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Appendix A04b: Health Risk Assessment

1 Introduction

1.1 Purpose

The purpose of this Health Risk Assessment (HRA) is to evaluate local community risk and hazard impacts from the Proposed Oakland Harbor Turning Basins Widening Project (Proposed Project). This document provides details on the analyses performed to assess the potential risks associated with Toxic Air Contaminants (TACs) and particulate matter with an aerodynamic diameter of 2.5 micrometers (μm) or less ($PM_{2.5}$) emitted during construction of the Proposed Project.[1].

1.2 Project Setting

The Port of Oakland (Port), in partnership with the United States Army Corps of Engineers (USACE), is proposing the Proposed Project at the Oakland Seaport (Seaport) and in the City of Alameda. The Proposed Project involves construction to widen the diameter of the existing turning basins in the Seaport. The channels and turning basins were last improved (completed in 2009) to provide a water depth of 50 feet mean lower low water (MLLW) and to widen the turning basins (-50-Foot Project).

1.2.1 Location

The Proposed Project is located in both the City of Oakland and in the City of Alameda (Alameda). The Seaport is served by the Oakland Harbor, a federal waterway, which generally consists of the Entrance Channel, the Outer Harbor Channel and its Outer Harbor Turning Basin (OHTB), and the Inner Harbor Channel and its Inner Harbor Turning Basin (IHTB). The IHTB and OHTB are widened areas of the Inner and Outer Harbor Channels that allow large container vessels to turn around. The authorized width of the Inner Harbor Channel is 800 feet; the IHTB is 1,500 feet in diameter and is approximately 4.0 miles east of the Entrance Channel. The authorized width of the Outer Harbor Channel is 900 feet; the OHTB is 1,650 feet in diameter and is approximately 2.3 miles northeast of the Entrance Channel.[2] Berths 10 and 26 are on the landside of the Outer Harbor and are where handling of Class II non-hazardous waste and electrical infrastructure improvements will take place, respectively.

Expansion of IHTB consists of widening the existing IHTB an additional 334 feet—from 1,500 feet to 1,834 feet—with a depth of 50 feet MLLW, consistent with the existing depth of the IHTB. In addition to in-water work to widen the IHTB, landside property would be removed in two locations: Howard Terminal, and the Alameda Site. The landside locations of proposed improvements at the IHTB include a portion of property owned by the Port (Howard Terminal) to the north of the IHTB, and a portion of private property owned by FIC Alameda 365 LLC along the Alameda shoreline to the southeast of the IHTB (referred to in this document as the “Alameda Site”).

[1] $PM_{2.5}$ is used instead of PM_{10} because it has CEQA significance criteria under BAAQMD’s CEQA Guidelines. $PM_{2.5}$ reaches further into the lungs than PM_{10} resulting in potential for more health impacts from exposure, and therefore for a health risk assessment is the more appropriate criteria pollutant to characterize over PM_{10}.

[2] Dimensions provided for the channels and turning basins refer to the limits of the federal navigation channel.

The OHTB would be widened an additional 315 feet—from 1,650 feet to 1,965 feet—with a depth of 50 feet MLLW, consistent with the existing depth of the OHTB. Widening the OHTB does not require the removal of landside property. In the Seaport's Outer Harbor Terminal, the Proposed Project's landside activities would occur at Berth 26, in the TraPac Terminal; and at Berth 10, at the northeastern end of the Outer Harbor Terminal.

1.2.2 Construction Activities and Construction Phasing

Construction is expected to start in July 2027 with an approximate duration of 2 years, 4 months, and be completed in November 2029. **Table 1** summarizes the anticipated construction activities that would occur each year of construction and provides the location of the activity.

Table 1: Anticipated Schedule of Construction Activities by Construction Year

Construction Year[1]	Activity	Location
1	Electrical Infrastructure Installation	Berth 26 and Howard Terminal
1	Concrete/Asphalt Pavement Demolition and Removal	Howard Terminal
1	On-Land and In-Water Pile Removal	Howard Terminal
1-2	New Bulkhead Installation	Howard Terminal
2	Landside Excavation	Howard Terminal
2	In-Water Bulkhead Installation, Dredging, and In-Water Rock Installation	Howard Terminal
2	In-Water Bulkhead and Rock Installation	Inner Harbor Waterway by Schnitzer/Radius Recycling
2	Dredging	Outer Harbor
2	Warehouse and Concrete/Asphalt Pavement Demolition and Removal	Alameda Site
2	New Bulkhead Installation	Alameda Site
2-3	Landside Excavation	Alameda Site
2-3	On-Land and In-Water Pile Removal	Alameda Site
3	In-Water Removal of Existing Bulkhead	Alameda Site
3	In-Water Bulkhead Installation, Dredging, and In-Water Rock Installation	Alameda Site
3	Dredging	Outer Harbor
3	Dredging and Dredged Material Rehandling	Inner Harbor Waterway, Berth 10

Note:

[1] Anticipated construction years are 2027 (year 1), 2028 (year 2) and 2029 (year 3). The schedule outlines expected general sequencing of activities over the 3 construction years regardless of actual construction start date. The order of activities shown may occur concurrently with other activities in the same construction year; the rows shown are not meant to indicate that the listed activities occur in consecutive order.

Construction, excluding dredging, would occur Monday through Friday between the hours of 7 a.m. and 7 p.m. Dredging, associated transport to beneficial reuse sites, and offloading (but not transporting by truck) of material at Berth 10 would be conducted 24 hours per day, 7 days per week. Activities that would take place during dredging and also would be conducted 24 hours per day, 7 days per week include the transportation of material to beneficial reuse sites and the transportation and placement of dredged material at Berth 10. Dredging and other in-water construction work would be performed during the in-water work window of June 1 through November 30 of each construction year.

Details on the construction equipment, vehicle trips, in-water vessel activities, and engine specifications can be found in the *Air Quality, Energy, and Greenhouse Gas Analysis (Appendix A4B)*. The *Air Quality, Energy, and Greenhouse Gas Analysis* also details the general methodology and assumptions used in calculating criteria air pollutant and GHG emissions. This HRA details how the emissions in the *Air Quality, Energy and Greenhouse Gas Analysis* are further used to develop the TAC emissions used in the HRA.

1.2.3 Operation and Maintenance

No TAC emissions estimates or HRA were developed for operation and maintenance of the Proposed Project. Although the Proposed Project would not change projected cargo throughput at the Port, in-water operations following widening of the turning basins would have some changes compared to existing conditions. The USACE performed an economic analysis of the impact on the Seaport of widening the turning basins, including a forecast in vessel calls by vessel class for the future with the Proposed Project and future without the Proposed Project scenarios (Appendix C of USACE April 2023). The vessel fleet mix is expected to change in the future as a result of other economic and global influences to the shipping industry, including growth, efficiency improvements, and vessel emission improvements as well as the physical change to the turning basins. Projected cargo throughput growth and efficiency improvements that are anticipated to occur regardless of implementation of the Proposed Project were the same for both the Proposed Project and No Project future scenarios. For both scenarios, the trend is toward the use of larger ships, resulting in fewer vessel calls to transport the same volume of cargo; however, under the Proposed Project, total vessel calls would be reduced because the future fleet mix would include a greater percentage of large vessels to transport the same volume of cargo. Based on the comparison to the future baseline the Proposed Project, may result in decreased emissions from in-water activities as discussed *Air Quality, Energy, and Greenhouse Gas Analysis* (Appendix A4B). There would be no new sources of emissions with the Proposed Project, and the only changes would be to a projected change in vessel fleet mix and number of calls in the future compared to the future No-Project baseline scenario. The turning basin shift in spatial position is minimal and unlikely to substantially change the emissions that would reach potential sensitive receptors. There may be some potential changes in localized emissions due to changes in peak activity that may influence the acute Hazard Index (HI), however, it is unlikely that these peak activity changes would be substantially different when compared to the No-Project future baseline scenario given the Port landside operation scheduling mechanisms to control and minimize peak activity concerns.

USACE performs annual maintenance dredging of Oakland Harbor, the environmental impacts of which were most recently analyzed in the *Final Environmental Assessment/Environmental Impact Report for the Maintenance Dredging of the Federal Navigation Channels in San Francisco Bay Fiscal Years 2015-2024* (2015 EA/EIR; USACE and RWQCB 2015). A new multi-year EA/EIR is planned for coverage of the USACE maintenance dredging program for 2025-2034 and will be completed prior to construction of the Proposed Project. The Proposed Project is estimated to add up to 93,000 cy of dredged material annually. As discussed in *Air Quality, Energy, and Greenhouse Gas Analysis* (Appendix A4B), the increase in emissions from maintenance dredging annually will still result in a net decrease in emissions for the in-water emissions under the future Proposed Project compared to the future No Project scenario. Therefore, the quantity of TAC emissions will decrease. This may or may not result in changes to the overall health impacts due to differences in the location where emissions occur for vessels calling on the Port and locations of maintenance dredging. Because specific detail regarding the spatial location and timing of these emissions is not fully known, there was no health risk assessment conducted for operation and maintenance.

Proposed Project and Alternative Scenarios

The final array of alternatives was developed with different combinations of economically competitive components from the preliminary analysis. Various combinations of these components (footprints) make up the focused array of alternatives. Alternatives B, C, D-1, and D-2 assume beneficial placement of dredged material in compliance with Section 204(d) of WRDA 1992. Alternative D-0 is the Federal Standard Base Plan and includes the least cost placement of suitable material at SFDODS. It is included in the final array of alternatives for cost comparison purposes and is not evaluated herein. The final array of alternatives is presented in **Table 2**. All alternatives would incorporate minimization measures for fugitive dust and require use of Tier 4 engines for off-road construction equipment. Only Alternative D-2 considers electric dredging. For purposes of this document, the term Proposed Project refers to Alternative D which involves widening of both the IHTB and OHTB.

Table 2: Final Array of Alternatives

ALTERNATIVES	
A	No Action
B	Inner Harbor Only (Inner Harbor Variation 3), with beneficial placement of eligible material
C	Outer Harbor Only (Outer Harbor Variation 8), with beneficial placement of eligible material
D-1	Inner and Outer Harbor (Inner Harbor Variation 3 and Outer Harbor Variation 8), with beneficial placement of eligible material
D-2	Inner and Outer Harbor (Inner Harbor Variation 3 and Outer Harbor Variation 8), with beneficial placement of eligible material and the use of electric dredges in lieu of diesel dredges

The main difference between the unmitigated and mitigated scenarios described int this document are the use of Tier 4 final engines for the landside construction equipment. For electric dredging in the event of electricity supply issues, temporary use of diesel dredging is included in this scenario.

Table 3 lists the assumptions for each of the different equipment types used in the construction of the Proposed Project Alternatives.

Table 3: Construction Equipment Engine Assumptions for the Proposed Project

Construction Equipment Type	Unmitigated	Mitigated
Dredgers	Diesel for Alternatives B, C, and D1 Main: Diesel Tier 4 Auxiliary: Diesel Tier 3/Tier 4 (2029) Electric for Alternative D2 with 240 hours per year of diesel dredging.	Same as Unmitigated.
Tugs (tow boats)	Main Engine: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029) Auxiliary Engines: Diesel Tier 3 (2027); Diesel Tier 4 (2028-2029)	Same as Unmitigated
Barges (and scows)	Auxiliary: Diesel Tier 4	Same as Unmitigated
Dive Boats	Main: Diesel Tier 3 Auxiliary: Diesel Tier 3	Same as Unmitigated
Off-Road Construction	OFFROAD Default Mix	Tier 4 final
Hauling Trucks (HHDT)	EMFAC Diesel Default Mix	Same as Unmitigated
Worker Vehicles (50% LDA, 50% LDT)	EMFAC Gasoline Default Mix	Same as Unmitigated

Note:

[1] HHDT = heavy, heavy-duty truck, LDT = light duty truck, EMFAC = Emission Factor Model for motor vehicles.

The Port has decided that the use of electric dredging equipment would be a component of the Proposed Project and includes constructing the necessary electrical infrastructure in the Outer Harbor to allow for the use of the electrical dredgers. Alternatives D1 and D2 includes widening both the IHTB and OHTB to improve the safety and efficiency of maneuvering larger vessels. Other alternatives include showing the emissions associated with construction of only the IHTB (Alternative B) or OHTB (Alternative C), respectively.

1.3 Document Organization

This document is organized in accordance with the key aspects of an HRA as outlined by the Office of Environmental Health Hazard Assessment (OEHHA) in their 2015 Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA 2015). The following sections are included in this HRA:

- Section 2, Overview of Health Risk Assessments, presents the purpose and key aspects and uncertainties regarding HRAs.
- Section 3, Chemicals of Concern, describes the chemicals that are addressed in the HRA.
- Section 4, TAC Emissions, describes how the TAC emissions estimates are developed.

- Section 5, Air Dispersion Modeling, describes key aspects of air dispersion modeling.
- Section 6, Estimated Air Concentrations, describes the annual average concentration of $PM_{2.5}$ from project construction.
- Section 7, Exposure Assessment, describes how a sensitive receptor is exposed to a TAC and the dose of chemical exposure.
- Section 8, Toxicity Assessment, describes the key health endpoints and the numerical quantification of these impacts.

2 Overview of Health Risk Assessments

An HRA was conducted to evaluate the potential health impacts from sources of TACs that would be emitted during construction of the Proposed Project. This report details the key assumptions and results of the HRA, which was conducted following the OEHHA, California Air Resources Board (CARB), and Bay Area Air Quality Management District (BAAQMD) HRA guidelines.

An HRA is designed to provide information to state and local agencies and to the general public on the extent of airborne emissions from stationary and mobile sources and the potential public health impacts of those emissions. The standard approach currently used for HRAs was originally proposed by the National Academy of Sciences in 1983 (NAS 1983) and was updated in 1994 by the National Academy of Sciences (NAS 1994). The methodology outlined in these reports presents four key steps involved in the risk assessment process:

1. Hazard Identification
2. Exposure Assessment
3. Dose-Response Assessment
4. Risk Characterization

Hazard identification involves identifying the pollutants of concern emitted by a facility or project and the types of adverse health effects associated with exposure to those chemicals, including whether a pollutant is a potential human carcinogen or is associated with other types of adverse health effects.

Exposure assessment is used to estimate the extent of public exposure to emitted substances. In practice, this means estimating exposure levels for each emitted substance for which potential cancer risk or non-cancer health hazards for acute (short-term or short-contact) and chronic (long-term) exposures would be evaluated. This involves emission quantification, modeling of environmental transport (air dispersion modeling), evaluation of environmental fate (where the chemical ends up), identification of exposure routes (how a person comes into contact with a chemical), identification of exposed populations, and estimation of short-term (acute) and long-term (chronic) exposure levels.

Dose-response assessment is the process of characterizing the relationship between exposure to a chemical and incidence of an adverse health effect in exposed populations. In quantitative carcinogenic risk assessment, the dose-response relationship is expressed in terms of a potency slope that is used to calculate the probability or risk of cancer associated with an estimated exposure. It is assumed in cancer risk assessments that risk is directly proportional to dose, and that there is no threshold for a person's body to deal with the exposure that would reduce the harm. For noncarcinogenic effects, dose-response data developed from animal and human studies are used to develop noncancer Reference Exposure Levels (RELs). These RELs are defined as the concentration at which no adverse noncancer health effects are anticipated, even in sensitive members of the general population. Unlike cancer health effects, noncancer health effects are generally assumed to have thresholds for adverse effects. In other words, a pollutant would not cause harm until exposure to that pollutant has reached or exceeded a certain concentration and/or dose (the REL). The RELs are air concentrations intended to indicate the threshold below which no health effects would occur for the general population.

Risk characterization is the final step of risk assessment. In this step, modeled concentrations and exposure information are combined with potency factors and RELs that are developed through dose-response assessment. The result is a total cancer risk or hazard index that indicates the potential chance that exposure to the pollutants would result in hazardous health effects.

Even with the detailed process and methodology outlined above, there is uncertainty with any HRA. The uncertainty comes from lack of adequate data in many areas, which makes it necessary to rely on assumptions. The assumptions used in an HRA are designed to err on the side of protecting human health and are intended to avoid underestimation of risk to the public. Therefore, conservative assumptions are built into the HRA process.

Any individual assumption may overestimate or underestimate the actual risk. Key assumptions that result in uncertainty include extrapolation of toxicity data from animals to humans, estimation of emissions, assumptions used in air dispersion models, and assumptions used to estimate exposure. Variation in measured parameters and variation among the human population (e.g., height, weight, breathing rate, and susceptibility to chemical toxicity) all lead to increased uncertainty. Interaction between chemicals is assumed to be additive for cancer and non-cancer health impacts affecting the same target organ or system. In the case of substances that could act synergistically, the HRA may underestimate the risks. For substances with antagonistic effects that cancel the effect of other substances, the HRA may overestimate risk.

Chronic and cancer health effects estimated over short periods such as construction activity have additional uncertainty. Cancer potency factors are based on animal lifetime studies or worker studies with long-term exposure (lifetime exposures of 30 to 70 years) to the carcinogenic agent. Considerable uncertainty exists in trying to evaluate the cancer risk from a project that would last only a small fraction of a lifetime. Some studies indicate that the dose rate changes the potency of a given dose of a carcinogenic chemical. In other words, a dose delivered over a short period may have a different potency than the same dose delivered over a lifetime (OEHHA 2015). Given that HRAs involve uncertainty, it is important to keep in mind that risk estimates generated by an HRA should not be interpreted as the expected rates of disease in the exposed population, but rather an estimate of the potential for disease based on current knowledge and identified assumptions.

3 Chemicals of Concern

One of the first steps in preparing an HRA is to identify the potential chemicals of concern. OEHHA has identified a list of chemicals that are identified in California as toxic air contaminants (TACs) and has determined appropriate toxicity factors for these chemicals for use in HRAs. The sources of chemicals of concern during Proposed Project construction are emissions related to diesel and gasoline exhaust from the combustion of fossil-fueled construction equipment, in-water vessels, material hauling vehicles, and worker vehicles.

Diesel exhaust is a complex mixture of chemicals that includes hundreds of individual constituents. In addition to being identified by the State of California as a known carcinogen, diesel exhaust also has chronic health effects. The United States Environmental Protection Agency (USEPA) has not explicitly identified the mixture of diesel exhaust as a separate carcinogen, however, and typically would calculate the individual components of diesel exhaust to derive a total cancer impact from these individual components. For purposes of this HRA, diesel particulate matter (DPM) is treated as a mixture (in accordance with California standards) rather than a speciated set of individual components (as recommended by USEPA). One exception is the analysis of acute health impacts because an acute REL has not been determined for DPM. Construction equipment, in-water vessels, material hauling vehicles, and worker vehicles may emit DPM.

Various gasoline fuel-related TACs would also be emitted from gasoline-fueled vehicles. Specifically, TACs such as benzene, toluene, ethylbenzene, 1,3-butadiene, and xylenes may be emitted from gasoline-fueled vehicles.

The HRA analysis also evaluates the concentration of particulate matter of aerodynamic diameter less than 2.5 micrometers ($PM_{2.5}$). Although $PM_{2.5}$ is not a TAC, it is included in BAAQMD's CEQA significance thresholds for risks and hazards because both long-term and short-term exposure can cause a wide range of health effects because $PM_{2.5}$ can travel deep into lungs and enter the bloodstream. This HRA assumes that all vehicle exhaust, including DPM, contains $PM_{2.5}$. In addition, fugitive dust from construction activities, tire and brake wear, and dust from traveling on paved roads is also included in the emissions used to estimate $PM_{2.5}$ concentrations.

4 Toxic Air Contaminant Emissions

This HRA uses criteria pollutant emissions as a basis for development of TAC emissions. For details on the specific calculations used to develop the activity, engine specifications, and emission factors for criteria pollutants, see the *Air Quality, Energy, and Greenhouse Gas Analysis* (Appendix A4B). To estimate DPM emissions, particulate matter with aerodynamic radius of 10 micrometers or less (PM_{10}) emissions from those sources of diesel exhaust are used in a 1:1 ratio. To obtain emissions estimates for the individual TACs that make up the organic gases in gasoline exhaust, a speciation factor is applied (i.e., the ratio of emissions of an individual TAC compared to total organic gas emissions). Similarly, diesel emissions sources can be speciated into individual TACs to estimate acute health effects.

For use in air dispersion modeling for this HRA, the emissions were converted to an emission rate in terms of grams per second. To convert the total mass emissions to grams per second, the total mass of emissions is converted from tons to grams. To obtain the emission rate, the total mass emissions are distributed over the appropriate period of time. For example, emissions for a source that operates 12 hours per day, 5 days per week are illustrated with the following equation:

$$Emission\ Rate\ (\frac{grams}{sec}) = Mass\ Emissions(\frac{tons}{year}) * \frac{2{,}000\ pounds}{1\ ton} * \frac{453.592\ grams}{1\ pound} * \frac{1\ year}{52\ weeks} * \frac{1\ week}{5\ days} * \frac{1\ day}{12\ hours} * \frac{1\ hour}{60\ minutes} * \frac{1\ minute}{60\ sec}$$

For a source that operates 24 hours per day, 7 days per week, the number of days per week would change from 5 to 7 and the number of hours per day would change from 12 to 24.

Although not all emissions sources are operating for a full calendar year, emissions are assigned this way to get an accurate annual average concentration when combined with the air dispersion modeling factors, which assume that emissions would occur 52 weeks per year on either the 12-hour, 5-day-a-week schedule or the 24-hour, 7-day-a-week schedule. The key to properly evaluating emission time in the HRA is to ensure that the total mass of emissions would be the same when considering the variable emission rate used in air dispersion modeling. It is also important in assignment of exposure factors and age-specific factors to ensure that the total emissions are fully considered in the HRA when using annual average dispersion factors.

Emissions rates from different emission types that use the same air model source are added for each air model source configuration to get the total emission rate for each source modeled. For instance, construction equipment operating in Alameda was assigned to the model source for land activities, called IHCONS (for Inner Harbor Construction South), and the electrical infrastructure work near Berth 26 was assigned to the model source for this construction area, called EINFRA (Electrical Infrastructure Area). This calculation is relatively straightforward for the landside construction and dredging activity. For the tow boats traveling to the beneficial reuse site and all vehicles, including worker and truck trips, the emissions must be adjusted to allocate only the amount of emissions that occur in a given modeling domain. For tow boats, the distance for the tugs traveling in the Inner Harbor Channel or Outer Harbor Channel until they exit the model domain is used to estimate the mass emissions, which are then converted to emission rates. For vehicles on roadways, the total number of trips for each vehicle trip type (worker, Class I, Class II, recycle, and other) were allocated to potential road segments inside and outside of the Proposed Project work sites. Each segment’s actual distance in the model domain was used to calculate the emissions associated with that particular modeled segment. Details of these emission allocations and adjustment to the modeling domains are shown in **Table 4** for tow boats **Table 5** and for road allocations.

Table 4: Tow Boat Adjusted Distance

Source	Distance (Miles)
Inner Harbor Tug Path	3.57
Outer Harbor Tug Path	1.75

Table 5: Road Adjusted Distances

Location[4]	Trip Type	Path	Fraction of Round Trips[3]	AERMOD Sources Representing Road Links[1,2]	Distance (miles)
Alameda	Class I Landfill and Recycler	Inbound from I-880 SB	1	E3, E, D	6.06
Alameda	Class I Landfill and Recycler	Outbound on I-880 SB	1	D, E, E4	5.95
Alameda	Class II Landfill	In from I-880 SB	0.5	W3, C1F, C1E, C1, C1B, E1, E, D	14.22
Alameda	Class II Landfill	In from I-980 SB	0.5	980, C1C, C1B, E1, E, D	9.60
Alameda	Class II Landfill	Out from I-880 NB	0.5	W2, C2G, C2F, C2E, C2D, C2C, C2B, E2, E, D	14.26
Alameda	Class II Landfill	Out on I-980 NB	0.5	D, E, E2, C2B, C2C, C2D, 980O	10.38
Alameda	Worker, Hauling Other	In from I-80 EB	0.25	SF4, C1F, F1, F, H2A, D1, D	9.37
Alameda	Worker, Hauling Other	In from I-880 NB	0.25	C2, C2A, C2B, D2, POSEY, D	8.35
Alameda	Worker, Hauling Other	In from I-880 SB	0.25	W3, C1F, F1, F, H2A, D1, D	9.26
Alameda	Worker, Hauling Other	In from I-980 SB	0.25	G1, D1, D	5.68
Alameda	Worker, Hauling Other	Out on I-80 WB	0.25	D, D3, C2D, C2E, C2F, C2G, SF3	9.92
Alameda	Worker, Hauling Other	Out on I-880 NB	0.25	W2, C2G, F2, F, D1, D	9.03
Alameda	Worker, Hauling Other	Out on I-880 SB	0.25	D, D4A, D4, C1B, C1A, C1	6.78
Alameda	Worker, Hauling Other	Out on I-980 NB	0.25	D, D1, G2	5.56
Howard Terminal	Class I Landfill and Recycler	In from I-880 NB	1	C2, C2A, C2B, C2C, C2D, C2E, H1, H2A, HT	5.90
Howard Terminal	Class I Landfill and Recycler	Out on I-880 SB	1	HT, H2, H2A, C1, C1C, C1B, C1A, C1	5.94
Howard Terminal	Class II Landfill	In from I-880 SB	0.5	W3, C1F, F1, F, HT	4.79
Howard Terminal	Class II Landfill	In from I-980 SB	0.5	G1, HT	1.33
Howard Terminal	Class II Landfill	Out on I-880 NB	0.5	W2, C2G, F2, F, HT	4.69
Howard Terminal	Class II Landfill	Out on I-980 NB	0.5	G2, HT	1.22

Location[4]	Trip Type	Path	Fraction of Round Trips[3]	AERMOD Sources Representing Road Links[1,2]	Distance (miles)
Howard Terminal	Worker, Hauling Other	In from I-80 EB	0.25	SF4, C1F, F1, F HT	4.60
Howard Terminal	Worker, Hauling Other	In from I-880 NB	0.25	C2, C2A, C2B, C2C, C2D, C2E, H1, H2A, HT	5.90
Howard Terminal	Worker, Hauling Other	In from I-880 SB	0.25	W3, C1F, F1, F, HT	4.79
Howard Terminal	Worker, Hauling Other	In from I-980 SB	0.25	G1, HT	1.33
Howard Terminal	Worker, Hauling Other	Out on I-80 WB	0.25	HT, F, F2, C2G, SF3	5.32
Howard Terminal	Worker, Hauling Other	Out on I-880 NB	0.25	W2, C2G, F2, F, HT	4.69
Howard Terminal	Worker, Hauling Other	Out on I-880 SB	0.25	HT, H2, H2A, C1, C1C, C1B, C1A, C1	5.94
Howard Terminal	Worker, Hauling Other	Out on I-980 NB	0.25	G2, HT	1.22
Outer Harbor	Hauling Berth 10 Class II Landfill	In from I-580 WB	0.5	A2, A	2.97
Outer Harbor	Hauling Berth 10 Class II Landfill	In from I-880 SB option 1	0.25	A1, A	2.59
Outer Harbor	Hauling Berth 10 Class II Landfill	In from I-880 SB option 2	0.25	A3, A	2.23
Outer Harbor	Hauling Berth 10 Class II Landfill	Out on I-580 EB	0.5	A, B2	2.17
Outer Harbor	Hauling Berth 10 Class II Landfill	Out on I-880 NB	0.5	A, B3	2.26
Outer Harbor	Worker, Hauling Other	In from I-580 WB	0.25	A2, A	2.97
Outer Harbor	Worker, Hauling Other	In from I-80 EB	0.25	SF1, A	1.98
Outer Harbor	Worker, Hauling Other	In from I-880 NB	0.25	CB4, C, C27, C2G, C2F, C2E, C2D, C2C, C2B, C2A, C2	8.95
Outer Harbor	Worker, Hauling Other	In from I-880 SB option 1	0.125	A1, A	2.59
Outer Harbor	Worker, Hauling Other	In from I-880 SB option 2	0.125	A3, A	2.23
Outer Harbor	Worker, Hauling Other	Out on I-580 EB	0.25	B2, A	2.17
Outer Harbor	Worker, Hauling Other	Out on I-80 WB	0.25	SF2, A	1.30
Outer Harbor	Worker, Hauling Other	Out on I-880 NB	0.25	B3, A	2.26

Location[4]	Trip Type	Path	Fraction of Round Trips[3]	AERMOD Sources Representing Road Links[1,2]	Distance (miles)
Outer Harbor	Worker, Hauling Other	Out on I-880 SB	0.25	C1, CA1, C1B, C1C, C1D, C1E, C1F, C17, C, CB4	11.57
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	In from I-580 WB	0.25	A2, CBEIN, B26	3.73
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	In from I-80 EB	0.25	SF1, CBEIN, B26	2.74
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	In from I-880 NB	0.25	B26, C, C27, C2G, C2F, C2E, C2D, C2C, C2B, C2A, C2	8.22
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	In from I-880 SB option 1	0.125	A1, CBEIN, B26	3.35
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	In from I-880 SB option 2	0.125	A3, CBEIN, B26	3.00
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	Out on I-580 EB	0.25	B2, CBEIN, B26	2.93
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	Out on I-80 WB	0.25	SF2, CBEIN, B26	2.07
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	Out on I-880 NB	0.25	B3, CBEIN, B26	3.03
Outer Harbor	Worker, Hauling Other Electrical Infrastructure	Out on I-880 SB	0.25	C1, CA1, C1B, C1C, C1D, C1E, C1F, C17, C, B26	8.25

Notes:

1. Road links are sections of roads that when combined represent the roads within the modeling domain. A road link may be repeated if another path later splits to another travel path. The link is only a portion of the total travel length as once it leaves the general West Oakland, Alameda area interstates, it is no longer considered in the model domain and the incremental contribution is considered de minimis.
2. To distinguish between truck and passenger vehicles in AERMOD the letters "NT" were added to a link to represent non-truck source parameters.
3. When multiple pathways of travel to and from a location where possible, it was assumed that there was equal weighting between travel paths.
4. Workers for the Schnitzer Steel/Radius Recycling work were assumed to drive to Howard Terminal as this is in-water work.

4.1 Worker Vehicles Emissions

Worker vehicles using gasoline were speciated using the total organic gas emissions multiplied by the speciation factor or ratio of the individual TAC to the total organic gas emissions. **Table 6** shows the speciation profile for gasoline. This was used for the acute and chronic hazard index, as well as the excess lifetime cancer risk calculations.

Table 6: Speciation Profiles

Chemical	TOG Ratio	Speciation Profile Source	Type	TOG Type
Acetaldehyde	0.0028	BAAQMD Table 14	Gas	Exhaust
Benzene	0.0247	BAAQMD Table 14	Gas	Exhaust
1,3-Butadiene	0.0055	BAAQMD Table 14	Gas	Exhaust
Ethylbenzene	0.0105	BAAQMD Table 14	Gas	Exhaust
Formaldehyde	0.0158	BAAQMD Table 14	Gas	Exhaust
Hexane	0.016	BAAQMD Table 14	Gas	Exhaust
Methanol	0.0012	BAAQMD Table 14	Gas	Exhaust
Methyl Ethyl Ketone	0.0002	BAAQMD Table 14	Gas	Exhaust
Naphthalene	0.0005	BAAQMD Table 14	Gas	Exhaust
Propylene	0.0306	BAAQMD Table 14	Gas	Exhaust
Styrene	0.0012	BAAQMD Table 14	Gas	Exhaust
Toluene	0.0576	BAAQMD Table 14	Gas	Exhaust
Xylenes	0.048	BAAQMD Table 14	Gas	Exhaust
Acetaldehyde	0.0735	CARB 818	OFFROAD	Exhaust
Benzene	0.02	CARB 818	OFFROAD	Exhaust
1,3-Butadiene	0.0019	CARB 818	OFFROAD	Exhaust
Formaldehyde	0.1471	CARB 818	OFFROAD	Exhaust
Methanol	0.0003	CARB 818	OFFROAD	Exhaust
Methyl Ethyl Ketone	0.0148	CARB 818	OFFROAD	Exhaust
Styrene	0.0006	CARB 818	OFFROAD	Exhaust
Toluene	0.0147	CARB 818	OFFROAD	Exhaust
Xylenes	0.0105	CARB 818	OFFROAD	Exhaust
Acetaldehyde	0.15942	EPA 4674	Diesel	Exhaust

Chemical	TOG Ratio	Speciation Profile Source	Type	TOG Type
Benzene	0.01045	EPA 4674	Diesel	Exhaust
Formaldehyde	0.08505	EPA 4674	Diesel	Exhaust
Methyl Ethyl Ketone	0.0286	EPA 4674	Diesel	Exhaust
Toluene	0.01518	EPA 4674	Diesel	Exhaust
Xylenes	0.01206	EPA 4674	Diesel	Exhaust

Notes:

BAAQMD = Bay Area Air Quality Management District
CARB = California Air Resources Board
USEPA = United States Environmental Protection Agency
TOG = total organic gases

Sources: BAAQMD 2012, CARB 2022, USEPA 2022b

4.2 Truck Vehicles Emissions

The emissions from heavy, heavy-duty trucks using diesel on-road engines were speciated using the total organic gas emissions multiplied by the speciation factor shown in **Table 6**. These emissions were used only in the acute hazard index calculations. For the chronic hazard index and excess lifetime cancer risk, DPM emissions were assumed to be equal to the PM_{10} emissions from diesel exhaust.

4.3 Construction Equipment Emissions

Emissions calculations for construction equipment using diesel offroad engines were speciated using the total organic gas emissions multiplied by the speciation factor shown in **Table 6**. These emissions were used only in the acute hazard index calculations. For the chronic hazard index and excess lifetime cancer risk, DPM emissions were assumed to be equal to the PM_{10} emissions from diesel exhaust. For $PM_{2.5}$ concentration, the $PM_{2.5}$ emissions were used.

4.4 In-Water Equipment Emissions

Emissions from in-water equipment using diesel offroad engines were speciated using the total organic gas emissions multiplied by the speciation factor (e.g., TOG or PM ratio) shown in **Table 6**. These emissions were used only in the acute hazard index calculations. The same speciation factors were used for tow boats, barges, and diesel dredgers. For the chronic hazard index and excess lifetime cancer risk, DPM emissions were assumed to be equal to the PM_{10} emissions from diesel exhaust. For $PM_{2.5}$ concentration, the $PM_{2.5}$ emissions were used.

4.5 Fugitive Dust Emissions

Fugitive dust emissions were assumed not to contain any TACs. Fugitive dust arises from wind-blown dust from material piles, traveling on roadways, passing over land to smooth it, bulldozing material into piles, and transferring material to trucks. Fugitive dust emissions were only used to obtain the $PM_{2.5}$ concentration using the $PM_{2.5}$ emissions reported in the *Air Quality, Energy, and Greenhouse Gas Analysis* (Appendix A4B).

5 Air Dispersion Modeling

Modeling was performed using USEPA's AERMOD executable version 22112 (USEPA 2022a). AERMOD was used to estimate breathing-zone concentrations of TACs and $PM_{2.5}$ at receptor locations, which are then used to perform the exposure and risk assessment to calculate the potential cancer risk and non-cancer health impacts at each receptor location (discussed in the next three chapters). The inputs and assumptions used in the model are summarized below.

Emission Rate: A unit emission rate (1 gram per second) was used in the AERMOD analysis, which allows for the AERMOD results or dispersion factors to be multiplied by project-specific emission rates (in units of grams per second) to identify the project-specific ambient air concentrations because there is a linear relationship.

Meteorological Data: Meteorological data were processed using two on-site meteorological stations that operate under the auspices of the National Oceanic and Atmospheric Administration's (NOAA's) Center for Operational Oceanographic Products and Services (CO-OPS): Berth 34 (Site ID: 9414776) and Berth 67 (Site ID 9414763). The meteorological data at Berth 34 were used for AERMOD modeling of all emission sources operating in the Outer Harbor, including work at Berth 10 and near Berth 26. The Berth 67 meteorological data were applied for all Inner Harbor emissions, including work at Howard Terminal and the Alameda Site. The Oakland Airport meteorological station was used to substitute any missing data as a surface meteorological station in AERMET. The locations and wind roses for the two stations are shown in **Figure 6**. Upper air data were from Oakland International Airport.

Four years of meteorological data from 2017-2020 were used (NOAA 2023). The project conservatively used four years of meteorological data from 2017 through 2020[3] even though these would be considered on-site meteorology stations. Five years of meteorological data are desired for non-site-specific meteorological data and one year of site-specific data. The Berth 34 and Berth 67 meteorology stations were selected after looking at several options in the area and comparing the differences between wind roses, station anemometer heights, and station locations. Although these stations had slightly lower (7.6 meters) anemometers than the recommended 10-meter height, it was determined that their proximity to the Project work areas made them more appropriate. The wind roses looked similar to other nearby options including the Oakland Airport station and did not suggest interference effects from surrounding land uses. The wind direction changes rapidly as the wind patterns transition to following land shortly after entering through the Golden Gate area and into the San Francisco Bay and is better reflected by using these stations.

Terrain: AERMOD uses the preprocessor AERMAP to incorporate terrain elevation into the model. Terrain and elevation data were imported from the United States Geological Survey's (USGS') National Elevation Data (NED) set with 1/3 arc-second resolution and a horizon datum of the North American Datum of 1983. To incorporate the elevated roads in and around the Project site, the USGS 1/3 arc-second NED and 2010 San Francisco Coast and 2006 Alameda light detection and ranging (LIDAR) data were used, similar to the process described in the HRA supporting the West Oakland Community Action Plan (WOCAP) (BAAQMD 2019).

Urban Source Designation: AERMOD allows the option to designate sources as urban or rural. Selecting the urban option accounts for heat island effects. This requires the user to enter a population for the area. AERMOD's Implementation Guide suggests using the Metropolitan Statistical Area (MSA), which, for this Project, is San Francisco-Oakland-Berkeley with a population of 4,749,008. The default surface roughness of 1 meter was used.

[3] Five years of recent meteorological data that met the completeness requirements were not available.

Receptors: A total of 31,092 receptors were established for this analysis. Receptors were modeled at a fine grid with 20-meter spacing in West Oakland and areas in Alameda and Oakland near the Proposed Project work sites consistent with the smallest receptor spacing recommended by BAAQMD in its CEQA Guidelines (BAAQMD 2023). Additional receptors were modeled at a fine grid of 50-meter spacing at the Seaport landside area and Schnitzer Steel/Radius Recycling site, which is primarily workers, as well as a final receptor grid of 250-meter spacing to capture the remainder of the modeling domain, which is the same as the WOCAP HRA. Receptors were modeled at a 1.8-meter release height. **Figure 7** shows the receptor grid used in the modeling.

Source Parameters: Emissions from construction equipment, on-road vehicles, and fugitive dust were modeled with a series of volume sources (landside construction areas and roadways) or area sources (in-water sources). Volume sources were used for landside construction areas and vehicle roadways; these source types are commonly used when emissions initially disperse three-dimensionally with no upward velocity of the plume. Volume sources are defined by their release height, initial vertical dimension (plume depth), and initial lateral dimension (plume width). The landside construction work areas were modeled as adjacent volume sources with 20- by-20-meter volume size. Roadways were modeled as adjacent volume sources. For volume sources, **Table 7** shows the BAAQMD recommended source parameters for road volume sources (BAAQMD 2023) and for construction equipment from SCAQMD's Localized Significant Threshold Methodology (SCAQMD 2008).

Table 7: AERMOD Source Parameters

Source Type[4]	Release Height (m)	Initial Vertical Dimension (m)	Initial Lateral Dimension (m)
Offroad Land Construction Equipment (volume)[1]	5	1.4	4.65
In-water Equipment (area)[2]	6	4.74	--
Trucks (adjacent volume)[3]	3.4	3.16	3.72
Worker Vehicles (adjacent volume)[3]	1.3	1.21	3.72

Notes:

1 Parameters based on SCAQMD Localized Significance Threshold Methodology (SCAQMD 2008).

2 These release parameters were the same used in the HRA for WOCAP (BAAQMD 2019) and West Oakland HRA (CARB 2008).

3 These parameters are the recommended values in BAAQMD's latest modeling guidance for CEQA Table 11 (BAAQMD 2023). All roads were assumed to be the maximum road width for a traffic lane of 8 meters. The initial lateral dimension is the plume width divided by 2.15. The initial vertical dimension is plume height divided by 2.15.

4 Fugitive dust was modeled with the same dispersion parameters as the exhaust emissions to reduce the amount of different source configurations and to reduce modeling time.

m = meters

In-water sources were modeled as area sources because their travel paths are less defined. This approach is consistent with the modeling done for the WOCAP HRA (BAAQMD 2019). The area source parameters require only the release height and initial vertical dimension; these are shown in **Table 7** and are based on values from the WOCAP HRA (BAAQMD 2019) and CARB's 2008 HRA of West Oakland (CARB 2008). **Figure 8** shows the locations of the sources from an overall perspective.

Variable Emission Rates: Construction emissions were modeled under two variable emission release scenarios. All dredging activities, including the tow boats used to transport material to the beneficial reuse site and equipment used at Berth 10 to offload material from barges/scows, were assumed to operate at the same emission rate 24 hours a day, 7 days a week during the construction phase. All other emission sources were assumed to operate at the same emission rate over a 12-hour day from 7 a.m. to 7 p.m., 5 days a week (Monday through Friday). This scenario was selected to coordinate the approximate schedule of use with the diurnal changes in wind speed and direction that can occur from daytime to nighttime.

Output: The output of AERMOD is the 1-hour maximum air concentration and annual average air concentration in units of micrograms per cubic meter ($\mu g/m^3$) at each receptor in the model for each group of sources.

Domain: The modeling domain was selected to match the domain used by BAAQMD in the WOCAP HRA (BAAQMD 2019). This is a 7 kilometer by 5-kilometer domain. This is larger than the suggested 1,000 feet from project sites recommended in BAAQMD's CEQA Guidelines (BAAQMD 2023). Therefore, the full length of vehicle trips and tug trips was not included as these sources moved farther out of the main construction areas in the Inner and Outer Harbors. This is common for HRAs because the incremental contribution from sources decreases as they get farther from the receptors being modeled. It is common to model vehicles only until they reach major roadways; however, given the proximity of the Proposed Project to disadvantaged communities and the fact that several major freeways to be used by Proposed Project vehicles pass alongside these communities, emissions from these vehicles traveling on these highways through the disadvantaged communities were included.

6 Estimated Air Concentrations

The estimated emission rate in terms of grams per second for each source is multiplied by the unit rate emission factor from the air dispersion modeling and summed over all sources for a given pollutant. This results in the ambient air concentration of a specific chemical in units of $\mu g/m^3$. Of interest to this HRA is the concentration of $PM_{2.5}$ because this is the only criteria pollutant for which BAAQMD has additional health-related thresholds and other pollutants, such as the ozone precursors of ROG and NO_X, require substantially more information to account for background concentrations and conversion effects as discussed in the follow paragraph. The concentration of $PM_{2.5}$ for the unmitigated and mitigated Proposed Project scenarios is shown in

Table 8. **Figure 17** and **Figure 22** show the distribution of the $PM_{2.5}$ concentration across the modeling domain for the unmitigated and mitigated scenario for all Alternatives.

Table 8: $PM_{2.5}$ Concentrations from Construction at Maximum Location

Scenario/Receptor	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	$PM_{2.5}$ Concentration (µg/m³)
Alternative B – Unmitigated Maximum $PM_{2.5}$ Concentration (Berth 10)	560950	4186050	20.7
Alternative B – Mitigated Maximum $PM_{2.5}$ Concentration (Berth 10)	560900	4186050	18.34
Alternative C -Unmitigated Maximum $PM_{2.5}$ Concentration (Berth 26)	559700	4184900	3.26
Alternative C -Mitigated Maximum $PM_{2.5}$ Concentration (Berth 26)	559600	4184900	0.8
Alternative D-1 Unmitigated Maximum $PM_{2.5}$ Concentration (Berth 10)	560900	4186000	18.57
Alternative D-2 Mitigated Maximum $PM_{2.5}$ Concentration (Berth 10)	560950	4186000	19.9

Notes:

BAAQMD = Bay Area Air Quality Management District
µg/m³ = micrograms per cubic meter
UTM = Universal Transverse Mercator Coordinate System NAD83 Zone 10

7 Exposure Assessment

Potential receptors were characterized as residents, day-care children, school children, medical patients, senior center users, and recreational users. The maximally exposed receptor for assuming residential exposure (similar to a Point of Maximum Impact [PMI]), as well as the actual maximum residential receptor (MEIR), is reported. Given a specific receptor location, residential exposure assumptions are the most conservative compared to those for day-care children, school children, medical patients, senior center users, and recreational users.

Because the Proposed Project construction areas are surrounded by workers, residences, and future residential locations, the results report several different receptor locations in both the Inner and Outer Harbor areas. The maximally exposed location assuming residential exposure is reported similar to a point of maximum impact. Exposure levels at residential locations are reported for both the highest exposed residential receptor in existence currently and the highest exposed future planned residential receptor in the Outer Harbor area, West Oakland near the Inner Harbor work, and Alameda near the Inner Harbor work. There are several areas that could potentially have residential receptors at the time of construction of the Proposed Project based on recently completed construction and/or existing development plans; these include residences at Howard Terminal (proposed development), the North Housing Project in Alameda (Bay 37; planned development), and Lookout at Bay 37 in Alameda (recently completed construction). Exposure levels at worker locations are also reported.

Risk assessment guidelines from OEHHA (2015) recommend the exposure parameters used to estimate excess lifetime cancer risks and chronic non-cancer Hazard Index (HI) for all potentially exposed populations.

The inhalation dose is a function of the concentration of a chemical and the intake of that chemical. The dose can be calculated as follows:

$$Dose = \frac{Conc * DBR * ET * EF * ED * CF}{AT}$$

Where:

Dose	=	Dose of chemical (milligrams per kilogram-day [mg/kg-day])
Conc	=	Chemical concentration in air (micrograms per cubic meter [µg/m^3])
DBR	=	Daily breathing rate (liters per kilogram-day [L/kg-day])
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time (days)
CF	=	Conversion factor (cubic meters per liter [m^3/L] and mg/µg)

The DBR was set to the 95th percentile for the third trimester, 0 to 2 years. The 80th percentile DBR was used for ages 2 to 15 years and 16 to 30 years as recommended by CAPCOA (2015) and BAAQMD (2023). The exposure frequency was assumed to be the calendar days for a given year of the construction work schedule. The exposure frequency for residents was 350 days per year, consistent with a resident being present at the home (outside or with their windows open) except for two weeks out of the year (to account for a 2-week vacation away from home) and an exposure duration for the whole construction period. There was no further adjustment for fraction of time at home. The averaging time was based on 70 years. The details of the exposure factors for the receptors are shown in **Table 9**.

Table 9: Age-Sensitivity Factors (Exposure Factors)

Population	Age Bin	Overlap	Calendar Year	Exposure Years	DBR	EF	CF	FAH	WA F	ASF	AT
Worker	16-70	12_5	2027	1	230	0.68	0.000001	1	2.8	1	70
Worker	16-70	12_5	2028	1	230	0.68	0.000001	1	2.8	1	70
Worker	16-70	12_5	2029	1	230	0.68	0.000001	1	2.8	1	70
Worker	16-70	24_7	2027	1	230	0.68	0.000001	1	1	1	70
Worker	16-70	24_7	2028	1	230	0.68	0.000001	1	1	1	70
Worker	16-70	24_7	2029	1	230	0.68	0.000001	1	1	1	70
Residential	3rd trimester	12_5	2027	0.25	361	0.96	0.000001	1	1	10	70
Residential	0-2	12_5	2027	0.75	1,090	0.96	0.000001	1	1	10	70
Residential	0-2	12_5	2028	1	1,090	0.96	0.000001	1	1	10	70
Residential	0-2	12_5	2029	0.25	1,090	0.96	0.000001	1	1	10	70
Residential	2-16	12_5	2029	0.75	572	0.96	0.000001	1	1	3	70
Residential	3rd trimester	24_7	2027	0.25	361	0.96	0.000001	1	1	10	70
Residential	0-2	24_7	2027	0.75	1,090	0.96	0.000001	1	1	10	70
Residential	0-2	24_7	2028	1	1,090	0.96	0.000001	1	1	10	70
Residential	0-2	24_7	2029	0.25	1,090	0.96	0.000001	1	1	10	70
Residential	2-16	24_7	2029	0.75	572	0.96	0.000001	1	1	3	70
School	2-16	12_5	2027	1	520	0.49	0.000001	1	4.2	3	70
School	2-16	12_5	2028	1	520	0.49	0.000001	1	4.2	3	70
School	2-16	12_5	2029	1	520	0.49	0.000001	1	4.2	3	70
School	2-16	24_7	2027	1	520	0.49	0.000001	1	1	3	70
School	2-16	24_7	2028	1	520	0.49	0.000001	1	1	3	70
School	2-16	24_7	2029	1	520	0.49	0.000001	1	1	3	70

Notes:

ASF = Age Specific Factor
AT = Averaging time (days)
CF = Conversion factor (cubic meters per liter [m3/L] and mg/µg)
DBR = Daily breathing rate (liters per kilogram-day [L/kg-day])
ED = Exposure duration (years)
EF = Exposure frequency (days/year)
FAH = Fraction of time at home
WAF = Worker Adjustment Factor

For workers who are not exposed constantly in contrast to a resident assumed to be at home constantly, it is important to consider if their exposure overlaps in time with when the source emissions are being released. For instance, a worker that works a regular 9 a.m. to 5 p.m. job would overlap in time with a source that only operated 9 a.m. to 5 p.m. and would have 8 hours of exposure. If the source operated continuously, the worker would only be exposed for 8 of the 24 hours, or a third of the time, and therefore be exposed to a third of the emissions. On the other hand, a worker who works a 3 p.m. to 11 p.m. shift with a source that only operated from 9 a.m. to 5 p.m. would only have 2 hours of overlap, or only a quarter of the time, and therefore be exposed to only a quarter of the emissions. In these cases, an adjustment to the annual average concentration needs to be made to account for the increased concentration that occurs during these overlapping time periods. This is done using a worker adjustment factor added to the dose calculation. For the project sources that operate on a 12-hour-per-day, 5-day-per-week schedule that overlaps with the same worker shift, the worker adjustment factor is 2.8; that is, the worker has the potential to receive approximately 2.8 times higher concentration and therefore exposure to the TACs than indicated by the annual average for a specific source that operates on the overlapping schedule. For the project sources that operate on a 24-hour-per-day, 7-day-per-week schedule, the worker adjustment factor is 1.

7.1 Sensitive Receptors

Air quality does not affect every individual in the population in the same way, and some groups are more sensitive to adverse health effects than others. The term “sensitive individuals” or “sensitive receptors” refers to those segments of the population most susceptible to poor air quality: children, the elderly, and individuals with pre-existing, serious health problems affected by air quality (CARB 2005). Examples of sensitive receptor locations are residences, schools and school yards, parks and playgrounds, daycare centers, nursing homes, and medical facilities. Residences can include houses, apartments, and senior living complexes. Medical facilities can include hospitals, convalescent homes, and health clinics. Playgrounds include play areas associated with parks and community centers.

The Proposed Project would impact sensitive receptors near three general work areas: the Outer Harbor near Berth 26 and Berth 10; Howard Terminal at the northern portion of the IHTB; and Alameda near the southern portion of the IHTB. Staging areas are near these primary work areas, and would impact sensitive receptors similar to those in the primary work areas, although there would not be significant amounts of emissions at the staging areas because these are primarily for placing equipment and supplies when not in use in the primary work areas and would only have occasional equipment use when loading or unloading supplies. Trucks would travel along roads and pass by sensitive receptors situated along these truck routes. The Outer Harbor construction areas are surrounded by various Seaport operations, the East Bay Municipal Utility District (EBMUD) wastewater treatment plant, Interstate 80 (I-80), Interstate 880 (I-880), and rail yards. The nearest residences are those in West Oakland on the opposite side of I-880, including housing along Frontage Road and Wood Street, with the nearest residences about 0.5 mile from Berth 10. The Prescott School and Ralph J Bunche Academy in West Oakland are about 1 mile from the Outer Harbor construction activities. Raimondi Park is about 0.75 mile from Berth 10. The IHTB work on the Oakland side would occur at Howard Terminal and near the shoreline of Schnitzer/Radius Recycling. Currently, there are Seaport-related activities, industrial operations, a PG&E electrical substation, and office and commercial buildings near these work areas. The closest residences are the Phoenix Lofts on 2nd Street near Brush Street, which are approximately 1,000 feet from the proposed construction and staging at Howard Terminal. The proposed Oakland Waterfront Ballpark District at Howard Terminal has residences planned immediately adjacent to the Proposed Project. Hively, a center for social services for children and families, is along Myrtle Street about 1,000 feet from the Proposed Project Howard Terminal site, and is a family resource center. Oakland Achieves is a high school about 1,000 feet from the Proposed Project Howard Terminal site. The

Alameda side of the IHTB is surrounded by a shipyard (Bay Ship and Yacht) to the west, and warehouses on and adjacent to the work area. Estuary Park is across the street from the Alameda Site. The nearest school is Ruby Bridges Elementary school, approximately 0.5 mile south. The closest existing residences are along Mosley and Mitchell Avenues. Planned residences for Bay 37 would be adjacent to the Proposed Project work areas, as well as the planned North Housing off Mosley Avenue.

8 Toxicity Assessment

A risk (or toxicity) assessment characterizes the relationship between the magnitude of exposure and the nature and magnitude of adverse health effects that may result from such exposure. For purposes of calculating exposure criteria to be used in risk assessments, adverse health effects are classified into two broad categories: cancer and non-cancer endpoints. Toxicity values, used to estimate the likelihood of adverse effects occurring in humans at different exposure levels, are identified as part of the toxicity assessment component of a risk assessment.

In this HRA, diesel exhaust and speciated gasoline total organic gases are the only chemicals of potential concern that are quantified. Under California identification of air toxics by OEHHA, DPM is used as a surrogate measure of carcinogen exposure for the mixture of chemicals that make up diesel exhaust. For gasoline and gasoline exhaust, the individual chemicals making up the primary components are used to estimate health effects based on common speciation profiles (CARB 2022).

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 potential carcinogens. The upper-bound incremental probability means that the “true carcinogenic risk” of an individual is unlikely to exceed the model-derived cancer risk estimates and, therefore, is likely to be less than the predicted (modeled) risk. Therefore, the modeled cancer risks would represent a conservative scenario. For this HRA, the estimated excess lifetime cancer risk for a resident is adjusted using the age sensitivity factors (ASFs) or exposure factors recommended by OEHHA (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 2 years of age, and by a factor of 3 for exposures that occur from 2 years through 15 years of age. No weighting factor (i.e., an ASF of 1, which is equivalent to no adjustment) is applied to exposure from ages 16 to 70 years. These ASFs are shown in **Table 9**.

The estimated risk is expressed as a unitless probability. The cancer risk attributed to a chemical is calculated by multiplying the chemical intake or dose at the human exchange boundaries (e.g., lungs if the chemical is being inhaled) by the chemical-specific cancer potency factor (CPF).

The equation used to calculate the potential excess lifetime cancer risk for the inhalation pathway is as follows:

$$Risk_i = Dose * CPF_i * ASF$$

Where:

$Risk_i$	=	Cancer risk, the incremental probability of an individual developing cancer as a result of inhalation exposure to a particular potential carcinogen (unitless)
Dose	=	Dose of chemical (mg/kg-day)
CPF_i	=	Cancer potency factor for chemical “i” (mg chemical/kg body weight-day)$^{-1}$
ASF	=	Age sensitivity factor (unitless)

The CPFs for potential carcinogens that are anticipated to be present at the Proposed Project sites are shown in **Table 10**.

Table 10: Toxicity Factors

Chemical	Cancer Potency Factor	Chronic REL	Acute REL
1,3-Butadiene	0.6	2	660
Acetaldehyde	0.01	140	470
Benzene	0.1	3	27
Diesel Particulate Matter (DPM)	1.1	5	N/A
Ethylbenzene	0.0087	2,000	N/A
Formaldehyde	0.021	9	55
Hexane	N/A	7,000	N/A
Methanol	N/A	4,000	28,000
Methyl Ethyl Ketone	N/A	-	13,000
Naphthalene	0.12	9	N/A
Propylene	N/A	3,000	N/A
Styrene	N/A	900	21,000
Toluene	N/A	420	5,000
Xylenes	N/A	700	22,000

Notes:

N/A= no toxicity factors recommended by OEHHA.
REL = reference exposure level

Source: CalEPA 2022

The potential for chemical exposure to result in chronic (long-term) non-cancer effects is evaluated by comparing the estimated annual average air concentration to the chemical-specific non-cancer chronic RELs. When calculated for a single chemical, the comparison yields a ratio termed a hazard quotient (HQ). To evaluate the potential for adverse chronic non-cancer health effects from simultaneous exposure to multiple chemicals, the HQs for all chemicals are summed, yielding a hazard index.

The equations used to calculate the chemical-specific HQs and the overall HI are as follows:

$$Chronic\ HQ_i = C_i/REL_i$$

$$Chronic\ HI = \sum HQ_i$$

Where:

Chronic HQ_i	=	Chronic hazard quotient for chemical "i" (unitless)
Chronic HI	=	Hazard index (unitless)
C_i	=	Annual average air concentration for chemical "i" (µg/m^3)
REL_i	=	Chronic non-cancer reference exposure level for chemical "i" (µg/m^3)

In summing values for a hazard index, the organ end point (e.g., respiratory system, nervous system) is considered and only those chemicals that have the same target organ end point are summed together.

Acute (short-term) non-cancer impacts were estimated in a similar manner to chronic non-cancer impacts, by estimating the HQs for all chemicals and summing them to yield a hazard index but using a 1-hour maximum concentration and an acute REL. **Table 10** contains the CPF and chronic and acute RELs used in this HRA.

9 Risk Characterization and HRA Results for the Proposed Project Alternatives

9.1 Cancer Risk

The excess cancer risk is estimated for both worker and residential exposure scenarios. Because Proposed Project construction sites are on the Oakland side (Howard Terminal) north of the IHTB, on the Alameda side (Alameda Site) south of the IHTB, and at the OHTB, the maximum residential cancer risk for both residential and worker key receptors were identified for the these three areas and include a location for both existing residences and planned residences, as well as locations where there may be workers but are not workers necessarily associated with the Proposed Project. In addition, the location for maximum residential exposure was identified; however, this location is at Howard Terminal in the proposed area planned for excavation. Therefore, no existing or future residence would coincide with this maximum exposed location. The maximum cancer risks are shown in **Table 11** and **Table** 12 for construction Alternative B unmitigated and mitigated respectively. The maximum cancer risks are shown in **Table 13** and **Table 14** for construction Alternative C unmitigated and mitigated respectively. The maximum cancer risks are shown in **Table 15** for construction—Alternative D-1, and **Table 16** for construction—Alternative D-2 mitigated. **Figure 9** and **Figure 10** show the change in excess lifetime cancer risk across the modeling domain if all receptors in the modeling domain were assumed to be residents for Alternative D-1 and D-2, respectively. **Figure 11** through **Figure 14**show the change in excess lifetime cancer risk across the modeling domain if all receptors in the modeling domain were assumed to be residents for Alternatives B and C for both unmitigated and mitigated scenarios. Both figures show that excess lifetime cancer risk rapidly decreases as receptors are located farther from the Proposed Project construction activity. The majority of the modeling domain has excess lifetime cancer risk substantially below 10 in a million, which is the BAAQMD CEQA significance threshold for excess lifetime cancer risks.

Table 11: Cancer Risk--Construction Inner Harbor Only Alternative B

Receptor	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Excess Lifetime Cancer Risk (in a million)
Maximum Exposed Existing Resident in Alameda at Mosley Avenue and Monterey Circle	562830	4182645	72.14
Maximum Exposed Existing Resident near Howard Terminal at Phoenix Lofts	563114	4183647	37.09
Maximum Exposed Planned Resident at Bay 37	563142	4182944	96.22
Maximum Exposed Worker	562940	4182920	31.18
Maximum Exposed Location	562834	4183367	853.53

Table 12: Cancer Risk--Construction Inner Harbor Only Alternative B Mitigated

Receptor	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Excess Lifetime Cancer Risk (in a million)
Maximum Exposed Existing Resident in Alameda at Mosley Avenue and Monterey Circle	562870	4182645	11.69
Maximum Exposed Existing Resident near Howard Terminal at Phoenix Lofts	563114	4183647	8.31
Maximum Exposed Planned Resident at Bay 37	563142	4182944	20.81
Maximum Exposed Worker	562940	4182920	10.46
Maximum Exposed Location	562834	4183367	278.52

Table 13: Cancer Risk--Construction Outer Harbor Only Alternative C

Receptor	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Excess Lifetime Cancer Risk (in a million)
Maximum Exposed Existing Resident near 9th Street and Pine Street	561500	4185000	6.77
Maximum Exposed Existing Resident in Alameda at Mosley Avenue and Monterey Circle	562770	4182645	2.08
Maximum Exposed Planned Resident at Bay 37	563142	4182944	1.83
Maximum Exposed Worker	560000	4185250	1.39
Maximum Exposed Location	560000	4185250	46.54

Table 14: Cancer Risk--Construction Outer Harbor Only Alternative C Mitigated

Receptor	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Excess Lifetime Cancer Risk (in a million)
Maximum Exposed Existing Resident near 9th Street and Pine Street	561500	4185000	1.44
Maximum Exposed Existing Resident in Alameda at Mosley Avenue and Monterey Circle	562810	4182665	0.22
Maximum Exposed Planned Resident at Bay 37	563142	4182944	0.19
Maximum Exposed Worker	560000	4185250	0.15
Maximum Exposed Location	559250	4185500	4.98

Table 15: Cancer Risk – Construction—Alternative D-1 Unmitigated

Receptor	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Excess Lifetime Cancer Risk (in a million)
Maximum Exposed Existing Resident in Alameda at Mosley Avenue and Monterey Circle	562810	4182665	74.15
Maximum Exposed Existing Resident near Howard Terminal at Phoenix Lofts	563114	4183647	39.37
Maximum Exposed Planned Resident at Bay 37	563142	4182944	97.99
Maximum Exposed Worker	562940	4182920	31.21
Maximum Exposed Location	562834	4183367	855.53

Notes:

[1] Maximum exposed location for cancer risk assumes residential exposure assumptions.

HI = Health Index
HRA = Health Risk Assessment
$\mu g/m^3$ = micrograms per cubic meter
NA = not applicable
$PM_{2.5}$ = particulate matter 2.5 microns in diameter or less
UTM = Universal Transverse Mercator Coordinate System NAD83 Zone 10

Table 16: Cancer Risk – Construction—Alterantive D-2 Mitigated

Receptor	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Excess Lifetime Cancer Risk (in a million)
Maximum Exposed Existing Resident in Alameda at Mosley Avenue and Monterey Circle	562810	4182665	11.86
Maximum Exposed Existing Resident near Howard Terminal at Phoenix Lofts	563114	4183647	8.51
Maximum Exposed Planned Resident at Bay 37	563142	4182944	20.96
Maximum Exposed Worker	562940	4182920	14.12
Maximum Exposed Location	562834	4183367	278.85

Notes:

HI = Health Index
HRA = Health Risk Assessment
μg/m^3 = micrograms per cubic meter
NA = not applicable
$PM_{2.5}$ = particulate matter 2.5 microns in diameter or less
UTM = Universal Transverse Mercator Coordinate System NAD83 Zone 10

9.2 Non-Cancer Chronic Hazard Index

The chronic HI is used to estimate the long-term non-cancer health impacts. **Table 17** show the chronic HI for the all Alternatives. **Figure 15** shows the location of the maximum chronic HI for both the unmitigated and mitigated Proposed Project. Chronic HI below 1 is considered to indicate that exposure would not result in any adverse health effects, while those above 1 indicate that receptors may experience health effects. For chronic non-cancer health impacts, the order of magnitude above 1 does not correspond linearly to an increased magnitude of non-cancer health effects (i.e., a chronic HI of 2 does not indicate twice the likelihood of non-cancer health effects compared to a chronic HI of 1), unlike cancer risks where a cancer risk of 2 in a million is twice as likely to occur compared to a risk of 1 in a million.

Table 17: Chronic Health Index – Construction—All Alterantives

Alternative	Receptor Type	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Chronic HI
Alternative B	Maximum Chronic HI (Alameda Warehouse)	562880	4182900	2.32
Alternative B Mitigated	Maximum Chronic HI (Alameda Warehouse)	562880	4182900	0.39
Alternative C	Maximum Chronic HI (Port near Outer Harbor)	560000	4185250	0.11
Alternative C Mitigated	Maximum Chronic HI (Port near Outer Harbor)	560000	4185250	0.012
Alternative D-1	Maximum Chronic HI (Alameda Warehouse)	562920	4182900	2.32
Alternative D-2	Maximum Chronic HI (Alameda Warehouse)	562880	4182900	0.39

Notes:

HI = hazard index
UTM = Universal Transverse Mercator Coordinate System NAD83 Zone 10

9.3 Non-Cancer Acute Hazard Index

Acute HI is used to estimate the short-term non-cancer health impacts. In most cases, these health effects are temporary and resolve once people are no longer exposed to the TACs. **Table 18** shows the acute HI for the Proposed Project. **Figure 16** shows the location of the maximum acute HI for both the unmitigated and mitigated Proposed Project. Similar to the chronic HI, acute HI below 1 is considered to indicate that exposure would not result in any adverse health effects, while those above 1 indicate that receptors may experience health effects. For acute non-cancer health effects, the order of magnitude above 1 does not correspond linearly to an increased magnitude of non-cancer health effects (i.e., an acute HI of 2 does not indicate twice the likelihood of non-cancer health effects compared to an acute HI of 1), unlike cancer risks where a cancer risk of 2 in a million is twice as likely to occur compared to a risk of 1 in a million.

Table 18: Acute Health Index—Construction—All Alternatives

Receptor Type	NAD 83 Zone 10 UTM X Coordinate (meter)	NAD 83 Zone 10 UTM Y Coordinate (meter)	Acute Hazard Index
Alternative B Maximum Acute HI	562920	4182900	0.2
Alternative B Mitigated Maximum Acute HI	562920	4182900	0.05
Alternative C Maximum Acute HI	560050	4185500	0.005
Alternative C Mitigated Maximum Acute HI	560050	4185500	0.0007
Alternative D-1 Maximum Acute HI (Alameda Warehouse)	562940	4182900	0.29
Alternative D-2 Acute HI (Alameda Warehouse)	562940	4182900	0.05

Notes:

HI = hazard index
UTM = Universal Transverse Mercator Coordinate System NAD83 Zone 10

10 Cumulative Health Risk Assessment Methodology and Results

10.1 Past Conditions

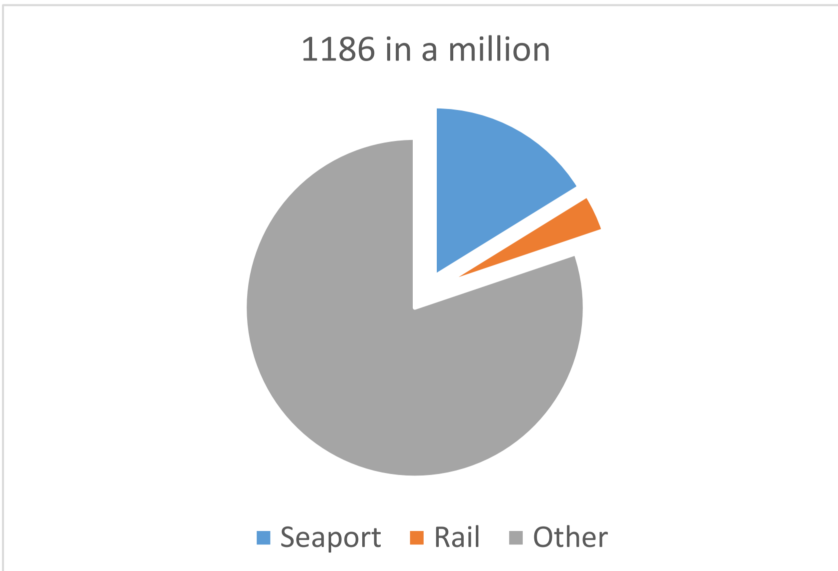
10.1.1 2008 HRA

Studies have been conducted previously near the Seaport to quantify the health effects of air pollution from various sources in and around the West Oakland community (CARB 2008, BAAQMD 2019). In 2008, CARB, BAAQMD, the Port, and Union Pacific Railroad published an extensive HRA for the West Oakland community characterizing the public health impacts from DPM emissions in the base year of 2005. The emission sources considered and quantified in that study included both land- and water-based sources, including activity associated with the Seaport, non-Port locomotives, non-Port marine vessels (such as bulk vessels that call Schnitzer/Radius Recycling, passenger ferries, and tugboats), non-Port trucks, and other significant sources of DPM in and around the West Oakland community. The study area included the Seaport, the ocean west of the Golden Gate Bridge 17 nautical miles out to the outer buoys in the precautionary zone, the inner Bay waterway between the Golden Gate Bridge and the Seaport, and the nearby communities; in all, the study covered a 100-kilometer (km) by 100 km area (about 2,800 square miles). Results were only reported in the West Oakland area and did not include Alameda, downtown Oakland, or Emeryville.

This 2008 HRA was comprehensive in capturing the vessels operating in the Seaport and throughout the entire San Francisco Bay. Sources in West Oakland that were specifically modeled include truck emissions, including those operating on major Interstates 80, 880, 980, and 580, as well as the major and minor arterials bounded by these expressways. Truck-based business activity and facilities with diesel-powered cargo handling equipment were included. Locomotive-related emissions included locomotives that traveled from the boundaries of the Joint Intermodal Terminal (operated by Burlington Northern and Santa Fe) and Union Pacific Railroad rail yards to the edge of the West Oakland community, as well as Amtrak trains traveling through the West Oakland community. Major construction projects that occurred in 2005 (base year for emissions) in the West Oakland area were included in the emissions inventory. Finally, stationary point sources in West Oakland were also included.

The 2008 HRA did not identify the maximum exposed residential receptor but indicated that some areas had excess cancer risk from all DPM sources over 1,500 in one million (or 15 in 10,000). The population-weighted cancer risk from all sources was 1,186 in one million (or 11.86 in 10,000) excess cancer risks. **Figure 1** shows the contribution of Seaport and non-Seaport sources to this population-weighted cancer risk. Port-related sources contributed about 16 percent of the population-weighted cancer risk. **Figure 2** shows the contribution of sources to this population-weighted cancer risk by source category.

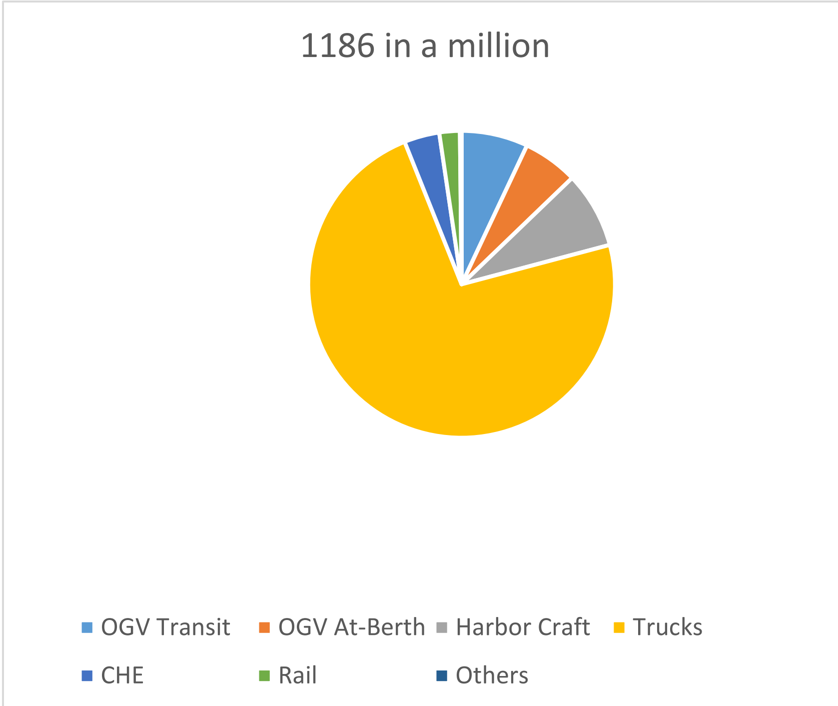
Figure 1: Population-Weighted Excess Cancer Risk from 2008 HRA from Port, Rail, and Other Sources



Note: Rail is the Union Pacific Railroad.

Other Sources includes Non-port and Non-Union Pacific railyard areas in and adjacent to West Oakland that include: on-road trucks on nearby freeways, ocean-going vessels (OGVs), harbor craft, cargo-handling equipment, locomotives, passenger rail, Amtrak maintenance facility, major construction projects, stationary point sources, truck-based businesses and distribution centers. 2005 Base Year.

Figure 2: Population-Weighted Excess Cancer Risk from 2008 HRA from All Sources



Note: All sources include sources in or near the West Oakland community (non-Port and non-rail), Port, and Rail. Trucks include both Port and non-Port trucks. CHE includes both Port and rail CHE. 2005 Base Year.

The 2008 HRA included estimates of emissions in the future assuming growth and implementation of many of the CARB strategies that were implemented to reach the goals outlined in CARB's *Diesel Risk Reduction Plan* (CARB 2000) and CARB's *Emission Reduction Plan for Ports and Goods Movement in California* (CARB 2006); these strategies yielded an 85 percent reduction in DPM by 2020. **Figure 3** shows the emissions used in the 2008 analysis for the projected 2020 year and the Seaport's actual 2020 emissions. The 2020 Seaport Emission Inventory was about 40 percent lower than this "future 2020" projection. **Figure 4** shows the anticipated change in excess cancer risk in 2020 based on these "future 2020" projections. Other sources includes non-port and non-Union Pacific railyard areas in and adjacent to West Oakland that include: on-road trucks on nearby freeways, OGVs, harbor craft, cargo-handling equipment, locomotives, passenger rail, Amtrak maintenance facility, major construction projects, stationary point sources, truck-based businesses, and distribution centers. These reductions are a result of implementation of air quality regulations requiring the use of diesel particulate filters; other diesel emission reductions, such as using shore power at berth, have decreased DPM emissions of cargo-handling equipment, trucks, locomotives, and OGVs.

Figure 3: Projected and Actual Seaport DPM Emissions Projected from 2008 HRA

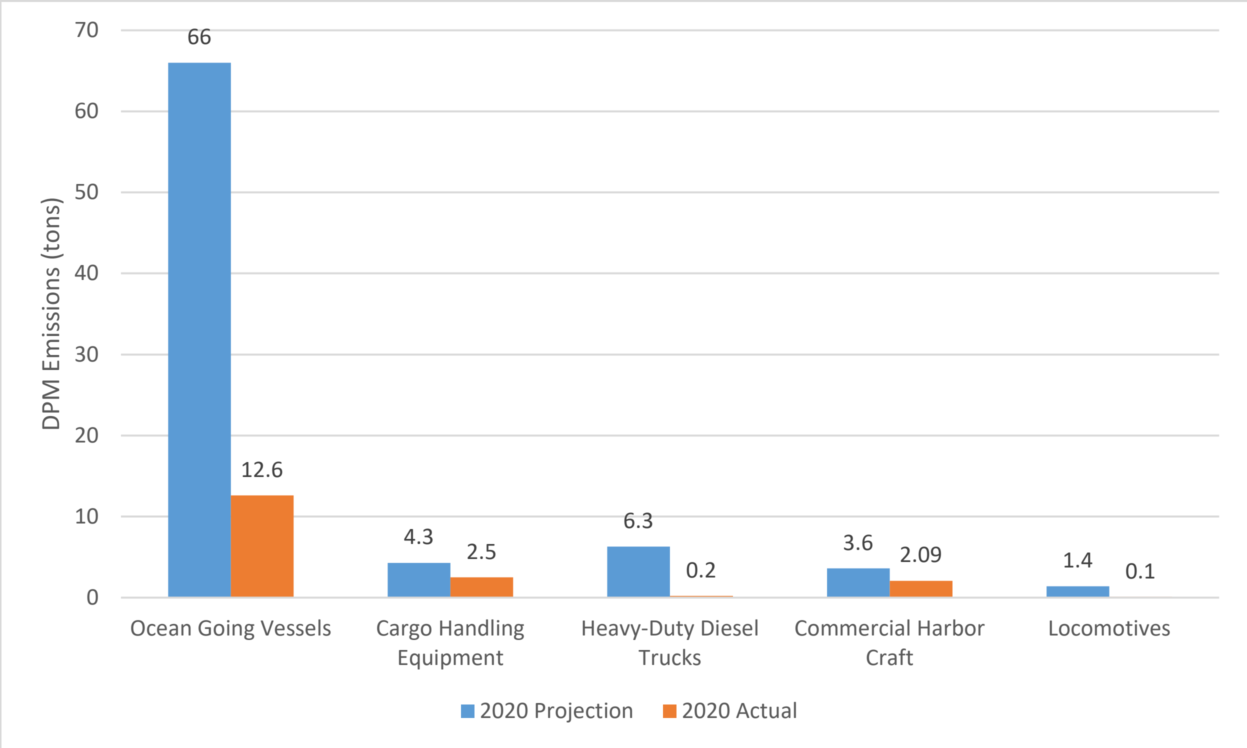
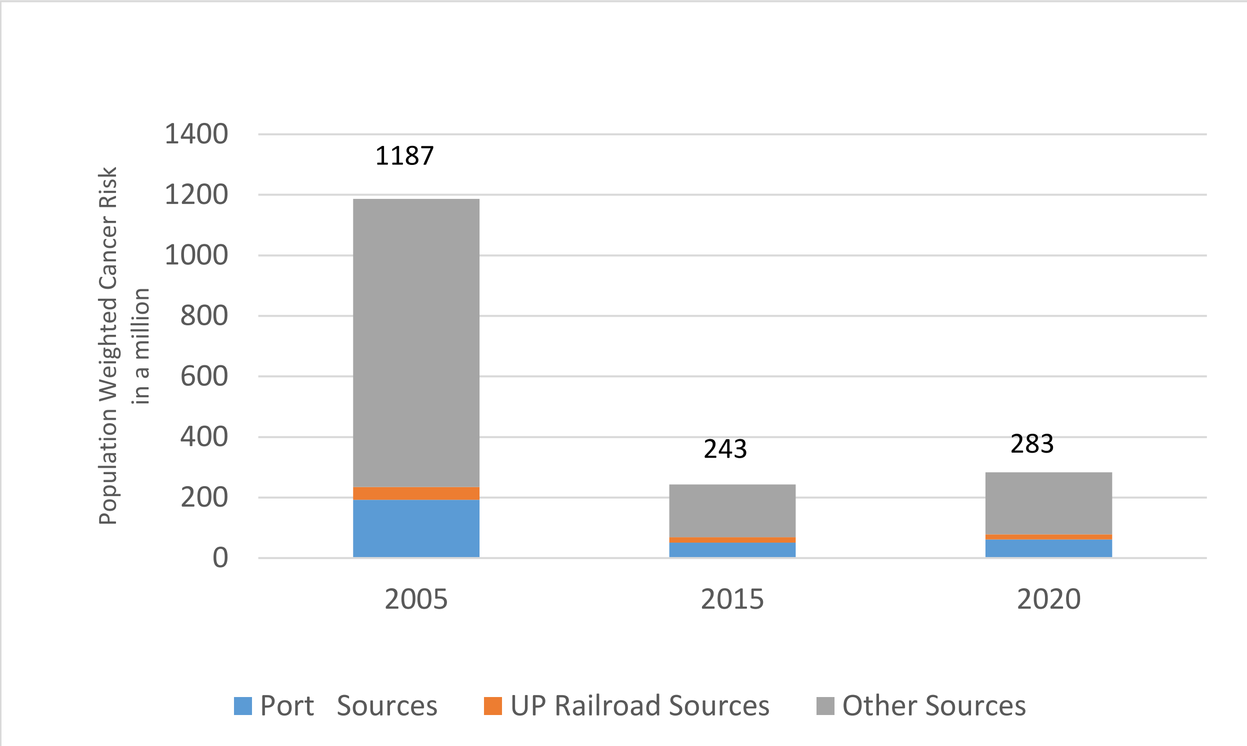


Figure 4: 2005, 2015 and 2020 Population Weighted Cancer Risk in West Oakland from 2008 HRA



10.2 Existing Conditions

10.2.1 2019 HRA

BAAQMD conducted an HRA for the West Oakland community during development of the WOCAP. The study estimated emission inventories for three scenarios: a “current base year” 2017, near-term future year 2024, and far-term future year 2029. The future year inventories included anticipated reductions attributable to existing regulations and known changes in source activity. In addition, future year inventories assumed implementation of additional mitigation measures identified in the WOCAP in areas where high levels of air pollution may persist, and further actions may be warranted. The WOCAP study focused on emissions of DPM and other TACs with cancer toxicities and on $PM_{2.5}$ concentrations.

Although a direct comparison between the CARB 2008 HRA and the BAAQMD WOCAP HRA is not possible due to the vastly different methodologies used for emission estimates, air dispersion, and cancer risk exposure factors (use of age-specific factors and revised breathing rates) and assessments, it is still useful to see the values of the BAAQMD WOCAP HRA in comparison to the values reported in the CARB study to illustrate the progress in reducing emissions and health impacts to the West Oakland Community.

Table 19 and **Table 20** show the results of BAAQMD’s WOCAP HRA for the 2017 and 2024 scenarios, including the West Oakland source contribution and the ”other” “background” source contributions.[4] The background cancer risk was only provided on an area-weighted basis, which is averaging risk over the modeled domain (or area) rather than weighting the risk by population (or where people live). Therefore, the areas identified as having the highest concentrations of TACs (including DPM) are not necessarily in highly populated residential areas. For example, the 2017 base year HRA for West Oakland has an area-weighted risk of 302.5 in one million (or 3.025 in 10,000); and when weighted for population, has a cancer risk of 199.3 in one million (or 1.993 in 10,000). The background cancer risk was reported as 421 in one million (or 4.2 in 10,000) on an area-wide basis. The 2024 near-term results include an area-weighted risk of 235 in one million (or 2.35 in 10,000), and show a population-weighted cancer risk of 119.9 in one million (or 1.199 in 10,000). Port-related sources are 67.5 in one million (or 6.75 in 10,000) on a population-weighted basis in 2017, and 64.9 in one million (or 6.49 in 100,000) on a population-weighted basis in 2024. **Figure 5** shows the population-weighted cancer risk for the West Oakland sources, excluding background for 2017 and 2024. The recent WOCAP HRA by BAAQMD demonstrates that there have been substantial reductions in cancer risk attributed to the Seaport and other sources in West Oakland compared to the 2005 baseline HRA conducted by CARB.

[4] This includes various stationary sources, area sources, on-road vehicles, offroad equipment, ship and tugs not associated with the Port of Oakland or West Oakland as well as biogenic emissions based on information from BAAQMD’s emission inventories, CARB emissions inventories, and EPA Biogenic Emission Inventory System.

Table 19: WOCAP 2019 HRA Results for 2017 Scenario

Location of Sources	Average Annual $PM_{2.5}$ Concentration (µg/m³)	Average Annual DPM Concentration (µg/m³)	Area Weighted Average Excess Cancer Risk	Population Weighted Average Excess Cancer Risk
West Oakland	1.71	0.39	303 in one million	199 in one million
"Other" Background	6.9	0.46	421 in one million	NA
Total	**8.61**	**0.85**	**724 in one million**	**NA**

Notes:

[1] The population-weighted cancer risk is 199 in a million for West Oakland. Population-weighted cancer risk from other "background" sources was not included.

[2] Cells marked NA means that this information was not provided in BAAQMD's reports or data that have been made public.

[3] "Other" Background sources include various stationary sources, area sources, on-road vehicles, offroad equipment, ships, and tugs not associated with the Port of Oakland or West Oakland

DPM = diesel particulate matter
HRA = Health Risk Assessment
µg/m³ = micrograms per cubic meter
NA = not available; not addressed in WOCAP 2019 HRA
$PM_{2.5}$ = particulate matter 2.5 microns in diameter or less
WOCAP = West Oakland Community Action Plan

Source: BAAQMD 2019. Final Environmental Impact Report Owning our Air: The West Oakland Community Action Plan, Appendix C

Table 20: WOCAP 2019 HRA Results for 2024 Scenario

Location of Sources	Average Annual $PM_{2.5}$ Concentration (µg/m^3)	Average Annual DPM Concentration (µg/m^3)	Area Weighted Average Excess Cancer Risk	Population Weighted Average Excess Cancer Risk
West Oakland	1.71	0.30	235 in one million	119.9 in one million
“Other” Background	NA	NA	NA	NA
Total	**NA**	**NA**	**NA**	**NA**

Notes:

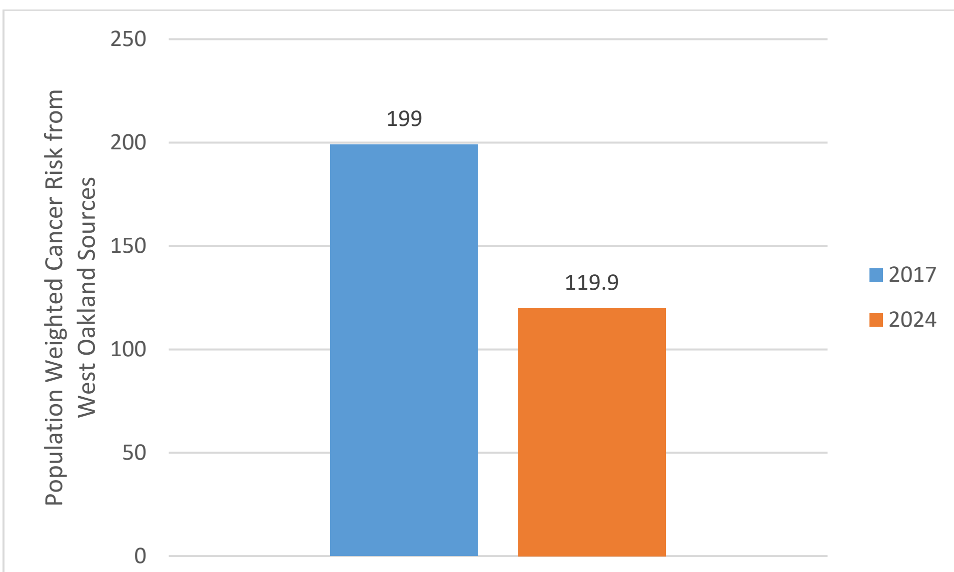
[1] The population-weighted cancer risk is 199 in a million for West Oakland. Population=-weighted cancer risk from other “background” sources was not included.

[2] Cells marked NA means that this information was not provided in BAAQMD’s reports or data that have been made public.

DPM = diesel particulate matter
HRA = Health Risk Assessment
µg/m^3 = micrograms per cubic meter
NA = not available; not addressed in WOCAP 2019 HRA
$PM_{2.5}$ = particulate matter 2.5 microns in diameter or less
WOCAP = West Oakland Community Action Plan

Source: BAAQMD 2019. Final Environmental Impact Report Owning our Air: The West Oakland Community Action Plan, Appendix C

Figure 5:Population Weighted Cancer Risk from West Oakland Sources, WOCAP 2019 HRA



10.3 Future Conditions

Several future projects have the potential to affect the health of residents in the vicinity of the Proposed Project. Some of these projects have included HRAs in their CEQA documentation such as the proposed Oakland Waterfront Ballpark District at Howard Terminal, Eagle Rock Aggregates Project, and the Alameda Point Project, while others have not. To give a sense of the order of magnitude of the cumulative risk associated with past, present, and future conditions, those numbers that are readily available are presented here; this section includes a qualitative discussion of how those estimates would potentially combine with information from the WOCAP HRA and the Proposed Project to characterize potential future health impacts.

Two key future projects at the Port of Oakland are the proposed Oakland Waterfront Ballpark District at Howard Terminal and the Eagle Rock Aggregates Oakland Terminal Project. In addition, the Port has been awarded grants to begin infrastructure improvements aimed at electrification of the Seaport and related equipment. On the Alameda side, key projects with HRA information include the Alameda Point Project and other existing large sources in Alameda, including Bay Ship and Yacht, which leases land and waterfront space to various ship and water support services; and Northern California Power Agency, which operates two natural gas combustion turbines rated at 25 MW each. All of these projects completed CEQA analyses that included HRAs or were included in BAAQMD's stationary source screening map,[5] which is an estimate by BAAQMD of the potential health impacts from these facilities. Sources in BAAQMD's stationary source screening map for West Oakland were already included in the WOCAP and are not specifically called out in this cumulative analysis. Although details for individual receptors are not available for comparison to the Proposed Project's maximum reported receptors, the values from these HRAs can give context to the overall change in cumulative risk. The proposed Oakland Waterfront Ballpark District at Howard Terminal reported a net mitigated excess lifetime cancer risk of 6.5 in a million at the existing off-site maximum exposed resident. This cancer risk would be additive to those receptors identified for the Proposed Project near Howard Terminal. The Eagle Rock Aggregates Oakland Terminal Project reported a mitigated excess lifetime cancer risk of 7.2 in a million at the maximum exposed resident. This cancer risk would be additive to those receptors identified for the Proposed Project nearest to the Outer Harbor Turning Basin construction. Alameda Point reported a mitigated excess lifetime cancer risk of 4 in a million at the maximum exposed resident. This cancer risk would be additive to those receptors identified in the Proposed Project nearest to Alameda construction. BAAQMD listed Bay Ship and Yacht and Northern California Power Agency as sources in Alameda, which were not included in WOCAP and reported excess lifetime cancer risk of 157 and 27.01 in a million obtained from BAAQMD's stationary source screening map,[6] respectively. These cancer risks would be additive to those receptors identified in the Proposed Project nearest to Alameda construction.

10.4 Total Cumulative Health Risk Assessment Results

It is difficult to properly indicate and combine the results of different HRAs due to differences in methodology and not having the underlying details to properly combine values for specific individual receptors. Although the WOCAP HRA primarily covers the sources in West Oakland and impacts on West

5 BAAQMD's Stationary Source Screening map can be found at: https://baaqmd.maps.arcgis.com/apps/webappviewer/index.html?id=845658c19eae4594b9f4b805fb9d89a3.

6 https://baaqmd.maps.arcgis.com/apps/webappviewer/index.html?id=845658c19eae4594b9f4b805fb9d89a3

Oakland, many of these sources would also impact Alameda residences, although to a lesser extent. There are some additional Alameda sources not included in the WOCAP that would further add to the existing cumulative health impacts in West Oakland and Alameda. Some of these sources that would add to the risk outlined in the WOCAP HRA include the vessels for Bay Ship and Yacht, industrial stationary sources in Alameda, and construction activities associated with residential projects near the Inner Harbor. **Table 21** shows the potential health impacts on a cumulative basis when considering the values reported in the WOCAP HRA, sources not included in the WOCAP HRA, and available planned projects in the nearby communities since the development of WOCAP and the Proposed Project. This summary table gives a general sense of the order of magnitude of the cumulative health impacts. It is an overestimation of risk because in most cases only the maximum reported cancer risk can be combined, and not the risk at individual and specific locations. For instance, the Proposed Project cancer risk is in Howard Terminal, and the maximum cancer risk from Eagle Rock Aggregates was closer to the OHTB. If the actual risk at each of these separate locations is added, a smaller number than 71 in a million would result. On the converse side, adding the Proposed Project cancer risk to the proposed Oakland Waterfront Ballpark at Howard Terminal would be less of an overestimate. Because these projects are occurring in similar locations, the location of the maximum cancer risk near Howard Terminal, such as the Phoenix Lofts, would be additive. Therefore, the 15 in a million (6.5 from the proposed Oakland Waterfront Ballpark plus 8.29 for the Proposed Project at Phoenix Lofts) may be close to the actual cancer risk for these two combined projects.

Table 21: Cumulative Health Impacts

Project	Excess Lifetime Cancer Risk (in one million)	$PM_{2.5}$ Concentration ($\mu g/m^3$)
WOCAP HRA	724	8.61
Waterfront Ballpark at Howard Terminal	6.5	0.19
Eagle Rock Aggregates	7.2	1.1
Alameda Point Project	4	0.15
Bay Ship and Yacht	157	0.47
Northern California Power Agency	37.01	3.3
City of Alameda Stationary Sources	0.26	0.0
Alternative D2 Mitigated Proposed Project[1]	11.86	0.16
Total	947.83	13.98
Significance Threshold	100	0.8

Note

[1] This is the maximum residential location based on existing residential locations near Alameda..

$\mu g/m^3$ = micrograms per cubic meter

$PM_{2.5}$ = particulate matter with an aerodynamic diameter of 2.5 micrometers or less

WOCAP HRA = West Oakland Community Action Plan Health Risk Assessment

11 References

BAAQMD (Bay Area Air Quality Management District). 2012. Recommended Methods for Screening and Modeling Local Risks and Hazards. May. Available online at: https://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/baaqmd-modeling-approach.pdf. Accessed April 6, 2023.

BAAQMD. 2019. Owning Our Air: The West Oakland Community Action Plan. Available at: https://www.baaqmd.gov/community-health/community-health-protection-program/west-oakland-community-action-plan. Accessed June 28, 2023.

BAAQMD. 2023. California Environmental Quality Act Air Quality Guidelines. Available online at: https://www.baaqmd.gov/plans-and-climate/california-environmental-quality-act-ceqa/updated-ceqa-guidelines.

Cal/EPA (California Environmental Protection Agency). 2022. OEHHA/CARB Consolidated Table of Approved Risk Assessment Health Values. December. https://ww2.arb.ca.gov/resources/documents/consolidated-table-oehha-carb-approved-risk-assessment-health-values. Accessed April 6, 2023.

CAPCOA (California Air Pollution Control Officers Association). 2022. California Emission Estimator Model (CalEEMod) User’s Guide. Available online at: https://www.caleemod.com/user-guide. Accessed June 28, 2023.

CARB (California Air Resources Board). 2000. Diesel Risk Reduction Plan. Available online at: https://ww2.arb.ca.gov/resources/documents/guidance-documents. Accessed June 28, 2023.

CARB. 2006. Emission Reduction Plan for Ports and Goods Movement in California. Available online at: https://ww2.arb.ca.gov/sites/default/files/classic/ch/communities/ra/westoakland/documents/reduction.pdf.

CARB. 2008. Diesel Particulate Matter Health Risk Assessment for the West Oakland Community. Available online at: https://ww2.arb.ca.gov/resources/documents/west-oakland-study. Accessed July 6, 2023.

CARB. 2022. Speciation Profiles Used in CARB Modeling. Available online at: https://ww2.arb.ca.gov/speciation-profiles-used-carb-modeling.

(CARB) 2023. Hot Spots Analysis and Reporting Program https://ww2.arb.ca.gov/our-work/programs/hot-spots-analysis-reporting-program.

NAS (National Academy of Sciences). 1983. Risk Assessment in the Federal Government: Managing the Process. National Research Council, Committee on the Institutional Means for Assessment of Risks to Public Health, Washington, D.C. Available online at: https://nap.nationalacademies.org/catalog/366/risk-assessment-in-the-federal-government-managing-the-process.

NAS. 1994. Science and Judgment in Risk Assessment. Available online at: https://nap.national academies.org/catalog/2125/science-and-judgment-in-risk-assessment.

NOAA (National Oceanic and Atmospheric Administration). 2023. Global Hourly Data. Available online at: https://www.ncei.noaa.gov/data/global-hourly/.

OEHHA (Office of Environmental Health Hazard Assessment). 2015. Air Toxics Hot Spots Program Risk Assessment Guidelines, Guidance Manual for Preparation of Health Risk Assessments. Available online at: https://oehha.ca.gov/air/air-toxics-hot-spots.

SCAQMD (South Coast Air Quality Management District). 2008. Localized Significance Threshold Methodology. July. Available online at: http://www.aqmd.gov/home/regulations/ceqa/air-quality-analysis-handbook/localized-significance-thresholds. Accessed April 6, 2023.

USEPA (United States Environmental Protection Agency). 2022a. AERMOD Modeling System version 22112. Available online at: https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models.

USEPA. 2022b. Speciate. Available online at: https://www.epa.gov/air-emissions-modeling/speciate.

12 Tables and Figures

Figure 6: Meteorological Station Windroses 2017-2020

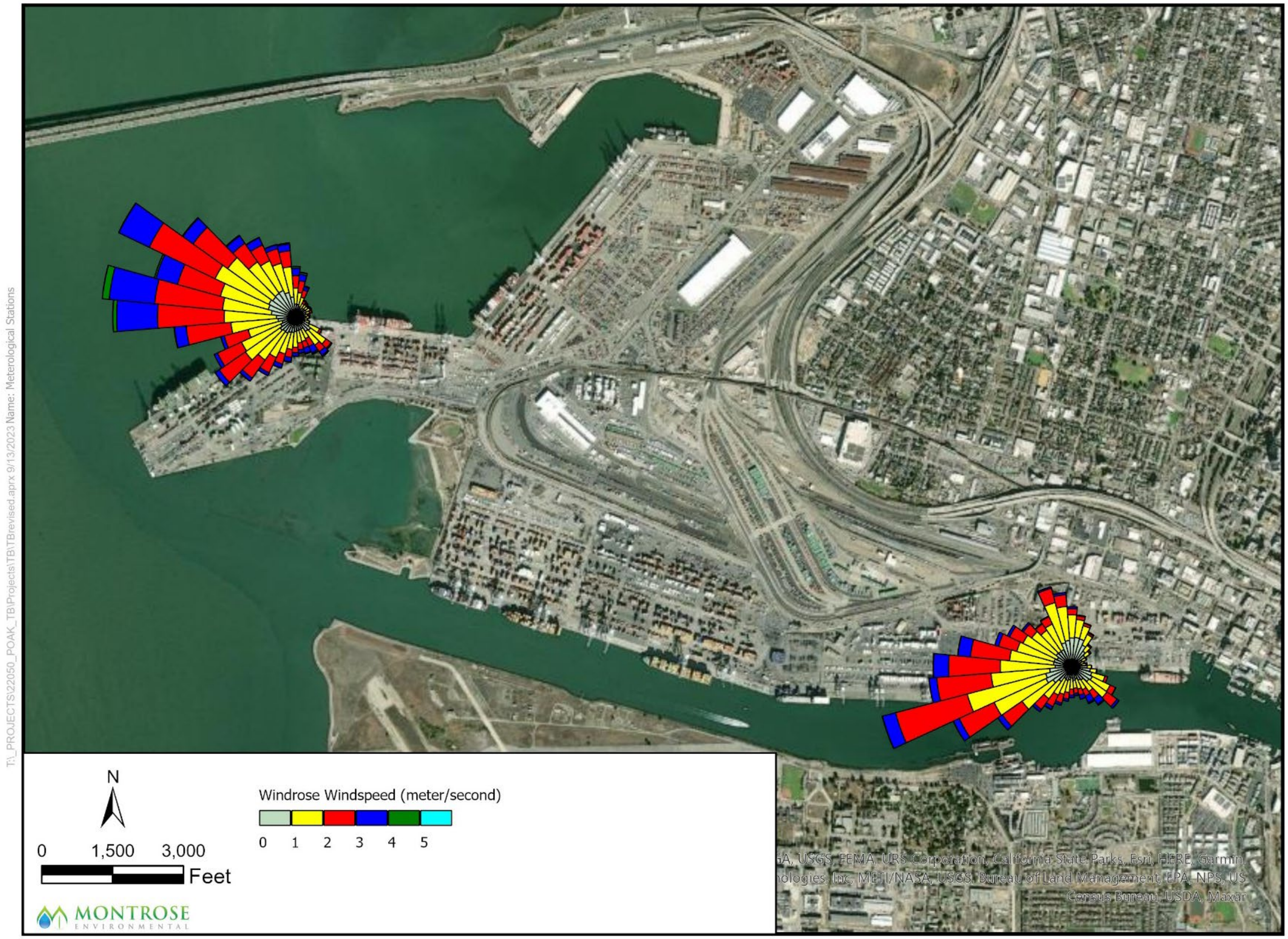


Figure 7: AERMOD Receptors

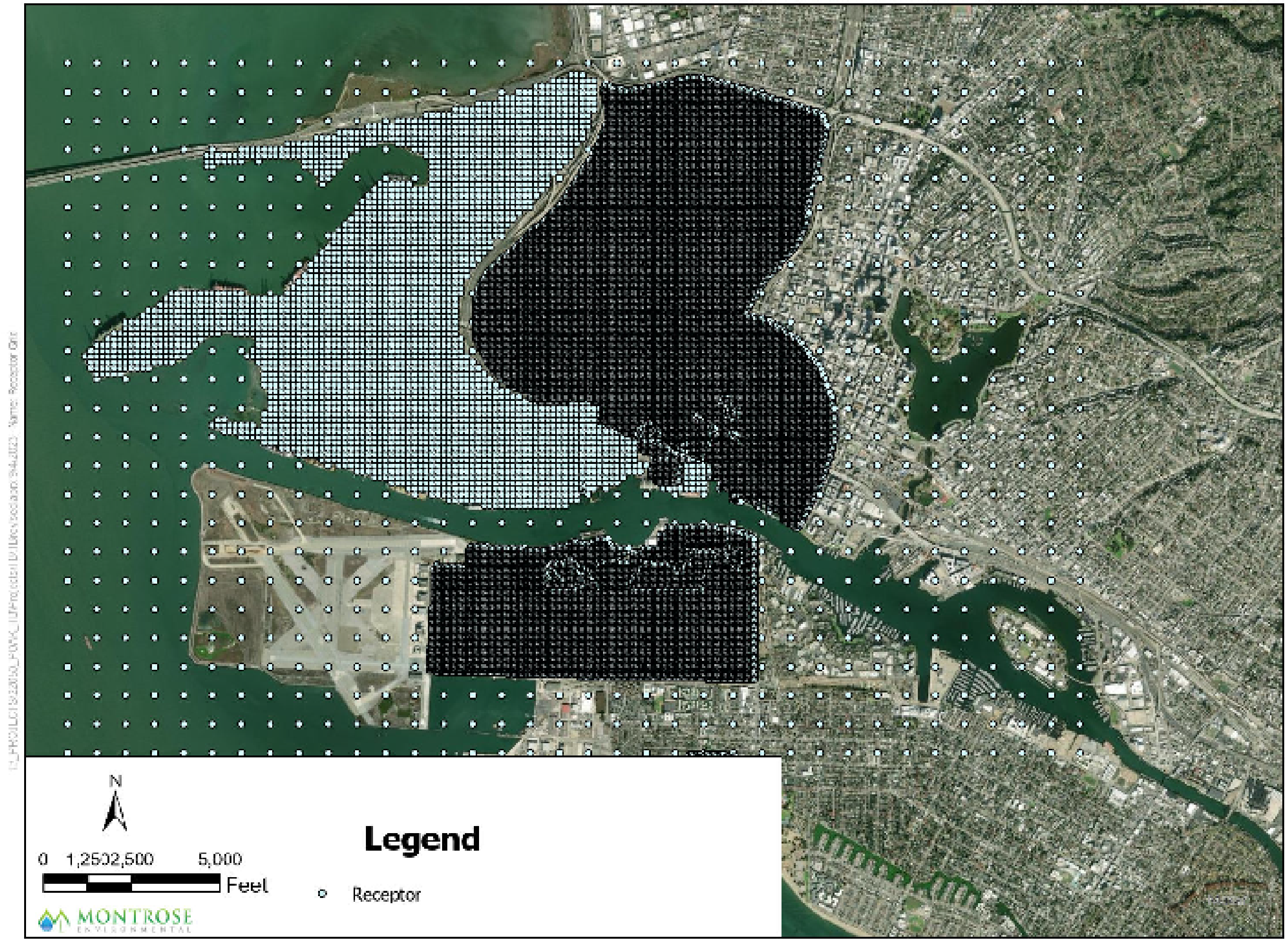


Figure 8: Construction Source Locations

Figure 9: Construction Cancer Risk—Alternative D1 (Residential Exposure Assumptions)

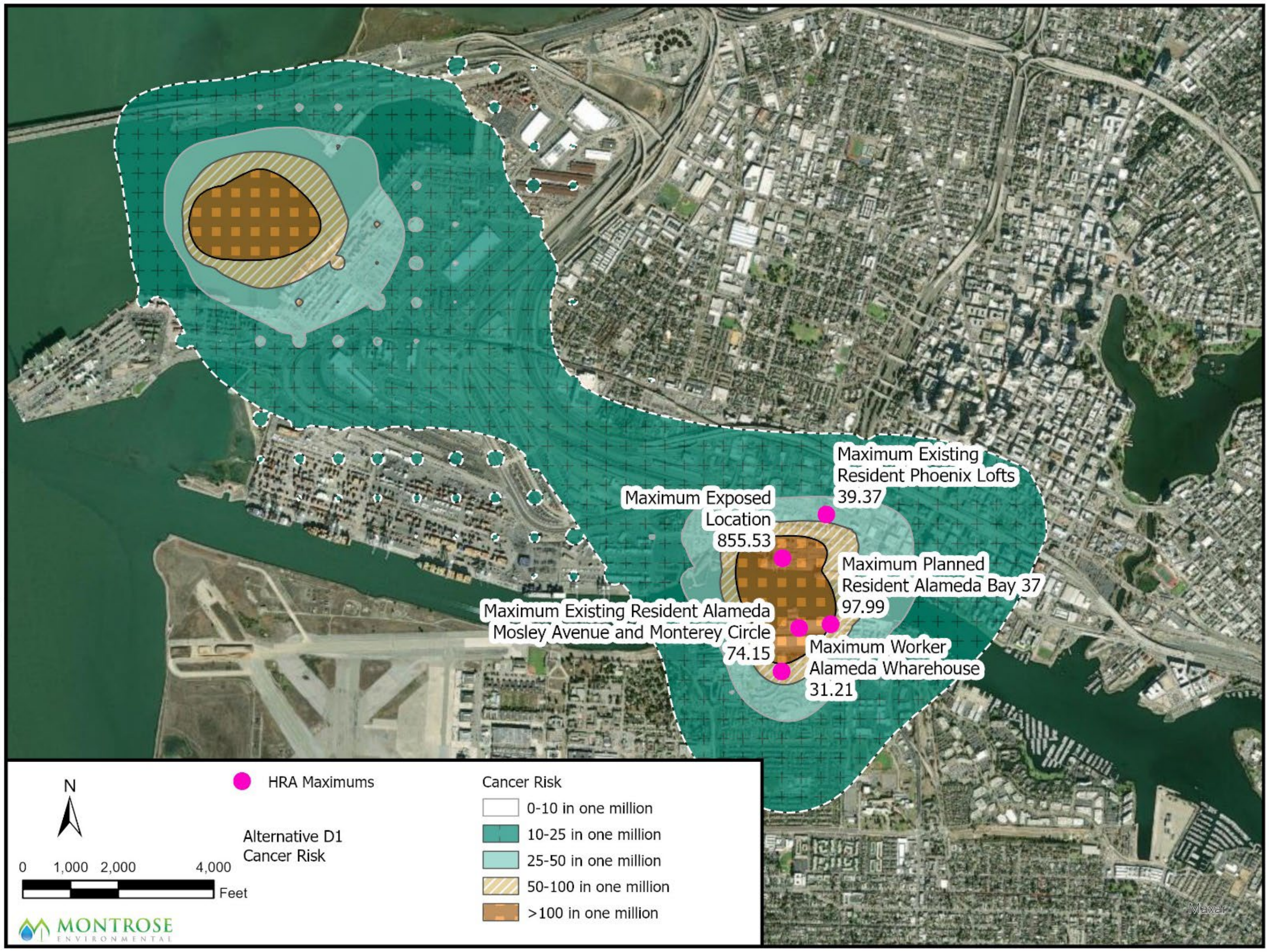


Figure 10: Construction Cancer Risk—Alternative D2 Mitigated (Residential Exposure Assumptions)

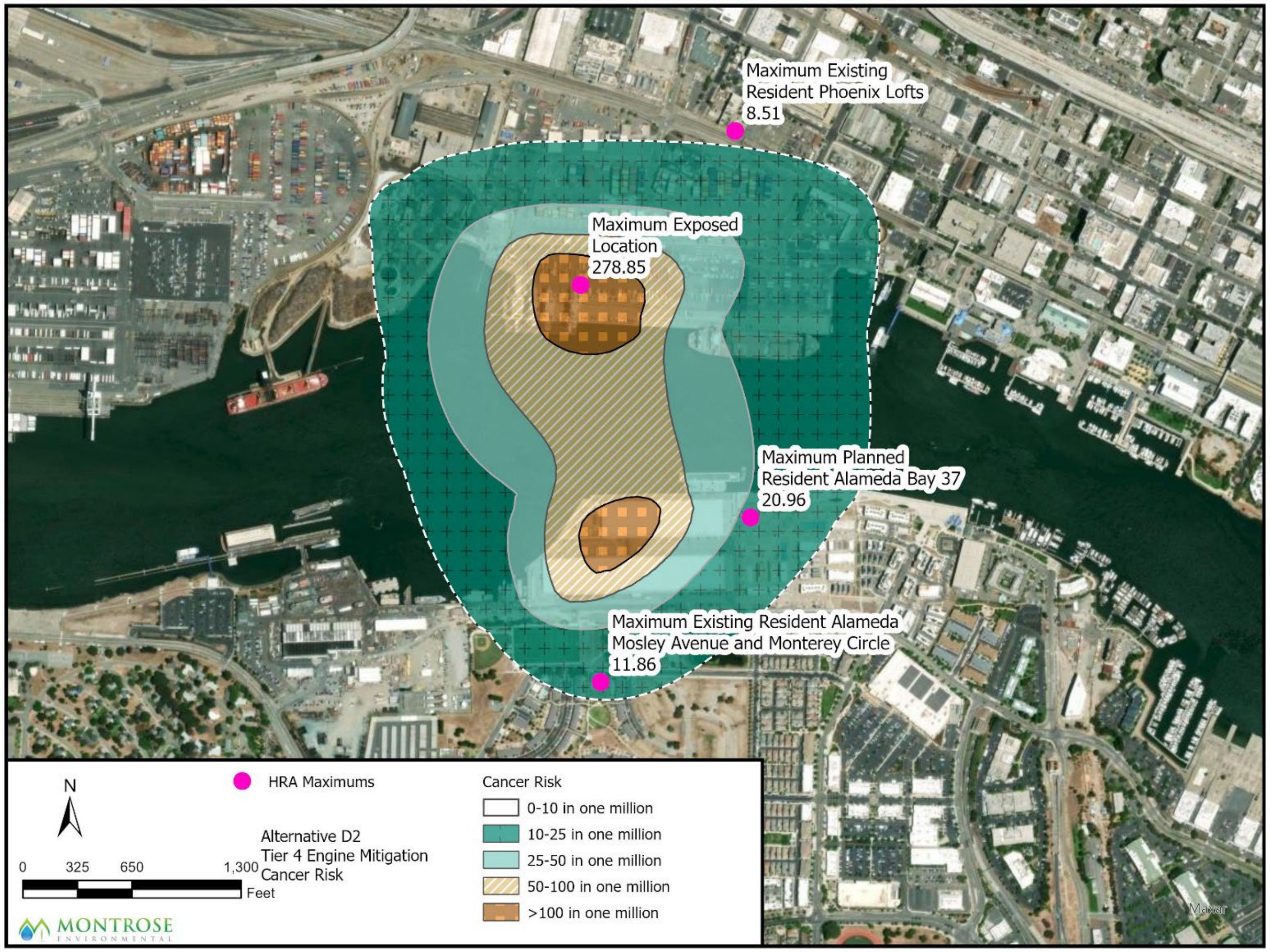


Figure 11: Construction Cancer Risk—Alternative B --Residential Exposure Assumptions

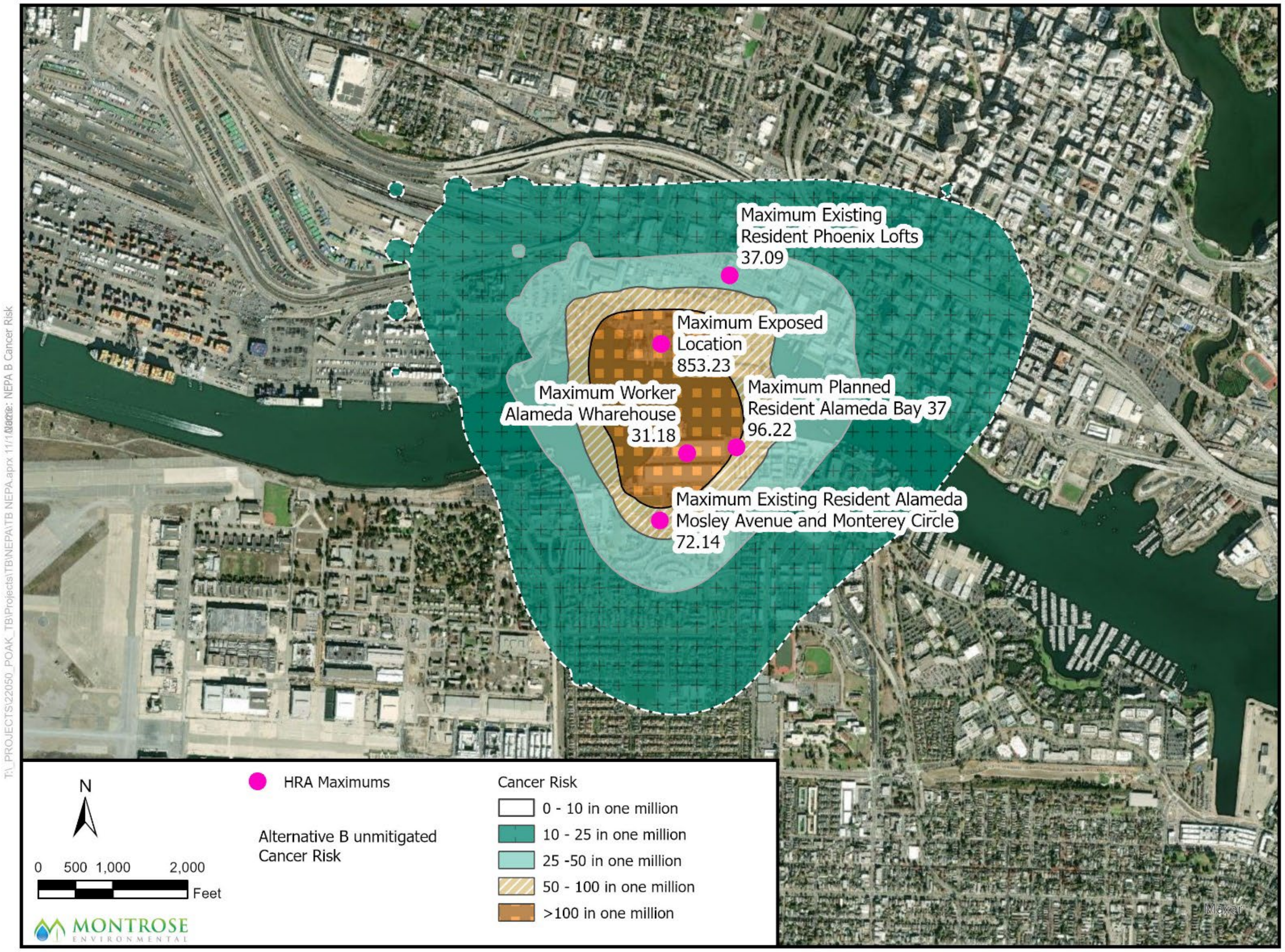


Figure 12: Construction Cancer Risk—Alternative B Mitigated --Residential Exposure Assumptions

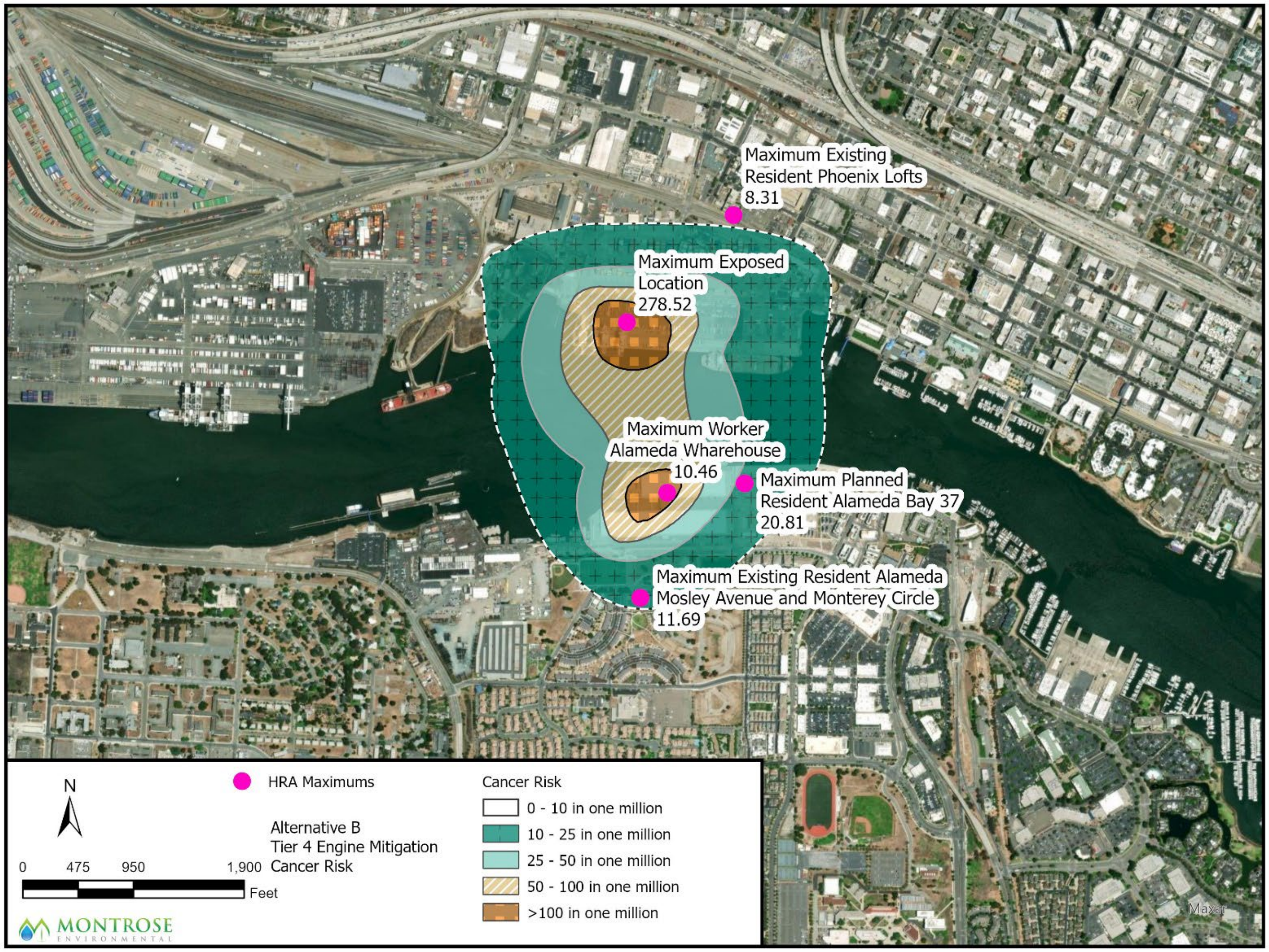


Figure 13: Construction Cancer Risk—Alternative C-Residential Exposure Assumptions

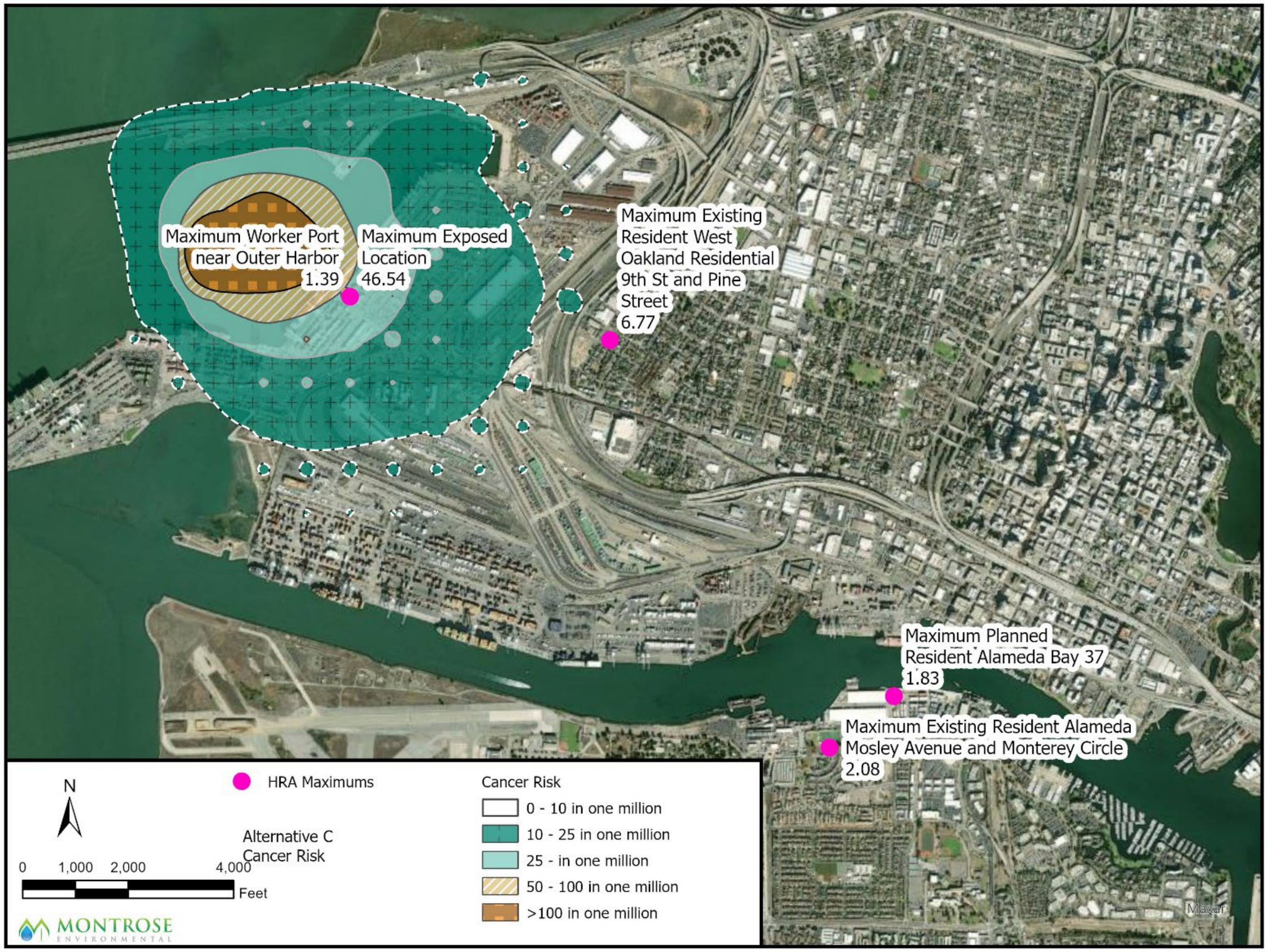


Figure 14: Construction Cancer Risk—Alternative C Mitigated -Residential Exposure Assumptions

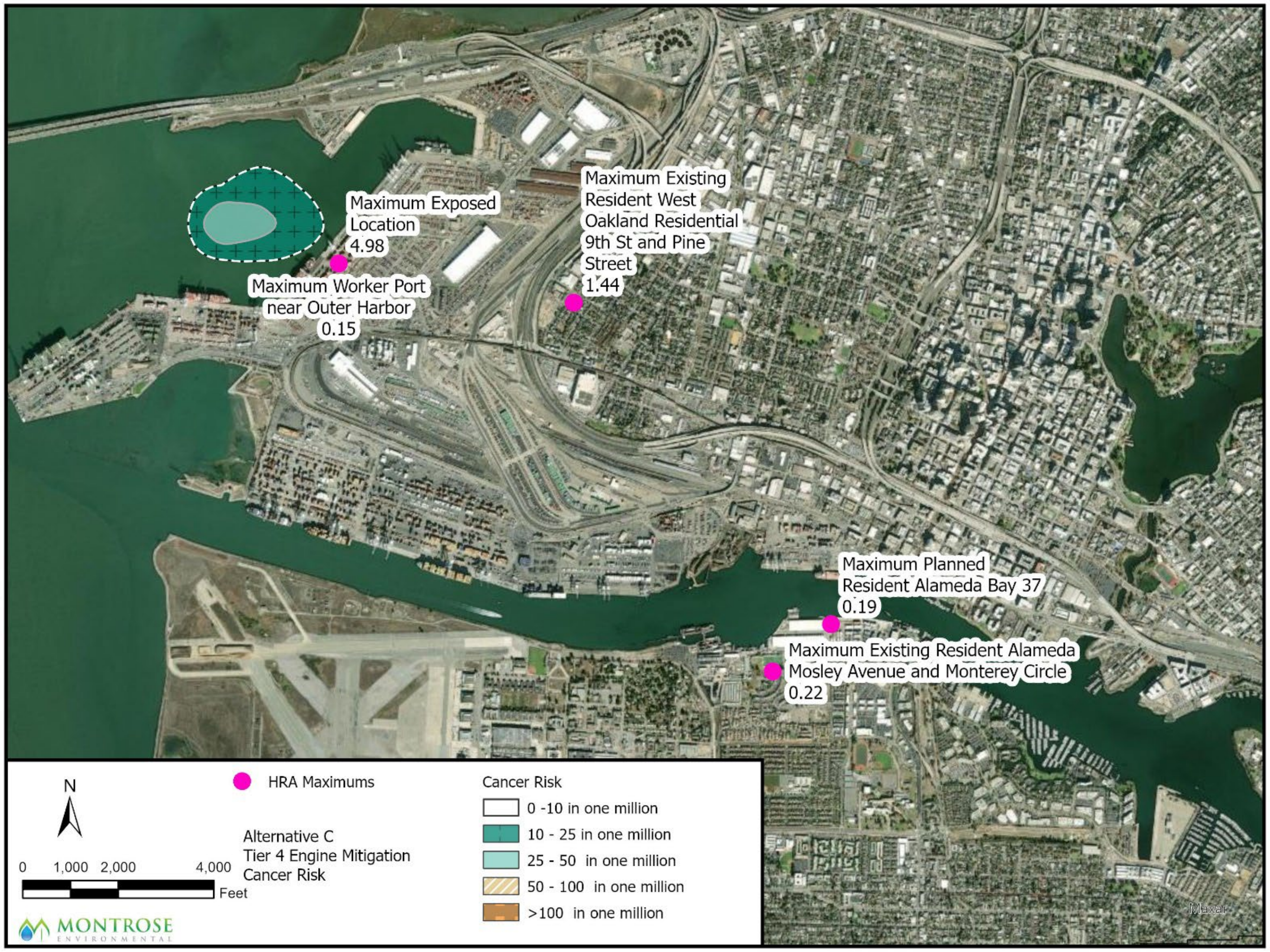


Figure 15: Construction Chronic Hazard Index

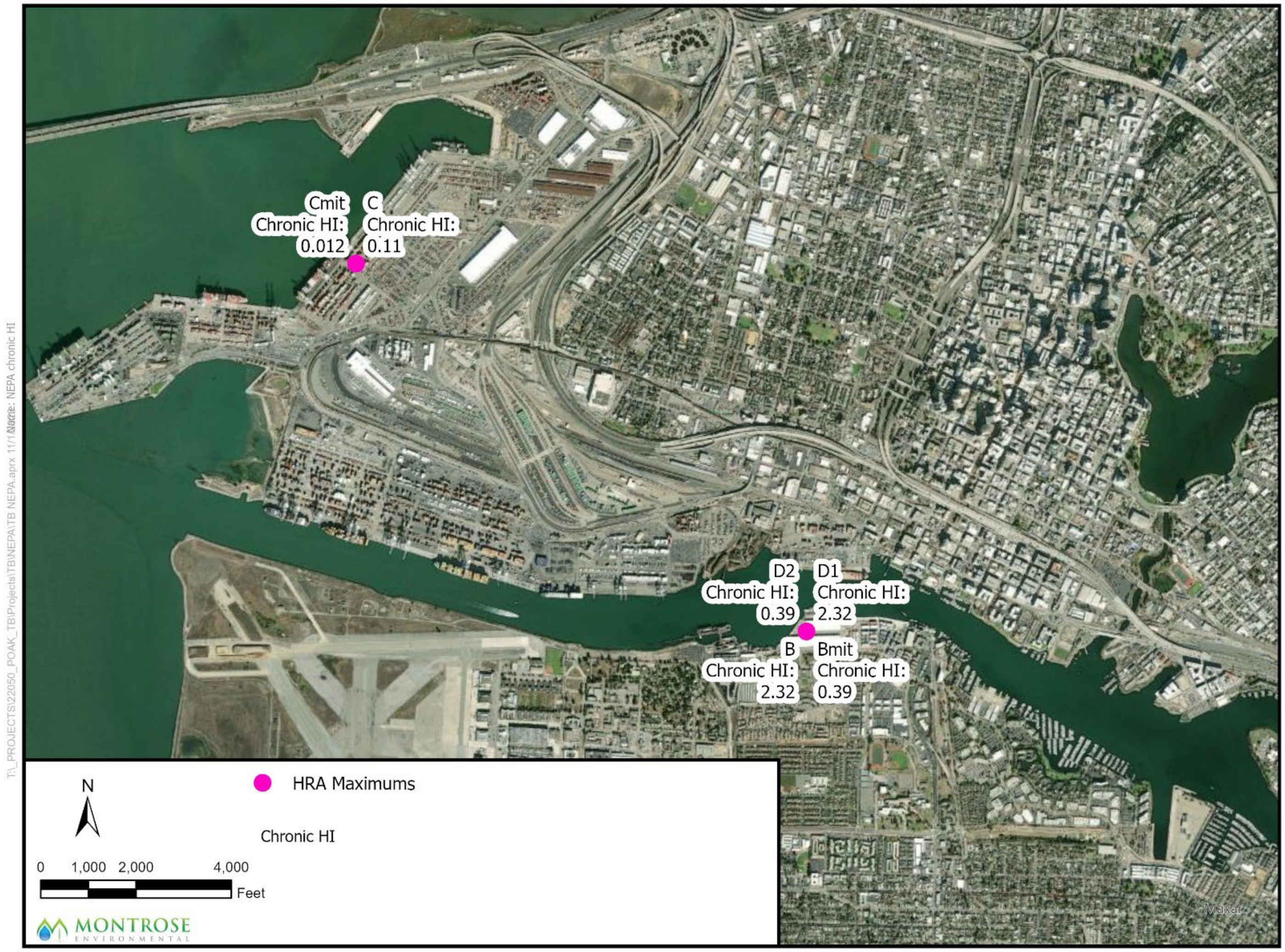


Figure 16: Construction Acute Hazard Index

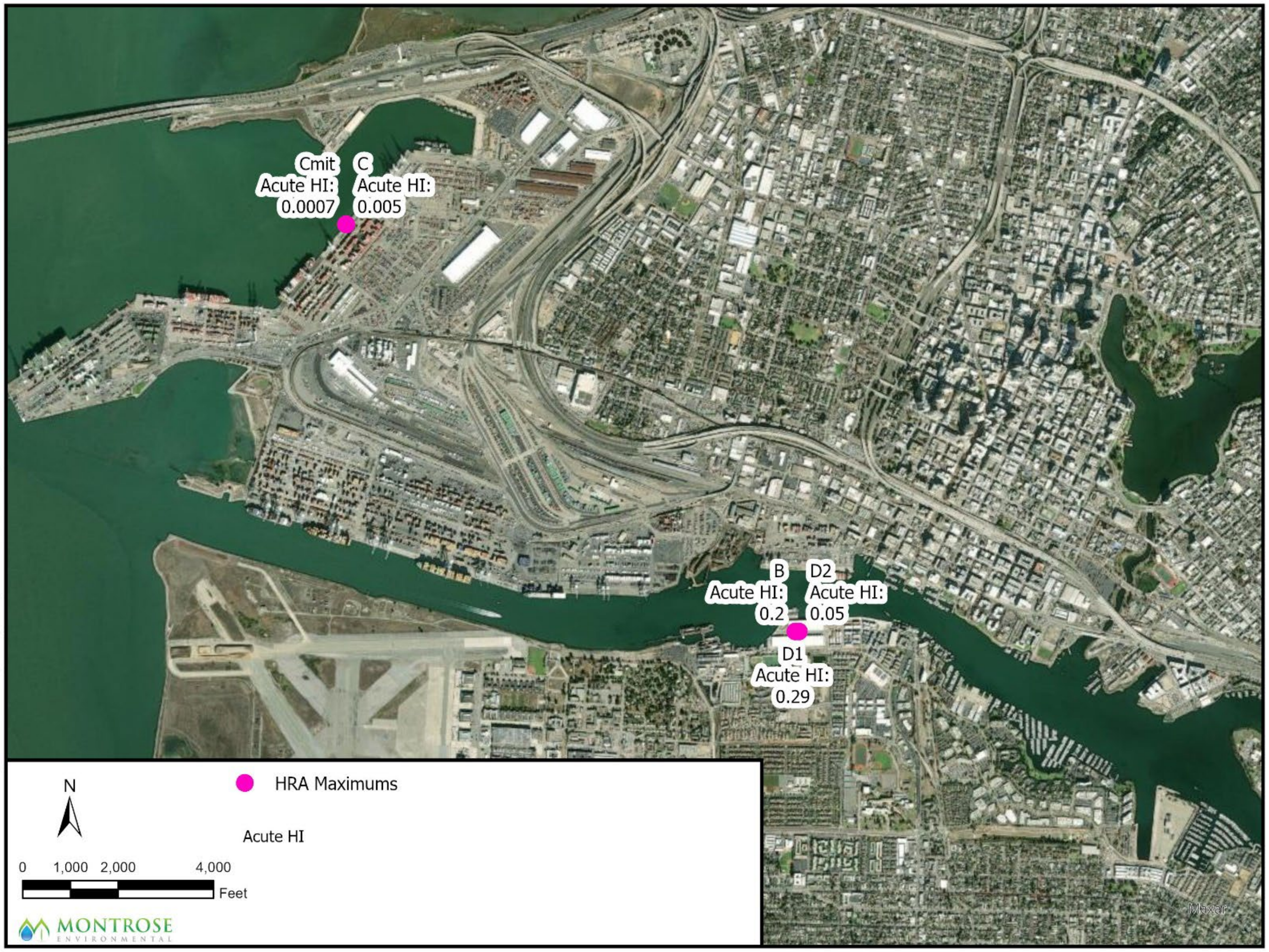


Figure 17: Alternative D1 $PM_{2.5}$ Concentration

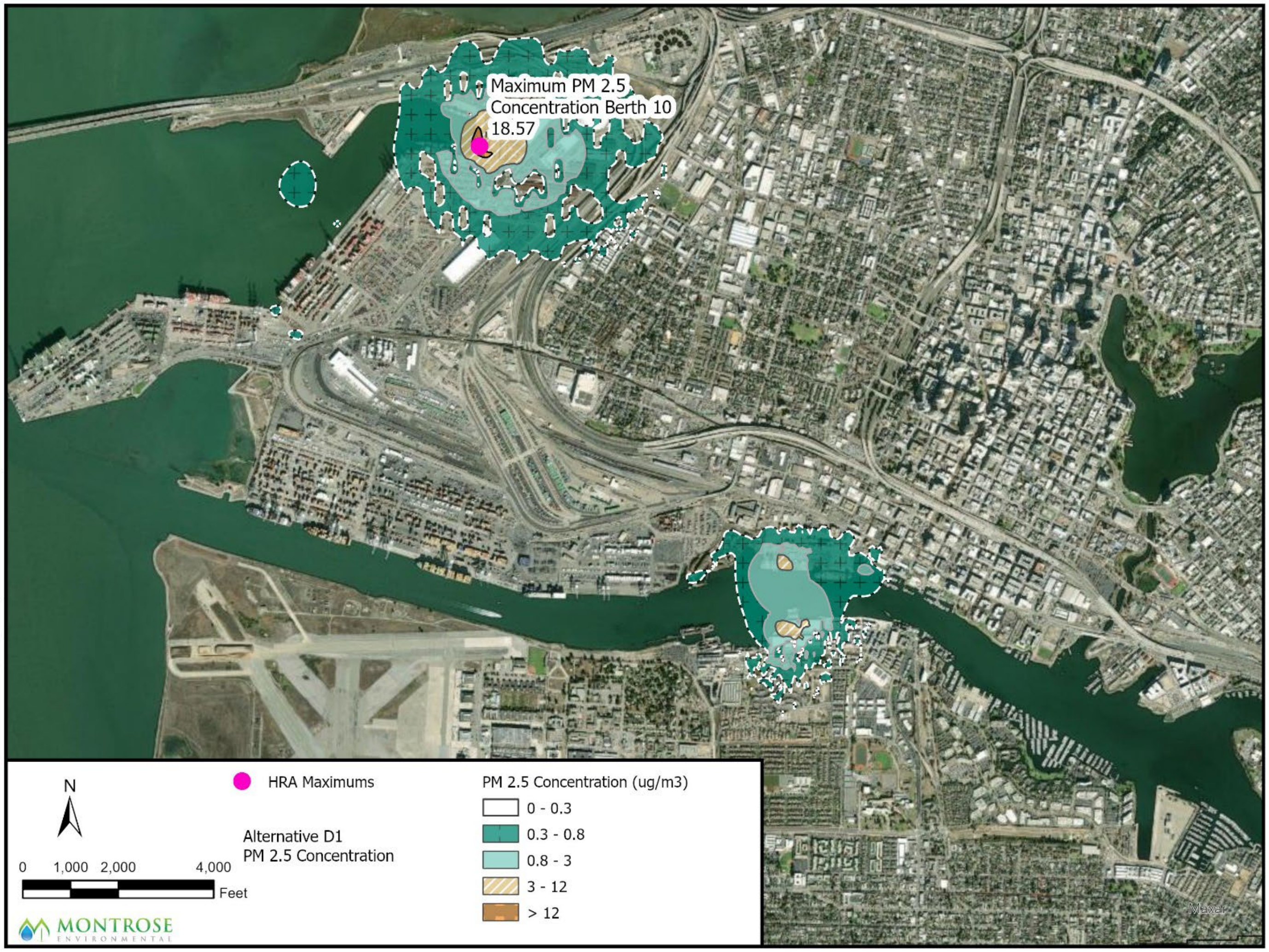


Figure 18: Alternative D2 Mitigated $PM_{2.5}$ Concentration

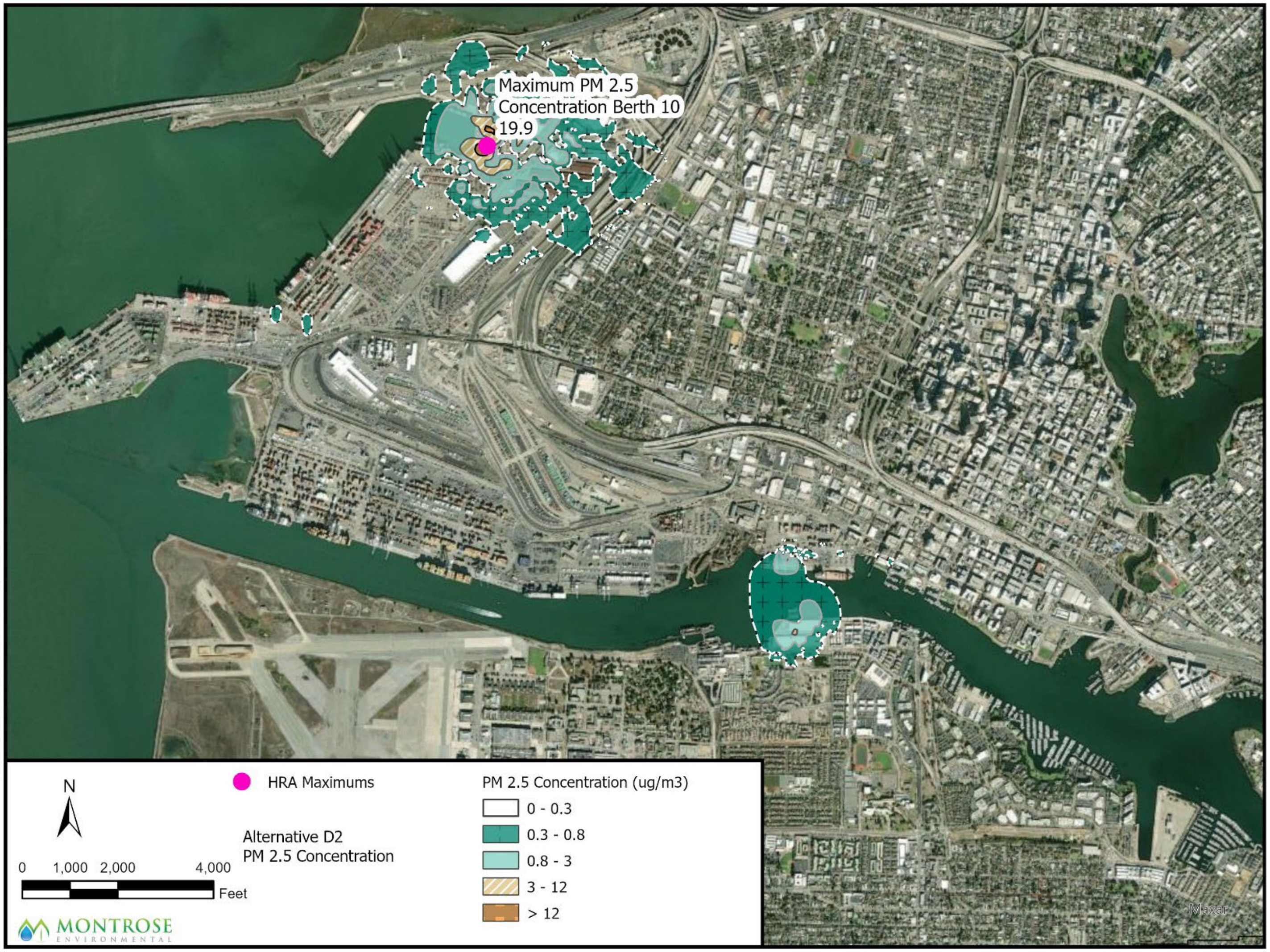


Figure 19: Alternative B $PM_{2.5}$ Concentration

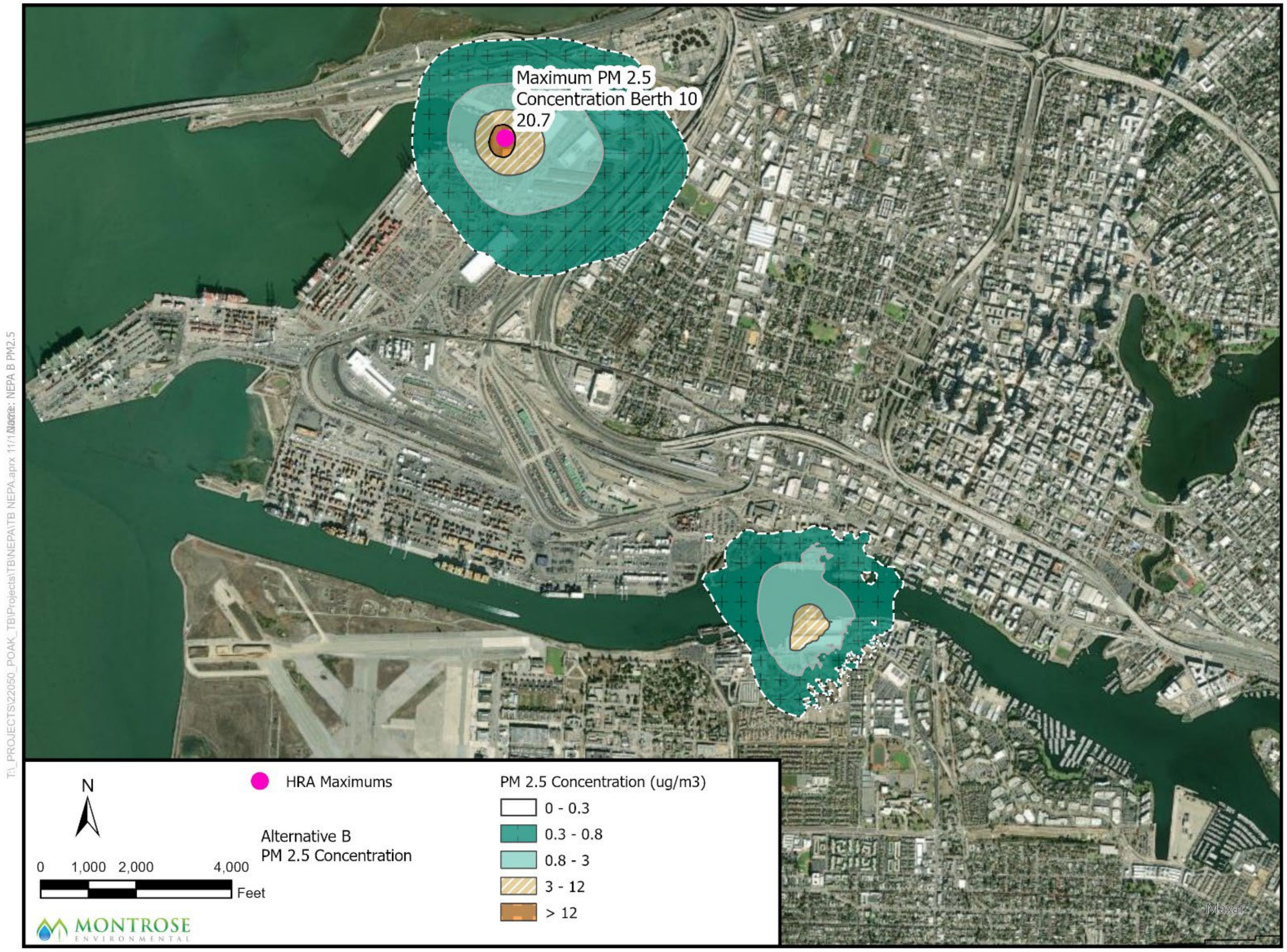


Figure 20: Alternative B Mitigated $PM_{2.5}$ Concentration

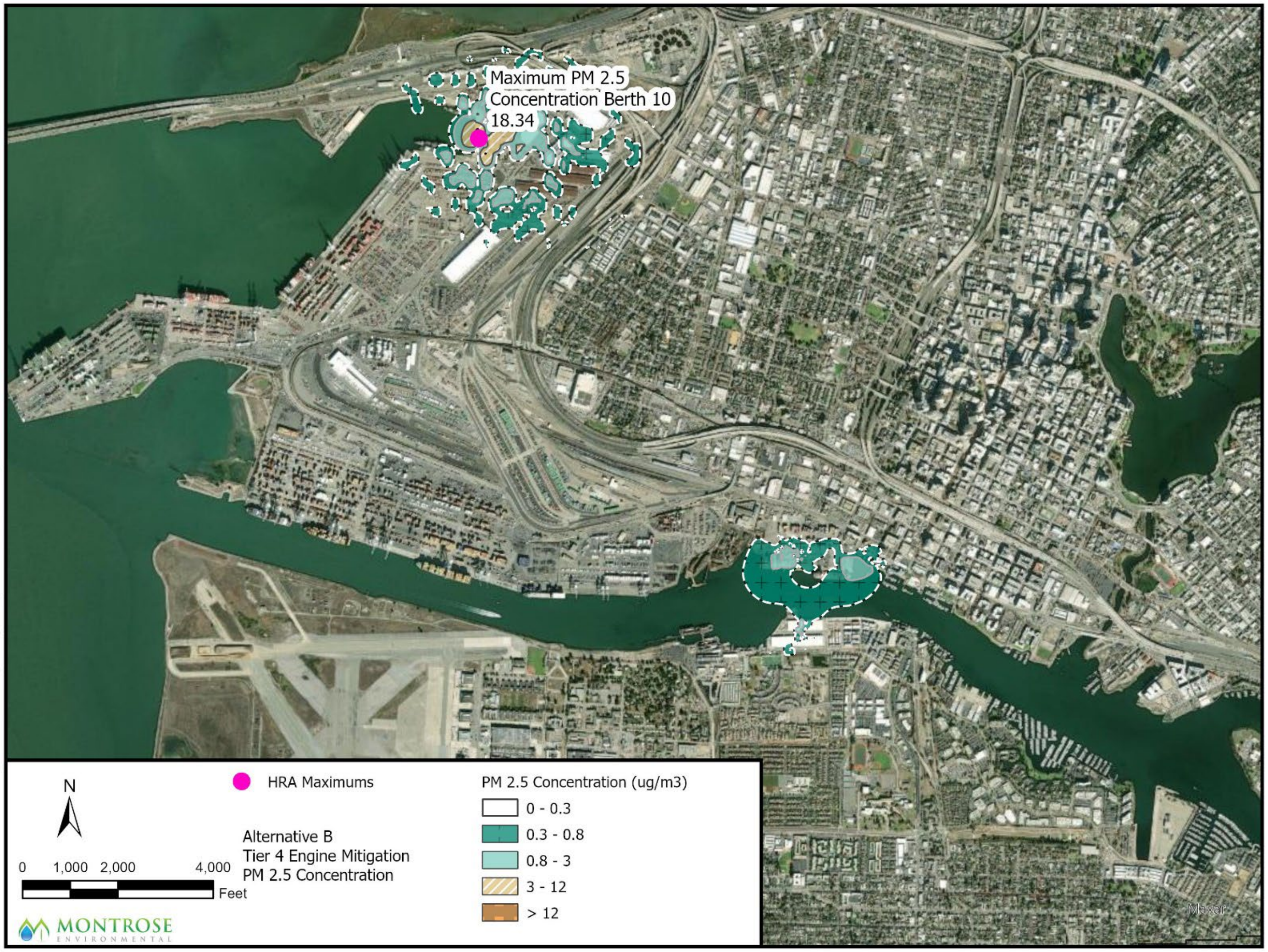


Figure 21: Alternative C $PM_{2.5}$ Concentration

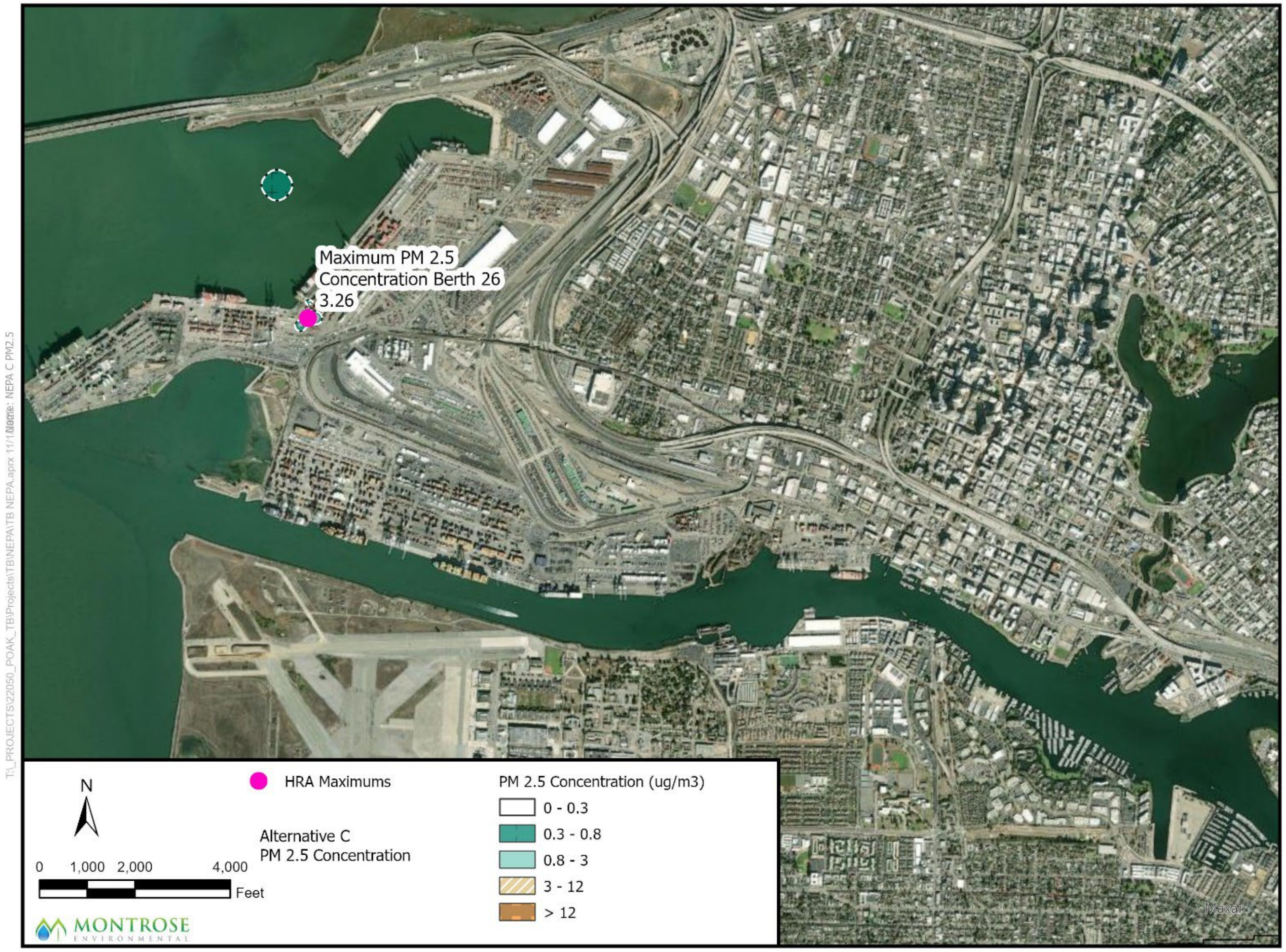


Figure 22: Alternative C Mitigated $PM_{2.5}$ Concentration