BALBOA RESERVOIR PROJECT

Air Quality Analysis Scope of Work – Final

Prepared for

San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

October 2018

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ACRONYMS AND ABBREVIATIONS

Acronym	Description
AERMOD	American Meteorological Society/Environmental Protection Agency regulatory air dispersion model
APEZ	Air Pollutant Exposure Zone
ATCM	Air Toxics Control Measure
CARB	California Air Resources Board
ASF	Age Sensitivity Factor
BAAQMD	Bay Area Air Quality Management District
Cal/EPA	California Environmental Protection Agency
CalEEMod	California Emissions Estimator Model
CO	carbon monoxide
CEQA	California Environmental Quality Act
CPF	Cancer Potency Factor
CRRP	Community Risk Reduction Plan
CRRP-HRA	Community Risk Reduction Plan Health Risk Analysis database
DPM	Diesel Particulate Matter
EIR	Environmental Impact Report
ESA	Environmental Science Associates
EMFAC2017	CARB's Emission Factor Model For On-Road Emissions
g/s	Gram per second
HHDT	heavy heavy-duty trucks
hp	horsepower
HRA	Health Risk Assessment
MHDT	medium heavy-duty trucks
MEISR	Maximally Exposed Individual Sensitive Receptor
NOx	nitrogen oxides
$PM_{2.5}$	Fine particulate matter less than 2.5 micrometers in aerodynamic diameter
PM_{10}	Particulate matter less than 10 micrometers in aerodynamic diameter
ROG	Reactive organic gases
SF DPH	San Francisco Department of Public Health
SF EP	San Francisco Planning Department Environmental Planning Division
SF Planning	San Francisco Planning Department
SO_2	sulfur dioxide
TAC	toxic air contaminant
TOG	Total organic gases
TIS	Traffic Impact Study
$\mu g/m^3$	micrograms per cubic meter

Acronym	Description
USGS	United States Geological Survey
µm	micrometers
U.S. EPA	United States Environmental Protection Agency
VDECS	Verified Diesel Emission Control Strategies

1.0 INTRODUCTION

Air Quality Analysis Scope of Work

Environmental Science Associate (ESA) will prepare an air quality analysis and associated air quality technical appendix in support of environmental clearance under the California Environmental Quality Act (CEQA) for the Balboa Reservoir Project (project). The air quality analysis will evaluate the air quality impacts resulting from construction and operation of the proposed project. ESA will prepare an air quality analysis that:

- Includes a concise project description;
- Explains the methods used to evaluate impacts;
- Presents the results of the air emission estimates and associated health risks; and
- Includes all cited references and a technical appendix. The appendix will include modeling results and assumptions in sufficient detail to allow a reviewer to track how emissions were estimated.

At least two weeks prior to ESA submitting administrative draft subsequent environmental impact report-1 (ADSEIR-1), ESA will present draft results of the criteria pollutant analysis, the dispersion modeling, and the health risk calculations for review by the Planning Department, via in-person meeting or teleconference, after initial modeling is complete. The goal of this preliminary review would be to assess results and determine if model refinements are necessary. Furthermore, the review will help identify feasible measures to reduce project impacts, if required based on the results, and the methods for evaluating the effectiveness of those measures.

This scope of work identifies the preliminary methods to be used to evaluate criteria air pollutant emissions[1] and health risks associated with toxic air contaminants (TACs) resulting from the project in concurrence with San Francisco Planning Department Environmental Planning (EP) Division's CEQA requirements. Specifically, it presents the methods that will be used to evaluate criteria air pollutant emissions, fine particulate matter ($PM_{2.5}$) emissions from vehicle exhaust and Diesel Particulate Matter (DPM) emissions from vehicle exhaust, as well as associated health risks from construction equipment exhaust and operational sources (both project and cumulative) on new and existing off-site sensitive receptors[2] located in the vicinity of the proposed project

1 The Air Quality Analysis does not evaluate greenhouse gas emissions, as they will be evaluated separately in the proposed project's environmental document.

2 The BAAQMD generally defines a sensitive receptor as a facility or land use that houses or attracts members of the population who are particularly sensitive to the effects of air pollutants, such as children, the elderly, and people with illnesses. Examples of sensitive receptors include residences, schools, and hospitals.

(refer to **Figure 1, Regional Location**) and on new on-site receptors at the project site (residential and childcare center).

The methods in this scope of work are preliminary. Detailed information (e.g., construction data, operational assumptions, etc.) and studies (e.g., transportation and circulation) are currently under development. Therefore, the approach described herein is preliminary and may need to be updated as detailed information is developed by the project sponsor. The final air quality analysis will detail the final methods, as well as assumptions used to prepare the proposed project's air quality analysis.

Project Description

The air quality analysis will include a brief project description that discusses the key elements of the proposed project, especially as they relate to air emissions and emission impacts.

The proposed Balboa Reservoir Project (proposed project) is located on an approximately 17-acre site in the central southern portion of San Francisco. **Figure 1, Regional Location**, shows the site extent and the location of the project within San Francisco. The project site is owned by the City and County of San Francisco under the jurisdiction of the San Francisco Public Utilities Commission (SFPUC). The City, acting by and through its SFPUC, selected Reservoir Community Partners, LLC (a joint venture between BRIDGE Housing Corporation [a non-profit affordable housing developer] and Avalon Bay Communities) to act as master developer for the project site. The proposed project would develop the site with mixed-income housing, open space, community facilities, small retail, parking, infrastructure and street development. Reservoir Community Partners is the project sponsor for the proposed project.

The proposed project consists of two different density options to capture the full range of possible development on the project site: Base Project Option and City Policy Option. The two density options for the project site would have the same land uses, similar site plans, and street configurations.

Overall, the proposed project would construct up to 1.64 to 1.8 million gross square feet (gsf) of uses, including between approximately 1.28 and 1.58 million gsf of residential uses (1,100 to 1,550 dwelling units), between 231,000 and 339,900 gsf of parking, approximately 10,000 gsf of childcare or community uses, and approximately 7,500 gsf of retail. The buildings would range in height from 25 to 85 feet. Approximately 4 acres would be devoted to publicly accessible open space. SFPUC would retain ownership of an 80-foot-wide strip of land located along the southern edge of the site where underground water transmission pipelines are located. The proposed project would include stationary sources such as emergency generators (a maximum of two for the Base Project Option and a maximum of six for the City Policy Option) and idling emissions from delivery vehicles associated with the restaurant and retail land uses.

The project site is not located within an Air Pollutant Exposure Zone (APEZ), which is an area designated by the San Francisco Department of Public Health (SFDPH) as an area with poor air quality (SFDPH & SF Planning 2014). The closest parcels to the project site within the APEZ are those within 500 feet of I-280 bounded by Howth Street, Ocean Avenue, and Geneva Avenue, located approximately 1,300 feet to the southeast of the project site.

In Section 9.0, **Table 1, Project Characteristics (GSF)**, presents land use assumptions that will be used in the modeling. Project construction would require the excavation of approximately 171,000 cubic yards of soil, and the removal and disposal of approximately 56,000 cubic yards of soil. Construction of the proposed project would be completed in three phases. Phase 0 would include demolition, grading, excavation, sub-grade work, and construction of site infrastructure. This would be followed by two phases of vertical construction. Phase 1 would include construction of the townhomes and inner blocks. Phase 2 would include construction of the public parking garage and remaining blocks. The total duration for construction is anticipated to be 71 months, or six years. Construction is expected to begin in March 2021 and be completed in January 2027. The anticipated construction schedule is presented in **Table 2, Anticipated Project Construction Schedule**.

SOURCE: Google Earth, 2018; ESA, 2018

Balboa Reservoir

Figure 1
Regional Location

ESA

Assumptions and Deliverables

This scope of work makes the following key assumptions, grouped into major categories of the analysis.

Air Quality Analysis Drafts and Modeling Rounds

1. The air quality analysis will consist of the following components:
    a. A short technical summary (5-10 pages maximum) including:
        i. A list of assumptions used in the modeling in bullet format. Lists would be provided for construction modeling, operational modeling, and health risk modeling.
        ii. A list of equations used outside of models, including equation inputs.
    b. Tables presenting important data used in the modeling (e.g. model inputs), including the construction schedule, construction equipment, land use data matched to CalEEMod land use types, vehicle trip/VMT data, AERMOD modeling inputs, health risk values, etc.
    c. Tables presenting additional modeling results not included in the EIR section, such as construction emissions by source for each year, operational emissions by source for each year, detailed health risk results including coordinates of maximum impacted receptors, etc.
    d. Model outputs from CalEEMod, AERMOD, EMFAC, and other models used in the analysis.
    e. Screenshots of excel spreadsheets used in the analysis. Each tab of the spreadsheet would have up-front information describing the purpose of the calculation, the methods used, the assumptions used, and any relevant sources and citations.
2. ESA will conduct a maximum of two rounds of modeling. We will conduct one round of modeling for the preliminary draft air quality analysis (criteria pollutant emissions, dispersion modeling, and health risk calculations) for review by EP and the project sponsor prior to proceeding with completing the Air Quality section for ADSEIR-1. If refinements to the first round of modeling are required, ESA will prepare a second round of modeling. Each round of modeling will include both an uncontrolled and a controlled emissions scenario. These modeling results will be incorporated into the final air quality analysis. If additional refinements to the second round of modeling are needed (due to comments or requests from EP staff or the project sponsor; changes in the project description, construction schedule or activity data, updates to the traffic study; or any other action requiring changes to the modeling), additional budget will also be required, and ESA will provide a scope of work for project sponsor review at that time. We will also conduct one preliminary check-in meeting at least 2 weeks prior to submittal of the draft air quality analysis, and up to two meetings with EP staff to discuss HRA and modeling methods, the results of the HRA and criteria pollutant modeling, and/or EP's

comments on the various drafts of the air quality analysis. If additional meetings are needed, additional budget will be required.

3. ESA will prepare a maximum of two versions of the air quality analysis to allow for a maximum of two complete rounds of review by EP and the project sponsor. The draft air quality analysis will include the results of the first round of modeling. The final air quality analysis will include the results of the second round of modeling (if needed) and include responses to a consolidated set of review comments from EP and the project sponsor on the draft air quality analysis. If a second round of modeling is not needed, ESA will proceed with completing the ADSEIR-1 Air Quality section. The final air quality analysis will be part of ESA's ADSEIR-1 submittal. If an additional draft of the air quality analysis is required, additional budget will also be required, and ESA will provide a scope of work for this additional effort for project sponsor review at that time.
4. For the first round of modeling, ESA will model an uncontrolled emissions scenario and will then consult with EP staff and the project sponsor to determine the specific control measures to include in the controlled scenario. After consulting with EP staff and the project sponsor, ESA will model a controlled scenario. This is included in the first round of modeling. Including control measures in the first round of modeling will allow EP staff and the project sponsor to assess the impact of control measures and suggest refinements to the controlled scenario before the second round of modeling is conducted. The second round of modeling will therefore permit refinement to both the uncontrolled and controlled scenarios, to reduce the chance of needing a third round of modeling to adjust control measures. However, should a third round of modeling be required, ESA will coordinate with EP to identify exactly what changes would be required in order to more efficiently scope this effort.
5. For each round of review, including the review of this air quality analysis scope of work, the technical modeling, and each version of the air quality analysis, the project team will provide a consolidated set of comments from all parties (including EP staff, the project sponsor, the project sponsor's council, and any other reviewing parties). ESA will not accept piecemeal comments from each reviewing group separately. ESA assumes that EP staff will review comments provided by the project sponsor and all other parties and provide direction to ESA regarding how we should respond to project sponsor's comments.

Analysis Years and Scenarios

6. Operational criteria pollutant and TAC emission inventories will be developed for the following scenarios of the proposed project:
    a. **Base Project Option**
        i. **Phase 1: 2024**—This scenario includes operational emissions associated with all Phase 1 land uses and parcels for the Base Project Option.
        ii. **Full Buildout: 2027**—This scenario includes operational emissions associated with all Phase 1 and Phase 2 land uses and parcels for the Base Project Option, representing full buildout of the proposed project.

   b. **City Policy Option**

      i. **Phase 1: 2024**—This scenario includes operational emissions associated with all Phase 1 land uses and parcels for the City Policy Option.

      ii. **Full Buildout: 2027**—This scenario includes operational emissions associated with all Phase 1 and Phase 2 land uses and parcels for the City Policy Option, representing full buildout of the proposed project.

7. Construction of both Base Project and City Policy Options is expected to occur over 6 years, from March 2021 to January 2027, over the course of three phases. As noted above, operational emissions inventories will only be developed for two years: 2024 when Phase 1 is complete, and the full buildout year of 2027. Operational inventories will not be developed for interim years. Thus, in order to estimate combined construction and operational emissions for the proposed project scenarios for years 2024-2026, ESA will assume Phase 1 operational emissions are constant.

8. The project also includes three potential variants. These include Variant 1 which would relocate the 750-space underground parking garage to an above-ground location, Variant 2 which would shift South Street to the area along the SFPUC easement and relocate the 750-space underground parking garage to the north side of the site, and Variant 3 which would remove the pedestrian and bike access at San Ramon Way. None of the variants include changes to the land use totals as compared to the proposed project. As such, these variants are anticipated to result in the same construction and operational emissions as the proposed project (with the exception of Variant 1, which would require less excavation for the relocated parking garage, and therefore less construction activity and fewer truck trips and associated emissions). Therefore, ESA will not conduct emissions modeling for the variants.

9. Health risks will be developed for the following five exposure scenarios for the Base Project and City Policy Options (see Section 4.0 for additional detail):

   a. **Scenario 1 (construction):** off-site receptors evaluated starting when construction commences and exposed to all construction emissions for Phases 0, 1, and 2.

   b. **Scenario 2 (construction):** on-site receptors evaluated starting when construction for Phase 1 concludes and exposed to all Phase 2 construction emissions.

   c. **Scenario 3 (operation):** off-site receptors evaluated starting when construction commences (in 2021) and exposed to all construction emissions for Phases 0, 1, and 2 and 27 years of operational emissions (27 years of Phase 1 emissions and 24 years of Phase 2 emissions).

   d. **Scenario 4 (operation):** on-site receptors evaluated starting when construction for Phase 1 concludes (in 2024) and exposed to all Phase 2 construction emissions and 30 years of operational emissions (30 years of Phase 1 emissions and 27 years of Phase 2 emissions).

e. **Scenario 5 (operation):** off-site and on-site receptors evaluated starting when full buildout operation commences (in 2027) and exposed to 30 years of operational emissions for both Phases 1 and 2.

Data Collection and Emissions Modeling

10. The existing site is a parking lot, and does not contain any activities which generate emissions of criteria pollutants or TACs. Therefore, ESA will not conduct emissions modeling for the existing conditions scenario.
11. The project sponsor will provide all required project information necessary for the emissions modeling for construction and each operational scenario. For construction, this includes, but is not limited to, construction schedule and off-road equipment details, soil hauling and demolition debris volumes, daily/annual truck trips, haul truck travel routes, asphalt paving area, and construction worker commute information. For operations, this includes, but is not limited to, operational traffic data (including daily trip rates by land use for both light-duty and heavy-duty vehicles [such as delivery trucks], as indicated in the transportation analysis[3], emergency generator operation, and employee commute information. Transportation data will be provided by the transportation analysis. ESA also assumes that the trip generation for the project will be complete prior to the first round of modeling, per request from EP.
12. The TACs included in the HRA will be limited to the pollutants of primary concern associated with construction and operation of the project. These include diesel particulate matter (DPM), total organic gases (TOG) from gasoline vehicle operation, and $PM_{2.5}$ exhaust emissions from all combustion sources. Although additional TACs may be emitted from project construction and operation, they are not anticipated to contribute substantially to project health risks; however, the air quality analysis will determine the pollutants of primary concern based on an assessment of all TAC sources and their individual contribution to health risks.
13. ESA will not include sensitive receptors outside of the 1,000-meter modeling domain in our analysis.
14. ESA will not conduct modeling or emissions analysis for future or planned development projects in the surrounding area, or for other existing or future sources of TACs (such as Highway 280 or industrial sources) as part of any cumulative analysis. We assume that all background health risks and $PM_{2.5}$ concentrations pertinent to our analysis are included in the San Francisco Community Risk Reduction Plan city-wide HRA modeling file provided by EP staff.

Miscellaneous Assumptions

15. The BAAQMD is currently in the process of updating their CEQA Air Quality Guidelines. The timeline for the development and adoption of the new guidelines is

3 The Planning Department will not require a stand-alone Transportation Impact Study (TIS) for this project. Kittelson will prepare a combined TIS/Transportation and Circulation section of the SEIR.

currently not known, but their release is tentatively planned for some time in 2018. The air quality analysis will rely on the latest CEQA Air Quality Guidelines, revised in May 2017 (BAAQMD 2017a), until such time as the new CEQA Air Quality Guidelines are adopted by the BAAQMD. Any additional analysis required to comply with draft guidance from BAAQMD would be conducted by ESA at additional cost and scope, as directed by EP.

16. The air quality analysis will consist of the following components:
    a. A short technical summary (5-10 pages maximum) including:
        i. A list of assumptions used in the modeling in bullet format. Lists would be provided for construction modeling, operational modeling, and health risk modeling.
        ii. A list of equations used outside of models, including equation inputs.
    b. Tables presenting important data used in the modeling (e.g. model inputs), including the construction schedule, construction equipment, land use data matched to CalEEMod land use types, vehicle trip/VMT data, AERMOD modeling inputs, health risk values, etc.
    c. Tables presenting additional modeling results not included in the EIR section, such as construction emissions by source for each year, operational emissions by source for each year, detailed health risk results including coordinates of maximum impacted receptors, etc.
    d. Model outputs from CalEEMod, AERMOD, EMFAC, and other models used in the analysis.
    e. Screenshots of excel spreadsheets used in the analysis. Each tab of the spreadsheet would have up-front information describing the purpose of the calculation, the methods used, the assumptions used, and any relevant sources and citations.
17. **Deliverables: One (1)** electronic copy of the draft air quality analysis and the final air quality analysis (hard copies can be provided upon request) to EP for review and comment. In addition, ESA will provide the initial modeling results to EP for review and discussion prior to submission of the draft air quality analysis.

Objective and Methods

The air quality analysis will evaluate criteria air pollutant emissions and associated health risks associated with construction and operation of the project. Criteria air pollutants to be estimated include reactive organic gases (ROG), nitrogen oxides (NOx), particulate matter from vehicle exhaust with an aerodynamic diameter equal to or less than 10 microns (PM_{10}), and particulate matter from vehicle exhaust with an aerodynamic diameter equal to or less than 2.5 microns ($PM_{2.5}$). Fugitive emissions of PM_{10} and $PM_{2.5}$ during construction (dust from construction) will not be estimated in the air quality analysis, because the project would comply with the San

Francisco Construction Dust Control Ordinance (176-08) (City and County of San Francisco, 2008).[4] However, fugitive PM_{10} and $PM_{2.5}$ will be estimated for operation of the proposed project. For construction, health risks will be estimated for DPM and exhaust $PM_{2.5}$ from combustion sources, including off-road equipment and on-road haul trucks. For operation, health risks will be estimated for DPM and exhaust $PM_{2.5}$ from combustion sources, including emergency generators (two for the Base Project Option and six for the City Policy Option), on-road heavy-duty trucks (travel and idling), and exhaust TACs from operational gasoline vehicles (i.e. project-generated traffic).

The approach for the air quality analysis will be consistent with EP requirements, utilizing technical information from the Bay Area Air Quality Management District (BAAQMD), California Air Pollution Control Officer's Association (CAPCOA), California Air Resources Board (CARB), Office of Environmental Health Hazard Assessment (OEHHA), and the U.S. Environmental Protection Agency (U.S. EPA). Consistent with guidelines and recommendations from these agencies, the health risk assessment (HRA) contained in the air quality analysis will evaluate the estimated incremental increase in lifetime cancer risks from exposure to emissions of DPM and the annual average $PM_{2.5}$ concentrations associated with combustion (i.e., exhaust) that would be emitted by project-related construction sources including off-road construction equipment, on-road heavy-duty haul trucks, and an asphalt recycling facility, and project-related operational sources including vehicle traffic, emergency generators (two for the Base Project Option and six for the City Policy Option), and delivery vehicle travel and idling.

The San Francisco Citywide HRA evaluates the cumulative lifetime cancer risks and annual average exhaust $PM_{2.5}$ concentrations from existing known sources of air pollution as part of the development of a Community Risk Reduction Plan (CRRP) (referred to as the CRRP-HRA). The modeling is documented in *The San Francisco Community Risk Reduction Plan: Technical Support Documentation* (BAAQMD, SF DPH & SF Planning, 2012). The cumulative HRA for the project will estimate lifetime excess cancer risk and annual average exhaust $PM_{2.5}$ concentrations that are attributable to other mobile and stationary sources as calculated in the CRRP-HRA, in addition to affects from the project. The CRRP-HRA was completed before OEHHA updated its Air Toxics Hot Spots Program Risk Assessment Guidelines in 2015, so the CRRP-HRA results will be adjusted to use the 2015 OEHHA Guidance (OEHHA 2015) by multiplying the cancer risk values by the factor 1.3744, as recommended by the BAAQMD (Lau pers. com.).[5]

4 The ordinance would reduce the quantity of dust generated during site preparation, demolition, and construction work to protect the health of the general public and on-site workers and minimize public nuisance complaints through measures that include dust suppression activities (e.g., watering), street sweeping, and material stockpile covers. Accordingly, PM_{10} and $PM_{2.5}$ dust are not discussed or evaluated further.

5 The scaling factor represents the average difference in residential cancer risk, as calculated using the latest 2015 OEHHA guidance, compared to the original 2003 OEHHA guidance. In other words, using the updated cancer risk calculations and age sensitivity factors from the 2015 OEHHA guidance, calculated residential lifetime excess cancer risk is 1.3744 times higher than residential cancer risk as calculated using the original 2003 OEHHA guidance, which was used in developing the CRRP-HRA.

Consistent with EP and BAAQMD's CEQA requirements, and the CRRP-HRA, this air quality analysis will evaluate:

1. Criteria air pollutant mass emissions associated with project construction and project operation.
2. Cancer risk and annual average exhaust $PM_{2.5}$ concentrations from construction emissions (including emissions from off-road equipment and on-road haul trucks) at off-site sensitive receptors located within 1,000 meters of the project boundary.
3. Cancer risk and annual average exhaust $PM_{2.5}$ concentrations from Phase 2 construction emissions at on-site sensitive receptors constructed during Phase 1.
4. Cancer risk and annual average exhaust $PM_{2.5}$ concentrations from operational emissions (including emissions from vehicle traffic, emergency generators, and delivery vehicle travel and idling) at off-site sensitive receptors located within 1,000 meters of the project boundary.
5. Cancer risk and annual average exhaust $PM_{2.5}$ concentrations from operational emissions at on-site sensitive receptors.
6. Cumulative cancer risk and annual average exhaust $PM_{2.5}$ concentrations (at off-site and on-site sensitive receptors) resulting from other stationary, area and mobile source emissions as calculated in the CRRP-HRA in addition to health impacts from the project construction and operational emissions.
7. Cumulative 2040 conditions, based on a qualitative assessment of the 2040 CRRP-HRA modeling, which shows that $PM_{2.5}$ and excess lifetime cancer risk generally decrease for sensitive receptor points within 1,000 meters under 2040 conditions without the project, including a qualitative assessment of health risk impacts from nearby projects within 1,000 meters.

The draft results of the criteria pollutant estimates, dispersion modeling, and health risk calculations will be provided to EP for review once the initial modeling is complete; these results will be part of the draft air quality analysis. The purpose of submitting draft results to EP is to assess the preliminary results and determine if model refinements are necessary and/or to identify additional (or refinements to) control measures to reduce project impacts and the methods for assessing their effectiveness. Furthermore, the review will help identify additional feasible control measures to reduce project impacts, if required based on the results from the first round of modeling, and the methods for evaluating the effectiveness of those control measures.

Document Organization

This scope of work is divided into nine sections as follows:

- **Section 1.0 – Introduction** describes the purpose and scope of the air quality analysis, the project description, the objectives and overall methods used in the air quality analysis, and outlines document organization.

- **Section 2.0 – Emissions Calculation Methods** describes the methods that will be used to estimate criteria air pollutant and TAC emissions from construction and operation of the project.
- **Section 3.0 –Air Concentration Methods** presents the air dispersion modeling, the data to be used in the model (e.g., meteorology, source characterization, sensitive receptor characteristics, terrain), and identifies the sensitive receptor locations evaluated in the HRA.
- **Section 4.0 – Risk Characterization Methods** provides an overview of the method that will be used to conduct the HRA (such as cancer risk).
- **Section 5.0 – Control Measures** identifies the approach to identifying control measures and describes several preliminary reduction measures that could reduce criteria pollutant emissions, $PM_{2.5}$ and DPM and/or health risks.
- **Section 6.0 – Cumulative Analysis** summarizes the approach to be used in the HRA cumulative analysis.
- **Section 7.0 – Uncertainties** summarizes the critical uncertainties associated with the air quality analysis modeling for both criteria pollutants and TACs.
- **Section 8.0 – References** lists the references cited in this scope of work
- **Section 9.0 – Tables** presents all tables referenced in this scope of work

2.0 EMISSION CALCULATION METHODS
Air Quality Analysis Scope of Work

The following sections discuss methods used to calculate emissions of criteria pollutants and TACs for each source associated with the proposed project. The section is separated into construction emissions and operational emissions. All assumptions used to estimate construction and operational emissions will be included in the air quality analysis. The following emissions estimates will be reported for both Base and City Policy Options:

1. **Construction**: Average daily and total annual construction emissions for each year of construction.

2. **Construction plus operation:**
   a. Average daily construction emissions plus average daily operational emissions during years when construction and operation overlap.
   b. Annual construction emissions plus annual operational emissions during years when construction and operation overlap (using the operational emissions scenarios described below).

3. **Operation**: Average daily and annual maximum operational emissions at project buildout.

Operational emissions inventories will be developed for comparison for the scenarios identified under the Assumptions and Deliverables in Section 1.0.

Calculation Methods for Construction Emissions

Project construction-related emissions of criteria pollutants and DPM (e.g., off-road equipment exhaust, and on-road vehicle exhaust) will be estimated using a project-specific construction-phasing schedule and a project-specific equipment mix to be provided by the project sponsor pursuant to a pending data request. ESA will estimate average daily and total annual construction-related criteria pollutant emissions for each construction phase and year of construction, and total annual DPM and $PM_{2.5}$ emissions for the HRA. ESA will assume that all off-road and on-road equipment is diesel-powered (unless specified otherwise by the project sponsor, such as for certain pieces of electric equipment), and that all off-road equipment and on-road vehicle exhaust emissions of PM_{10} are DPM (see Section 3.0 for additional discussion of DPM and PM_{10}).

Calculation methods for each source of construction emissions are explained separately below. If any refinements are needed for input into the modeling for criteria pollutants or for the HRA, or if the project description changes further, ESA will use updated information to estimate emissions, pending the schedule for the air quality analysis and the overall project schedule. If project changes cannot be accommodated in the air quality analysis schedule, ESA will notify EP immediately to discuss schedule and document management. If additional modeling beyond the first two rounds of modeling is necessary, additional budget would be required, and ESA would prepare a scope of work for this effort for review and approval by EP staff and the project sponsor at that time. Please refer to the list of assumptions in Section 1.0 above.

Construction emissions under a controlled scenario will also be estimated in consultation with EP staff and the project sponsor regarding specific control measures to include.

Off-Road Equipment

To estimate off-road construction equipment emissions, ESA will use the California Emission Estimator Model (CalEEMod), version 2016.3.2. CalEEMod is a statewide land use emissions computer model designed to provide a uniform platform for government agencies, land use planners, and environmental professionals to quantify potential criteria pollutant and greenhouse gas emissions from a variety of land use projects. The model is considered to be an accurate and comprehensive tool for quantifying air pollutant emissions from land use projects throughout California, and is recommended by BAAQMD for land-use CEQA analyses.[6] Where specialty equipment pieces are used, emission factors from the California Air Resources Board's 2011 Off-Road Equipment Model (OFFROAD2011) emission rate program will be used to quantify emissions based on **Equation 1** below. Equipment horsepower will be based on information provided by the project sponsor. Where project-specific data is unavailable, CalEEMod default values will be used.

Equation 1: $$E_{phase} = \sum_{i} (Activity_i * EF_i * LF_i * HP_i) * Conv$$

Where:

E_{phase} = Total exhaust emissions for the phase, pounds per day

Activity = Equipment activity, hours per day (to be specified by project sponsor)

EF = Engine emissions factor, grams/horsepower-hour (CalEEMod/OFFROAD2011)

LF = Engine load factor, unitless (CalEEMod/OFFROAD2011)

HP = Engine horsepower, hp (project sponsor or CalEEMod/OFFROAD2011)

Conv = Conversion factor, 0.002205 pounds/grams

i = Equipment type

On-Road Mobile Sources

In addition to off-road equipment, project construction would require on-road vehicles for materials import/export (i.e., haul trucks), employee commute trips, on-site personnel movement, and vendor trips.

6 See: http://www.caleemod.com.

On-road haul truck emissions will be calculated using haul truck trip estimates and trip length provided by the project sponsor or transportation analysis, if available. If project-specific information on disposal site(s) for demolition debris and exported fill material is not available from the project sponsor, ESA will use CalEEMod default value of 20 miles for haul truck trips. Vendor truck trips will be calculated by CalEEMod based on land use and building square footage and an assumed vendor truck trip length of 7.3 miles (CalEEMod default), unless project-specific information on vendor trips is available from the project sponsor or contained in the transportation analysis. Construction worker trip emissions will also be estimated using the daily number of workers provided by the project sponsor (or contained in the transportation analysis), if available, or default values from the CalEEMod model, if necessary. Estimated on-road construction criteria pollutant emissions for each construction phase will be totaled for each year of construction and, consistent with BAAQMD guidance, averaged over the number of work days in the construction phase for each year of construction to determine average daily emissions on an annual basis. Estimated on-road emissions of DPM and $PM_{2.5}$ exhaust will be calculated for each year to estimate total cancer risk and annual average exhaust $PM_{2.5}$ concentration for the HRA.

Criteria pollutants generated by on-road vehicle trips will be calculated for each phase using **Equation 2**.

Equation 2: $$E_{phase} = \sum_{i} (Activity_i * EF_i * Distance_i) * Conv$$

Where

E_{phase}	=	Total exhaust emissions for the phase, pounds per day
Activity	=	Vehicle trips, trips per day (project sponsor)
Distance	=	Vehicle trip length, miles per trip (project sponsor)
EF	=	Engine emissions factor, grams/mile (EMFAC2014)
Conv	=	Conversion factor, 0.002205 grams/pound
i	=	Vehicle type

Haul Truck Idling

Idling emissions associated with heavy-duty trucks (haul trucks, concrete trucks, material delivery trucks, water trucks, etc.) will be estimated based on the anticipated number of truck trips as provided by the project sponsor, and idling emission factors for heavy-duty vehicles from CARB's EMission FACtor model for on-road emissions (EMFAC2017). It is assumed that idling activities would total 15 minutes per trip, representing three separate 5-minute idling occurrences: check-in to the site or queuing at the site boundary upon arrival, on-site idling during loading/unloading, and check-out of the site or queuing at the site boundary upon departure. The 5-minute limit per idling occurrence is consistent with the CARB's Air Toxics Control Measure (ATCM) to Limit Diesel-Fueled Commercial Motor Vehicle Idling.

Evaporatives (Asphalt)

Emissions of ROG from asphalt paving will be estimated within CalEEMod based on the acres of paving for each construction phase as provided by the project sponsor. ESA will review representative product data sheets to identify if TACs would be emitted during the paving process, and if so, include in the HRA.

Architectural Coatings

Emissions of ROG from architectural coatings will be estimated within CalEEMod, based on the square footage of new building as provided by the project sponsor.

Calculation Methods for Operational Emissions

ESA will estimate project operational criteria pollutant emissions (ROG, NO_X, exhaust and fugitive PM_{10}, and exhaust and fugitive $PM_{2.5}$) from mobile sources, area sources and energy sources using CalEEMod 2016.3.2 and EMFAC2017. The TACs included in the HRA will be limited to the pollutants of primary concern associated with construction and operation of the proposed project: DPM from off-road construction equipment, on-road construction haul trucks, operational emergency generators, and operational on-road heavy-duty trucks; TOGs from gasoline vehicle operation (project-generated traffic); and $PM_{2.5}$ exhaust emissions from off-road construction equipment, on-road construction haul trucks, operational emergency generators, and operational on-road heavy-duty trucks. Although additional TACs may be emitted from project construction and operation, they are not anticipated to contribute substantially to project health risks, and will therefore not be included in the air quality analysis.

There are no activities producing emissions at the existing site, so it is assumed that existing emissions are zero, and ESA will not conduct emissions modeling for existing conditions. Thus, project-related operational emissions for all components of the project will represent the net increase in emissions compared to existing conditions associated with the proposed project.

Mobile Sources

Operation of the proposed project would generate emissions from on-road motor vehicle activity generated by the new land uses associated with the project. These trips include visitors and deliveries to new non-residential uses (retail, restaurant, childcare facility, and open space).

Operational mobile source criteria pollutant and DPM emissions for the project will be estimated using traffic data from the transportation consultant (i.e., trip generation rates, pass-by tips, etc.) and the CalEEMod emissions model or EMFAC2017 (see Equation 2 above). We will base the air emission estimates on project-specific trip generation rates to be reported in the transportation analysis and vehicle miles travelled calculated using model default trip distances (unless the project team can provide project-specific trip distances or VMT).

Vehicles also emit TACs in their exhaust and through evaporation and thus will be evaluated in the HRA. The majority of operational vehicles will be gasoline-powered (i.e., visitors driving light-duty automobiles), and DPM is therefore not a concern for these vehicles. However, gasoline vehicles produce emissions of TOGs; many constituents of TOGs are TACs. Non-DPM TACs are typically associated with gasoline vehicles. Estimates of gasoline-related TAC emissions will be based on CalEEMod and EMFAC2017 ROG emission rates from gasoline vehicles, ROG to total organic gas (TOG) conversion factors from U.S. EPA (U.S. EPA 2005), and TOG-speciation values obtained from BAAQMD (BAAQMD 2012a).

The project will also include medium- and heavy-duty trucks delivering materials and goods to the project site (such as material deliveries and vendor trucks associated with retail and restaurant uses); these vehicles may be diesel-powered. ESA will obtain estimates from the transportation consultant regarding daily deliveries, including the percentage of which are estimated to be from diesel trucks. For deliveries by diesel truck, ESA will use the CalEEMod default fleet mix for light heavy-duty trucks (LHD1 and LHD2 = 32%), medium heavy-duty trucks (MHD = 53%), and heavy heavy-duty trucks (HHDT = 15%). ESA will estimate DPM and $PM_{2.5}$ exhaust emissions from delivery vehicles using Equation 2 above, and calculate health risks from these emissions following the methods described in Section 4.0 below, based on the anticipated location of the truck loading areas and delivery vehicle idling locations.

Area Sources

Operation of the proposed project would also generate emissions from area sources, including landscaping equipment, consumer products, paint and other architectural coatings, and natural gas combustion in heaters, boilers, and restaurant stoves. Area source emissions will be estimated using the CalEEMod emissions model and land use type and size information provided by the project sponsor.

Natural Gas Combustion

With regard to energy usage, the consumption of fossil fuels to generate electricity and to provide heating and hot water generates criteria pollutants. However, since electricity generation will occur at power plants located outside of the city (and possibly outside of the state), these emissions will not be included in the air quality analysis. (In addition, CalEEMod does not estimate criteria pollutant emissions from electricity consumption and they are thus not typically included in CEQA analyses.) Future natural gas consumption rates will be estimated based on specific square footage of the project's retail and restaurant land uses, as well as predicted water supply needs of the project. On-site natural gas consumption for the proposed project will be calculated within CalEEMod, unless project-specific natural gas usage rates are available from the project sponsor. CalEEMod incorporates correction factors to account for compliance with the 2016 Title 24 Building Standards Code. Since the proposed project would also be required to meet the Title 24 standards in effect at the time of building permit application, this analysis will incorporate an additional correction factor to account for the updated 2019 Title 24 Building Standards Code (which will go into effect on January 1, 2020).

All woodstoves and wood-burning fireplaces will also be removed from the CalEEMod modeling pursuant to BAAQMD regulations (BAAQMD 2015).

Consumer Products

A daily emission factor of $1.5*10^{-5}$ pounds of ROG per square foot per day for consumer products will be assumed in the emissions modeling to replace the CalEEMod default value, based on guidance from the BAAQMD and EP staff (Kirk pers. com.). ESA will use default CalEEMod values and assumptions where project-specific information is not available for all other assumptions.

Stationary Sources

It is anticipated that operation of the proposed project would include the operation of stationary sources, which are anticipated to include emergency generators and idling emissions from delivery vehicles associated with commercial and retail land uses.

Emergency Generators and Fire Pumps

Back-up diesel generators are required by the San Francisco Building Code for buildings with occupied floor levels greater than 75 feet in height. For the Base Project Option, there will be no buildings taller than 75 feet, and the project design will seek to avoid generators and use battery backups for any emergency power required by the SF Building Code. However, it may be necessary in some instances to use diesel generators for emergency power for some buildings and/or features. For this analysis, ESA will assume that the Base Project Option will include up to two diesel generators at an average of 400 horsepower each. For the City Policy Option, there will be four buildings greater than 75 feet; therefore, ESA will assume an additional four generators, for a total of six emergency generators.

ESA will model the specific location of each generator based on information from the project sponsor. If specific generator locations are not provided by the project sponsor, ESA will conservatively assume that the generators will be located on the west side of Block D or the north side of Block B, close to and directly upwind of residential receptors in Block D and residential and daycare receptors in Block B; these locations are also the closest potential locations to off-site receptors directly west of the project boundary.

Emergency generator emissions will be estimated based on a maximum annual non-emergency operation schedule of 50 hours each, consistent with emergency standby engine testing limits established in BAAQMD Regulation 9-8-330.3. Emissions factors for the generators will be based on emission limits established for new stationary emergency standby diesel-fueled internal combustion engines in ARB's *Airborne Toxic Control Measure for Stationary Compression Ignition Engines* final regulation for model year 2008 and newer engines of horsepower greater than 750 (CARB 2011). Alternative emission factors include U.S. EPA federal Tier 2 diesel engine standards for diesel engines with a power rating >560 kilowatts (kW).

The proposed project would also have fire pumps for each building; ESA will assume that these pumps would be powered by diesel engines in the case of emergencies when grid electricity is not available, unless information to the contrary is provided by the project sponsor. The fire pumps would be powered by the emergency generators described above for each project option and no additional diesel engines would be needed for emergency operation.

Vehicle Idling

Idling emissions associated with delivery vehicles at loading docks and other locations will be estimated based on the anticipated number of delivery trips at each land use, as provided by the project sponsor, and idling emission factors for heavy-duty vehicles from CARB's EMFAC2017 emission rate program. It is assumed that idling activities would total 5 minutes per trip for trucks, consistent with the ARB's ATCM to Limit Diesel-Fueled Commercial Motor Vehicle Idling. Based on the foregoing assumptions, ESA will calculate new project-related delivery vehicle idling emissions based on the traffic analysis report and additional data from the project sponsor, in order to calculate net new idling emissions associated with the project. Unless specific loading locations are provided by the project sponsor or transportation consultant, it will be conservatively assumed that these idling emissions will be located along the south portion of West Street directly upwind of residential receptors in Block D and along South Street close to the residential and daycare receptors in Blocks A and B; these locations are also the closest potential locations to off-site receptors directly west of the project boundary.

3.0 ESTIMATED AIR CONCENTRATIONS

Air Quality Analysis Scope of Work

ESA will conduct a detailed assessment of health risks and hazards (HRA) resulting from project construction and operation. Consistent with the CRRP-HRA, ESA will estimate health risks from TACs (primarily DPM) and annual average exhaust $PM_{2.5}$ concentrations at all sensitive receptors located within 1,000 meters of the proposed project's boundaries. For the proposed project, this would include construction emissions and operational traffic (including TOG emissions from gasoline combustion in vehicles). The HRA will be conducted following methods in BAAQMD's Health Risk Screening Analysis Guidelines (BAAQMD 2012b, 2017) and in the California Office of Environmental Health Hazard Assessment (OEHHA) Air Toxics Hot Spots Program Guidance (OEHHA 2015).

Chemical Selection

The HRA will evaluate health risks associated with the proposed project based on exposure of sensitive receptors to TAC emissions,[7] including DPM, as well as exhaust $PM_{2.5}$. While DPM is a complex mixture of gases and fine particles that includes over 40 substances that are listed by the U.S. EPA as hazardous air pollutants and by the ARB as toxic air contaminant (University of California, Los Angeles 1998), the DPM analysis will use PM_{10} emissions as a surrogate for DPM emissions. OEHHA guidance indicates that the cancer potency factor to be used to evaluate cancer risks were developed based on whole (gas and particulate matter) diesel exhaust, and that the surrogate for whole diesel exhaust is DPM, with PM_{10} serving as the basis for the potential risk calculations (Office of Environmental Health Hazard Assessment 2003). In addition to evaluating the effects of TAC concentrations, the HRA will also evaluate annual average exhaust $PM_{2.5}$ concentrations. This is consistent with BAAQMD's May 2017 CEQA Guidelines, *California Environmental Quality Act: Air Quality Guidelines*, which indicate that $PM_{2.5}$ be evaluated in community-scale impacts of air pollution based on scientific studies and recommendations by the Bay Area Health Directors to the BAAQMD's Advisory Council (BAAQMD 2017).

The HRA will also evaluate TOGs from gasoline vehicles for operations. As noted in Section **Error! Reference source not found.**, gasoline vehicles produce emissions of TOG, which comprises certain TACs. Estimates of gasoline-related TAC emissions will be based on CalEEMod and EMFAC2017, ROG to total organic gas (TOG) conversion factors from USEPA (USEPA 2005), and TOG-speciation values obtained from BAAQMD (BAAQMD 2012a).

7 Toxic air contaminants to be evaluated in this analysis include 1,3-Butadiene, Acetaldehyde, Benzene, Ethylbenzene, Formaldehyde, and Naphthalene.

The HRA will evaluate any additional TACs based on their likely individual contribution to health risks in order to determine the full suite of pollutants of primary concern for the project.

Sources

The EPA's AERMOD steady-state Gaussian dispersion model will be used to evaluate DPM and annual average exhaust $PM_{2.5}$ concentrations at off-site and on-site receptor locations that would result from construction and operational activities associated with the proposed project. Construction sources include off-road construction equipment, on-road diesel trucks (including haul trucks, material delivery trucks), and idling. Operational sources include traffic (TOGs from gasoline combustion), idling of heavy-duty diesel delivery vehicles, and emergency generators.

AERMOD Modeling

ESA will use the most recent version of the American Meteorological Society/Environmental Protection Agency regulatory air dispersion model (AERMOD version 9.6.1) to estimate concentrations of TACs and $PM_{2.5}$ at off-site sensitive receptors. For each receptor location, AERMOD generates air concentrations that result from emissions from multiple sources. The AERMOD model requires numerous inputs, such as meteorological data, source parameters, topographical data, and receptor characteristics. Where project-specific information is not available, ESA will use default parameter sets that are designed to produce conservative (i.e., overestimates of) air concentrations (U.S. EPA 2016a, 2016b). **Table 3, Overall AERMOD Modeling Parameters**, summarizes the overall modeling parameters to be used in AERMOD.

As noted above, the HRA will evaluate health risks based on exposure of sensitive receptors to DPM, TOGs from gasoline vehicle operation, and $PM_{2.5}$ exhaust emissions from all combustion sources. AERMOD will be run for one pollutant: PM_{10} will be modeled to represent emissions of DPM and $PM_{2.5}$.

Meteorological Data

Meteorological data from the nearest meteorological air monitoring site will be used. The nearest air monitoring site is the Mission Bay (Site ID# 5803) monitoring site. The most recently available dataset (2008) will be used, which is consistent with the CRRP-HRA (BAAQMD, SF DPH & SF Planning, 2012). The dataset will be obtained from the BAAQMD.

Terrain and Land Use Considerations

Terrain and elevation data will be imported from the United States Geological Survey's (USGS) National Elevation Dataset (United States Geological Survey 2013). Elevations for all receptors are from the CRRP-HRA modeling. Based on the land use characteristics in the project vicinity, urban dispersion coefficients will be used in AERMOD. The site will be modeled with the urban population of 884,363 for July 1, 2017 (US Census Bureau 2018). The urban option in AERMOD accounts for increased turbulence associated with the urban heat island effect.

Emission Rates

Emission rates from the various emission sources (e.g., construction activities, roadways, emergency generators, etc.) will be based on the anticipated hours of activity for each source and other information as described in Section 2.0 above. Because each emission source will be modeled separately within AERMOD, ESA will use a unitized emission rate concept for each source, where each source is modeled with a unitized emission rate of 1 gram/second (g/s). The modeled concentration at each receptor (micrograms per cubic meter [μ/m^3]/[g/s]) represents a “dispersion factor,” which will then be multiplied by the actual emission rate of each source to determine actual concentrations, and the final result from all the sources will be superimposed. This approach is called the “Summation Concept,” where the concentration and deposition fluxes at each receptor are the linear addition of the resulting values from each source.

For annual average ambient air concentrations, the estimated annual average dispersion factors are multiplied by the annual average emission rates for each source. The emission rates will vary day to day, with some days having no emissions. For simplicity, the model will assume a constant emission rate during an entire year.

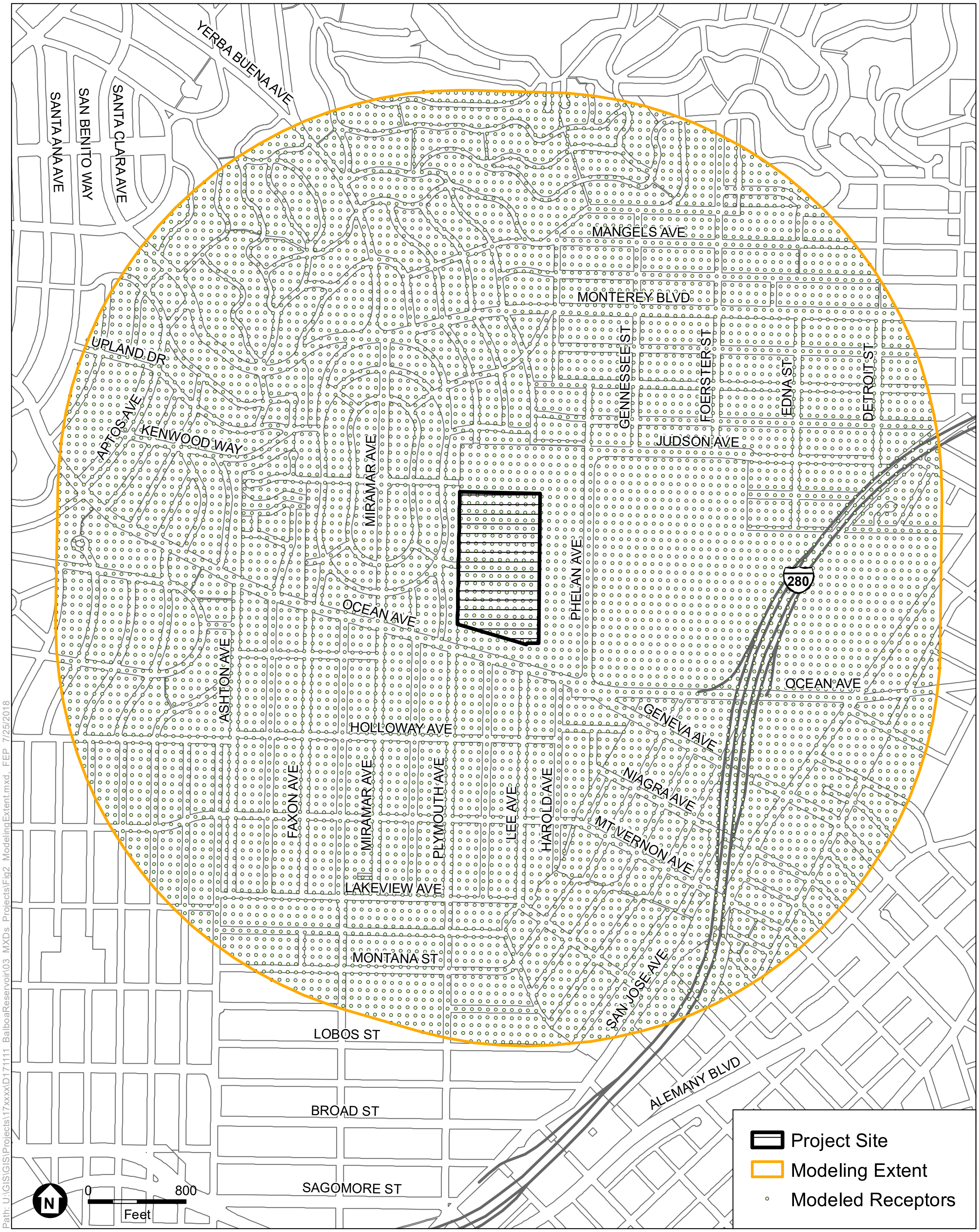
Source Parameters

Source parameters are required to model the dispersion of emissions. Construction sources will be modeled as an area source within AERMOD using the same release parameters used in the CRRP-HRA, including a release height of 5 meters and an initial vertical dimension of 1.4 meters (BAAQMD, SF DPH & SF Planning, 2012). Roadways will be modeled as line-area sources (volume sources will not be used since sensitive receptors may be located in the exclusion zone of the volume source, and U.S. EPA recommends using line-area sources in these cases [U.S. EPA 2012]). The line-area source width will correspond to the roadway width, while the modeled release height will be 2.5 meters and the initial vertical dimension will be 2.3 meters, consistent with the CRRP-HRA modeling and U.S. EPA Haul Road Guidance (U.S. EPA 2012). Delivery vehicle idling will be modeled as a line-area source, since the loading area cover a large area and vehicles will be idling throughout this area. Emergency generators will be modeled as stationary point sources located at-grade (assuming the generators will be located in the building basements and their emissions will be ventilated at street-level). **Table 4, Source Modeling Parameters**, summarizes the source modeling parameters to be used in AERMOD.

Receptors

A 20-meter receptor modeling grid will be modeled within AERMOD to represent both off-site and on-site sensitive receptors. This grid will be co-located with the CRRP-HRA grid. The receptor modeling grid will extend 1,000 meters from the project boundary to evaluate the effects of construction activities and roadway traffic associated with project operations, as shown in **Figure 2, Project Boundary and Modeling Extent**. Receptors will be placed at a height of 1.8 meters above terrain height, which represents the default breathing height for ground floor receptors. Maximum annual average concentrations will be estimated for each receptor location.

Sensitive receptor locations will include residential areas, daycares, schools (for children under 16 years of age), and hospitals. **Figure 3, Sensitive Receptor Parcels**, presents the parcels that are characterized as "residential" using data from SF OpenData (SF County 2018), based on residential land use and/or zoning data. However, these zoning data may not capture all sensitive residential receptor locations near the project site. As such, ESA will assume that all modeled receptors within the 20 meter CRRP receptor grid are residential for risk modeling purposes in the HRA, and then verify that the receptor locations with the highest health risks from the project's contribution are in fact residents. In addition to residential receptors to the north, west, and south of the project site, ESA has identified a number of daycares and schools within 1,000 meters of the project site; these are presented in **Table 5, Sensitive Receptor Locations: Daycares and Schools**.

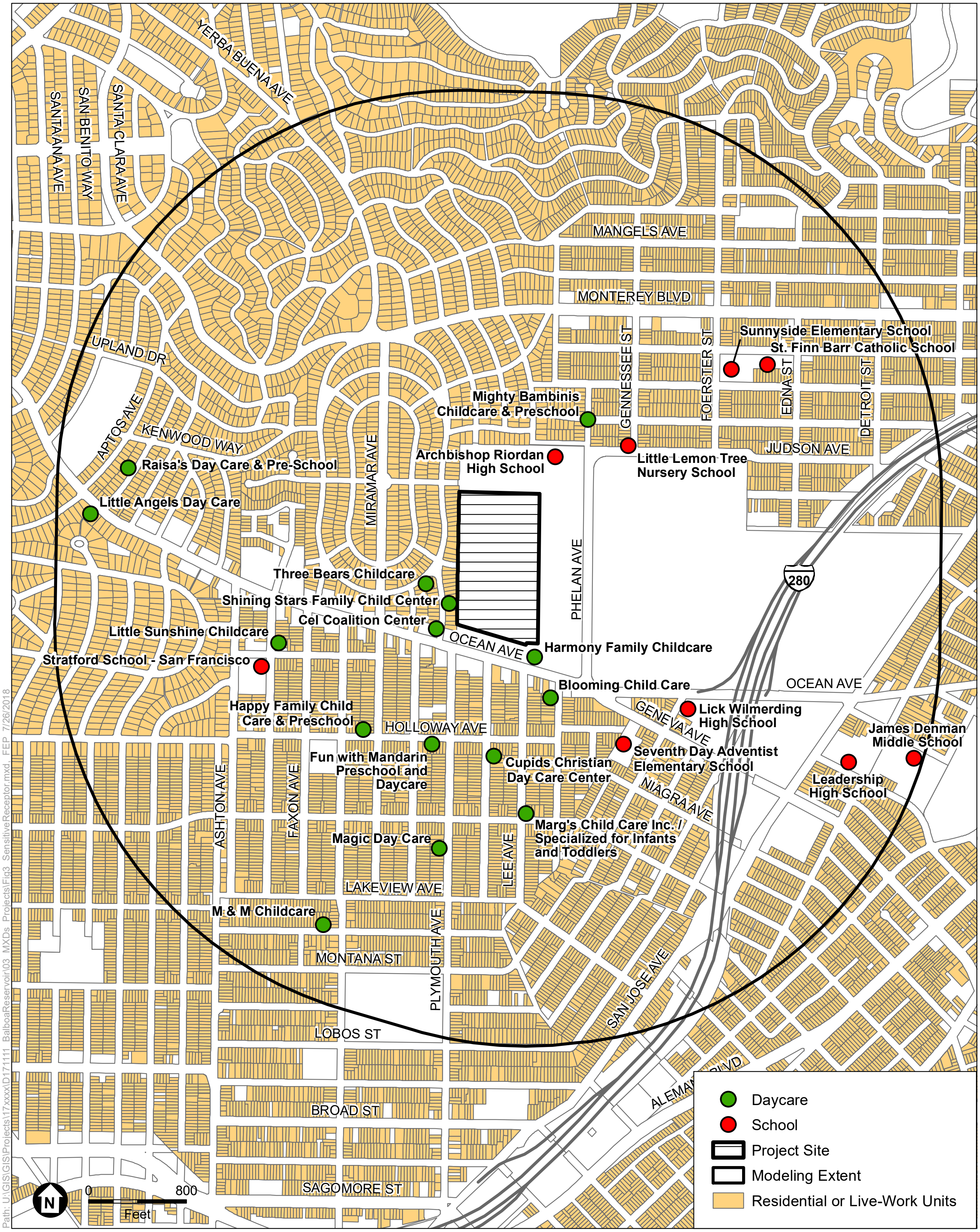


SOURCE: San Francisco Planning Department, 2018; ESA, 2018

Balboa Reservoir

Figure 2
Project Boundary and Modeling Extent

ESA



SOURCE: San Francisco Planning Department, 2018; ESA, 2018

Balboa Reservoir

Figure 3
Sensitive Receptor Parcels

ESA

4.0 RISK CHARACTERIZATION METHODS

Air Quality Analysis Scope of Work

In March 2015, OEHHA updated the methods for estimating cancer risks to use higher estimates of cancer potency during early life exposures and different assumptions for breathing rates and length of residential exposures. The new guidance, *Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments*, incorporates advances in risk assessment with consideration of infants and children using Age Sensitivity Factors (ASF) (OEHHA 2015). These updated exposure factors can result in numeric life-time health risk values to be approximately two to three times higher than those calculated under the previous OEHHA guidelines. The BAAQMD has issued draft guidelines on adopting the 2015 OEHHA Guidance Manual (BAAQMD 2016); however, the 2015 OEHHA guidelines have not been formally adopted by the BAAQMD. Based on BAAQMD and EP guidance, a refined HRA will be performed in accordance with OEHHA's 2015 guidelines to quantify potential impacts from TACs emitted during construction and operation (OEHHA 2015, BAAQMD 2016).

ESA will estimate project-specific and cumulative health risks for both construction and operational TAC emissions, including DPM and TACs from gasoline vehicle TOG emissions. ESA will calculate project-level lifetime excess cancer risk and annual average exhaust $PM_{2.5}$ concentrations. These calculations will be based on the emission calculation methods identified in Section 2.0 above, annual average pollutant concentrations from AERMOD discussed in Section 3.0, and accepted dose and risk calculations from OEHHA and BAAQMD, as discussed in this section below (OEHHA 2015, BAAQMD 2016).

Prior to conducting any modeling, ESA will confirm with the Planning Department the appropriate modeling assumptions.

Project Sources Evaluated

As discussed in Section 1.0 above, ESA will evaluate excess lifetime cancer risk and annual average exhaust $PM_{2.5}$ concentrations at off-site and future on-site sensitive receptor locations associated with project construction and operational emissions. Health risks from construction activity (e.g., off-road construction equipment and heavy-duty trucks) will be calculated using the methods explained in the following sections. Health risks from operational activity (mobile sources, emergency generators, and idling from delivery vehicles) will be calculated using the methods discussed below.

Exposure Assessment

Cancer risk as a result of exposure to DPM occurs exclusively through the inhalation pathway (OEHHA 2015). Therefore, the HRA will only evaluate cancer risks from inhalation and no other exposure pathways (e.g., dermal and ingestion pathways)

ESA will use the existing 20-meter receptor modeling grid from the CRRP-HRA out to 1,000 meters from the project site to represent both off-site and on-site sensitive receptors. As shown in Figure 3 and Table 5, not all surrounding receptors are residential. The specific location of nearby sensitive receptors within the CRRP-HRA receptor grid will be developed in consultation with EP.

Potentially Exposed Populations

This analysis will conservatively evaluate the following receptor populations:

- Off-site residents
- Off-site daycare receptors
- Off-site school receptors
- On-site residents
- On-site daycare receptors

Because child resident exposure assumptions are more conservative than those for adult residents, a conservative approach of considering all off-site receptors as initially child residents will be used in this HRA. Once child receptors have been exposed for 16 years, adult exposure parameters will be used (see **Table 6, Exposure Parameters**).

Residential exposure assumptions are more conservative than those for other sensitive receptor types because residential uses have the longest exposure duration, the highest breathing rates by applicable age group, and the highest exposure frequency. Consequently, the HRA will conservatively assume that all sensitive receptors are residential receptors.

Construction Scenario

For the construction HRA, two separate scenarios will be evaluated for both the Base and High Density Assumptions as follows. These scenarios are based on the 30-year exposure requirement in the OEHHA guidelines (OEHHA 2015).

1. **HRA Scenario 1.1 (Base Project Option)**: off-site receptors will be evaluated starting when construction commences for Phase 1 (March 2021) and exposed to all construction emissions for Phase 1 and Phase 2 (6 years, ending in January 2027).

   HRA Scenario 1.2 (City Policy Option): off-site receptors will be evaluated starting when construction commences for Phase 1 (March 2021) and exposed to all construction emissions for Phase 1 and Phase 2 (6 years, ending in January 2027).

2. **HRA Scenario 2.1 (Base Project Option)**: on-site receptors present at the project site once Phase 1 is complete will be evaluated starting when construction for Phase 1 concludes (August 2024) and exposed to all Phase 2 construction emissions (2.5 years, from September 2024 to January 2027).

   HRA Scenario 2.2 (City Policy Option): on-site receptors present at the project site once Phase 1 is complete will be evaluated starting when construction for Phase 1 concludes (August 2024) and exposed to all Phase 2 construction emissions (2.5 years, from September 2024 to January 2027).

Child residents will be evaluated starting with the fetus at the beginning of its third trimester, and child daycare and school receptors will be evaluated starting at age 2 per OEHHA guidance (2015).

Operational Scenarios

For the operational HRA, three separate scenarios will be evaluated for both the Base and City Policy Assumptions as follows. These scenarios are based on the 30-year exposure requirement in the OEHHA guidelines (OEHHA 2015).

1. **HRA Scenario 3.1 (Base Project Option)**: off-site receptors will be evaluated starting when construction commences and exposed to all construction emissions (one year for Phase 0, 2.5 years for Phase 1, and 2.5 years for Phase 2 for 6 years total) and 27 years of operational emissions (27 years of Phase 1 emissions and 24 years of Phase 2 emissions for 30 years total, beginning in 2021 with construction of Phase 0 and ending in 2051 with operation). This is equivalent to the Scenario 1.1 construction exposure plus 24 years of operational exposure.

   HRA Scenario 3.2 (City Policy Option): off-site receptors will be evaluated starting when construction commences and exposed to all construction emissions (one year for Phase 0, 2.5 years for Phase 1, and 2.5 years for Phase 2 for 6 years) and 27 years of operational emissions (27 years of Phase 1 emissions and 24 years for Phase 2 for 30 years total, beginning in 2021 with construction and ending in 2051 with operation). This is equivalent to the Scenario 1.2 construction exposure plus 24 years of operational exposure.

2. **HRA Scenario 4.1 (Base Project Option)**: On-site receptors present at the project site once Phase 1 is complete will be evaluated starting when construction for Phase 1 concludes (August 2024) and exposed to all Phase 2 construction emissions (2.5 years, from August 2024 to January 2027) and 30 years of operational emissions (30 years of Phase 1 emissions and 27 years of Phase 2 emissions for 30 years total, beginning in 2024 with Phase 2 construction and ending in 2054 with operation). This is equivalent to the Scenario 2.1 construction exposure plus 30 years of operational exposure.

   HRA Scenario 4.2 (City Policy Option): On-site receptors present at the project site once Phase 1 is complete will be evaluated starting when construction for Phase 1 concludes (August 2024) and exposed to all Phase 2 construction emissions (2.5 years, from September 2024 to January 2027) and 30 years of operational emissions (30 years of Phase 1 emissions and 27 years of Phase 2 emissions for 30 years total, beginning in 2024 with Phase 2 construction and ending in 2054 with operation). This is equivalent to the Scenario 2.2 construction exposure plus 30 years of operational exposure.

3. **HRA Scenario 5.1 (Base Project Option)**: off-site and on-site receptors will be evaluated starting when full buildout operation commences (expected to occur as soon as Phase 2 construction concludes in January 2027) and exposed to 30 years of operational emissions (ending in 2056).

   HRA Scenario 5.2 (City Policy Option): off-site and on-site receptors will be evaluated starting when full buildout operation commences (expected to occur as soon as Phase 2 construction concludes in January 2027) and exposed to 30 years of operational emissions (ending in 2056).

As for the construction scenario, child residents will be evaluated starting with the fetus at the beginning of its third trimester and child daycare and school receptors will be evaluated starting at age 2 per OEHHA guidance (2015). The first operational scenario (HRA Scenario 3.1 and 3.2) considers receptors that are exposed to *both* construction and operational emissions over a 30-year period of time, and will determine the maximum exposed individual when considering all sources of emissions from the project. For all three scenarios, it is assumed that for each phase of construction, operations will commence as soon as construction is complete for that phase. Therefore, there will be overlapping construction and operational exposure starting when Phase 1 construction is complete (August 2024) and ending when Phase 2 construction is complete (January 2027) for both existing off-site and new on-site receptors. The air quality analysis will assess the overlap in construction and operational emissions exposure to all modeled sensitive receptors based on the three operational scenarios discussed above for both the Base and City Policy Options.

Health risks will be calculated for each of the scenarios as detailed in Section **Error! Reference source not found.**.

ESA will prepare a single AERMOD modeling file for the project site to calculate concentrations of TACs and $PM_{2.5}$ at all modeled on-site and off-site sensitive receptor locations (we will not prepare separate AERMOD modeling runs for each project scenario). This modeling file will represent all project scenarios listed above, since the location of many operational emissions sources (e.g. vehicle trips, truck idling, emergency generators) are assumed to be consistent between all project scenarios. The main differences between the scenarios are the number of dwelling units, the building heights, and project-generated vehicle trips, but the source types remain constant. However, some sources of emissions may change between project scenarios, such as emergency generator emissions (e.g. number of generators and their locations) and mobile source emissions associated with vehicle traffic. If necessary, the AERMOD file will include multiple source locations for these sources and group them appropriately, so that unitized dispersion factors can be generated for all sources and source locations individually. The appropriate emission rates for each source/location by scenario will then be applied to the dispersion factors generated by AERMOD to calculate receptor pollutant concentrations for each scenario. As discussed above, ESA will use a series of area sources, line-area sources, and point sources (also see Table 2 below) to model proposed project emissions sources.

As discussed above in Section **Error! Reference source not found.**, the emission rates for all sources will be unitized to generate dispersion factors from AERMOD, which will then be multiplied in a post-processing step by the actual emission rate of each source for each project scenario to determine actual concentrations associated with each project scenario. This way the single AERMOD run will represent a proxy for all project scenarios, and the resulting AERMOD concentrations will be scaled by the actual emissions associated with each project scenario to approximate scenario-specific concentrations at each receptor location in the modeling domain.

As noted above in Section 1.0 (see assumption #11), this analysis will be limited by emissions data availability for proposed project construction and operations. ESA assumes that no modeling will be conducted for proposed project sources for which activity/emissions data is not readily available. If information for certain sources cannot be obtained, ESA will document that the information is not available and explain the steps taken to obtain this information.

Exposure Assumptions

The exposure parameters that will be used to estimate excess lifetime cancer risk for all potentially exposed populations for the HRA will be obtained using risk assessment guidelines from OEHHA (2015) and BAAQMD (2016). **Table 6, Exposure Parameters**, shows the proposed exposure parameters that will be used for the HRA.

Calculation of Intake

The dose estimated for each exposure pathway is a function of the concentration of a chemical and the intake of that chemical. The intake factor for inhalation, IF_{inh}, will be calculated as follows using **Equation 3**. The values used in this equation are presented in **Table 6** below.

Equation 3: $$IF_{inh} = \frac{DBR * FAH * EF * ED * MAF * ASF * CF}{AT}$$

Where:

IF_{inh} = Intake Factor for Inhalation (m^3/kg-day)

DBR = Daily Breathing Rate (L/kg-day)

FAH = Frequency of time at home (unitless)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

AT = Averaging Time (days)

MAF = Model Adjustment Factor (unitless)

ASF = Age Sensitivity Factor (unitless)

CF = Conversion Factor, 0.001 (m^3/L)

The chemical intake or dose is estimated by multiplying the intake factor for inhalation, IF_{inh}, by the chemical concentration in air, C_i. This calculation is mathematically equivalent to the dose algorithm given in the current OEHHA guidance (OEHHA 2015).

Toxicity Assessment

The assessment of toxicity determines the relationship between the magnitude of chemical exposure and the nature and magnitude of adverse health effects resulting from this exposure. Adverse health effects will be calculated for both cancer and non-cancer endpoints. Toxicity values that are used to estimate the likelihood of adverse health effects occurring in humans at different exposure levels are identified as part of the toxicity assessment component of an HRA.

The toxicity values used in the analysis for DPM and gasoline-related TACs are from OEHHA and CARB (CARB 2017, BAAQMD 2012a). These toxicity values are for carcinogenic (cancer) effects. The primary pathway for exposures is assumed to be inhalation, as discussed above. The incremental risks will be determined for each TAC emission source (DPM for construction and operation and TOG for operation) and summed to obtain an estimated total incremental cancer health risk.

Table 7, Carcinogenic Toxicity Values for Diesel Particulate Matter and Toxic Air Contaminants from Total Organic Compound Emissions from Gasoline Vehicles, shows the cancer potency factor (CPF) for DPM and TOGs that will be used in the HRA.

Age Sensitivity Factors (ASF)

The estimated excess lifetime cancer risks for children receptors (resident, daycare, and school) will be adjusted using the ASFs recommended in the California Environmental Protection Agency (Cal/EPA) OEHHA Technical Support Document (Cal/EPA 2009) and OEHHA guidance (2015). This approach accounts for an "anticipated special sensitivity to carcinogens" of infants and children. Cancer risk estimates are weighted by a factor of 10 for exposures that occur from the third trimester of pregnancy to two years of age and by a factor of three for exposures that occur from two years through 15 years of age. No weighting factor (i.e., an ASF of one, which is equivalent to no adjustment) is applied to ages 16 to 70 years. **Table 6** shows the ASFs to be used for all child receptors.

Cancer Risk Characterization

Excess lifetime cancer risks are estimated as the upper-bound incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to carcinogens. The risk is expressed as a unitless probability, and will be calculated as the number of cancer incidences per million individuals in the HRA. The cancer risk for each chemical is calculated by multiplying the chemical intake or dose at the human exchange boundaries (e.g., lungs) by the chemical-specific CPF.

Excess lifetime cancer risk occurs exclusively through the inhalation pathway and will be calculated according to **Equation 4**.

Equation 4: $Risk_{inh} = C_i * IF_{inh} * CPF_i * CF_1 * CF_2$

Where:

$Risk_{inh}$ = Cancer risk; the incremental probability of an individual developing cancer as a result of inhalation exposure to a particular carcinogen (per million)

C_i = Average annual air concentration of chemical, from AERMOD (μ/m^3)

IF_{inh} = Intake Factor for Inhalation (m^3/kg-day)

CPF_i = Cancer potency factor for chemical (mg chemical/kg body weight-day)$^{-1}$

CF_1 = Conversion factor, micrograms to milligrams (mg/µg)

CF_2 = Risk per million individuals

i = Chemical

5.0 CONTROL MEASURES

Air Quality Analysis Scope of Work

Each draft of the air quality analysis and first round of modeling will include identification of control measures that could reduce criteria air pollutant and air toxic emissions. ESA will model two versions of construction and operations for the project: 1) an uncontrolled scenario; and 2) a controlled scenario with mitigation measures from the Balboa Park Station Area Plan and additional potential control measures. Based on the results of the first round of modeling for the controlled scenario, additional consultation and coordination with EP and the project sponsor is anticipated to occur to identify these measures.

ESA will consult with EP staff to determine whether controls should be modeled for construction equipment for any necessary mitigation measure scenarios.

6.0 CUMULATIVE ANALYSIS
Air Quality Analysis Scope of Work

ESA will calculate the cumulative lifetime excess cancer risks and annual average exhaust $PM_{2.5}$ exhaust concentrations from the project and the background sources in the surrounding area at the off-site sensitive receptor locations within the modeling domain. Cumulative health risks will be estimated by combining predicted cancer risk and annual average exhaust $PM_{2.5}$ concentrations from the AERMOD analysis, for construction and operational activities associated with the project, with the City's CRRP-HRA cancer risk and annual average exhaust $PM_{2.5}$ concentration database.

Since the proposed project and nearby sensitive receptors are not located in the APEZ, ESA will not directly assess project impacts on the Maximally Exposed Individual Sensitive Receptor (MEISR) against a specific cumulative threshold. ESA will instead evaluate the cumulative cancer risk and annual average exhaust $PM_{2.5}$ concentration at all modeled sensitive receptor locations in order to determine the project's impact on the extent of the APEZ in the surrounding area, and identify the following:

1. The maximum lifetime excess cancer risks and annual average $PM_{2.5}$ exhaust concentrations contribution from the project for those off-site receptors not located in the APEZ during existing conditions, but which would be placed in the APEZ during existing plus project conditions; and
2. The maximum lifetime excess cancer risks and annual average $PM_{2.5}$ exhaust concentrations contribution from the project for those off-site receptors located in the APEZ during existing conditions and which would continue to be located in the APEZ during existing plus project conditions.

For determining whether the project would place off-site receptors not located in the APEZ during existing conditions into the APEZ with the project's contribution to lifetime excess cancer risks and annual average $PM_{2.5}$ exhaust concentrations (# 1 above), the following health-protective criteria will be used (BAAQMD 2009, SF DPH 2014):

1. Cumulative annual average $PM_{2.5}$ exhaust concentrations greater than 9 $\mu g/m^3$, and/or
2. Excess cancer risk from the contribution of emissions from all modeled sources greater than 90 per one million population.

ESA will rely on the CRRP-HRA for background data for the year 2014, including lifetime excess cancer risk and annual average exhaust $PM_{2.5}$ concentrations, for the cumulative analysis. Because the CRRP-HRA does not include the impact of the latest OEHHA guidelines (2015) regarding the ASFs, ESA will adjust the CRRP-HRA cancer risk values by a factor 1.3744, as recommended by the BAAQMD (Lau pers. com.). The CRRP update is currently underway, but is not anticipated to be complete before the air quality analysis for the project is conducted. Therefore, the current CRRP modeling will be used for the air quality analysis. A 2040 analysis of project-related emissions will not be conducted. The 2040 citywide modeling shows that excess cancer risk generally decreases for receptor points within 1,000 meters of the project site under 2040 conditions, and $PM_{2.5}$ concentrations remain relatively constant with slight increases. For 2014-2017, at receptors within 1,000 meters of the project site, cancer risks range from 0.5-100.8 excess cancers per million and $PM_{2.5}$ concentrations range from 8.1-11.3 μ/m^3. For 2040, at receptors within 1,000 meters of the project site, cancer risks range from 0.3-88.9 excess cancers per million and $PM_{2.5}$ concentrations range from 8.1-11.8 μ/m^3. This decrease in cancer risk from 2014-2040 is due to a variety of reasons including stricter emission standards, cleaner engines, and more efficient vehicles. The 2014 modeling does not include these emission standards and cleaner engines, nor does it include construction-related emissions.

The 2040 model includes the overall development forecasts associated with the Balboa Park Station Area Plan, but does not include specific projects associated with the Plan. Therefore, the 2040 model does not include specific project-related growth from the proposed project. However, the development from the proposed project does fit within the overall growth projections for the Balboa Park Station Area Plan. In addition, the difference between the growth (and associated cancer risk) assumed for the project site in the Balboa Park Station Area Plan (and therefore in the 2040 model) versus what is proposed for the project is negligible. Therefore, the cumulative analysis for 2014, which is based on existing conditions plus the proposed project, presents a worst-case cumulative assessment of health risks. The air quality analysis will present existing (2014) plus project risks and will qualitatively discuss how the future cancer risks decrease under 2040 conditions with the proposed project, but that total $PM_{2.5}$ concentrations slightly increase over time. Because the project would not result in more trips under 2040 conditions compared to proposed project buildout conditions, and $PM_{2.5}$ emissions from the project would actually decrease over time as the vehicle fleet becomes cleaner and new emission standards are put into place, the project's $PM_{2.5}$ concentrations would not increase in 2040 compared to project buildout conditions. Therefore, the project's contribution to the total cumulative $PM_{2.5}$ concentrations in 2040 would likely decrease as an overall percentage.

The CRRP-HRA includes the following major sources of emissions:

- On-road mobile sources—cars and trucks—on freeways and surface streets with traffic volumes of more than 1,000 vehicles per day.
- Permitted, stationary sources, including gasoline dispensing stations, prime and standby diesel generators, wastewater treatment plants, recycling facilities, dry cleaners, large boilers, and other industrial facilities.
- Caltrain passenger diesel locomotives.
- Ships and harbor craft, including cruise ships, excursion boats, and tug boats.
- The Transbay Terminal bus depot, including diesel emissions from local transit buses.

ESA will include construction-related emissions from nearby occurring or reasonably foreseeable projects within 1,000 meters of the project site, if known, or will include a qualitative discussion of those projects and their likely impact on the MEISR as part of the cumulative analysis. ESA assumes no additional modeling will be required for the cumulative analysis.

7.0 UNCERTAINTIES
Air Quality Analysis Scope of Work

ESA will provide a summary discussion of the critical uncertainties associated with the air quality analysis modeling for both criteria pollutants and TACs. Due to the complex nature of uncertainties associated with the numerous calculations performed in the air quality analysis, our discussion will be qualitative in nature unless specific quantified estimates of uncertainty are readily available.

The following topics will be included in the uncertainty discussion:

1. **Emission calculations**: uncertainties associated with CalEEMod modeling, project-specific data, emission factors, general assumptions, and other methods and calculations associated with the criteria pollutant and TAC emissions estimation.
2. **Air concentrations and source representation**: uncertainties associated with the AERMOD dispersion model, including the representation of emissions sources within AERMOD
3. **Exposure assumptions**: uncertainties associated with estimating human exposure to TACs emitted by the project, such as exposure durations and exposure frequency.
4. **Toxicity assessment**: uncertainties associated with toxicity values for DPM and TOG-related TACs.
5. **Risk calculations**: uncertainties associated with estimating cancer risk for sensitive receptors, including inhalation dose factors and lifetime excess cancer risk estimates

8.0 REFERENCES

Air Quality Analysis Scope of Work

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9.0 TABLES

Air Quality Analysis Scope of Work

TABLE 1
PROJECT CHARACTERISTICS (GSF)

Proposed Use	Base Project Option	City Policy Option [a]	Project Variants 1, 2, and 3 [b]
Residential	1,283,000 (1,100 DU)	1,547,000 (1,550 DU)	1,283,000 (1,100 DU)
Commercial (Retail / Café)	7,500	7,500	7,500
Community Facilities (Childcare)	10,000	10,000	10,000
Parking	339,900 (1,300 spaces)	231,000 (650 spaces)	339,900 (1,300 spaces)
Open Space	4 acres	4 acres	4 acres
Total Built Area	**1,640,400**	**1,795,500**	**1,640,400**

NOTES:
[a] Numbers are still under development and are not final
[a] The variants do not involve changes in the land use characteristics as compared to the Base Project Option. The only changes are associated with the location of the 750-space parking garage and the street circulation plan.

ABBREVIATIONS:
GSF = gross square feet
DU = dwelling units

TABLE 2
ANTICIPATED PROJECT CONSTRUCTION SCHEDULE

Construction Phase / Sub-phase	Start Date	End Date	Work Days
Base Project and City Policy Options			
Phase 0 (Demolition, Excavation, Grading, Site Preparation, Drainage/Utilities/Sub-Grade)	**3/1/2021**	**2/28/2022**	**260**
Phase 1	**3/1/2022**	**8/31/2024**	**600**
Phase 2	**9/1/2024**	**1/31/2027**	**600**
Total – All Construction	**3/1/2021**	**1/31/2027**	**1,460**

TABLE 3
OVERALL AERMOD MODELING PARAMETERS

Pathway	Description	Parameter
Control	Averaging Time	Period average
	Urban Population	884,363 [a]
	Model Version	AERMOD v 9.4.0
Source	Spacing	*See Table 4*
	Release Height	*See Table 4*
	Initial Vertical Dimension	*See Table 4*
	Initial Lateral Dimension	*See Table 4*
	Variable Emission Factor	7am to 8pm construction
Receptor	Receptor Height	1.8m [b]
	Grid	20m x 20m [b]
Meteorology	Surface Data	Mission Bay (Site ID# 5803) monitoring site [b]
	Upper Air	Oakland
	Station Elevation	2m

NOTES:
a For July 1, 2017, City of San Francisco (US Census Bureau 2016).
b from the CRRP-HRA (BAAQMD, SF DPH & SF Planning, 2012)

SOURCES:
1. United States Census Bureau. 2016. QuickFacts: San Francisco city, California. Available at htthttps://www.census.gov/quickfacts/fact/table/sanfranciscocitycalifornia,US/PST045217. Accessed July 2017.
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ABBREVIATIONS:
m = meters

TABLE 4
SOURCE MODELING PARAMETERS

Period	Source	Source Type [a]	Source Dimension [m]	Number of Sources [b]	Release Height [c] [m]	Initial Vertical Dimension [d] [m]	Initial Lateral Dimension [e] [m]	Stack Diameter [f] [m]	Temperature [f] [K]	Velocity [f] [m/s]
Construction	Off-Road Construction Equipment	Area / Volume	Project Area	2	5	1.4	n/a	n/a	n/a	n/a
	On-Road Trucks	Line Area	Variable	Variable	2.55	2.37	variable	n/a	n/a	n/a
Operation	Mobile Sources	Line Area	Variable	Variable	2.0	2.3	variable	n/a	n/a	n/a
	Loading Truck Idling	Area / Volume	Variable	1	2.5	2.37	variable	n/a	n/a	n/a
	Emergency Generators	Point	n/a	2-6	3.66	n/a	n/a	1.83	739.8	45.3

NOTES:

a Construction will be modeled as an area source covering the project site, consistent with the CRRP-HRA (BAAQMD, SF DPH & SF Planning, 2012); it may also be modeled as a volume source pending model runtime limitations.

b Construction will be modeled as two separate sources: one source for Phase 1, and one source for Phase 2. The number of on-road mobile sources is based on the geometry of the truck or traffic routes. There would be two emergency generators for the Base Project and six for the City Policy Option.

c Release height for off-road construction equipment and on-road operational mobile sources from the CRRP-HRA (BAAQMD, SF DPH & SF Planning, 2012). For on-road construction trucks and operational loading truck idling, the release height is equal to 0.5 * top of plume height, which is equal to 1.7 * the vehicle height, which is equal to 3 meters; equation = 0.5 * 1.7 * 3 = 2.55 (U.S. EPA 2012). Generator release height from the CRRP-HRA, Table 13 (BAAQMD, SF DPH & SF Planning, 2012).

d Initial vertical dimension for off-road construction equipment and on-road operational mobile sources from the CRRP-HRA (BAAQMD, SF DPH & SF Planning, 2012). Initial vertical dimension for on-road construction trucks and operational loading truck idling is equal to the top of the plume height ÷ 2.15 = 1.7 * 3 / 2.15 = 2.37.

e The initial lateral dimension is the length of the side divided by 2.15, per the AERMOD User's Guide (U.S. EPA 2016a).

f From the CRRP-HRA (Table 13) (BAAQMD, SF DPH & SF Planning, 2012). Not applicable to sources other than the generator.

SOURCES:

1. United States Environmental Protection Agency. 2012. Haul Road Workgroup Final Report Submission to EPA-OAQPS. March. Available at: https://www3.epa.gov/scram001/reports/Haul_Road_Workgroup-Final_Report_Package-.20120302.pdf. Accessed March 2017.
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ABBREVIATIONS:
K = Kelvin
m/s = meters per second

TABLE 5
SENSITIVE RECEPTOR LOCATIONS: DAYCARES AND SCHOOLS

Name	Address	Distance from Project Boundary (ft.)	Direction	In APEZ?
Daycares				
Shining Stars Family Child Center	1242 Plymouth Avenue	30	West	No
Harmony Family Childcare	1100 Ocean Ave #520	50	South	No
Blooming Child Care	265 Harold Avenue	50	South	No
Cel Coalition Center	1205 Plymouth Avenue	160	Southwest	No
Three Bears Childcare	19 Southwood Drive	220	West	No
Mighty Bambinis Childcare & Preschool	Staples & Phelan Streets	750	northeast	No
Fun with Mandarin Preschool and Daycare	325 Holloway Avenue	1,000	Southwest	No
Cupids Christian Day Care Center	178 Brighton Avenue	1,000	South	No
Happy Family Child Care & Preschool	520 A Holloway Avenue	1,200	Southwest	No
Little Sunshine Childcare	308 Jules Ave	1,400	West	No
Marg's Child Care Inc. / Specialized for Infants and Toddlers	50 Grafton Avenue	1,400	South	No
City College of San Francisco Ocean Campus Child Development Lab School	W Road, Bungalows 212/213	1,600	East	Yes
Magic Day Care	963 Plymouth Ave	1,800	South	No
Raisa's Day Care & Pre-School	61 Pinehurst Way	2,700	West	No
Little Angels Day Care	2135 Ocean Avenue	2,700	West	No
M & M Childcare	210 Thrift Street	2,700	South	No
Twin Peaks Daycare	446 Ralston Street	3,000	West	No
Schools				
Archbishop Riordan High School	175 Phelan Ave	30	North	No
Little Lemon Tree Nursery School	1 Gennessee Street & Judson Avenue	900	northeast	No
Seventh Day Adventist Elementary School	66 Geneva Avenue	1,100	Southeast	Yes
Lick Wilmerding High School	755 Ocean Avenue	1,300	Southeast	Yes
Stratford School - San Francisco	301 De Montfort Avenue	1,600	Southwest	No
Sunnyside Elementary School	250 Foerster Street	1,800	Northeast	No
St. Finn Barr Catholic School	419 Hearst Avenue	2,100	Northeast	No
Leadership High School	350 Seneca Avenue	2,500	Southeast	No
James Denman Middle School	241 Oneida Avenue	3,000	Southeast	No

TABLE 6
EXPOSURE PARAMETERS

Receptor Type	Exposure Scenario	Exposure Parameters								
		Receptor Age Group	Daily Breathing Rate (DBR) [a] [L/kg-day or L/kg-8hrs]	Exposure Duration (ED) [b] [years]	Fraction of Time at Home (FAH) [c] [unitless]	Exposure Frequency (EF) [d] [days/year]	Averaging Time (AT) [e] [days]	Model Adjustment Factor (MAF) [f] [unitless]	Age Sensitivity Factor (ASF) [g] [unitless]	Intake Factor (IFinh) [h] [m^3/kg-day]
Off-Site Child Resident	Scenario 1.1 and 1.2 (construction)	3rd Trimester	361	0.25	1	350	25,550	1	10	0.0124
		Age 0<2 Years	1,090	2	1				10	0.2986
		Age 2<9 Years	631	4	1				3	0.1037
	Scenario 3.1 and 3.2 (construction + operation)	3rd Trimester (construction)	361	0.25	1	350	25,550	1	10	0.0124
		Age 0<2 Years (construction)	1,090	2	1				10	0.2986
		Age 2<16 Years (construction)	572	4	1				3	0.0940
		Age 2<16 Years (operation)	572	10	1				3	0.2351
		Age 16<30 Years	261	14	0.73				1	0.0365
	Scenario 5.1 and 5.2 (operation)	3rd Trimester	361	0.25	1	350	25,550	1	10	0.0124
		Age 0<2 Years	1,090	2	1				10	0.2986
		Age 2<16 Years	572	14	1				3	0.3291
		Age 16<30 Years	261	14	0.73				1	0.0365

Receptor Type	Exposure Scenario	Exposure Parameters								
		Receptor Age Group	Daily Breathing Rate (DBR) [a] [L/kg-day or L/kg-8hrs]	Exposure Duration (ED) [b] [years]	Fraction of Time at Home (FAH) [c] [unitless]	Exposure Frequency (EF) [d] [days/year]	Averaging Time (AT) [e] [days]	Model Adjustment Factor (MAF) [f] [unitless]	Age Sensitivity Factor (ASF) [g] [unitless]	Intake Factor (IFinh) [h] [m^3/kg-day]
On-Site Child Resident	Scenario 2.1 and 2.2 (construction)	3rd Trimester	361	0.25	1	350	25,550	1	10	0.0124
		Age 0<2 Years	1,090	2	1				10	0.2986
	Scenario 4.1 and 4.2 (construction + operation)	3rd Trimester (construction)	361	0.25	1	350	25,550	1	10	0.0124
		Age 0<2 Years (construction)	1,090	2	1				10	0.2986
		Age 2<16 Years (operation)	572	14	1				3	0.3291
		Age 16<30 Years	261	14	0.73				1	0.0365
	Scenario 5.1 and 5.2 (operation)	3rd Trimester	361	0.25	1	350	25,550	1	10	0.0124
		Age 0<2 Years	1,090	2	1				10	0.2986
		Age 2<16 Years	572	14	1				3	0.3291
		Age 16<30 Years	261	14	0.73				1	0.0365

Receptor Type	Exposure Scenario	Exposure Parameters								
		Receptor Age Group	Daily Breathing Rate (DBR) [a] [L/kg-day or L/kg-8hrs]	Exposure Duration (ED) [b] [years]	Fraction of Time at Home (FAH) [c] [unitless]	Exposure Frequency (EF) [d] [days/year]	Averaging Time (AT) [e] [days]	Model Adjustment Factor (MAF) [f] [unitless]	Age Sensitivity Factor (ASF) [g] [unitless]	Intake Factor (IFinh) [h] [m^3/kg-day]
Off-Site Child Daycare	Scenario 1.1 and 1.2 (construction)	Age 0<2 Years [i]	1,200	2	n/a	250	25,550	4.2	10	0.9863
		Age 2<9 Years	640	4					3	0.3156
	Scenario 3.1 and 3.2 (construction + operation)	Age 0<2 Years (construction)	1,200	2	n/a	250	25,550	4.2	10	0.9863
		Age 2<16 Years [j] (construction)	520	4				4.2	3	0.2564
		Age 2<16 Years [j] (operation)	520	10				4.2	3	0.6411
		Age 16<30 Years [j]	240	14				1	1	0.1381
	Scenario 5.1 and 5.2 (operation)	Age 0<2 Years	1,200	2	n/a	250	25,550	4.2	10	0.9863
		Age 2<16 Years [j]	520	14				4.2	3	0.8975
		Age 16<30 Years [j]	240	14				1	1	0.1381
On-Site Child Daycare	Scenario 2.1 and 2.2 (construction)	Age 0<2 Years [i]	1,200	2	n/a	250	25,550	4.2	10	0.9863
	Scenario 4.1 and 4.2 (construction + operation)	Age 0<2 Years (construction)	1,200	2	n/a	250	25,550	4.2	10	0.9863
		Age 2<16 Years [j] (operation)	520	11				4.2	3	0.7052
		Age 16<30 Years [j]	240	17				1	1	0.1677
	Scenario 5.1 and 5.2 (operation)	Age 0<2 Years	1,200	2	n/a	250	25,550	4.2	10	0.9863
		Age 2<16 Years [j]	520	14				4.2	3	0.8975
		Age 16<30 Years [j]	240	14				1	1	0.1381

Receptor Type	Exposure Scenario	Exposure Parameters								
		Receptor Age Group	Daily Breathing Rate (DBR) [a] [L/kg-day or L/kg-8hrs]	Exposure Duration (ED) [b] [years]	Fraction of Time at Home (FAH) [c] [unitless]	Exposure Frequency (EF) [d] [days/year]	Averaging Time (AT) [e] [days]	Model Adjustment Factor (MAF) [f] [unitless]	Age Sensitivity Factor (ASF) [g] [unitless]	Intake Factor (IFinh) [h] [m^3/kg-day]
Off-Site School Child	Scenario 1.1 and 1.2 (construction)	Age 2<9 Years	640	6	n/a	180	25,550	4.2	3	0.3409
	Scenario 3.1 and 2.2 (construction + operation)	Age 2<16 Years [i] (construction)	520	6	n/a	180	25,550	4.2	3	0.2770
		Age 2<16 Years [l] (operation)	520	8				4.2	3	0.3693
		Age 16<30 Years [k]	240	16				1	1	0.1136
	Scenario 5.1 and 5.2 (operation)	Age 2<16 Years [i]	520	14	n/a	180	25,550	4.2	3	0.6462
		Age 16<30 Years [k]	240	16				1	1	0.1136

Receptor Type	Exposure Scenario	Receptor Age Group	Daily Breathing Rate (DBR) [a] [L/kg-day or L/kg-8hrs]	Exposure Duration (ED) [b] [years]	Fraction of Time at Home (FAH) [c] [unitless]	Exposure Frequency (EF) [d] [days/year]	Averaging Time (AT) [e] [days]	Model Adjustment Factor (MAF) [f] [unitless]	Age Sensitivity Factor (ASF) [g] [unitless]	Intake Factor (IFinh) [h] [m^3/kg-day]
		Exposure Parameters								

NOTES:

a Daily breathing rates are from OEEHA (2015) based on BAAQMD guidance (2016) as follows: for child residents, 95th percentile 24-hour breathing rates (OEHHA Table 5.6) for 3rd trimester and age 0<2 years and 80th percentile 24-hour breathing rates (OEHHA Table 5.7) for age 2<9 years, age 2<16 years, and age 16<30 years; for child daycare, 95th percentile 8-hour moderate intensity breathing rates (OEHHA Table 5.8) for 3rd trimester, age 0<2 years, and age 2<9 years; for school, 95th percentile 8-hour moderate intensity breathing rates (OEHHA Table 5.8) for age 2<16 years.

b The exposure duration for Scenario 1.1 and 1.2 off-site receptors represent 6 years of exposure to construction emissions (the entire construction period for the proposed project). The exposure duration for Scenario 2.1 and 2.2 on-site receptors represent 2 years of exposure to construction emissions (Phase 2 construction). The exposure duration for Scenario 3.1 and 3.2 off-site receptors represent 6 years of exposure to construction emissions and 24 years of exposure to full-buildout operational emissions. The exposure duration for Scenario 4.1 and 4.2 on-site receptors represent 2 years of exposure to construction emissions (for Phase 2 construction) and 28 years of exposure to full-buildout operational emissions. The EDs are separated into construction and operational exposures to more clearly identify the values used for each receptor group and exposure period. The exposure duration for Scenario 5.1 and 5.2 receptors represent 30 years of exposure to full-buildout operational emissions. The EDs for scenarios 1.2, 2.2, 3.2, 4.2, and 5.2 for the City Policy Assumption may differ slightly from the values provided in the table pending the actual construction schedule for the City Policy Assumption.

c Fraction of time at home are set to 1.0 for all age groups less than 16 years, since there are potentially schools within cancer risk isopleths of one in a million or greater, per BAAQMD guidance (2016). For age groups greater than 16 years, values from OEHHA (2015) Table 8.4 were used.

d Exposure frequency represents default residential exposure frequency from BAAQMD guidance (2016).

e Averaging time represents 70 years for lifetime cancer risk, per OEHHA (2015).

f The Model Adjustment Factor is applied to adjust the annual average concentration from AERMOD associated with construction emissions (Scenario 1 and part of Scenario 2), which assumes constant emissions 24 hours per day and 7 days per week, to actual the actual construction emission schedule and receptor exposure for daycare and school receptors, which is based on 8 hours per day and 5 days per week of both construction emissions and receptor exposure (equation = [24 hours / 8 hours] * [7 days / 5 days] = 4.2). The MAF conservatively assumes that all construction operations and emissions occur while the children are present at the daycare or school, so the overlap in emissions and exposure is 100%. The MAF is based on the Worker Adjustment Factor (WAF) described by OEHHA (2015) in Section 5.4.1.2 and Table 5.10. The MAF is not used for operational emissions (part of Scenario 2 and all of scenario 3) because the annual average concentration from AERMOD from operational emissions assumes constant emissions 24 hours per day and 7 days per week, which accurately reflects operational emissions.

g Age sensitivity factors from OEHHA (2015) Table 8.3

h IF_{inh} is calculated as follows: DBR * FAH * EF * ED * MAF * ASF * DF * CF / AT, where CF = 0.001 m^3/L

i The earliest age at the daycare is assumed to be 6 weeks, and the earliest age at the school is assumed to be 2 years, based on BAAQMD guidance (2016).

j For daycare receptors under Scenarios 3, 4, and 5, it was conservatively assumed that once the child leaves daycare, they will continue to attend school near the project site, and once they leave school, they will live near the project site. The daily breathing rates for daycare receptors for age 16<30 years are the same as for residential receptors.

k For school receptors under Scenarios 3 and 5, it was conservatively assumed that once the child leaves school, they will live near the project site. The daily breathing rates for school receptors for age 16<30 years are the same as for residential receptors.

SOURCES:

1. Office of Environmental Health Hazard Assessment. 2015. *Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments*. February. Available: <http://oehha.ca.gov/air/hot_spots/hotspots2015.html>. Accessed: March 2017.
2. Bay Area Air Quality Management District, San Francisco Department of Public Health, and San Francisco Planning Department. 2012. *The San Francisco Community Risk Reduction Plan: Technical Support Documentation*. December. Available at http://www.gsweventcenter.com/Appeal_Response_References/2012_1201_BAAQMD.pdf. Accessed March 2017.
3. Bay Area Air Quality Management District. 2016. *Air Toxics NSR Program Health Risk Assessment (HRA) Guidelines*. January. Available at http://www.baaqmd.gov/~/media/files/planning-and-research/rules-and-regs/workshops/2016/reg-2-5/hra-guidelines_clean_jan_2016-pdf.pdf?la=en. Accessed March 2017.

ABBREVIATIONS:
kg = kilogram
L = liter
m^3 = cubic meters

TABLE 7
CARCINOGENIC TOXICITY VALUES FOR DIESEL PARTICULATE MATTER AND TOXIC AIR CONTAMINANTS FROM TOTAL ORGANIC COMPOUND EMISSIONS FROM GASOLINE VEHICLES

Chemical	CAS Number	Cancer Potency Factor [mg/kg-day]$^{-1}$	Unit Cancer Risk Weighted Factor [µg/m^3]$^{-1}$
Diesel Particulate Matter	9901	1.1	—
Toxic Air Contaminants from Total Organic Compounds [a]	n/a	—	1.81x10^{-6}

NOTES:
[a] TACs include acetaldehyde, benzene, 1,3-butadiene, ethylbenzene, formaldehyde, and naphthalene.

SOURCES:
1. Bay Area Air Quality Management District. 2017. *Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values*. Last Updated: February 23, 2017. Available: <http://www.arb.ca.gov/toxics/healthval/contable.pdf>. Accessed: April 2017.

ABBREVIATIONS:
CAS = chemical abstract services