Appendix C
Health Risk Assessment Detail

ESA

Attachment A

Health Risk Assessment Methodology and Assumptions

A health risk assessment (HRA) is accomplished in four steps: 1) hazards identification, 2) exposure assessment, 3) toxicity assessment, and 4) 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 (i.e., residence, school, daycare centers, hospitals, senior fare facilities, recreational areas, adult, infant, child).

This HRA was conducted in accordance with technical guidelines developed by federal, state, and regional agencies, including U.S. Environmental Protection Agency (USEPA), California Environmental Protection Agency (CalEPA), California Office of Environmental Health Hazard Assessment (OEHHA) *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*[1] and the Bay Area Air Quality Management District (BAAQMD) *Health Risk Screening Analysis Guidelines*.[2] This HRA addresses the emissions from construction activities including onsite equipment and haul trucks. Specific focus is on diesel particulate matter (DPM) and particulate matter equal to or less than 2.5 micrometers (fine particulate or $PM_{2.5}$) emissions. Cumulative impacts from nearby stationary sources, Interstate 680 and rail activities were also addressed.

According to CalEPA, a HRA should not be interpreted as the expected rates of cancer or other potential human health effects, but rather as estimates of potential risk or likelihood of adverse effects based on current knowledge, under a number of highly conservative assumptions and the best assessment tools currently available.

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., 30 year) exposure to TAC such as DPM 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).

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1 Office of Environmental Health Hazard Assessment, *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, February 2015, http://oehha.ca.gov/air/hot_spots/hotspots2015.html.

2 Bay Area Air Quality Management District, *Health Risk Screening Analysis Guidelines*, January 2010, http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/hrsa_guidelines.ashx

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

Toxic air contaminants – 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 toxic air contaminants (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 – an analysis designed to predict the generation and dispersion of TAC in the outdoor environment, evaluate the potential for exposure of 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 (i.e., schools, residences, and recreational 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 TAC, the extended timeframes over which the exposures are evaluated, and the inability to verify the results. Limitations and uncertainties associated with the 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 TAC emissions; (d.) concentration prediction errors with dispersion models; and (e.) the variability in lifestyles, fitness and other confounding factors of the human population. This HRA was performed using the best available data and methodologies, notwithstanding the following uncertainties:

- There are uncertainties associated with the estimation of emissions from project activities. Where project-specific data, such as emission factors, are not available, default assumptions in emission estimation were used.
- The limitations of the air dispersion model provide a source of uncertainty in the estimation of exposure concentrations. According to USEPA, errors due to the limitation

of the algorithms implemented in the air dispersion model in the highest estimated concentrations of +/- 10 percent to 40 percent are typical.[3]

- The source parameters used to model emission sources add uncertainty. For all emission sources, the source parameters used source-specific, recommended as defaults, or expected to produce more conservative results. Discrepancies might exist in actual emissions characteristics of an emission source and its representation in the dispersion model.
- The exposure duration estimates do not take into account that people do not usually reside at the same location for 30 years and that other exposures (i.e., school children) are also of much shorter durations than was assumed in this HRA. This exposure duration is a highly conservative assumption, since most people do not remain at home all day and on average residents change residences every 11 to 12 years. In addition, this assumption adopts that residents are experiencing outdoor concentrations for the entire exposure period.
- For the risk and hazards calculations as well as the cumulative health impact, numerous assumptions must be made in order to estimate human exposure to pollutants. These assumptions include parameters such as breathing rates, exposure time and frequency, exposure duration, and human activity patterns. While a mean value derived from scientifically defensible studies is the best estimate of central tendency, most of the exposure variables used in this HRA are high-end estimates. The combination of several high-end estimates used as exposure parameters may substantially overestimate pollutant intake. The excess lifetime cancer risks calculated in this HRA are therefore likely to be higher than may be required to be protective of public health.
- The Cal/EPA cancer potency factor for DPM was used to estimate cancer risks associated with exposure to DPM emissions from construction activities. However, the cancer potency factor derived by Cal/EPA for DPM is highly uncertain in both the estimation of response and dose. In the past, due to inadequate animal test data and epidemiology data on diesel exhaust, the International Agency for Research on Cancer (IARC), a branch of the World Health Organization, had classified DPM as Probably Carcinogenic to Humans (Group 2); the USEPA had also concluded that the existing data did not provide an adequate basis for quantitative risk assessment.[4] However, based on two recent scientific studies,[5] IARC recently re-classified DPM as Carcinogenic to Humans to

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3 United States Environmental Protection Agency, *Guideline on Air Quality Models (Revised), 40 Code of Federal Regulations, Part 51, Appendix W*, November 2005, https://www3.epa.gov/scram001/guidance/guide/appw_05.pdf

4 United States Environmental Protection Agency, *Health Assessment Document for Diesel Engine Exhaust*, May 2002, https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=29060

5 Attfield MD, Schleiff PL, Lubin JH, Blair A, Stewart PA, Vermeulen R, Coble JB, Silverman DT, *The Diesel Exhaust in Miners Study: A Nested Case-Control Study of Lung Cancer and Diesel Exhaust*, June 2012, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3369553/

Group 1,[6] which means that the agency has determined that there is "sufficient evidence of carcinogenicity" of a substance in humans and represents the strongest weight-of-evidence rating in IARC's carcinogen classification scheme. This determination by the IARC may provide additional impetus for the USEPA to identify a quantitative dose-response relationship between exposure to DPM and cancer.

In summary, the estimated health impacts in this HRA are based primarily on a series of conservative assumptions related to predicted environmental concentrations, exposure, and chemical toxicity. The use of conservative assumptions tends to produce upper-bound estimates of risk. BAAQMD acknowledges this uncertainty by stating: "the methods used [to estimate risk] are conservative, meaning that the real risks from the source may be lower than the calculations, but it is unlikely that they will be higher." The USEPA notes that the conservative assumptions used in a HRA are intended to assure that the estimated risks do not underestimate the actual risks posed by a site and that the estimated risks do not necessarily represent actual risks experienced by populations at or near a site.[7]

HAZARDS IDENTIFICATION

California Air Resources Board (CARB) has developed a list of TAC, where a TAC is "an air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health (California Health and Safety Code Section 39655). All USEPA hazardous air pollutants are TAC. The CARB administers the Air Toxics "Hot Spots" program under Assembly Bill 2588 "Hot Spots" Information and Assessment Act, which requires periodic local review of facilities which emit TAC. Local air agencies periodically must prioritize stationary sources of TAC and prepare health risk assessments for high-priority sources.

Diesel exhaust is a complex mixture of numerous individual gaseous and particulate compounds emitted from diesel-fueled combustion engines. Diesel particulate matter is formed primarily through the incomplete combustion of diesel fuel. DPM is removed from the atmosphere through physical processes including atmospheric fall-out and washout by rain. Humans can be exposed to airborne DPM by deposition on water, soil, and vegetation; although the main pathway of exposure is inhalation. Cal/EPA has concluded that potential cancer risk from inhalation exposure to whole diesel exhaust outweigh the multi-pathway cancer risk from the speciated components.

In August 1998, the CARB identified DPM as an air toxic. The CARB developed the *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.[8,9] The documents represent proposals to reduce DPM

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[6] International Agency for Research on Cancer, *Diesel Engine Exhaust Carcinogenic*, June 2012, https://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

[7] United States Environmental Protection Agency, *Risk Assessment Guidance for Superfund Human Health Risk Assessment*, December 1989, https://www.epa.gov/sites/production/files/2015-09/documents/rags_a.pdf

[8] California Air Resources Board, *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles*, October 2000, http://www.arb.ca.gov/diesel/documents/rrpfinal.pdf

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 aimed to require the use of state-of-the-art catalyzed DPM filters and ultra-low-sulfur diesel fuel.

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 TAC. The CARB study detected diesel exhaust by using ambient air carbon soot measurements as a surrogate for diesel emissions. The study reported that 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 TAC, 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. Based on 2012 estimates of statewide exposure, DPM is estimated to increase statewide cancer risk by 520 cancers per million residents exposed over a lifetime.[10]

Exposure to DPM results in a greater incidence of chronic non-cancer health effects, such as cough, labored breathing, chest tightness, wheezing, and bronchitis. Individuals particularly vulnerable to DPM are children, whose lung tissue is still developing, the elderly and people with illnesses who may have other serious health problems that can be aggravated by exposure to DPM. In general, children are more vulnerable than adults to air pollutants because they have higher inhalation rates, narrower airways, and less mature immune systems. In addition, children with allergies may have an enhanced allergic response when exposed to diesel exhaust).

COMMUNITY AIR RISK EVALUATION

The BAAQMD's Community Air Risk Evaluation (CARE) program was initiated in 2004 to evaluate and reduce health risks associated with exposure to outdoor air toxics in the Bay Area. Based on findings of the latest report, DPM was found to account for approximately 85 percent of the cancer risk from airborne toxics. Carcinogenic compounds from gasoline-powered cars and light duty trucks were also identified as significant contributors: 1,3-butadiene contributed four percent of the cancer risk-weighted emissions, and benzene contributed three percent. Collectively, five compounds—DPM, 1,3-butadiene, benzene, formaldehyde, and acetaldehyde—were found to be responsible for more than 90 percent of the cancer risk attributed to emissions. All of these compounds are associated with emissions from internal combustion engines. The most important sources of cancer risk-weighted emissions were combustion-related sources of DPM, including on-road mobile sources (31 percent), construction equipment (29 percent), and ships and harbor craft (13 percent). A 75 percent reduction in DPM was predicted between 2005 and 2015 when the inventory accounted for

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[9] California Air Resources Board, *Risk Management Guidance for the Permitting of New Stationary Diesel-Fueled Engines*, October 2000, https://www.arb.ca.gov/diesel/documents/rmgFinal.pdf

[10] California Air Resources Board, *Summary: Diesel Particulate Matter Health Impacts*, April 12, 2016, https://www.arb.ca.gov/research/diesel/diesel-health_summ.htm

CARB's diesel regulations. Overall, cancer risk from TAC dropped by more than 50 percent between 2005 and 2015, when emissions inputs accounted for state diesel regulations and other reductions.[11]

Modeled cancer risks from TAC in 2005 were highest near sources of DPM: near core urban areas, along major roadways and freeways, and near maritime shipping terminals. Peak modeled risks were found to be located east of San Francisco, near West Oakland, and the maritime Port of Oakland. BAAQMD has identified seven impacted communities in the Bay Area:

- Western Contra Costa County and the cities of Richmond and San Pablo.
- Western Alameda County along the Interstate 880 corridor and the cities of Berkeley, Alameda, Oakland, and Hayward.
- San Jose.
- Eastern side of San Francisco.
- Concord.
- Vallejo.
- Pittsburgh and Antioch.

The proposed project is adjacent to the city of Martinez, which is part of the seven CARE program impacted communities in the Bay Area. The health impacts in the Bay Area, as determined both by pollution levels and by existing health vulnerabilities in a community, are approximately 160 cancer risk per million persons, while in Martinez, the health impacts is approximately 128 cancer risk per million persons.[12]

ADDRESSING SOURCES OF AIR POLLUTANTS IN COMMUNITY PLANNING

In May of 2016, the BAAQMD published *Planning Health Places: A Guidebook for Addressing Local Sources of Air Pollutants in Community Planning*.[13] The BAAQMD's primary goal in providing the *Guidebook* is to support and promote infill development; which is important to reducing vehicle miles traveled and the associated air emissions, while minimizing air pollution exposure for existing and future residents. The *Guidebook* provides developers and planners with the information and tools needed to create health-protective communities.

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11 Bay Area Air Quality Management District, *Improving Air Quality and Health in Bay Area Communities, Community Air Risk Program Retrospective & Path Forward (2004 – 2013)*, April 2014, http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CARE%20Program/Documents/CARE_Retrospective_April2014.ashx?la=en

12 Bay Area Air Quality Management District, *Identifying Areas with Cumulative Impacts from Air Pollution in the San Francisco Bay Area*, March 2014. http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CARE%20Program/Documents/ImpactCommunities_2_Methodology.ashx?la=en

13 Bay Area Air Quality Management District, *Planning Health Places: A Guidebook for Addressing Local Sources of Air Pollutants in Community Planning, January 2016*, http://www.baaqmd.gov/~/media/files/planning-and-research/planning-healthy-places/draft_planninghealthyplaces_marchworkshop-pdf.pdf?la=en

The *Guidebook* recommends Best Practices to Reduce Emissions and Reduce Exposure to Local Air Pollution. Implementing as many Best Practices to Reduce Emissions as is feasible will reduce potential health risks to the greatest extent. The *Guidebook* also lists examples of a variety of strategies to reduce exposure to, and emissions of, air pollution, including the adoption of air quality-specific ordinances, standard conditions of approval, and incorporation of policies into general plans and other planning documents. The BAAQMD recommends implementing all best practices to reduce exposure that are feasible and applicable to a project in areas that are likely to experience elevated levels of air pollution. To reduce exposure to pollutants, the *Guidebook* recommends practices like installing indoor air filtration systems, planting dense vegetation, implementing project design which provides a buffer between sensitive receptors and emission source, and developing alternative truck routes.

The *Guidebook* provides an interactive map of the Bay Area showing areas with estimated elevated levels of fine particulates and/or toxic air contaminants. The interactive map shows locations where further study is needed, such as a detailed health risk assessment; specifically locations next to major roads and freeways and large industrial sites, as well as the downtown districts of cities.

EXPOSURE 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. The results of an analysis allow predicted concentrations of pollutants to be compared directly to air quality standards and other criteria such as health risks based on modeled concentrations.

A rising pollutant plume reacts with the environment in several ways before it levels off. First, the plume's own turbulence interacts with atmospheric turbulence to entrain ambient air. This mixing process reduces and eventually eliminates the density and momentum differences that cause the plume to rise. Second, the wind transports the plume during its rise and entrainment process. Higher winds mix the plume more rapidly, resulting in a lower final rise. Third, the plume interacts with the vertical temperature stratification of the atmosphere, rising as a result of buoyancy in the unstable-to-neutrally stratified mixed layer. However, after the plume encounters the mixing lid and the stably stratified air above, its vertical motion is dampened.

Molecules of gas or small particles injected into the atmosphere will separate from each other as they are acted on by turbulent eddies. The Gaussian mathematical model such as AERMOD simulates the dispersion of the gas or particles within the atmosphere. The formulation of the Gaussian model is based on the following assumptions:

- The predictions are not time-dependent (all conditions remain unchanged with time)
- The wind speed and direction are uniform, both horizontally and vertically, throughout the region of concern
- The rate of diffusion is not a function of position
- Diffusion in the direction of the transporting wind is negligible when compared to the transport flow

Dispersion Modeling Approach

Air dispersion modeling was performed to estimate the downwind dispersion of DPM exhaust emissions resulting from construction activities. The following sections present the fundamental components of an air dispersion modeling analysis including air dispersion model selection and options, receptor locations, meteorological data, and source exhaust parameters.

Model Selection and Options

AERMOD (Version 16216)[14] was used for the dispersion analysis. AERMOD is the USEPA preferred atmospheric dispersion modeling system for general industrial sources. The model can simulate point, area, volume, and line sources. AERMOD 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 assuming no pollutant decay.

The selection of the appropriate dispersion coefficients depends on the land use within three kilometers (km) of the project site. The types of land use were 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 USEPA *Guideline on Air Quality Models* recommends using urban dispersion coefficients; otherwise, the appropriate rural coefficients can be used. Based on observation of the area surrounding the project site, rural (urban is only designated within dense city centers such as downtown San Francisco) dispersion coefficients were applied AERMOD.

Receptor Locations

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 having a high demand on respiratory system function.

Residential areas are located northwest, southeast, and west of the proposed project in the Vine Hill neighborhood. There are no schools or daycare centers located within 1,000 feet of the proposed project. 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

[14] US Environmental Protection Agency, *AERMOD Modeling System*, https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod

USGS information for the area. Sensitive receptors were placed at existing residences to estimate health impacts due to proposed project construction on existing receptors. **Figure A-1** presents the existing receptors. The maximum exposure individual receptors for existing residences is located on Central Avenue to the north of the project site. Sensitive receptors were also placed at the proposed project to estimate health impacts on new residences due to existing sources such as nearby permitted stationary sources, Interstate 680, and rail activities. **Figure A-2** presents the proposed receptors within the northeast portion of the project site. The maximum exposure individual receptors for proposed northeast residences of the project site is located within the southern portion of the proposed northeast residences. **Figure A-3** presents the proposed receptors within the southwest portion of the project site. The maximum exposure individual receptors for proposed southwest residences of the project site is located within the northern portion of the proposed southwest residences.

Meteorological Data

Air quality is affected by the rate, amount, and location of pollutant emissions and the associated meteorological and geographical conditions that influence pollutant movement and dispersal. Atmospheric conditions, including wind speed, wind direction, stability, and air temperature, in combination with local surface topography (i.e., geographic features such as mountains, valleys, and San Francisco Bay), determine the effect of air pollutant emissions on local air quality.

The climate of the greater San Francisco Bay Area, including Contra Costa County, is a Mediterranean-type climate characterized by warm, dry summers and mild, wet winters. The climate is determined largely by a high-pressure system that is often present over the eastern Pacific Ocean off the West Coast of North America. In winter, the Pacific high-pressure system shifts southward, allowing storms to pass through the region. During summer and fall, air emissions generated within the Bay Area can combine with abundant sunshine under the restraining influences of topography and subsidence inversions to create conditions that are conducive to the formation of photochemical pollutants, such as ozone and secondary particulates, such as sulfates and nitrates.

The project site lies in the Diablo Valley-San Ramon Valleys climatological sub-region of the Bay Area. The Diablo Valley is a broad valley, approximately five miles wide and ten miles long. The Carquinez Strait is at its north end; in the south, it tapers into the San Ramon Valley. Major cities in the Diablo Valley are Concord and Walnut Creek. San Ramon Valley continues south from the Diablo Valley, extending from south of Walnut Creek to Dublin. San Ramon Valley is long and narrow, approximately 12 miles long and one mile wide. At its southern end it opens to the Amador Valley. Its major towns are Danville and San Ramon.[15]

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[15] Bay Area Air Quality Management District, *Climate, Physiography, And Air Pollution Potential – Bay Area and Its Subregions*, http://hank.baaqmd.gov/dst/papers/bay_area_climate.pdf

FIGURE A-1
HEALTH RISK ASSESSMENT EXISTING RECEPTORS

FIGURE A-2
HEALTH RISK ASSESSMENT PROPOSED NORTHEAST RECEPTORS

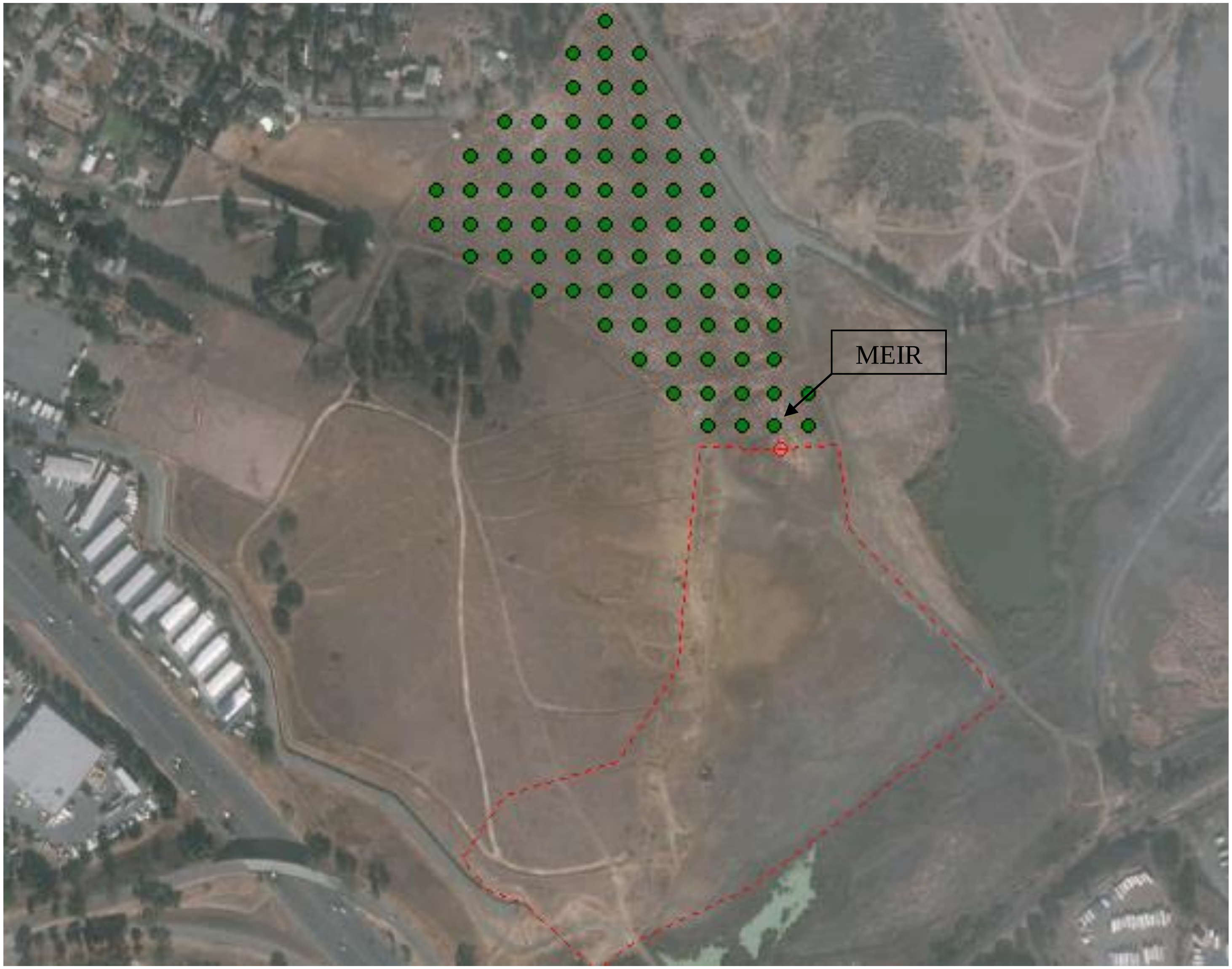

FIGURE A-3
HEALTH RISK ASSESSMENT PROPOSED SOUTHWEST RECEPTORS

The Coast Range on the west side of these valleys is 1,500 to 2,000 feet high. This is sufficiently high to block much of the marine air from reaching the valleys. During the daytime, there are two weakly predominant flow patterns: upvalley flow and westerly flow across the lower elevations of the Coast Range. On clear nights, a surface inversion sets up and separates the surface flow from the upper layer flow. When this happens, the terrain channels the flow downvalley toward the Carquinez Straits. This downvalley drainage pattern can be observed all the way to Martinez at the end of the valley.

Wind speeds in these valleys rank as some of the lowest in the Bay Area. For example, in the middle of the Diablo Valley, the District station in Concord reports annual average wind speeds of 4.7 miles per hour (mph), and Danville in the middle of the San Ramon Valley reports annual average wind speeds of five mph. However, winds can pick up in the afternoon near the town of San Ramon because it is located at the eastern end of the Crow Canyon gap. Through this gap, polluted air from cities near the bay is able to travel across Hayward to the San Ramon Valley during the summer months.

Air temperatures are cooler in the winter and warmer in the summer because these valleys are further from the moderating effect of large water bodies, and because the Coast Range blocks marine air flow. In the Diablo Valley during the winter, Concord records daily maximum temperatures in the mid 50's. During the summer, average daily maximum temperatures are in the high 80's to 90 degrees. Average minimum temperatures in winter are in the low to mid 40's. Shielded by the Coast Range to the west, rainfall amounts in the Diablo Valley are relatively low. For example, Martinez in the north reports an annual average of 18.5 inches, while Walnut Creek reports 19 inches.[16]

Hourly meteorological data from BAAQMD's Concord monitoring station (surface data), located approximately six miles to the southeast of the proposed project, and Oakland International Airport (upper air) were used in the dispersion modeling analysis. Meteorological data from 2009 through 2013 were used. **Figure A-4** displays the annual wind rose. Wind directions are predominately from the south-southwest with a low frequency of calm wind speed conditions, as shown in **Figure A-5**. The average annual wind speed is 4.2 miles per hour.

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16 Bay Area Air Quality Management District, *Climate, Physiography, and Air Pollution Potential – Bay Area and Its Subregions*, http://hank.baaqmd.gov/dst/papers/bay_area_climate.pdf

FIGURE A-4
WINDROSE FOR CONCORD

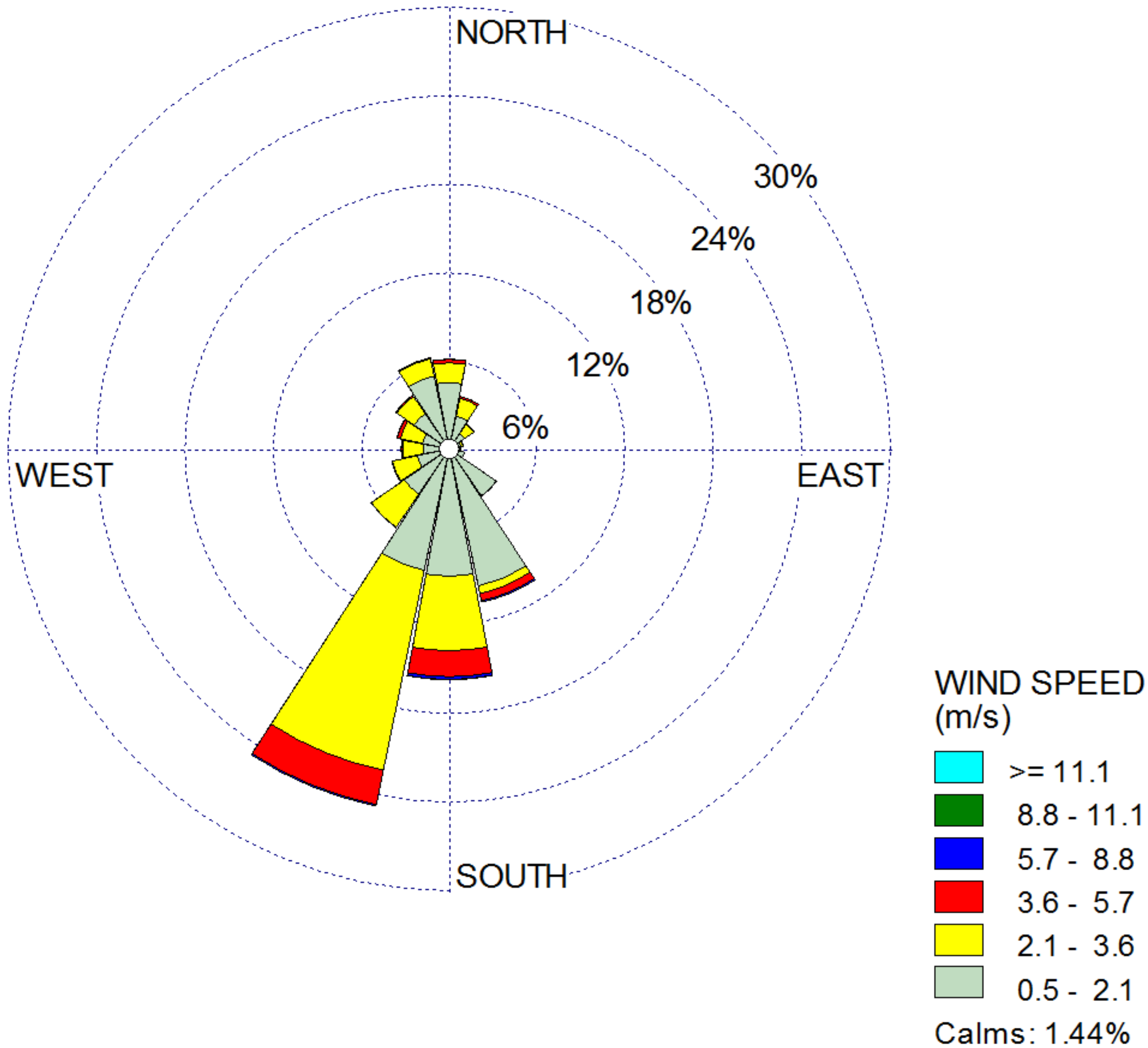
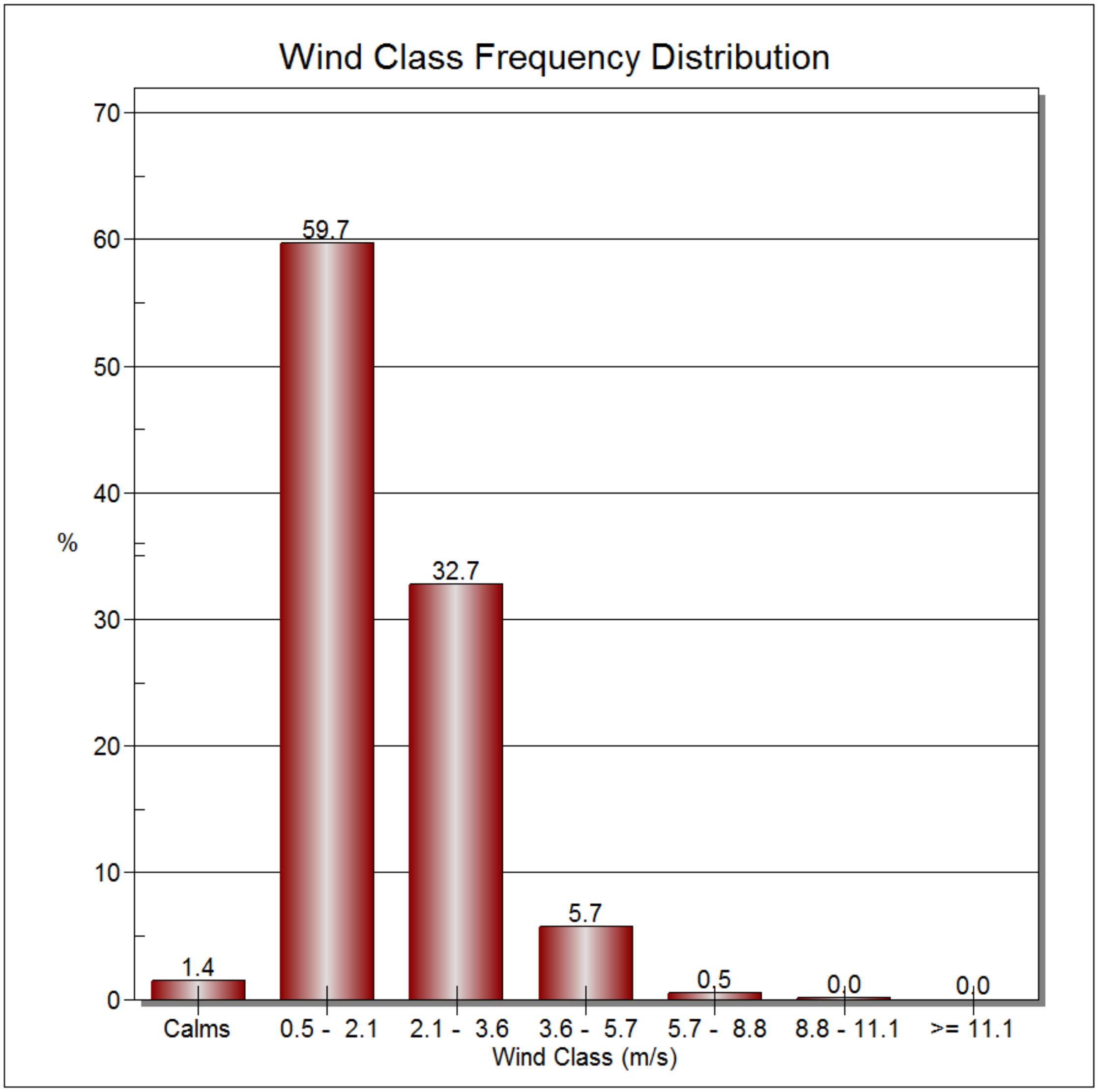


FIGURE A-5
WIND SPEED DISTRIBUTION FOR CONCORD



Source Release Characteristics

Construction equipment activities were treated as an area source. The release height of the off-road equipment exhaust was 3.05 meters and an initial vertical dimension of 4.15 meters. Haul trucks were treated as a line source (i.e., volume sources placed at regular intervals) located along an access road. 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.[17] Typically, construction activities would occur eight hours per day, on Monday through Friday.

Terrain elevations for emission source locations were used (i.e., complex terrain) based on available USGS DEM for the area. AERMAP (Version 11103)[18] was used to develop the terrain elevations.

EXPOSURE PARAMETERS

This HRA was conducted following methodologies in OEHHA's *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*.[19] This was accomplished by applying the estimated concentrations at the receptors analyzed to the established cancer risk estimates and acceptable reference concentrations for non-cancer health effects.

OEHHA's revisions to its *Guidance Manual* were primarily designed to ensure that the greater sensitivity of children to cancer and other health risks is reflected in HRAs. For example, OEHHA now recommends that risks be analyzed separately for multiple age groups, focusing especially on young children and teenagers, rather than the past practice of analyzing risks to the general population, without distinction by age. OEHHA also now recommends that statistical "age sensitivity factors" be incorporated into a HRA, and that children's relatively high breathing rates be accounted for. On the other hand, the *Guidance Manual* revisions also include some changes that would reduce calculated health risks. For example, under the former guidance, OEHHA recommended that residential cancer risks be assessed by assuming 70 years of exposure at a residential receptor; under the *Guidance Manual*, this assumption is lessened to 30 years.

OEHHA has developed exposure factors (e.g., daily breathing rates) for six age groups including the last trimester to birth, birth to 2 years, 2 to 9 years, 2 to 16 years, 16 to 30 years, and 16 to 70 years. These age bins allow for more refined exposure information to be used when estimating exposure and the potential for developing cancer over a lifetime. This means that exposure variates are needed for the third trimester, ages zero to less than two, ages two to less

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17 While trucking emissions contribute substantially to overall project emissions, they are spread over many miles. Hence, the portion of trucking emissions that would impact one receptor is much smaller than the emissions that the clustered off-road activity at the project site would impact a receptor near the site. For example, the DPM emissions from truck travel within 1,000 feet of the project are less than one percent of the total off-road DPM emissions.

18 US Environmental Protection Agency, *AERMAP*, https://www.epa.gov/scram/air-quality-dispersion-modeling-related-model-support-programs#aermap

19 Office of Environmental Health Hazard Assessment, *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, February 2015, http://oehha.ca.gov/air/hot_spots/hotspots2015.html

than nine, ages two to less than 16, ages 16 to less than 30, and ages 16 to 70. Residential receptors utilize the 95th percentile breathing rate values. The breathing rates are age-specific and are 1,090 liters per kilogram-day for ages less than 2 years, 745 liters per kilogram-day for ages 2 to 16 years, 335 liters per kilogram-day for ages 16 to 30 years, and 290 liters per kilogram-day for ages 30 to 70 years. A school child breathing rate is 520 liters per kilogram-day and an off-site worker breathing rate is 230 liters per kilogram-day.

OEHHA developed age sensitivity factors (ASF) to take into account the increased sensitivity to carcinogens during early-in-life exposures. 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.

Based on OEHHA recommendations, the cancer risk to residential receptors assumes exposure occurs 24 hours per day for 350 days per year while accounting for a percentage of time at home. OEHHA evaluated information from activity pattern databases to estimate the fraction of time at home (FAH) during the day. This information was used to adjust exposure duration and cancer risk based on the assumption that a person is not present at home continuously for 24 hours and therefore exposure to emissions is not occurring when a person is away from their home. In general, the FAH factors are age-specific and are 0.85 for ages less than 2 years, 0.72 for ages 2 to 16 years, and 0.73 for ages 30 to 70 years.

OEHHA has decreased the exposure duration currently being used for estimating cancer risk at the maximum exposed individual resident from 70 years to 30 years. This is based on studies showing that 30 years is a reasonable estimate of the 90th to 95th percentile of residency duration in the population. Additionally, OEHHA recommends using the 9 and 70-year exposure duration to represent the potential impacts over the range of residency periods.

Given the exposure durations of less than 24 hours, sensitive recreational receptors were evaluated for acute impacts only. Based on OEHHA recommendations, for children at school sites, exposure is assumed to occur 10 hours per day for 180 days (or 36 weeks) per year. Cancer risk estimates for children at school sites are calculated based on 9 year exposure duration. School sites also include teachers and other adult staff which are treated as off-site workers.

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 30-year annual average concentration (microgram per cubic meter [$\mu g/m^3$]), and the lifetime exposure adjustment.

Following guidelines established by OEHHA, the incremental cancer risks attributable to the proposed project were calculated by applying exposure parameters to modeled DPM 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:

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

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 in microgram (μg)/cubic meter (m^3)
{DBR}	= Daily breathing rate in liter (L)/kg body weight – day
A	= Inhalation absorption factor, 1.0
ASF	= Age Sensitivity Factor
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
FAH	= Fraction of Time at Home
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 proposed 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.

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 proposed 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 (in μg/m^3) and the REL (in μg/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 ($\mu g/m^3$) during the 70 year exposure period.

REL = Concentration at which no adverse health effects are anticipated.

The chronic REL for DPM was established by the California OEHHA[20] as 5 $\mu g/m^3$. 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 USEPA Speciate 4.2)[21] was used to assess the acute impacts. Acrolein emissions are approximately 1.3 percent of the total diesel fuel emissions. The acute REL for acrolein was established by the California OEHHA[22] as 2.5 $\mu g/m^3$.

CUMULATIVE SOURCES

The BAAQMD's *CEQA Air Quality Guidelines* include standards and methods for determining the significance of cumulative health risk impacts.[23] The method for determining cumulative health risk requires the tallying of health risk from permitted stationary sources, rail activities, and roadways in the vicinity of a project (i.e., within a 1,000-foot radius or "zone of influence") to determine whether the cumulative health risk thresholds are exceeded.

BAAQMD has developed a geo-referenced database of permitted emissions sources throughout the San Francisco Bay Area, and has developed the *Stationary Source Risk & Hazard Analysis Tool* for estimating cumulative health risks from permitted sources.[24] One permitted source is located within 1,000 feet of the project site. **Table A-1** provide the estimated screening cancer risk, hazard impacts, and the $PM_{2.5}$ concentrations for the nearby permitted source. The permitted source is an emergency diesel generator associated with Central Contra Costa Sanitary District and located to the east of the project site. The screening impact values represent impacts at the source property line.

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20 Office of Environmental Health Hazards Assessment, *Acute, 8-hour, and Chronic Reference Exposure Levels*, June 2014, http://www.oehha.ca.gov/air/allrels.html

21 Provides for a speciation faction of 1.3 percent of acrolein per DPM emission rate

22 Office of Environmental Health Hazards Assessment, *Acute, 8-hour, and Chronic Reference Exposure Levels*, June 2014, http://www.oehha.ca.gov/air/allrels.html

23 Bay Area Air Quality Management District, *CEQA Air Quality Guidelines*, May 2017, http://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en

24 Bay Area Air Quality Management District, *CEQA Tools and Methodologies*, http://www.baaqmd.gov/plans-and-climate/california-environmental-quality-act-ceqa/ceqa-tools

TABLE A-1
SCREENING HEALTH IMPACTS – PERMITTED SOURCES

Facility ID	Facility Type	Address	Cancer Rick	Hazard Impact	$PM_{2.5}$ Concentration
14064	Central Contra Costa Sanitary District	990 Central Avenue	77.3	0.0274	0.018

SOURCE: Bay Area Air Quality Management District, *Stationary Source Risk & Hazard Analysis Tool*, May 2011 and Email from Alison Kirk at BAAQMD on October 27, 2017 - Stationary Source Inquiry Form Request – Bayview Residential Project.

A distance adjustment multiplier (located 900 feet from the nearest proposed receptor) of 0.05 was applied to the Central Contra Costa Sanitary District (ID #14064) stationary source (diesel generator). For the proposed receptor, **Table A-2** provides the estimated adjusted cancer risk, hazard impacts, and the $PM_{2.5}$ concentrations for the nearby permitted source; adjusted for distance from the emission sources to proposed receptor. The cancer risk is also adjusted by a factor of 2.6 to account for the Revised OEHHA *Guidance Manual* (see following discussion).

TABLE A-2
ADJUSTED HEALTH IMPACTS – PROPOSED RECEPTORS

Facility ID	Facility Type	Address	Cancer Rick	Hazard Impact	$PM_{2.5}$ Concentration
14064	Central Contra Costa Sanitary District	990 Central Avenue	10.0	0.003	0.001

SOURCE: Bay Area Air Quality Management District, *Stationary Source Risk & Hazard Analysis Tool*, May 2011 and Email from Alison Kirk at BAAQMD on October 27, 2017 - Stationary Source Inquiry Form Request – Bayview Residential Project. Cancer risk was subsequently also adjusted by a factor of 2.6 to account for the Revised OEHHA Guidance Manual and BAAQMD's *Distance Adjustment Multiplier for Diesel Internal Combustion Engine*.

BAAQMD has also developed a geo-referenced database of roadways throughout the San Francisco Bay Area and has developed the *Highway Screening Analysis Tool* for estimating cumulative health risks from major roadways. **Table A-3** display the health impacts from Interstate 680 in association with the proposed residences at ground floor. **Table A-4** display the health impacts from Interstate 680 in association with the proposed residences at second floor. Typically, health impacts are lower at second floor. The nearest proposed receptor is located approximately 260 feet from Interstate 680.

BAAQMD *CEQA Air Quality Guidelines* also require the inclusion of surface streets within 1,000 feet of the proposed project with annual average daily traffic of 10,000 or greater. BAAQMD has developed a county-specific tool, *Roadway Screening Analysis Calculator*, for estimating cumulative health risks from minor roadways. No roadways meet this criteria.

TABLE A-3
Interstate 680 HEALTH IMPACTS AT GROUND FLOOR

Distance from Nearest Travel Lane (feet)	Cancer Risk	Chronic Impact	Acute Impact	$PM_{2.5}$ Concentration
10	412	0.145	0.073	1.286
25	346	0.121	0.062	1.076
50	277	0.097	0.052	0.860
75	235	0.082	0.046	0.726
100	205	0.071	0.041	0.632
200	141	0.049	0.029	0.432
260	123	0.042	0.025	0.374
300	111	0.038	0.022	0.336
400	92.3	0.032	0.018	0.279
500	79.9	0.027	0.015	0.241
750	60.3	0.020	0.011	0.181
1000	48.7	0.016	0.012	0.145

SOURCE: Bay Area Air Quality Management District, *Highway Screening Analysis Tool*, May 2011. Cancer Risk was subsequently adjusted by a factor of 2.6 to account for the Revised OEHHA Guidance Manual.

TABLE A-4
Interstate 680 HEALTH IMPACTS AT SECOND FLOOR

Distance from Nearest Travel Lane (feet)	Cancer Risk	Chronic Impact	Acute Impact	$PM_{2.5}$ Concentration
10	229	0.080	0.066	0.707
25	225	0.078	0.056	0.695
50	209	0.073	0.049	0.646
75	191	0.067	0.043	0.590
100	175	0.061	0.039	0.539
200	130	0.045	0.028	0.399
260	115	0.040	0.024	0.351
300	105	0.036	0.022	0.319
400	88.6	0.030	0.018	0.269
500	77.3	0.026	0.014	0.234
750	59.0	0.020	0.011	0.177
1000	47.9	0.016	0.012	0.143

SOURCE: Bay Area Air Quality Management District, *Highway Screening Analysis Tool*, May 2011. Cancer Risk was subsequently adjusted by a factor of 2.6 to account for the Revised OEHHA Guidance Manual.

The rail activities occur adjacent and to the south (approximately 725 feet to the nearest proposed residences) of the proposed project. These rail activities were analyzed to estimate the diesel emissions and operational profile as a means to estimate the health impacts for inclusion in the cumulative analysis. **Table A-5** displays the health impacts from rail activities in association with proposed residences at ground floor.

TABLE A-5
RAIL ACTIVITIES HEALTH IMPACTS

Distance from Nearest Travel Lane (feet)	Cancer Risk	Chronic Impact	$PM_{2.5}$ Concentration
10	41.1	0.005	0.027
25	35.0	0.004	0.023
50	28.3	0.004	0.018
75	24.0	0.003	0.016
100	20.9	0.002	0.013
200	14.4	0.002	0.009
300	11.0	0.001	0.007
400	9.01	0.001	0.006
500	7.59	0.001	0.005
725	5.64	0.000	0.003
750	5.43	0.000	0.003
1000	4.13	0.000	0.002

SOURCE: Bay Area Air Quality Management District, *Rail Activities Screening Analysis Tool*, 2016. Cancer Risk was subsequently adjusted by a factor of 2.6 to account for the Revised OEHHA Guidance Manual.

ADJUSTMENT OF BAAQMD DATA FOR REVISED OEHHA GUIDANCE

This HRA was conducted following methodologies in OEHHA's *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*,[25] BAAQMD's *Stationary Source Risk & Hazard Analysis Tool* for estimating cumulative health risks from permitted sources, *Highway Screening Analysis Tool* for estimating cumulative health risks from major roadways, and *Roadway Screening Analysis Calculator* for estimating cumulative health risks from surface streets were based on the previous OEHHA guidance. Thus, an adjustment factor was developed to adjust the BAAQMD-developed cancer risks to account for the revised OEHHA guidance. The cancer risks for project construction activities as well as nearby rail activities were developed using AERMOD and the revised OEHHA guidance and thus were not further adjusted.

OEHHA's revisions to its *Guidance Manual* were primarily designed to ensure that the greater sensitivity of children to cancer and other health risks is reflected in HRA. For example, OEHHA now recommends that risks be analyzed separately for multiple age groups, focusing especially on young children and teenagers, rather than the past practice of analyzing risks to the general population, without distinction by age. OEHHA also now recommends that

[25] Office of Environmental Health Hazard Assessment, *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, February 2015, http://oehha.ca.gov/air/hot_spots/hotspots2015.html

statistical "age sensitivity factors" be incorporated into a HRA, and that children's relatively high breathing rates be accounted for. On the other hand, the *Guidance Manual* revisions also include some changes that would reduce calculated health risks. For example, under the former guidance, OEHHA recommended that residential cancer risks be assessed by assuming 70 years of exposure at a residential receptor; under the *Guidance Manual*, this assumption is lessened to 30 years.

The revised OEHHA guidance has developed exposure factors (e.g., daily breathing rates) for six age groups including the last trimester to birth, birth to 2 years, 2 to 9 years, 2 to 16 years, 16 to 30 years, and 16 to 70 years. OEHHA also developed age sensitivity factors (ASF) to take into account the increased sensitivity to carcinogens during early-in-life exposures. 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.

In the previous OEHHA guidance, the adult breathing rate of 302 liters per kilogram per day (L/kg-day) and the children breathing rate of 581 L/kg-day was recommended. For estimating cancer risks for residential receptors over a 70 year lifetime, the incorporation of the ASF results in a cancer risk adjustment factor of 1.7.

In the revised OEHHA guidance, residential receptors utilize the 95th percentile breathing rate values. The breathing rates are age-specific and are 1,090 liters per kilogram-day for ages less than 2 years, 745 liters per kilogram-day for ages 2 to 16 years, and 335 liters per kilogram-day for ages 16 to 30 years.

These differences in breathing rates, exposure duration, and other factors result in difference in health risk results. According to the SJVAPCD, these differences would increase the likelihood of finding significant health risks by as much as three-fold. Based on calculations for this proposed project, an adjustment factor of 2.6 was calculated to account for differences in the previous OEHHA and revised OEHHA guidance related to differences in breathing rates, incorporation of a age sensitivity factors, incorporation of a fraction of time at home during the day, and a modification of the lifetime exposure of 70 to 30 years. The adjustment factor was determined by evaluating the cancer risk for the rail activities using the previous OEHHA guidance and comparing to the cancer risk for the rail activities using the revised OEHHA guidance.

Several presentations have reviewed the differences between the previous and revised OEHHA guidance and have determined that the differences range from 2.1 to 3.0, using a 30 year exposure and 95th percentile breathing rates, depending on the type of emission source.[26] Cancer

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[26] ERM, *Updated Health Risk Assessment Guidelines*, March 31, 2015, http://www.erm.com/contentassets/c107b8507dbb4cd3a58e04f1e6438384/erm-oehha-webinar-3-31-15.pdf
San Joaquin Valley Air Pollution Control District, *Update to District's Risk Management Policy to Address OEHHA's Revised Risk Assessment Guidance Document*, May 28, 2015, http://www.valleyair.org/busind/pto/staff-report-5-28-15.pdf
San Joaquin Valley Air Pollution Control District, *Update On District's Implementation Of OEHHA's Revised Air Toxics Health Risk Assessment Guidelines*, August 20, 2015, http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2015/August/presentations/09.pdf

risks associated with nearby permitted stationary source, Interstate 680, and rail activities were adjusted by a factor of 2.6.

EXPOSURE REDUCTION MEASURES

The following provides background information on air quality exposure reduction measures to address localized health impacts related to DPM and $PM_{2.5}$ emissions from Interstate 680, rail activities, and stationary sources.[27]

Residential Setback from Roadways: Limit residential units located within the set distance of 500 feet to Interstate 680. Avoiding residential development within 500 feet of a major roadway is an effective strategy for reducing exposure to DPM and fine particulate matter and/or cancer risk from a roadway. Research findings indicate that roadways generally influence air quality within a few hundred feet – about 500 to 600 feet downwind from the vicinity of heavily traveled roadways or along corridors with significant truck traffic. This distance will vary by location and time of day or year, prevailing meteorology, topography, nearby land use, traffic patterns, as well as the individual pollutant.[28]

Phase Residential Development: Phase residential developments located within the setback distance of 500 feet from Interstate 680 until 2023, or as late as feasible. In 2008, CARB adopted a regulation that requires diesel trucks to retrofit or replace their engines so that by 2023, nearly all trucks would have a 2010 or newer model year engine. Therefore, DPM emissions from diesel trucks will decline by approximately 80 percent by 2023. This measure allows proposed projects to avoid exposing sensitive receptors to high levels of DPM from heavy duty trucks on roadways. As CARB's On-Road Heavy Duty Diesel Vehicles Regulation[29] gets implemented, DPM emissions will decrease over time, which will reduce cancer risk near major roadways.

Site Layout: Design buildings and sites to limit exposure from sources of TAC emissions. Locate operable windows, balconies, and building air intakes as far away as is feasible from emission sources.

Building design can be an important factor in improving indoor air quality, especially when considering the location of the air intake for air ventilation. In general, $PM_{2.5}$ concentrations decrease with distance and with building height, therefore air intake locations should be located farthest away from emission sources as possible to provide the cleanest ventilation to building occupants.

Operable windows and balconies should be installed away from Interstate 680 and other sources of air pollution (i.e., on the north side where the exposure concentrations are likely to be

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[27] Metropolitan Transportation Commission and Association of Bay Area Governments, *Plan Bay Area Environmental Impact Report,* April 17, 2017, http://www.planbayarea.org/2040-plan/environmental-impact-report

[28] US Environmental Protection Agency, *Near Roadway Air Pollution and Health: Frequently Asked Questions,* August 2014, https://www.epa.gov/sites/production/files/2015-11/documents/420f14044_0.pdf

[29] The regulation requires diesel trucks and buses that operate in California to be upgraded to reduce emissions. Newer heavier trucks and buses must meet PM filter requirements beginning January 1, 2012. Lighter and older heavier trucks must be replaced starting January 1, 2015. By January 1, 2023, nearly all trucks and buses will need to have 2010 model year engines or equivalent, http://www.arb.ca.gov/msprog/onrdiesel/onrdiesel.htm

lower). Similarly, if mechanical ventilation is installed, the proposed project should consider installing inoperable windows along the south side. This strategy will reduce the possibility of higher polluted air from entering the building and also increases the efficiency and performance standard of the mechanical filter.

Minimum Efficiency Reporting Value Filters: Installation of an air filtration system can reduce cancer risks, health impacts and DPM exposure for residents and other sensitive populations in buildings that are in close proximity to major roadways. Air filtration devices should be rated Minimum Efficiency Reporting Value (MERV)-13 or higher. MERV-13 air filters are considered high efficiency filters able to remove 80 percent of $PM_{2.5}$ from indoor air.[30] MERV-13 air filters may reduce concentrations of DPM from emission sources by approximately 53 percent and cancer risk by 42 percent. As part of implementing this measure, an ongoing maintenance plan for the building's air filtration system would be required.

Air filtration protects residents and other sensitive receptors from exposure to pollutants by reducing the pollutant concentration in indoor air circulated from outdoor air. Air filtration places a control on a building's mechanical ventilation system that filters particles from the air. The effectiveness of a filter depends on its (1) efficiency to remove particles from passing air; (2) a ventilation system's air flow rate; and (3) the path the clean air follows after it leaves the filter. To ensure adequate health protection to sensitive receptors, a ventilation system should meet the following minimal design standards:

- A MERV-13, or higher, rating that represents a minimum of 80 percent efficiency to capture fine particulates;
- At least one air exchange(s) per hour of fresh outside filtered air;
- At least four air exchange(s) / hour recirculation; and
- At least 0.25 air exchange(s) per hour in unfiltered infiltration.[31]

The effectiveness of air filtration is highly variable and based upon a building's design and maintenance. For example, the presence of operable windows, the placement of the air intakes, operation and maintenance of the ventilation system, and proper sealings will impact the effectiveness of air filtration and thus residents' exposure to DPM from nearby sources of emissions.

The CARB recently studied the effectiveness of air filtration, along with other mitigation measures, as a strategy to reduce exposure to nearby traffic pollution.[32] The study found that the use of air filtration tends to be relatively effective. The study notes that air filtration could be

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[30] US Environmental Protection Agency, *Residential Air Cleaners*, http://www.epa.gov/iaq/pubs/residair.html

[31] San Francisco Department of Public Health, *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*, May 2008, http://www.gsweventcenter.com/Draft_SEIR_References%5C2008_0501_SFDPH.pdf

[32] California Air Resources Board, *Status of Research on Potential Mitigation Concepts to Reduce Exposure to Nearby Traffic Pollution*, August 2012, http://www.arb.ca.gov/research/health/traff-eff/research%20status%20-reducing%20exposure%20to%20traffic%20pollution.pdf

especially effective in residences with consideration to California's requirement that new homes have mechanical ventilation systems installed.

Installation of MERV-13 filters in residential units represents a feasible option that is recommended by a number of entities. The City and County of San Francisco requires MERV-13 filters be installed in residential buildings located in air quality hot spots as defined by San Francisco's Health Code Article 38.[33] In addition, the American Society of Heating, Refrigerating, and Air Conditioning Engineers, recommends, in their green building guide, that a minimum of MERV-13 rated air filtration be required in building locations where the air quality is designated to be in non-attainment with the National Ambient Air Quality Standards for $PM_{2.5}$.[34] The United States Green Building Council requires that new construction be equipped with a MERV-13 or higher rated air filter in new construction for buildings and homes to receive air filtration green building credit points.[35]

Tree Planting: Plant trees and/or vegetation between sensitive receptors and emission sources. Large, evergreen trees (those with foliage year-round) with long-life spans work best in trapping $PM_{2.5}$. In addition, trees with branches and leaves that have a sticky surface and trees with a fine, complex foliage structure that allow significant in-canopy airflow also perform well. Specific tree recommendations include: Pine (*Pinus nigra* var. *maritima*), Cypress (X *Cupressocyparis leylandii*), Hybrid popular (*Populus deltoids X trichocarpa*), and Redwoods *(Sequoia sempervirens*).

Planting certain trees can be an effective strategy for reducing exposure to air pollution. With certain trees, fine particulates become trapped and filtered by the leaves, stems, and twigs of the trees. Trapped pollution particles are eventually washed to the ground by rainfall. Research supports a reduction in particulate matter concentration ranging from 0.5 to 5 percent from planting trees near a source of $PM_{2.5}$.

In addition to the type of tree, the placement of the trees, relative to major roadways, and how densely they are planted are important considerations in using trees as a strategy to reduce air pollution exposure. The $PM_{2.5}$ removal effectiveness of trees is greatest when the trees are planted closest to the edge of the roadway or stationary source, for this is where pollution concentrations are highest. Beyond 500 feet, concentrations begin to diminish considerably, thereby diminishing the need for or effectiveness of tree planting as a strategy. Ideally, trees should be planted within 500 feet from a roadway to be considered an effective strategy.

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[33] City and County of San Francisco, *Green Building Requirements Summary and Verification Form*, http://sfdbi.org/sites/sfdbi.org/files/migrated/FileCenter/Documents/Permit_Review_Services/Green_Building_Requirements/LEED_component_columns.pdf

[34] ASHRAE Journal's Guide to Standard 189.1, *Balancing Environmental Responsibility, Resource Efficiency and Occupant Comfort*, June 2010, https://www.ashrae.org/resources--publications/bookstore/standard-189-1

[35] LEED for New Construction Rating System, http://new.usgbc.org/leed/rating-systems

In regards to density, trees should be planted so that they are grouped as close together as possible to ensure a rather dense collection of tree stands. The denser the trees, the more effective the foliage, trunks and canopies will be in collecting particulate matter.[36] [37]

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[36] United States Environmental Protection Agency, *Recommendation for Construction Roadside Vegetation Barriers to Improve Near-Road Air Quality*, July 2016, https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=321772&simpleSearch=1&searchAll=Recommendations+for+constructing+roadside+vegetation+barriers+to+improve+near+road+air+quality

[37] Sacramento Metropolitan Air Quality Management District, *Landscaping Guidance for Improving Air Quality Near Roadways*, April 2017, http://www.airquality.org/LandUseTransportation/Documents/SMAQMDFinalLandscapingGuidanceApril2017.pdf

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM
350	days per year
25,550	days per lifetime

1090	95th Percentile Daily Breathing Rates (L/kg-day)	0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)	2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)	2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)	16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)	30<70 Years

0.85	fraction of time at home	0<2 Years
0.72	fraction of time at home	2<16 Years
0.73	fraction of time at home	16<70 Years

Project: Bayview Residential
Date: November 15, 2017
Condition: Unmitigated
Receptor: Existing
Condition: Four Year Exposure

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2018	0.11	0.03	1,090	10.0	0.85	4.62
2	2019	0.56	0.17	1,090	10.0	0.85	24.0
3	2020	0.44	0.13	745	4.75	0.72	5.18
4	2021	0.37	0.11	745	3.00	0.72	2.75
5	2022			745	3.00	0.72	
6	2023			745	3.00	0.72	
7	2024			745	3.00	0.72	
8	2025			745	3.00	0.72	
9	2026			745	3.00	0.72	
10	2027			745	3.00	0.72	
11	2028			745	3.00	0.72	
12	2029			745	3.00	0.72	
13	2030			745	3.00	0.72	
14	2031			745	3.00	0.72	
15	2032			745	3.00	0.72	
16	2033			745	3.00	0.72	
17	2034			335	1.70	0.73	
18	2035			335	1.00	0.73	
19	2036			335	1.00	0.73	
20	2037			335	1.00	0.73	
21	2038			335	1.00	0.73	
22	2039			335	1.00	0.73	
23	2040			335	1.00	0.73	
24	2041			335	1.00	0.73	
25	2042			335	1.00	0.73	
26	2043			335	1.00	0.73	
27	2044			335	1.00	0.73	
28	2045			335	1.00	0.73	
29	2046			335	1.00	0.73	
30	2047			335	1.00	0.73	

0.17	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
No	Significant?
0.03	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.22	Acute Hazard Impact
1	Significance Threshold
No	Significant?
36.5	Cancer Risk (Child)
10	Significance Threshold
Yes	Significant?
2.84	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
36.5	30-Year Exposure Cancer Risk
10	Significance Threshold
Yes	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM	
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien	
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM	
350	days per year	
25,550	days per lifetime	
1090	95th Percentile Daily Breathing Rates (L/kg-day)	0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)	2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)	2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)	16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)	30<70 Years
0.85	fraction of time at home	0<2 Years
0.72	fraction of time at home	2<16 Years
0.73	fraction of time at home	16<70 Years

Project:	Bayview Residential
Date:	November 15, 2017
Condition:	Unmitigated
Receptor:	Existing
Condition:	Three Year Exposure

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2019	0.56	0.17	1,090	10.0	0.85	24.0
2	2020	0.44	0.13	1,090	10.0	0.85	18.8
3	2021	0.37	0.11	745	4.75	0.72	4.35
4	2022			745	3.00	0.72	
5	2023			745	3.00	0.72	
6	2024			745	3.00	0.72	
7	2025			745	3.00	0.72	
8	2026			745	3.00	0.72	
9	2027			745	3.00	0.72	
10	2028			745	3.00	0.72	
11	2029			745	3.00	0.72	
12	2030			745	3.00	0.72	
13	2031			745	3.00	0.72	
14	2032			745	3.00	0.72	
15	2033			745	3.00	0.72	
16	2034			745	3.00	0.72	
17	2035			335	1.70	0.73	
18	2036			335	1.00	0.73	
19	2037			335	1.00	0.73	
20	2038			335	1.00	0.73	
21	2039			335	1.00	0.73	
22	2040			335	1.00	0.73	
23	2041			335	1.00	0.73	
24	2042			335	1.00	0.73	
25	2043			335	1.00	0.73	
26	2044			335	1.00	0.73	
27	2045			335	1.00	0.73	
28	2046			335	1.00	0.73	
29	2047			335	1.00	0.73	
30	2048			335	1.00	0.73	

0.17	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
No	Significant?
0.03	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.22	Acute Hazard Impact
1	Significance Threshold
No	Significant?
47.2	Cancer Risk (Child)
10	Significance Threshold
Yes	Significant?
2.63	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
47.2	30-Year Exposure Cancer Risk
10	Significance Threshold
Yes	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM
350	days per year
25,550	days per lifetime

1090	95th Percentile Daily Breathing Rates (L/kg-day)	0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)	2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)	2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)	16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)	30<70 Years

0.85	fraction of time at home	0<2 Years
0.72	fraction of time at home	2<16 Years
0.73	fraction of time at home	16<70 Years

Project:	Bayview Residential
Date:	November 15, 2017
Condition:	Mitigated
Receptor:	Existing
Condition:	Four Year Exposure

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2018	0.02	0.00	1,090	10.0	0.85	0.69
2	2019	0.08	0.03	1,090	10.0	0.85	3.60
3	2020	0.07	0.02	745	4.75	0.72	0.78
4	2021	0.06	0.02	745	3.00	0.72	0.41
5	2022			745	3.00	0.72	
6	2023			745	3.00	0.72	
7	2024			745	3.00	0.72	
8	2025			745	3.00	0.72	
9	2026			745	3.00	0.72	
10	2027			745	3.00	0.72	
11	2028			745	3.00	0.72	
12	2029			745	3.00	0.72	
13	2030			745	3.00	0.72	
14	2031			745	3.00	0.72	
15	2032			745	3.00	0.72	
16	2033			745	3.00	0.72	
17	2034			335	1.70	0.73	
18	2035			335	1.00	0.73	
19	2036			335	1.00	0.73	
20	2037			335	1.00	0.73	
21	2038			335	1.00	0.73	
22	2039			335	1.00	0.73	
23	2040			335	1.00	0.73	
24	2041			335	1.00	0.73	
25	2042			335	1.00	0.73	
26	2043			335	1.00	0.73	
27	2044			335	1.00	0.73	
28	2045			335	1.00	0.73	
29	2046			335	1.00	0.73	
30	2047			335	1.00	0.73	

0.03	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
No	Significant?
0.01	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.03	Acute Hazard Impact
1	Significance Threshold
No	Significant?
5.48	Cancer Risk (Child)
10	Significance Threshold
No	Significant?
0.43	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
5.48	30-Year Exposure Cancer Risk
10	Significance Threshold
No	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM
350	days per year
25,550	days per lifetime

1090	95th Percentile Daily Breathing Rates (L/kg-day)	0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)	2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)	2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)	16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)	30<70 Years

0.85	fraction of time at home	0<2 Years
0.72	fraction of time at home	2<16 Years
0.73	fraction of time at home	16<70 Years

Project: Bayview Residential
Date: November 15, 2017
Condition: Mitigated
Receptor: Existing
Condition: Three Year Exposure

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2019	0.08	0.03	1,090	10.0	0.85	3.60
2	2020	0.07	0.02	1,090	10.0	0.85	2.82
3	2021	0.06	0.02	745	4.75	0.72	0.65
4	2022			745	3.00	0.72	
5	2023			745	3.00	0.72	
6	2024			745	3.00	0.72	
7	2025			745	3.00	0.72	
8	2026			745	3.00	0.72	
9	2027			745	3.00	0.72	
10	2028			745	3.00	0.72	
11	2029			745	3.00	0.72	
12	2030			745	3.00	0.72	
13	2031			745	3.00	0.72	
14	2032			745	3.00	0.72	
15	2033			745	3.00	0.72	
16	2034			745	3.00	0.72	
17	2035			335	1.70	0.73	
18	2036			335	1.00	0.73	
19	2037			335	1.00	0.73	
20	2038			335	1.00	0.73	
21	2039			335	1.00	0.73	
22	2040			335	1.00	0.73	
23	2041			335	1.00	0.73	
24	2042			335	1.00	0.73	
25	2043			335	1.00	0.73	
26	2044			335	1.00	0.73	
27	2045			335	1.00	0.73	
28	2046			335	1.00	0.73	
29	2047			335	1.00	0.73	
30	2048			335	1.00	0.73	

0.03	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
No	Significant?
0.01	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.03	Acute Hazard Impact
1	Significance Threshold
No	Significant?
7.07	Cancer Risk (Child)
10	Significance Threshold
No	Significant?
0.39	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
7.07	30-Year Exposure Cancer Risk
10	Significance Threshold
No	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM	
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien	
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM	
350	days per year	
25,550	days per lifetime	
1090	95th Percentile Daily Breathing Rates (L/kg-day)	0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)	2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)	2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)	16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)	30<70 Years
0.85	fraction of time at home	0<2 Years
0.72	fraction of time at home	2<16 Years
0.73	fraction of time at home	16<70 Years

Project: Bayview Residential
Date: November 15, 2017
Condition: Unmitigated
Receptor: Proposed Northeast

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2021	0.53	0.28	1,090	10.0	0.85	39.3
2	2022			1,090	10.0	0.85	
3	2023			745	4.75	0.72	
4	2024			745	3.00	0.72	
5	2025			745	3.00	0.72	
6	2026			745	3.00	0.72	
7	2027			745	3.00	0.72	
8	2028			745	3.00	0.72	
9	2029			745	3.00	0.72	
10	2030			745	3.00	0.72	
11	2031			745	3.00	0.72	
12	2032			745	3.00	0.72	
13	2033			745	3.00	0.72	
14	2034			745	3.00	0.72	
15	2035			745	3.00	0.72	
16	2036			745	3.00	0.72	
17	2037			335	1.70	0.73	
18	2038			335	1.00	0.73	
19	2039			335	1.00	0.73	
20	2040			335	1.00	0.73	
21	2041			335	1.00	0.73	
22	2042			335	1.00	0.73	
23	2043			335	1.00	0.73	
24	2044			335	1.00	0.73	
25	2045			335	1.00	0.73	
26	2046			335	1.00	0.73	
27	2047			335	1.00	0.73	
28	2048			335	1.00	0.73	
29	2049			335	1.00	0.73	
30	2050			335	1.00	0.73	

0.28	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
No	Significant?
0.06	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.21	Acute Hazard Impact
1	Significance Threshold
No	Significant?
39.3	Cancer Risk (Child)
10	Significance Threshold
Yes	Significant?
1.76	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
39.3	30-Year Exposure Cancer Risk
10	Significance Threshold
Yes	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM		
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien		
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM		
350	days per year		
25,550	days per lifetime		
1090	95th Percentile Daily Breathing Rates (L/kg-day)		0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)		2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)		2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)		16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)		30<70 Years
0.85	fraction of time at home	0<2 Years	
0.72	fraction of time at home	2<16 Years	
0.73	fraction of time at home	16<70 Years	

Project: Bayview Residential
Date: November 15, 2017
Condition: Mitigated
Receptor: Proposed Northeast

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2021	0.08	0.04	1,090	10.0	0.85	5.89
2	2022			1,090	10.0	0.85	
3	2023			745	4.75	0.72	
4	2024			745	3.00	0.72	
5	2025			745	3.00	0.72	
6	2026			745	3.00	0.72	
7	2027			745	3.00	0.72	
8	2028			745	3.00	0.72	
9	2029			745	3.00	0.72	
10	2030			745	3.00	0.72	
11	2031			745	3.00	0.72	
12	2032			745	3.00	0.72	
13	2033			745	3.00	0.72	
14	2034			745	3.00	0.72	
15	2035			745	3.00	0.72	
16	2036			745	3.00	0.72	
17	2037			335	1.70	0.73	
18	2038			335	1.00	0.73	
19	2039			335	1.00	0.73	
20	2040			335	1.00	0.73	
21	2041			335	1.00	0.73	
22	2042			335	1.00	0.73	
23	2043			335	1.00	0.73	
24	2044			335	1.00	0.73	
25	2045			335	1.00	0.73	
26	2046			335	1.00	0.73	
27	2047			335	1.00	0.73	
28	2048			335	1.00	0.73	
29	2049			335	1.00	0.73	
30	2050			335	1.00	0.73	

0.04	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
No	Significant?
0.01	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.03	Acute Hazard Impact
1	Significance Threshold
No	Significant?
5.89	Cancer Risk (Child)
10	Significance Threshold
No	Significant?
0.26	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
5.89	30-Year Exposure Cancer Risk
10	Significance Threshold
No	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM	
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien	
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM	
350	days per year	
25,550	days per lifetime	
1090	95th Percentile Daily Breathing Rates (L/kg-day)	0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)	2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)	2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)	16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)	30<70 Years
0.85	fraction of time at home	0<2 Years
0.72	fraction of time at home	2<16 Years
0.73	fraction of time at home	16<70 Years

Project: Bayview Residential
Date: November 15, 2017
Condition: Unmitigated
Receptor: Proposed Southwest

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2021	0.70	0.33	1,090	10.0	0.85	46.0
2	2022			1,090	10.0	0.85	
3	2023			745	4.75	0.72	
4	2024			745	3.00	0.72	
5	2025			745	3.00	0.72	
6	2026			745	3.00	0.72	
7	2027			745	3.00	0.72	
8	2028			745	3.00	0.72	
9	2029			745	3.00	0.72	
10	2030			745	3.00	0.72	
11	2031			745	3.00	0.72	
12	2032			745	3.00	0.72	
13	2033			745	3.00	0.72	
14	2034			745	3.00	0.72	
15	2035			745	3.00	0.72	
16	2036			745	3.00	0.72	
17	2037			335	1.70	0.73	
18	2038			335	1.00	0.73	
19	2039			335	1.00	0.73	
20	2040			335	1.00	0.73	
21	2041			335	1.00	0.73	
22	2042			335	1.00	0.73	
23	2043			335	1.00	0.73	
24	2044			335	1.00	0.73	
25	2045			335	1.00	0.73	
26	2046			335	1.00	0.73	
27	2047			335	1.00	0.73	
28	2048			335	1.00	0.73	
29	2049			335	1.00	0.73	
30	2050			335	1.00	0.73	

0.33	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
Yes	Significant?
0.07	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.28	Acute Hazard Impact
1	Significance Threshold
No	Significant?
46.0	Cancer Risk (Child)
10	Significance Threshold
Yes	Significant?
2.06	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
46.0	30-Year Exposure Cancer Risk
10	Significance Threshold
Yes	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM	
2.5	Acute Reference Exposure Level (ug/m3) for Acrolien	
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM	
350	days per year	
25,550	days per lifetime	
1090	95th Percentile Daily Breathing Rates (L/kg-day)	0<2 Years
861	95th Percentile Daily Breathing Rates (L/kg-day)	2<9 Years
745	95th Percentile Daily Breathing Rates (L/kg-day)	2<16 Years
335	95th Percentile Daily Breathing Rates (L/kg-day)	16<30 Years
290	95th Percentile Daily Breathing Rates (L/kg-day)	30<70 Years
0.85	fraction of time at home	0<2 Years
0.72	fraction of time at home	2<16 Years
0.73	fraction of time at home	16<70 Years

Project: Bayview Residential
Date: November 15, 2017
Condition: Mitigated
Receptor: Proposed Southwest

Exposure Year	Calender Year	Maximum 1-Hour Acrolien Concentration (ug/m3)	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2021	0.10	0.05	1,090	10.0	0.85	6.90
2	2022			1,090	10.0	0.85	
3	2023			745	4.75	0.72	
4	2024			745	3.00	0.72	
5	2025			745	3.00	0.72	
6	2026			745	3.00	0.72	
7	2027			745	3.00	0.72	
8	2028			745	3.00	0.72	
9	2029			745	3.00	0.72	
10	2030			745	3.00	0.72	
11	2031			745	3.00	0.72	
12	2032			745	3.00	0.72	
13	2033			745	3.00	0.72	
14	2034			745	3.00	0.72	
15	2035			745	3.00	0.72	
16	2036			745	3.00	0.72	
17	2037			335	1.70	0.73	
18	2038			335	1.00	0.73	
19	2039			335	1.00	0.73	
20	2040			335	1.00	0.73	
21	2041			335	1.00	0.73	
22	2042			335	1.00	0.73	
23	2043			335	1.00	0.73	
24	2044			335	1.00	0.73	
25	2045			335	1.00	0.73	
26	2046			335	1.00	0.73	
27	2047			335	1.00	0.73	
28	2048			335	1.00	0.73	
29	2049			335	1.00	0.73	
30	2050			335	1.00	0.73	

0.05	Maximum Annual PM2.5 Concentration (ug/m3)
0.3	Significance Threshold (ug/m3)
No	Significant?
0.01	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
0.04	Acute Hazard Impact
1	Significance Threshold
No	Significant?
6.90	Cancer Risk (Child)
10	Significance Threshold
No	Significant?
0.31	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?
6.90	30-Year Exposure Cancer Risk
10	Significance Threshold
No	Significant?