-year annual average concentration (microgram per cubic meter [μg/m^3]), and the lifetime exposure adjustment.

9 California Office of Environmental Health Hazards Assessment Toxicity Criteria Database, 2010. http://www.oehha.ca.gov//.

10 Provides for a speciation faction of 1.3 percent of acrolein per DPM emission rate. http://www.epa.gov////.html.

11 California Office of Environmental Health Hazards Assessment Toxicity Criteria Database, 2010. http://www.oehha.ca.gov//.

Following guidelines established by OEHHA, the incremental cancer risks attributable to the project were calculated by applying exposure parameters to modeled TAC concentrations in order to determine the inhalation dose (mg/kg-day) or the amount of pollutants inhaled per body weight mass per day. The cancer risks occur exclusively through the inhalation pathway; therefore, the cancer risks can be estimated from the following equation:

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

Where:

Dose-inh	= Dose of the toxic substance through inhalation in mg/kg-day
10^{-6}	= Micrograms to milligrams conversion, Liters to cubic meters conversion
C_{air}	= Concentration in air (microgram (μg)/cubic meter (m^{3}))
{DBR}	= Daily breathing rate (liter (L)/kg body weight – day)
A	= Inhalation absorption factor
CRAF	= Cancer Risk Adjustment Factor, Age Sensitivity 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)

To determine incremental cancer risk, the estimated inhalation dose attributed to the project was multiplied by the cancer potency slope factor (cancer risk per mg/kg-day). The cancer potency slope factor is the upper bound on the increased cancer risk from a lifetime exposure to a pollutant. These slope factors are based on epidemiological studies and are different values for different pollutants. This allows the estimated inhalation dose to be equated to a cancer risk. Thus, if the inhalation dose (mg/kg-day) is estimated at 2.75 per million and the slope factor ($mg/kg\text{-}day^{-1}$) is 1.1; then the cancer risk is 3.0 per million persons.

Non-cancer adverse health impacts, acute (short-term) and chronic (long-term), are measured against a hazard index (HI), which is defined as the ratio of the predicted incremental exposure concentration from the project to a published reference exposure level (REL) that could cause adverse health effects as established by OEHHA. The ratio (referred to as the Hazard Quotient [HQ]) of each non-carcinogenic substance that affects a certain organ system is added to produce an overall HI for that organ system. The overall HI is calculated for each organ system. If the overall HI for the highest-impacted organ system is greater than one, then the impact is considered to be significant.

The HI is an expression used for the potential for non-cancer health effects. The relationship for the non-cancer health effects is given by the annual concentration ($\mu g/m^{3}$) and the REL ($\mu g/m^{3}$). The acute hazard index was determined using the "simple" concurrent maximum approach, which tends to be conservative (i.e., overpredicts).

The relationship for the non-cancer health effects is given by the following equation:

$$HI = C/REL$$

where,

HI	Hazard index; an expression of the potential for non-cancer health effects.
C	Annual average concentration (μg/m^3) during the 70 year exposure period
REL	The concentration at which no adverse health effects are anticipated.

CUMULATIVE ANALYSIS

The BAAQMD's *CEQA Air Quality Guidelines* include new standards and methods for determining the significance of cumulative health risk impacts for individual projects (BAAQMD, 2011). The method for determining health risk requires the tallying of health risk from permitted sources and major roadways in the vicinity of a project, then adding the project impacts to determine whether the cumulative health risk thresholds are exceeded. Cumulative health impacts of cancer risks, chronic impacts, and PM2.5 concentrations are analyzed.

BAAQMD has developed a geo-referenced database of permitted TAC emissions sources throughout the San Francisco Bay Area and has developed the *Stationary Source Risk & Hazard Analysis Tool* (dated May 2011) for estimating health risks from permitted sources. One permitted source (the Permanente Quarry's cement kiln, plant baghouses, stationary generators, and fugitive sources) is located within 1,000 feet of the fenceline of the Proposed Project. Cumulative health risk information associated with these sources was developed from the *Revised AB2588 Health Risk Assessment 2005, Average 2008/2009, and 2013 Production Scenarios for the Lehigh Southwest Cement Company* (AMEC Geomatrix, 2011).[12] The HRA was approved by BAAQMD and OEHHA.

For this cumulative source, the maximum exposed individual residence cancer risk is 8.5 in a million and the maximum chronic hazard index is 0.34. The maximum acute hazard index for the average 2008/2009 production level is estimated to be 2.1 (due to mercury emissions); which is above the BAAQMD CEQA Significance threshold. As a result, in 2010 a kiln mill dust conveyance system was implemented; the maximum acute hazard index for the 2010 production was estimated to be 1.5; which is above the BAAQMD CEQA Significance threshold.

In September 2010, Lehigh began testing the injection of powdered activated carbon sorbent into the kiln fuel gas to further reduce mercury emissions. Installation of the system was expected to begin in March 2011 and be completed and operational by May 2011. With implementation, the maximum acute hazard index for the 2011 production was estimated to be 0.76; which is below the BAAQMD CEQA Significance threshold. The maximum acute hazard index for the 2013 production (including facility changes related to stack exhaust parameters) was estimated to be 0.025; which is well below the BAAQMD CEQA Significance threshold.

The cement plant also generates 45,112 truck trips per year, which are included as a cumulative source.

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[12] *Revised AB2588 Health Risk Assessment 2005, Average 2008/2009, and 2013 Production Scenarios for the Lehigh Southwest Cement Company*
http://www.sccplanning.org/SCC/docs/Planning,%20Office%20of%20(DEP)/attachments/Environmental%20Documents/2250%20Hanson%20Quarry%20Attachment%20docs%20and%20images/AMEC_11_11191.000_Rev.HRA_033011.pdf

Additional nearby sources were provided and/or verified by BAAQMD.[13] None of these sources were determined to be within 1,000 feet of the fenceline.

BAAQMD has also developed a geo-referenced database of roadways throughout the San Francisco Bay Area and has developed the *Highway Screening Analysis Tool* (dated May 2011*)* for estimating health risks from roadways. State Route 85 and Interstate 280 are located adjacent (to the east and north, respectively) but not within 1,000 feet of the Proposed Project. Thus, the health impacts from these roadways were not included in the analysis.

[13] Email from Jackie Winkel at BAAQMD on September 29, 2011, Stationary Source Inquiry Form Request – Permanente Quarry.