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MINETA SAN JOSE AIRPORT SUPPLEMENTAL AIR QUALITY IMPACTS ANALYSIS

SAN JOSE, CALIFORNIA

RAMBOLL

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APPENDICES

1. INTRODUCTION

This report presents an estimate of the potential health impact of the emissions of criteria pollutants that are associated with the Amendment to the Norman Y. Mineta San Jose International Airport (the Airport or SJC) Master Plan[1] (the Proposed Project). As a result of the 2017 Runway Incursion Mitigation/Design Standards Analysis Study, the City of San Jose is proposing to amend the 2018 approved Airport Master Plan as follows:

- Shift the planning horizon year from 2027 to 2037;
- Modify future facilities requirements at the Airport to reflect updated demand forecasts; and,
- Modify certain components of the airfield to reduce the potential for runway incursions.

The implementation of these amendments to the 2018 approved Airport Master Plan constitute "the Proposed Project," with full build-out of the proposed improvements anticipated and start of operations in year 2037.

FRIANT RANCH DECISION

As background, Environmental Impact Reports (EIRs) prepared pursuant to the California Environmental Quality Act (CEQA) have long evaluated project-related health impacts of toxic air contaminants, such as diesel particulate matter, through quantitative and/or qualitative means relative to air district-issued thresholds of significance. However, EIRs historically have not evaluated the specific health impacts of project-related increases in criteria pollutants,[2] other than to note and summarize scientific literature regarding the general effect of those pollutants on health. Instead, in accordance with air district-issued thresholds of significance and industry standard practice at the time, CEQA analysis historically and traditionally focused on estimating project-related mass emissions totals for criteria pollutants and, in certain cases, conducting dispersion modeling to assess impacts on local ambient air quality concentrations.

In a recent court ruling in Sierra Club v. County of Fresno (Friant Ranch), the California Supreme Court determined the EIR was inadequate as it failed to correlate the significant increase in emissions that the project would generate to the adverse impacts on human health or explain why it is not scientifically possible to do so. In particular, the court noted that the project was significant for the emissions of criteria pollutants, including oxides of nitrogen (NOx), and particulate matter (PM), but did not explain the health impacts of the emissions of these two pollutants as a result of the Project. Ramboll understands the court's ruling to apply to both attainment and non-attainment areas, as there was no apparent distinction between the two in the court ruling. Ramboll also understand the Court's ruling to apply only when there is a significant impact as the Court's concern appears to primarily be with the statement of significant impacts without describing the health impacts.

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[1] City of San Jose Airport Department. 2018. Airport Master Plan for Norman Y. Mineta San Jose International Airport, As Amended Through August 2018. Available at: https://www.flysanjose.com/sites/default/files/improvement/MasterPlan-Update2018.pdf. Accessed: April 2019.

[2] Criteria pollutants are those pollutants with an air pollution standard or pollutants which are precursors to those with a standard. Pollutants with an air pollution standard include nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, particulate matter smaller than 2.5 microns in diameter and 10 microns in diameter, and ozone. Precursor pollutants to criteria pollutants include oxides of nitrogen (NOx), oxides of sulfur (SOx), carbon monoxide (CO), and volatile organic compounds (VOCs).

CEQA practitioners and other expert agencies (like air districts) are still developing tools and methodologies to provide the type of CEQA analysis described in the California Supreme Court's decision. In this report, Ramboll presents one method that can be used to correlate project-related mass emissions totals for criteria pollutants to estimated health-based consequences. More specifically, in order to estimate the health impacts of the increases of criteria pollutants for the Proposed Project, Ramboll applied a photochemical grid model (PGM), Comprehensive Air Quality Model with extensions (CAMx), to estimate the small increases in concentrations of ozone and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)[3] in the region as a result of the emissions of criteria and precursor pollutants from the Proposed Project. Ramboll then applied a U.S. Environmental Protection Agency (USEPA)-authored program, the Benefits Mapping and Analysis Program (BenMAP)[4], to estimate the resulting health impacts from the small increases in concentration. Only the impacts of ozone and $PM_{2.5}$ are estimated, as those are the pollutants that USEPA uses in BenMAP to estimate the impact of emissions of NOx, volatile organic compounds (VOCs), and $PM_{2.5}$. Ozone and $PM_{2.5}$ have the most critical health impacts and thus are the emissions evaluated to determine the Proposed Project's health impacts.

SUPPLEMENTAL EVALUATION

In light of a cited decision issued by the California Supreme Court issued in December 2018, this analysis estimates the health impacts of criteria pollutants and their precursors, specifically those that are evaluated by the U.S. Environmental Protection Agency (USEPA) in rulemaking setting the national ambient air quality standards: NOx, VOC, carbon monoxide (CO), ozone (O_3), sulfur dioxide (SO_2), and $PM_{2.5}$. NOx and VOCs are not criteria air pollutants but, in the presence of sunlight, they form ozone and contribute to the formation of secondary $PM_{2.5}$ and thus are analyzed here. Effects of SO_2 and CO emissions are not evaluated as they were not quantified in the ADEIR, though their contribution to the formation of secondary $PM_{2.5}$ and ozone is expected to be small. The health impacts from ozone and $PM_{2.5}$ are examined for this Proposed Project because the USEPA has determined that these criteria pollutants would have the greatest impact to human health. The emissions of other criteria pollutants, including VOC and NOx are analyzed in their contribution in the formation of ozone and secondary $PM_{2.5}$.

The evaluation presented here is supplemental, in that it serves to describe the potential health impacts of the criteria pollutant emissions already disclosed in the Project's Draft EIR. This evaluation does not make a new significance determination, as the Project's air quality impacts were already found to be significant and unavoidable.

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[3] USEPA's default health effect functions in BenMAP for PM use fine particulate ($PM_{2.5}$) as the causal PM agent, so the health effects of PM_{10} are represented using $PM_{2.5}$ as a surrogate.

[4] https://www.epa.gov/benmap/benmap-ce-manual-and-appendices.

2. TECHNICAL APPROACH

The first step in the process is to run the PGM with appropriate information to assess the small increases in ambient air concentrations that the Proposed Project emissions may cause. PGMs require a database of information, including the spatial allocation of emissions, in the area to be modeled. This includes both base (background/existing) emissions and incremental emissions from the Proposed Project. The latest publicly available PGM database for Northern California, which contains baseline emissions, was developed by the Bay Area Air Quality Management District (BAAQMD) in support of the 2012 Central California Ozone Study (CCOS)[5] and was adapted for this analysis. This PGM database is tailored for Northern California using California-specific input tools (e.g., the Emission FACtors (EMFAC)[6] mobile source emissions model) and uses a high-resolution 4-km horizontal grid to better simulate meteorology and air quality in the complex terrain and coastal environment of California.

Proposed Project emissions included NO_X, respirable (PM_{10}) and fine ($PM_{2.5}$) primary particulate matter (PM), and VOCs. As discussed above, NO_X and VOC are precursors to ozone and are also precursors to secondarily formed $PM_{2.5}$. Incremental emissions between the Proposed Project year of 2037 and the Existing/Baseline year of 2018 were modeled in this analysis. Note that sources for which incremental emissions was negative were not modeled. These include emissions from GSE, on-road mobile NOx and ROG emissions, airside vehicle NOx and PM, and avgas tank fugitive VOC emissions. Therefore, the modelled emissions here (shown in Appendix A) below may not be the same as those presented in **Table 5.1-3** of the ADEIR. Average daily emission rates would be lower (notably, for ROG and NOx) if emission reductions between Existing/Baseline (2018) and Proposed Project (2037) were included. Accordingly, the estimated health impacts would be lower, if the reduction in emissions were incorporated.

The USEPA's air quality modeling guidelines (Appendix W[7]) and ozone and $PM_{2.5}$ modeling guidance[8] recommend using a PGM to estimate ozone and secondary $PM_{2.5}$ concentrations. The USEPA's modeling guidance does not recommend specific PGMs but provides procedures for determining an appropriate PGM on a case-by-case basis. Both the modeling guidelines and guidance note that the CAMx[9] and the Community Multiscale Air Quality (CMAQ[10]) PGMs have been used extensively in the past and would be acceptable PGMs. As such, the USEPA has prepared a memorandum[11] documenting the suitability for using CAMx and CMAQ for ozone and secondary $PM_{2.5}$ modeling of single-sources or group of sources.

To estimate the potential impacts of the Proposed Project's emissions on ambient air concentrations, the Proposed Project's incremental emissions were added to the CAMx 4-km annual PGM modeling

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5 http://www.baaqmd.gov/about-air-quality/research-and-data/research-and-modeling.

6 https://www.arb.ca.gov/emfac/.

7 https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf.

8 https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf.

9 http://www.camx.com/.

10 https://www.epa.gov/cmaq.

11 https://www3.epa.gov/ttn/scram/guidance/clarification/20170804-Photochemical_Grid_Model_Clarification_Memo.pdf.

database.[12] Significant operational (NOx and PM) and construction (NOx) emissions were evaluated to select the most conservative year for evaluation. Emissions from full build-out year (2037) were conservatively chosen here as they represent the year of greatest impact across all operational and construction years. Emissions during this year are from operations only, as construction will be complete. For comparison, peak daily mitigated NOx emissions from construction are 120 lb/day (this occurs in year 2020, and assumes all construction projects occur simultaneously), which is much lower than the operational emissions evaluated in year 2037 (5,643 lb/day). Thus, any impacts evaluated here are likely to overstate the potential impacts that might be estimated based on the construction emissions. Operational emissions from the Proposed Project were estimated as described in the Air Quality Section of the Draft EIR.[13]

For use in PGMs, each Proposed Project emissions source must be spatially distributed across the modeling grid cells so that they can be incorporated into the gridded emission inventory. The incremental emission inventory for the Proposed Project (that is, emissions above the Existing/Baseline 2018 conditions) was used in the analysis. This includes architectural coatings, VOCs in consumer products, VOCs from fuel storage tanks, natural gas combustion from boilers and other terminal sources, emissions from a hotel that would be developed as part of the Proposed Project, vehicle traffic to and from the airport, emissions from aircraft, auxiliary power units (APUs) and ground support equipment, and Airport-owned off-road vehicles and shuttles. The emissions from architectural coatings, consumer products, natural gas combustion, fuel storage tanks, hotel, airport-owned off-road vehicles and shuttles, APUs and GSE were allocated to the primary grid cell representing the SJC Airport. The vehicle traffic source category includes both passenger vehicles and trucks that access the airport. These mobile sources are also spatially distributed in both the site's grid cells, as well as the immediately adjacent grid cells. While it is expected that passenger vehicles and trucks may travel some distance outside of the airport, they were conservatively distributed near the site's grid cells based on travel routes. Aircraft emissions that occur on the airport surface were allocated to the airport grid cells, while emissions from airborne flight segments were distributed laterally and vertically along the dominant arrival and departure flight tracks up to the mixing height (3,000 ft above ground). Annual emission estimates from the Proposed Project were spatially gridded, temporally allocated, and chemically speciated to be used for photochemical grid modelling using the Sparse Matrix Operator Kerner Emissions (SMOKE) emissions modelling system supported by the USEPA. The emissions inventory, spatial allocation, and SMOKE inputs and outputs are shown in **Appendix A.**

As discussed above, the Northern California 2012 CCOS modeling database was used for this project. The Northern California modeling domain extends from the Northeast Plateau Air Basin to the north, to the South Coast Air Basin, and reaches beyond the width of the state. The modeling domain extent is shown in **Figure 1-1** of **Appendix B**. The Northern California 4-km PGM modeling databases is based on a 2012 base meteorological year and includes a future year emissions scenario. The 2035 future year projections were used for this analysis, as that is the nearest future year with base emissions available as of the date of this report. The Proposed Project's emissions were tagged for treatment by

[12] BAAQMD performed WRF meteorological modeling for the CCOS 4-km domain and 2012 calendar year that has been processed by WRFCAMx to generate CAMx 2012 4-km meteorological inputs for the CCOS domain. The CMAQ 2012 emissions have been converted to the format used by CAMx using the CMAQ2CAMx processor.

[13] To the extent that the Draft EIR used conservative inputs to estimate Proposed Project-related criteria pollutants and precursors, the analysis provided herein also is conservatively influenced by those inputs.

the source apportionment tools in CAMx to obtain the incremental ozone and $PM_{2.5}$ concentration impacts due to the Proposed Project's emissions. More details, including inputs and outputs of the PGM modeling are included in **Appendix B.** Specifically, Appendix B contains figures showing the location of Project ozone and $PM_{2.5}$ incremental impacts across the region.

Following completion of the CAMx source apportionment modeling, Ramboll used the USEPA's BenMAP[14, 15] program to estimate the potential health impacts of the Proposed Project's contribution to ozone and $PM_{2.5}$ concentration. BenMAP uses the concentration estimates produced by CAMx, along with population and health effect concentration-response (C-R) functions, to estimate various health effects of the concentration increases. BenMAP has a wide history of applications by the USEPA and others, including for local-scale analysis[16] as needed for assessing the health impacts of a project's emissions. We used the USEPA default BenMAP health effects C-R functions that are typically used in national rulemaking, such as the health effects impact assessment[17] for the 2012 $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). The health effects that we used for $PM_{2.5}$ include mortality (all causes), hospital admissions (respiratory, asthma, cardiovascular), emergency room visits (asthma), and acute myocardial infarction (non-fatal). For ozone, the endpoints are mortality, emergency room visits (respiratory) and hospital admissions (respiratory). Details on the BenMAP inputs and outputs and definitions for the health outcomes are shown in **Appendix C.**

[14] https://www.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution.

[15] https://www.epa.gov/sites/production/files/2015-04/documents/benmap-ce_user_manual_march_2015.pdf.

[16] https://www.epa.gov/benmap/benmap-ce-applications-articles-and-presentations#local.

[17] https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf.

3. RESULTS

This section presents the summary of results of the health impact analysis for the incremental increases in $PM_{2.5}$ and ozone resulting from primary and precursor emissions for these constituents. The results presented here describe the potential health impacts of the criteria pollutant emissions already disclosed in the Project's Draft EIR, and the results themselves do not constitute a new significance determination, as the Project's air quality impacts were already found to be significant and unavoidable.

It is important to note there are a number of conservative assumptions built into this evaluation, beginning with the quantification of emissions themselves. These conservative assumptions include, but are not limited to, the following:

- The aircraft emissions inventory does not quantify the benefits of various ICAO and USEPA programs to reduce aircraft emission, as they are still being developed by those entities and details of implementation are not known yet.
- Potential improvements to mobile-source emissions from Mitigation Measure MM-AQ-1 (Electric Vehicle Charging Stations) are not quantified. Further, potential improvements to onsite operational emissions arising from Project Design Features (PDFs) are not quantified (though certain on-going commitments may be captured in SJC's traffic study). Examples of unquantified PDFs that could potentially result in lower on-site emissions include:
    - PDF- AQ -3 (Airside Operations),
    - PDF- AQ -4 (Alternate-Fuel Maintenance Fleet),
    - PDF- AQ -7 (Green Cleaning),
    - PDF- AQ -12 (Cell Phone Lot),
    - PDF- AQ -13 (Electric Charging Stations),
    - PDF- AQ -14 (Low- or Zero- Emission Taxis),
    - PDF- AQ -16 (Taxi Dispatch), and
    - PDF-AQ-18 (Support of Federal Aviation Regulation).
- Sources which showed emission reductions between the Existing/Baseline year (2018) and Proposed Project year (2037) were not modeled (discussed further in Appendix A);
- Assumption that health effects occur at any concentration, including small incremental concentrations (discussed further in Appendix C);
- Assumption that all $PM_{2.5}$ is of equal toxicity (discussed further in Appendix C);

As such, results presented below are meant to represent an upper bound of potential impacts, and actual impacts may be zero.

POTENTIAL HEALTH IMPACTS

Overall, the estimated health impacts from ozone and $PM_{2.5}$ are negligible in light of background incidences. **Appendix C** contains details on the estimation of potential health impacts, including a comparison of all results to the background health incidence. The "background health incidence" is the actual incidence of health effects as measured in the local population in the absence of additional emissions from the Proposed Project. When taken into context, the small increase in incidences and the very small percent of the number of background incidences indicate that these health impacts are negligible in a developed, urban environment.

Specifically, for all the health endpoints quantified, the number of estimated incidences are between 0.00027% and 0.028% of the background health incidence. Tables 2-2 and 2-4 in Appendix C contain the percentages of background health incidence for all health endpoints evaluated.

$PM_{2.5}$-related health outcomes attributed to Proposed Project-related increases in ambient air concentrations included asthma-related emergency room visits (1.89 incidences per year), asthma-related hospital admissions (0.15 incidences per year), all cardiovascular-related hospital admissions (not including myocardial infarctions) (0.41 incidences per year), all respiratory-related hospital admissions (0.80 incidences per year), mortality (4.46 incidences per year), and nonfatal acute myocardial infarction (less than 0.21 incidences per year for all age groups).

Ozone-related health outcomes attributed to Proposed Project-related increases in ambient air concentrations included respiratory-related hospital admissions (2.07 incidences per year), mortality (1.11 incidences per year), and asthma-related emergency room visits (11.05 incidences per year for ages 0-17 and 14.59 incidences per year for ages 18-99).

Because the health impacts from ozone and $PM_{2.5}$ are negligible in light of background incidences, and health impacts from other criteria pollutants would be even smaller, the health impacts of those other criteria pollutants were not quantified.

UNCERTAINTY

Analyses that evaluate the increases in concentrations resulting from individual sources, and the health impacts of increases or decreases in pollutants as a result of regulation on a localized basis are routinely done. This analysis does not tie the increase in concentration to a specific health impact in an individual; however, it does use scientific correlations of certain types of health impacts from pollution to estimate increases in effects to the population at large.

There is a degree of uncertainty in these results from a combination of the uncertainty in the emission estimates themselves, of the increase in concentration resulting from the PGM, and the uncertainty of the application of the C-R increase. All simulations of physical processes, whether ambient air concentrations, or health impacts from air pollution, have a level of uncertainty associated with them, due to simplifying assumptions. The overall uncertainty is a combination of the uncertainty associated with each piece of the modeling study, in this case, the emissions quantification, the emissions model, the PGM, and BenMAP. While these results reflect a level of uncertainty, regulatory agencies, including the USEPA have judged that, even with the uncertainty in the results, the results provide sufficient information to the public to allow them to understand the potential health effects of increases or decreases in air pollution.

The approach and methodology of this analysis ensures that the uncertainty is of a conservative nature. In addition to the conservative assumptions built into the emissions noted above, there are a number of assumptions built into the application of C-R functions in BenMAP that may lead to an overestimate of health impacts. For example, for all-cause mortality impacts from $PM_{2.5}$, these estimates are based on a single epidemiological study that found an association between $PM_{2.5}$ concentrations and mortality. While similar studies suggest that such an association exists, there remains uncertainty regarding a clear causal link. This uncertainty stems from the limitations of epidemiological studies, such as inadequate exposure estimates and the inability to control for many factors that could explain the association between $PM_{2.5}$ and mortality such as lifestyle factors like smoking. Several reviews have evaluated the scientific evidence of health effects from specific particulate components (e.g., Rohr and Wyzga 2012; Lippmann and Chen, 2009; Kelly and Fussell, 2007). These reviews indicate that the evidence is strongest for combustion-derived components of PM including elemental carbon (EC), organic carbon (OC) and various metals (e.g., nickel and vanadium), however, there is still no definitive data that points to any particular component of PM as being more toxic than other components. The USEPA has also stated that results from various studies have shown the importance of considering particle size, composition, and particle source in determining the health impacts of PM (USEPA, 2009). Further, USEPA (2009) found that studies have reported that particles from industrial sources and from coal combustion appear to be the most significant contributors to PM-related mortality, consistent with the findings by Rohr and Wyzga (2012) and others. This is particularly important to note here, as the majority of PM emissions generated from the Project are from entrained roadway dust (see Appendix A), and not from combustion. Therefore, by not considering the relative toxicity of PM components, the results presented here are conservative.

Another uncertainty highlighted by the USEPA (2012) which applies to potential health impacts from both $PM_{2.5}$ and ozone, is the assumption of a log-linear response between exposure and health effects, without consideration for a threshold below which effects may not be measurable. The issue of a threshold for $PM_{2.5}$ and ozone is highly debated and can have significant implications for health impacts analyses as it requires consideration of current air pollution levels and calculating effects only for areas that exceed threshold levels. Without consideration of a threshold, effects of any change in air pollution below or above the threshold are assumed to impact health. Although the USEPA traditionally does not consider thresholds in its cost-benefit analyses, the NAAQS itself is a health-based threshold level that the USEPA has developed based on evaluating the most current evidence of health effects.

As noted above, the health impacts estimation using this method presumes that impacts seen at large concentration differences can be linearly scaled down to small increases in concentration, with no consideration of potential thresholds below which health impacts may not occur. This methodology of linearly scaling impacts is broadly accepted for use in regulatory evaluations and is considered as being health protective (USEPA, 2010). In summary, health impacts presented in this report are conservatively estimated, and the actual impacts may be zero.

4. REFERENCES

/1/ Kelly, F.J., J.C. Fussell, 2007. Particulate Toxicity Ranking Report. Report Number 2/07. Environmental Research Group, Kings College, London.

/2/ Lippmann, M., L.C. Chen, 2009. Health effects of concentrated ambient air particulate matter (CAPs) and its components. *Crit. Rev. Toxicol*., 39, 865e913.

/3/ Rohr A.C., R.E. Wyzga, 2012. Attributing Health Effects to Individual Particulate Matter Constituents. *Atmos Environ*., 62, 130-152. doi:10.1016/j.atmosenv.07.036.

/4/ USEPA, 2009. Integrated Science Assessment (ISA) For Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=216546

/5/ USEPA, 2010. Quantitative Health Risk Assessment for Particulate Matter. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. EPA-452/R-10-005. June 2010. Available: https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf.

/6/ USEPA, 2012. Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter. U.S. Environmental Protection Agency, Washington, DC, EPA-452/R-12-005. https://www3.epa.gov/ttn/ecas/docs/ria/naaqs-pm_ria_final_2012-12.pdf.

APPENDIX A

EMISSIONS INVENTORY, SPATIAL ALLOCATION, AND SMOKE SETUP
MINETA SAN JOSE AIRPORT
SAN JOSE, CALIFORNIA

1. INTRODUCTION

As set forth in the Project's Draft Environmental Impact Report (EIR), operational emissions from the Existing/Baseline (2018) and Proposed Project (2037) scenarios were estimated using Project-specific data, where available, and the following models: the Aviation Environmental Design Tool (AEDT) for aircraft, auxiliary power unit (APU) and ground support equipment (GSE) emissions; CARB's OFFROAD2017 model for airside equipment; CARB's EMFAC2017 model for on-road mobile sources; SCAQMD and USEPA methodologies for fuel tank fugitive VOCs; and methodologies consistent with the California Emissions Estimator Model (CalEEMod®) for emissions from the built environment (e.g., hotel, parking garages, expansion of terminal buildings and other airport facilities). These models employ widely accepted calculation methodologies for emission estimates combined with appropriate default data if site-specific information is not available.

Annual emission estimates from the Proposed Project need to be spatially gridded, temporally allocated, and chemically speciated to be used for photochemical grid modeling. The Sparse Matrix Operator Kerner Emissions (SMOKE) emissions modeling system (Coats, 1996; Coats and Houyoux, 1996)[1] is used for this process.

Development of the gridded emissions is described in detail in Section 0 of this Appendix.

2. PROPOSED PROJECT EMISSIONS AND SPATIAL ALLOCATION

Emissions were estimated for the Proposed Project to support the photochemical grid model (PGM) and are allocated into 4 km x 4 km grid cells. This section describes those emissions and how they were spatially allocated.

2.1 Proposed Project Emissions and Spatial Allocation

For use in PGMs, emissions must be spatially allocated over the area so that they can be incorporated into the gridded emission inventory. Significant operational (NOx and PM) and construction (NOx) emissions were evaluated to select the most conservative year for evaluation. Emissions from full build-out year (2037) were conservatively chosen here as they represent the year of greatest impact across all operational and construction years. Emissions during this year are from operations only, as construction will be complete. For comparison, peak daily mitigated NOx emissions from construction are 120 lb/day (this occurs in year 2020, and assumes all construction projects occur simultaneously), which is much lower than the operational emissions evaluated in year 2037 (5,643 lb/day). Thus, any impacts evaluated here are likely to overstate the potential impacts that might be estimated based on the construction emissions.

The total incremental emission inventory for the Proposed Project that was used in the PGM is shown below in **Table 2-1**. All emissions listed in **Table 2-1** represent the average daily incremental operational emissions calculated for the Proposed Project in 2037. Note that sources for which incremental emissions was negative were not modeled. These include emissions from GSE, on-road mobile NOx and ROG emissions, airside vehicle NOx and PM, and avgas tank fugitive VOC emissions. Therefore, the modelled emissions presented in **Table 2-1** below may not be the same as those presented in **Table 5.1-3** of the ADEIR. Average daily emission rates would be lower (notably, for ROG and NOx) if emission reductions between Existing/Baseline (2018) and Proposed Project (2037)

[1] https://www.cmascenter.org/smoke/

were included. Accordingly, the estimated health impacts would be lower, if the reduction in emissions were incorporated.

Mobile source emissions were split into categories based on the EMFAC2017 emission rates. For particulate matter, less than 2.5 microns in diameter ($PM_{2.5}$) emissions are used in the modelling; less than 10 microns in diameter (PM_{10}) emissions are presented for information below. SO_2 and CO are not included in this evaluation due to their small contribution to the formation of secondary $PM_{2.5}$ and ozone.

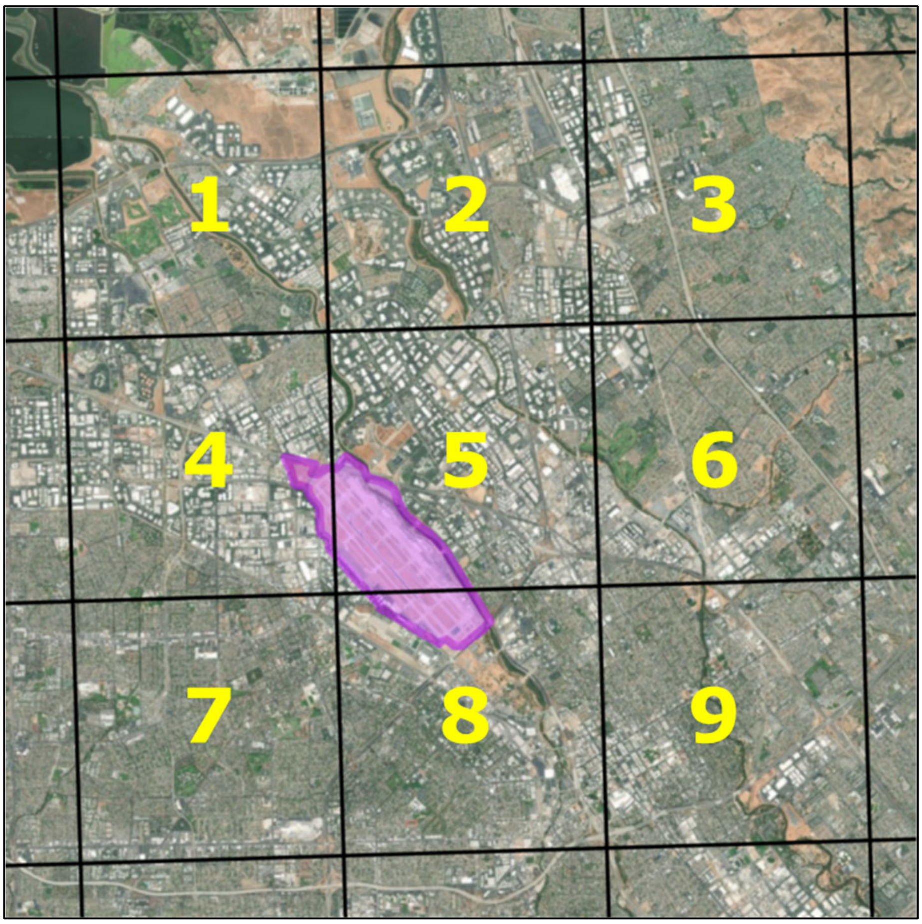
Table 2-1. Average Daily Criteria Air Pollutant Emissions Estimates

Emission Category	ROG	NOx	PM_{10}	$PM_{2.5}$
	lbs/day	lbs/day	lbs/day	lbs/day
Off-road Mobile				
Aircraft (Arrivals, Airborne emissions)	2.2	1,859	8.2	8.2
Aircraft (Departures, Airborne emissions)	0.0	2,225	2.7	2.7
Aircraft (Ground emissions)	6.7	1,522	5.1	5.1
APU	4.8	26	6.0	6.0
Airside Vehicles	0.2	0	0	0
Stationary				
Boilers	0.2	0.5	0.2	0.2
Other Miscellaneous NG	0.0	0.3	0.0	0.0
Jet Fuel Tanks	1.0	0	0	0
Gasoline Dispensing Facility	0.0	0	0	0
Energy (Hotel)	3.9	1.8	0.1	0.1
Consumer Products	31	0	0	0
Architectural Coatings	5.7	0	0	0
On-road Mobile	1.6	7.9	157	29
Diurnal	0.09	--	--	--
Hotsoak	0.20	--	--	--
Idling Exhaust	0.03	0.05	0.01	0.00
Brakewear	--	--	28	8.2
Tirewear	--	--	6.1	1.0
Resting Loss	0.09	--	--	--
Road Dust	--	--	122	19
Running Exhaust	0.11	4.1	0.72	0.44
Running Loss	0.74	--	--	--
Starting Exhaust	0.37	3.8	0.11	0.07
Total	**57**	**5,643**	**179**	**51**

Abbreviations: lbs – Pounds NOx - Nitrogen Oxides $PM_{2.5}$ - Particulate Matter less than 2.5 microns in diameter PM_{10} - Particulate Matter less than 10 microns in diameter ROG - Reactive Organic Gas

On-road mobile emissions include light, medium, and heavy-duty vehicles, according to the default fleet mix in EMFAC2017 for Santa Clara County. Project trip distribution pattern forecasts from the Proposed Project Traffic Study were used to allocate on-road mobile source emissions to model grid cells. **Figure 2-1** below shows the Project boundary overlay with the 4-km grid.

Figure 2-1. Overlap of Model Grid Cells on Project Site



On-road mobile emissions are assumed to be distributed over the grid cells numbered 1 through 9 in **Figure 2-1** (cell #5 covering the majority of the Airport facility and 8 surrounding cells), based on the following methodology:

- Trip percentages, as presented in Figure 7 of the Proposed Project Traffic Study, allocated to a single location were kept within the given grid cell.
- Trip percentages, as presented in Figure 7 of the Proposed Project Traffic Study, allocated to a given roadway link were split evenly between the destination cell (cell #5) and an origin cell (one of the outer 8 cells).

Table 2-2 below provides a summary of the spatial distribution of mobile emissions broken down by grid cell number.

Table 2-2. Mobile Emission Distribution

Grid cell number (as depicted in Figure 2-1)	Distribution (%)
1	1.5
2	8.5
3	0
4	12
5	50.5
6	0
7	2
8	21
9	4.5

Aircraft emissions are modelled using AEDT up to the mixing height (i.e., 3,000 ft above ground) and uses the aircraft fleet mix forecast from the FAA's Runway Incursion and Mitigation Study.[2] Emissions that occur on the airport surface (e.g., start-up, taxi, take-off and landing ground roll) are allocated to the surface layer of the airport grid cells. Emissions from airborne segments up to the mixing height are allocated to grid cells according to the most frequently-used arrival and departure paths flown by a commercial aircraft, which were selected based on runway utilization forecasts. An arrival track into Runway 30R and a departure track from Runway 30R was selected for purposes of modelling. These emissions were treated as elevated point sources to place the emissions into the grid cells where they occurred.

Figure 2-2 shows the modelled arrival and departure flight track overlay with the 4 km grid. Take-off and climb emissions are allocated to grid cells according to the length of the take-off flight track within each grid cell, while approach emissions are similarly allocated to grid cells based on the arrival track.

Figure 2-3 shows the vertical profile for the arrival and departure tracks. Tracks are modelled up to 3,000 ft above ground, consistent with emissions estimates from AEDT within the mixing height. Emissions within each grid column are distributed equally between the vertical layers of the CAMx model that correspond to the altitudes flown by the aircraft as they depart or arrive.

[2] Mineta-San Jose International Airport Master Plan Demand Forecast Update Technical Report, HNTB Corporation, June 2, 2017 prepared for the FAA's 2017 RIM study.

Figure 2-2. Overlay of Model Grid Cells on Flight Tracks

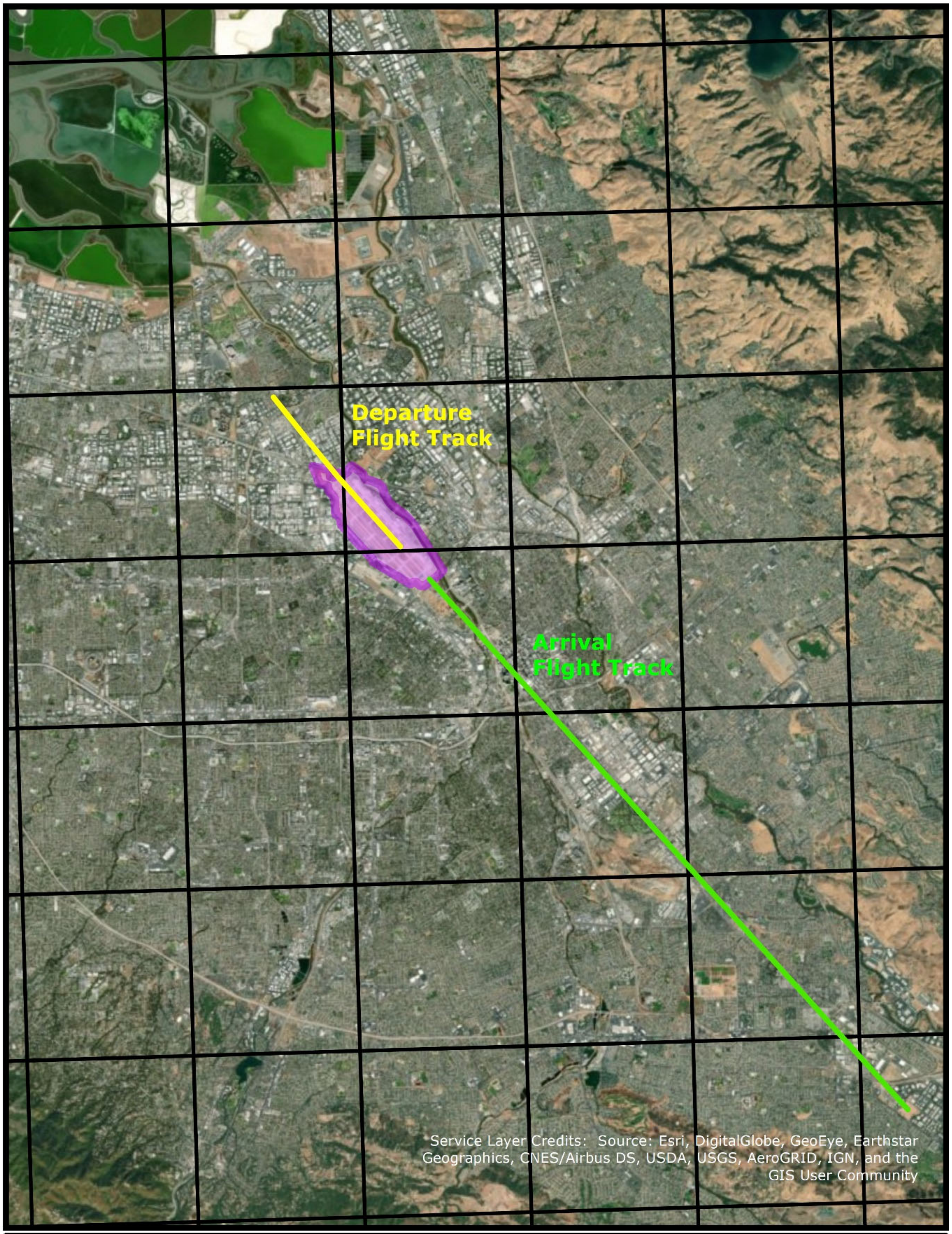
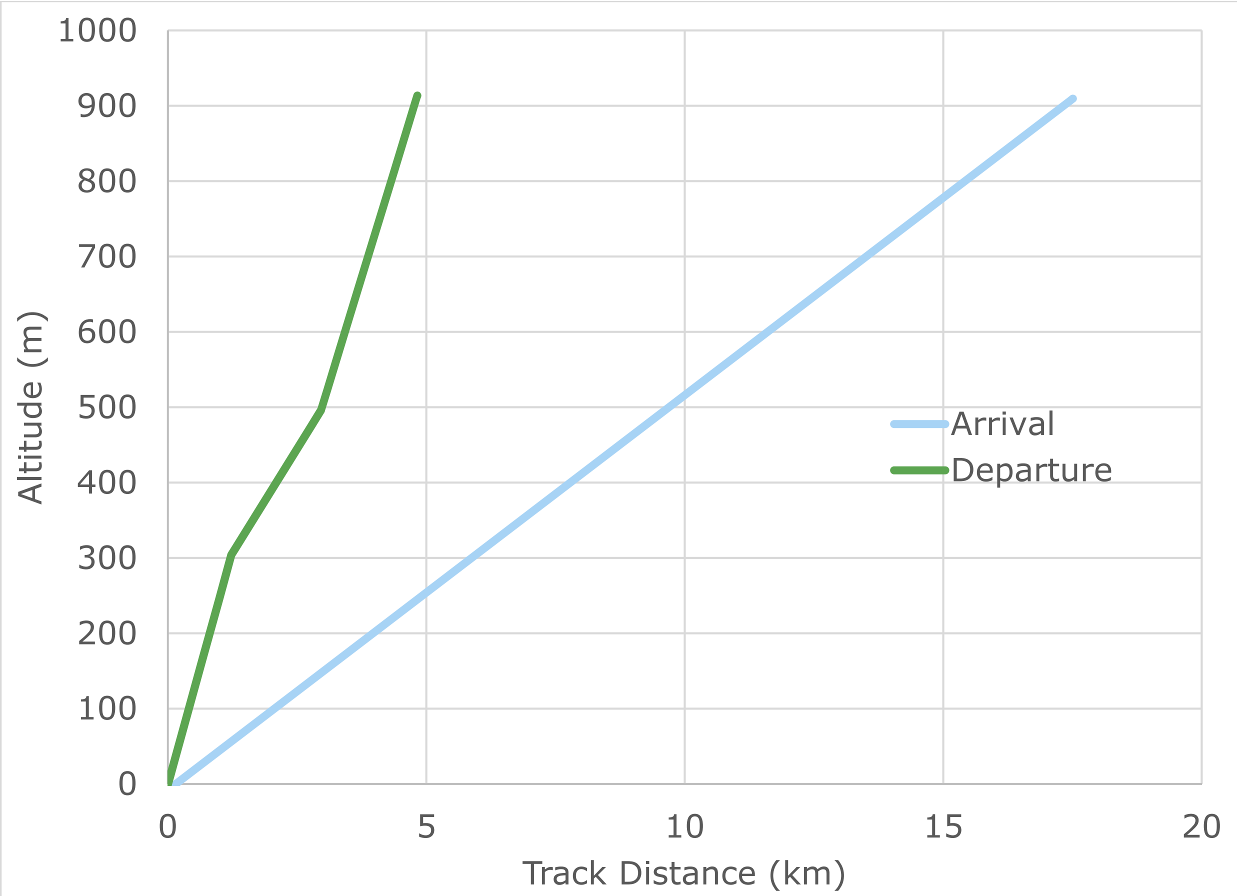


Figure 2-3. Vertical profile of Flight Tracks



2.2 Convert Project Inventories to SMOKE Input Format

The first step in the emissions processing was to convert the Project emission inventory into the Flat File 2010 (FF10) format for input to SMOKE. We assigned appropriate Source Classification Codes (SCCs) to the Project emissions sources. **Table 2-3** provides the SCCs assigned to each project source.

Table 2-3. Assigned SCC to Project Emission Sources

Emission Source	SCC	SCC Description
Stationary	20300908	Internal Combustion Engines; Commercial/ Institutional; Kerosene/Naphtha (Jet Fuel);Turbine: Evaporative Losses (Fuel Storage and Delivery System)
Stationary	2102006000	Stationary Source Fuel Combustion; Industrial; Natural Gas; Total: Boilers and IC Engines
Energy (Hotel)	2103006000	Stationary Source Fuel Combustion; Commercial/Institutional; Natural Gas; Total: Boilers and IC Engines
Off-road Mobile	2265008005	Mobile Sources; Off-highway Vehicle Gasoline, 4-Stroke; Airport Ground Support Equipment; Airport Ground Support Equipment

Emission Source	SCC	SCC Description
Off-road Mobile	2275070000	Mobile Sources; Aircraft; Aircraft Auxiliary Power Units; Total
Off-road Mobile	2275020000	Mobile Sources; Aircraft; Commercial Aircraft; Total: All Types
Off-road Mobile	2501060000	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Total: All Gasoline/All Processes
Architectural Coatings	2401001000	Solvent Utilization; Surface Coating; Architectural Coatings; Total: All Solvent Types
Consumer Products	2460000000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Processes; Total: All Solvent Types
Consumer Products	2460100000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Personal Care Products; Total: All Solvent Types
Consumer Products	2460200000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Household Products; Total: All Solvent Types
Consumer Products	2460400000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Automotive Aftermarket Products; Total: All Solvent Types
Consumer Products	2460500000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Coatings and Related Products; Total: All Solvent Types
Consumer Products	2460600000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All Adhesives and Sealants; Total: All Solvent Types
Consumer Products	2460800000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; All FIFRA Related Products; Total: All Solvent Types
Consumer Products	2460900000	Solvent Utilization; Miscellaneous Non-industrial: Consumer and Commercial; Miscellaneous Products (Not Otherwise Covered); Total: All Solvent Types
On-road Mobile	220100111B	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural[3] Interstate: Brake Wear
On-road Mobile	220100111R	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Resting Loss
On-road Mobile	220100111S	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Start
On-road Mobile	220100111T	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Tire Wear
On-road Mobile	220100111V	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Evap (except Refueling)
On-road Mobile	220100111X	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Vehicles (LDGV); Rural Interstate: Exhaust

[3] Rural and Urban mobile designations provide equivalent chemical speciation and temporal distributions, as the EMFAC mobile emissions model does not distinguish between the two.

Emission Source	SCC	SCC Description
On-road Mobile	220102011B	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Brake Wear
On-road Mobile	220102011R	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Resting Loss
On-road Mobile	220102011S	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Start
On-road Mobile	220102011T	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Tire Wear
On-road Mobile	220102011V	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Evap (except Refueling)
On-road Mobile	220102011X	Mobile Sources; Highway Vehicles - Gasoline; Light Duty Gasoline Trucks 1 & 2 (M6) = LDGT1 (M5); Rural Interstate: Exhaust
On-road Mobile	2201070110	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Total
On-road Mobile	220107011B	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Brake Wear
On-road Mobile	220107011I	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Idling
On-road Mobile	220107011R	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Resting Loss
On-road Mobile	220107011S	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Start
On-road Mobile	220107011T	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Tire Wear
On-road Mobile	220107011V	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Evap (except Refueling)
On-road Mobile	220107011X	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Interstate: Exhaust
On-road Mobile	220107013B	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Brake Wear
On-road Mobile	220107013I	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Idling
On-road Mobile	220107013R	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Resting Loss
On-road Mobile	220107013S	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Start

Emission Source	SCC	SCC Description
On-road Mobile	220107013T	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Tire Wear
On-road Mobile	220107013V	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Evap (except Refueling)
On-road Mobile	220107013X	Mobile Sources; Highway Vehicles - Gasoline; Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV); Rural Other Principal Arterial: Exhaust
On-road Mobile	220108011B	Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Brake Wear
On-road Mobile	220108011R	Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Resting Loss
On-road Mobile	220108011S	Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Start
On-road Mobile	220108011T	Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Tire Wear
On-road Mobile	220108011V	Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Evap (except Refueling)
On-road Mobile	220108011X	Mobile Sources; Highway Vehicles - Gasoline; Motorcycles (MC); Rural Interstate: Exhaust
On-road Mobile	223000111B	Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Vehicles (LDDV); Rural Interstate: Brake Wear
On-road Mobile	223000111T	Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Vehicles (LDDV); Rural Interstate: Tire Wear
On-road Mobile	223000111X	Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Vehicles (LDDV); Rural Interstate: Exhaust
On-road Mobile	223006011B	Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Trucks 1 thru 4 (M6) (LDDT); Rural Interstate: Brake Wear
On-road Mobile	223006011T	Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Trucks 1 thru 4 (M6) (LDDT); Rural Interstate: Tire Wear
On-road Mobile	223006011X	Mobile Sources; Highway Vehicles - Diesel; Light Duty Diesel Trucks 1 thru 4 (M6) (LDDT); Rural Interstate: Exhaust
On-road Mobile	223007111B	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Brake Wear
On-road Mobile	223007111I	Mobile Sources; Highway Vehicles – Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Idling
On-road Mobile	223007111T	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Tire Wear

Emission Source	SCC	SCC Description
On-road Mobile	223007111X	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 2B; Rural Interstate: Exhaust
On-road Mobile	2230072110	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Total
On-road Mobile	223007211B	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Brake Wear
On-road Mobile	223007211I	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Idling
On-road Mobile	223007211T	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Tire Wear
On-road Mobile	223007211X	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5; Rural Interstate: Exhaust
On-road Mobile	223007311B	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Brake Wear
On-road Mobile	223007311I	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Idling
On-road Mobile	223007311S	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Start
On-road Mobile	223007311T	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Tire Wear
On-road Mobile	223007311X	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7; Rural Interstate: Exhaust
On-road Mobile	223007513B	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Brake Wear
On-road Mobile	223007513I	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Idling
On-road Mobile	223007513S	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Start
On-road Mobile	223007513T	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Tire Wear
On-road Mobile	223007513X	Mobile Sources; Highway Vehicles - Diesel; Heavy Duty Diesel Buses (School & Transit); Rural Other Principal Arterial: Exhaust
On-road Mobile	2294000000	Mobile Sources; Paved Roads; All Paved Roads; Total: Fugitives

2.2.1 Generate Spatial Surrogates for 4-km Domains

As part of the analysis, the Project source emissions need to be spatially allocated to appropriate geographic locations. The emissions can be allocated to modeling grid cells using gridding surrogates. To process the Project emissions, a Project area-based spatial surrogate was developed. The surrogate was developed using the US Environmental Protection Agency (USEPA's) Spatial Allocation Tool,[4] which combines geographical information system (GIS)-based data (shapefiles) and modeling domain definitions to generate the appropriate gridded surrogate data set. The Project sources were then assigned specific surrogates for gridding by cross-referencing the SCCs. As mentioned above, all Project emissions were distributed in the modeling grid cells where the Project is located as shown in **Figure 2-1 and Figure 2-2** for arrival and departure emissions. The on-road mobile source emissions are spatially distributed in the site's grid cell and surrounding grid cells, as outlined in **Table 2-2**.

2.2.2 SMOKE 4 km Processing of Project Emissions

SMOKE system was used to process emissions for the Northern California 4-km modeling grid shown in **Figures 2-1 and 2-2**. A representative week from each month (seven days a month) was used to represent the entire month's emissions. Holidays were modeled separately as if they were a Sunday. SMOKE was applied to perform following tasks:

1. <u>Chemical Speciation</u>: Emission estimates of criteria air pollutants were speciated for the SAPRC07 AERO6 chemical mechanism employed in CMAQ in SMOKE processing. We used speciation profiles compatible with the SAPRC07 AERO6 mechanism for $PM_{2.5}$ from the BAAQMD's modeling system to be consistent with the regional modeling emissions. We then converted those emissions into CAMx-ready formats using CMAQ2CAMx conversion program and species mapping.
2. <u>Temporal Allocation</u>: Annual emission estimates were resolved on an hourly timescale for CAMx modeling. These allocations were determined from the particular source category, specified by the SCC. Monthly, weekly, and diurnal profiles were cross-referenced to SCC to provide the appropriate temporal resolution. The temporal profiles were also obtained from the BAAQMD's emissions modeling system.
3. <u>Spatial Allocation</u>: The Project emission estimates were spatially resolved to the grid cells for modeling using spatial surrogates as described above. For aircraft departure and arrival, the emissions were also spatially allocated in the center of the grid cells intersecting the flight paths and set up as elevated point sources (in the corresponding altitude bins) in a format that conforms to CAMx requirements.

2.2.3 QA/QC of Emissions Modeling

Standard quality assurance/quality control (QA/QC) was conducted during all aspects of the SMOKE emissions processing. These steps followed the approach recommended in USEPA modeling guidance (USEPA, 2007). SMOKE includes quality assurance (QA) and reporting features to keep track of the adjustments at each processing stage and ensure that data integrity is not compromised. We carefully reviewed the SMOKE log files for error messages and ensured that appropriate source profiles were used. All error records reported during processing were reviewed and resolved. This is important to ensure that source categories are correctly characterized. We also compared SMOKE input and output emissions: Summary tables were generated to compare input inventory totals against model-ready output totals to confirm consistency. Spatial plots were generated to visually verify correct spatial allocation of the emissions.

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[4] https://www.cmascenter.org/sa-tools/documentation/4.2/html/srgtool/SurrogateToolUserGuide_4_2.pdf

2.2.4 Merge SMOKE Pre-merged Emissions to Generate CAMx-ready Emission Inputs

The final step in the emissions processing is to merge the Project gridded emissions with other regional components through the gridded merge program (MRGUAM) for CAMx. We merged the daily emissions in the time format required by CAMx.

2.2.5 Emissions Summary

Summaries of the Project gridded CAMx model-ready emissions data are provided in this section. **Table 2-4** summarizes the annual emission inventory data input to SMOKE from the FF10 data files in short tons per year by Project region and pollutant. **Table 2-5** presents the emissions data after SMOKE processing. The consistency in data in **Tables 2-4** and **Table 2-5** offer confidence in the correct operation of the SMOKE emissions processing for CAMx.

Table 2-4. Project Emission Inventory Data Input to SMOKE by Source Type (lbs/day)

Type	NO_X	VOC	PM_{10}	$PM_{2.5}$
Off-road Mobile*	5,632.5	14.0	22.0	22.0
Stationary	0.8	1.2	0.2	0.2
Energy (Hotel)	1.8	3.9	0.1	0.1
Consumer Products	-	30.9	-	-
Architectural Coatings	-	5.7	-	-
On-road Mobile	7.9	1.6	156.6	29.3
Total	**5,643.0**	**57.3**	**178.9**	**51.6**

*Includes aircraft departure and arrival emissions.

Abbreviations:
NOx - Nitrogen Oxides
$PM_{2.5.}$ - Particulate Matter less than 2.5 microns in diameter
$PM_{10.}$ - Particulate Matter less than 10 microns in diameter
VOC - Volatile Organic Compounds

Table 2-5. Project Emission Inventory Data Output from SMOKE by Project Region (lbs/day)

Type	NO_X	VOC	PM_{10}	PM_{2_5}
Onsite	31.3	139.6	3.3	3.2
Offsite	187.3	87.4	203.7	46.7
Aircraft Arrival	1859.1	2.2	8.2	8.2
Aircraft Departure	2224.6	0.02	2.7	2.7
Total	**5,643.0**	**57.3**	**178.9**	**51.6**

Abbreviations:
NOx - Nitrogen Oxides
$PM_{2.5.}$ - Particulate Matter less than 2.5 microns in diameter
$PM_{10.}$ - Particulate Matter less than 10 microns in diameter
VOC - Volatile Organic Compounds

Spatial displays of the gridded emissions data are presented below. We examined the gridded emissions in 4-km grid to verify accurate spatial allocation by SMOKE. **Figures 2-2 through 2-5** displays gridded emissions for the Project inventory in the 4-km modeling grid.

Figure 2-2. Spatial Distribution of NOx Emissions (in lbs/day) for the Project in the Northern California 4-km Domain

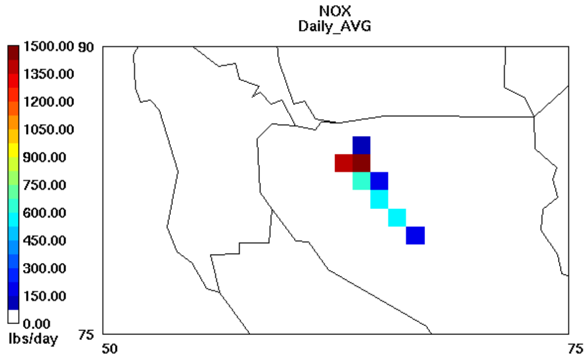


Figure 2-3. Spatial Distribution of VOC Emissions (in lbs/day) for the Project in the Northern California 4-km Domain

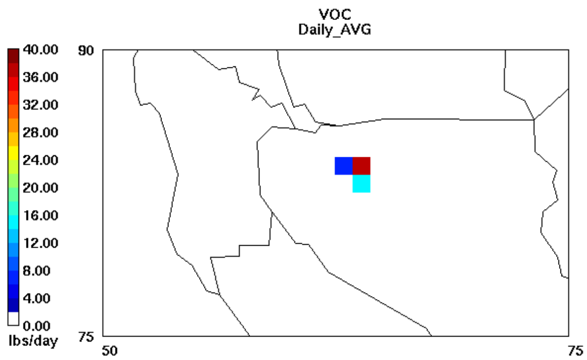


Figure 2-4. Spatial Distribution of PM_{10} Emissions (in lbs/day) for the Project in the Northern California 4-km Domain

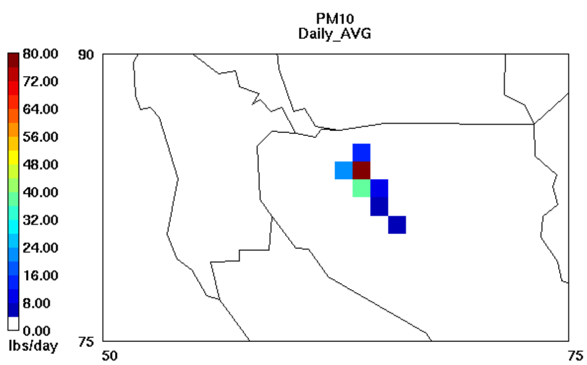
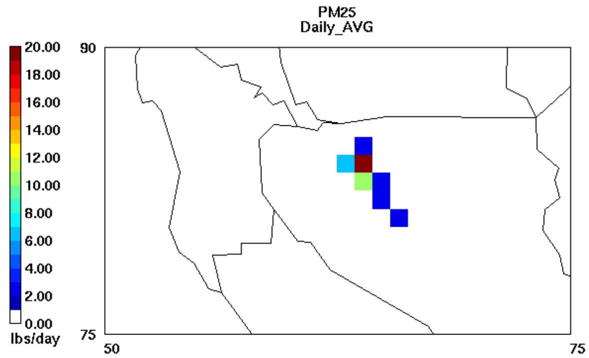


Figure 2-5. Spatial Distribution of $PM_{2.5}$ Emissions (in lbs/day) for the Project in the Northern California 4-km Domain



3. REFERENCES

/1/ Coats Jr., C.J., 1996. High-performance algorithms in the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. Proc. Ninth AMS Joint Conference on Applications of Air Pollution Meteorology with AWMA. Amer. Meteor. Soc., Atlanta, GA, 584-588.

/2/ Coats Jr., C.J., Houyoux, M.R., 1996. Fast Emissions Modeling with the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System. The Emission Inventory: Key to Planning, Permits, Compliance, and Reporting, Air & Waste Management Association. New Orleans, Louisiana.

/3/ EPA, 2007. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-454/B-07-002.

APPENDIX B

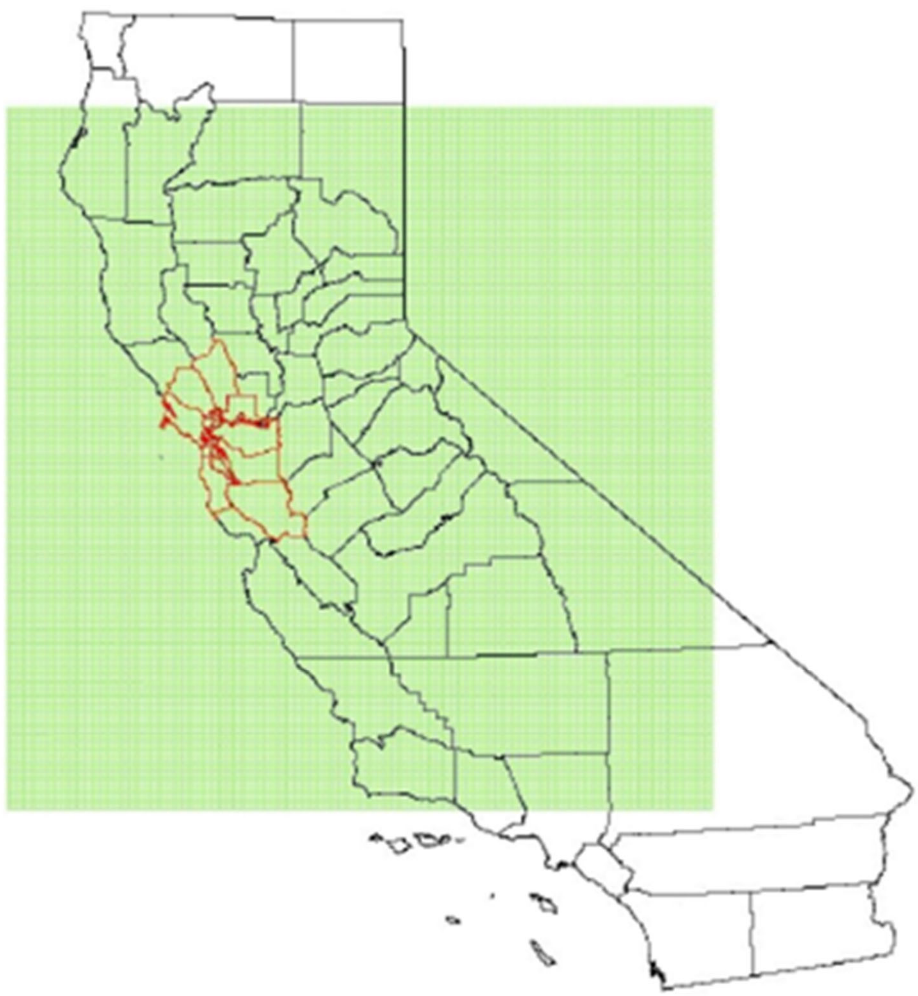
PGM INPUTS, OUTPUTS, AND ASSUMPTIONS
MINETA SAN JOSE AIRPORT
SAN JOSE, CALIFORNIA

1. REGIONAL AIR QUALITY MODELING PLATFORM

The Northern California 2012 4-km CAMx modeling database and a projected 2035 emissions database was used in this assessment. The 2012 base case is based on a Photochemical Grid Model (PGM) modeling databases developed by the BAAQMD. This PGM database is tailored for California using California-specific input tools (e.g., the EMFAC[1] mobile source emissions model) and use a high-resolution 4-km horizontal grid to better simulate meteorology and air quality in the complex terrain and coastal environment of California. This contrasts with EPA's national modeling platforms[2] used for national rulemakings (e.g., transport rules such as CSAPR[3] or defining new NAAQS) that use a coarser 12-km horizontal grid resolution.

Details of the model inputs, configuration, and results are presented in Section 2 of this Appendix.

Figure 1-1. Air quality modeling domains for Northern California[4]



[1] https://www.arb.ca.gov/emfac/

[2] https://www.epa.gov/air-emissions-modeling/2014-2016-version-7-air-emissions-modeling-platforms

[3] https://www.epa.gov/csapr

[4] https://ww3.arb.ca.gov/research/cabots/docs/9a-cabots-baaqmd-20170419.pdf

2. REGIONAL GRID MODELING

In this section, we describe the regional PGM modeling setup to assess the impact of the Proposed Project emissions on the ambient Particulate Matter less than 2.5 microns in diameter ($PM_{2.5}$) levels in the region. The 2012 base case modeling databases were developed by the BAAQMD for the Community Multiscale Air Quality (CMAQ) PGM. The CMAQ annual 2012 4-km modeling database and annual 2012 4-km Weather Research and Forecasting (WRF) meteorological model output files were obtained from the BAAQMD. The BAAQMD CMAQ and WRF 2012 4-km data were then processed to obtained 2012 4-km annual PGM modeling database for the Comprehensive Air Quality Model with extensions (CAMx). The following paragraphs described how Ramboll developed the CAMx 2012 4-km annual database used in this study, starting with the BAAQMD CMAQ and WRF 2012 4-km data. Preparation of the Proposed Project emissions inputs for CAMx is discussed in **Appendix A**.

2.1 Model Inputs and Configuration

Ramboll converted the 2012 CMAQ 2-D and in-line point emissions files from BAAQMD to CAMx area-/point-source emissions files using the CMAQ2CAMx interface program[5]. Seasalt emissions were developed using an emissions processor that integrates published sea spray flux algorithms to estimate sea salt PM emissions for input to CAMx. The CAMx sea salt emissions were then merged with area emissions files. We projected CAMx emissions data to 2035 using county, pollutant and source category-specific growth factors derived from ARB's California Emissions Projection Analysis Model (CEPAM) 2016 SIP inventory. CEPAM estimates emissions for a specific year based on growth and control factors. The growth factors account for county-specific economic activity profiles, population forecasts, and other socio/demographic activity. The control factors reflect the effects of adopted emission control rules.

The most commonly used prognostic meteorological models to provide meteorological fields for air quality modeling are the Weather Research and Forecasting (WRF) model (Skamarock et al., 2005) and the Fifth-Generation Mesoscale Model (MM5; Grell et al, 1994). MM5 is a nonhydrostatic, prognostic meteorological model developed in the 1970s by Pennsylvania State University and the National Center for Atmospheric Research (NCAR) and has been widely used for urban- and regional-scale photochemical, fine particulate, and regional haze regulatory modeling studies. However, development of MM5 ceased in 2006, and WRF has become the new standard model used in place of the older MM5 for regulatory air quality applications in the US. Developed jointly by NCAR and the National Center for Environmental Prediction in late 1990s, WRF has been under continuous development, improvement, testing and open peer-review for more than 10 years and used world-wide by hundreds of researchers and practitioners around the globe for a variety of mesoscale studies. BAAQMD adopted WRF version 3.8 for the 2012 simulations. For the current application, the meteorology remains unchanged for the future year simulation and BAAQMD WRF 2012 4-km model outputs were processed using the WRFCAMx[6] processor to generate the meteorological fields ready for CAMx. The WRF model employs a terrain-following coordinate system defined by pressure, using multiple layers that extend from the surface to 50 millibars (approximately 19 kilometers above ground level [AGL]). A layer averaging scheme is adopted for CAMx simulations to reduce the computational burden. **Table 2-1** presents the mapping from the WRF vertical layer structure to the CAMx vertical layers.

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[5] http://www.camx.com/download/support-software.aspx.

[6] WRFCAMx is available on the CAMx website (http://www.camx.com/download/support-software.aspx)

Table 2-1 Vertical layer structure for WRF and CAMx modeling.

WRF		CAMx			
Layer	**Height (m)**	**Layer**	**Height (m)**	**Thickness (m)**	**Sigma**
50	19260	28	19260	2625	0.0000
49	16635				
48	14423				
47	12436	27	12436	1849	0.1339
46	10587				
45	9234				
44	8100	26	8100	960	0.3119
43	7140				
42	6324				
41	5629	25	5629	594	0.4630
40	5034				
39	4524				
38	4086	24	4086	376	0.5806
37	3710				
36	3387				
35	3097	23	3097	261	0.6668
34	2835				
33	2600				
32	2389	22	2389	191	0.7341
31	2198				
30	2028				
29	1873	21	1873	139	0.7863
28	1735				
27	1609				
26	1497	20	1497	102	0.8261
25	1396				
24	1304	19	1304	87	0.8471
23	1217				
22	1133	18	1133	81	0.8661
21	1052				
20	974	17	974	75	0.8840
19	899				
18	827				
17	758	16	758	66	0.9088
16	692	15	692	64	0.9165
15	628				
14	566	14	566	59	0.9312
13	507	13	507	57	0.9382
12	450	12	450	53	0.9450
11	398	11	398	50	0.9513
10	348	10	348	46	0.9573
9	302	9	302	44	0.9629
8	258	8	258	40	0.9682
7	218	7	218	38	0.9731
6	180	6	180	36	0.9777
5	144	5	144	32	0.9821
4	112	4	112	31	0.9861
3	81	3	81	29	0.9899
2	52	2	52	27	0.9935
1	25	1	25	25	0.9969
0	0	0	0	0	1.0000

The lateral boundary conditions (BCs) for the 4-km state-wide modeling grid were extracted from a global model simulation for the year 2012. The Model for Ozone and Related Chemical Tracers Version 4 (MOZART-4; Emmons et al., 2010) is a global chemical transport model developed jointly by NCAR, the Geophysical Fluid Dynamics Laboratory, and the Max Planck Institute for Meteorology, and simulates chemistry and transport of tropospheric gases and bulk aerosols. The MOZART-4 simulation with updated meteorological fields derived from the National Aeronautics and Space Administration's Goddard Earth Observing System Model Version 5 (GEOS-5)[7] were downloaded from the UCAR website[8] and the MOZART2CAMx processor was used to derive both the boundary and the initial conditions for the modeling. Five days of spin-up periods were used for the 4-km grids to minimize the influence of the initial conditions.

Additional data used in the air quality modeling include ozone column data from the Ozone Monitoring Instrument (OMI) which continues the Total Ozone Mapping Spectrometer (TOMS) record for total ozone and other atmospheric parameters related to ozone chemistry (OMI officially replaced the TOMS ozone column satellite data on January 1, 2006). OMI data are available every 24-hours and are obtained from the TOMS ftp site[9]. The CAMx O3MAP program reads the OMI ozone column txt file data and interpolates to fill gaps and generated gridded daily ozone column input data. The OMI data is used in the CAMx (TUV) radiation models which is a radiative transfer model that develops clear-sky photolysis rate inputs for CAMx. The landuse file was generated with the WRFCAMx processor and modified to remove lakes and set coastal waters with a surf zone width of 50 m, this file was used to update the emissions database and provide more realistic representation of sea salt emissions.

Table 2-2 presents the CAMx configuration used for the modeling in this Proposed Project analysis. In the past, the Carbon-Bond IV (CB4) chemical mechanism (Gery et al., 1989) has been predominantly used for the California State Implementation Plan (SIP) SIP modeling. In 1999, however, California Air Resources Board's (CARB's) Reactivity Scientific Advisory Committee recommended switching to the 1999 State-wide Air Pollution Research Center (SAPRC99) chemical mechanism (Carter, 2000) based on a comprehensive review by Stockwell (1999), and SAPRC99 has since been the mechanism of choice for the California SIPs. The 2007 update to the SAPRC chemistry mechanism, called SAPRC07 (Carter, 2010), replaced the dated SAPRC99 mechanism. The version implemented in CAMx is SAPRC07TC, which includes additional model species to explicitly represent selected toxics and reactive organic compounds and uses numerical expressions of rate constants that are compatible with the current chemistry mechanism solver. The partitioning of inorganic aerosol constituents (sulfate, nitrate ammonium and chloride) between gas and aerosol phases is performed using the ISORROPIA module. The SOAP semi-volatile equilibrium scheme performs the organic aerosol-gas partitioning. These processes are described in more detailed in the CAMx user guide.

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[7] http://www.acd.ucar.edu/wrf-chem/mozart.shtml

[8] https://www.acom.ucar.edu/wrf-chem/mozart.shtml

[9] ftp://toms.gsfc.nasa.gov/pub/omi/data/

Table 2-2. CAMx modeling configuration.		
Science Option	**Configuration**	**Notes**
Model Code	CAMx v6.5	Released April 2018
Horizontal Grid	4-km 1-way nesting	
O3 and PM 4-km	185 x 185 grid cells	
Vertical Grid	28 vertical layers extending up to ~19 km AGL	Collapsed from 50 WRF/MM5 layers (see Table 3-1)
Initial Conditions	Extracted from the MOZART global model outputs	5-day spin-up for 4-km domain
Boundary Conditions	Extracted from the MOZART global model outputs	Boundary concentration set for 4-km domain extracted using MOZART2CAMx
Photolysis Rate	Photolysis rates lookup table	Derived from satellite measurements and TUV processor
Gas-phase Chemistry	SAPRC07TC	Solved by the Euler Backward Iterative (EBI) solver
Aerosol-phase Chemistry	ISORROPIA (inorganic aerosol) SOAP v2.1 (organic aerosol)	
Meteorological Input Preprocessor	WRFCAMx v4.7	
Advection	Piecewise Parabolic Method (PPM)	
Diffusion	Eddy diffusion algorithm	

2.2 Model Results

The future modeling scenario was simulated using the CAMx source apportionment technology. Both cumulative concentrations from all the sources and the concentrations from Proposed Project-specific emissions are derived from a single simulation following the previous section model configuration. The model results of hourly $PM_{2.5}$ concentrations were processed into aggregated metrics that are relevant to health effects.

The metrics relevant to the $PM_{2.5}$ health effects selected in this study are 24-hour annual average concentrations (see **Appendix C**). **Figure 2-1** shows spatial plots of annual average and a single day episode maximum 24-hour average $PM_{2.5}$ concentrations from the base case. In the base case, the central portion of California shows annual $PM_{2.5}$ concentrations between 10 and 15 $\mu g/m^3$ with isolated regions in Glenn and Butte county that could reach up to 20 $\mu g/m^3$. Contributions of the Proposed Project emissions to annual average $PM_{2.5}$ are about 0.139 $\mu g/m^3$ at the most impacted areas and contributions to the maximum 24-hour average are less than 0.5 $\mu g/m^3$ at the most impacted areas. The largest impact for the maximum 24-hour average episode represents only 2 percent of the total $PM_{2.5}$ at that location. **Figure 2-2** presents increases in annual average and maximum 24-hour average $PM_{2.5}$ due to the Project by $PM_{2.5}$ component at the grid cell of maximum impact. It confirms that the $PM_{2.5}$ increases due to the Project are mostly due to primary PM components.

Figure 2-1. Results of the 4 km $PM_{2.5}$ Modeling Domain

$PM_{2.5}$ Concentrations from the Base Case Scenario (left panels);
Increases in $PM_{2.5}$ due to the Proposed Project (center and right panels);
Annual Averages (top panels);
Maximum 24-hour Averages (bottom panels)

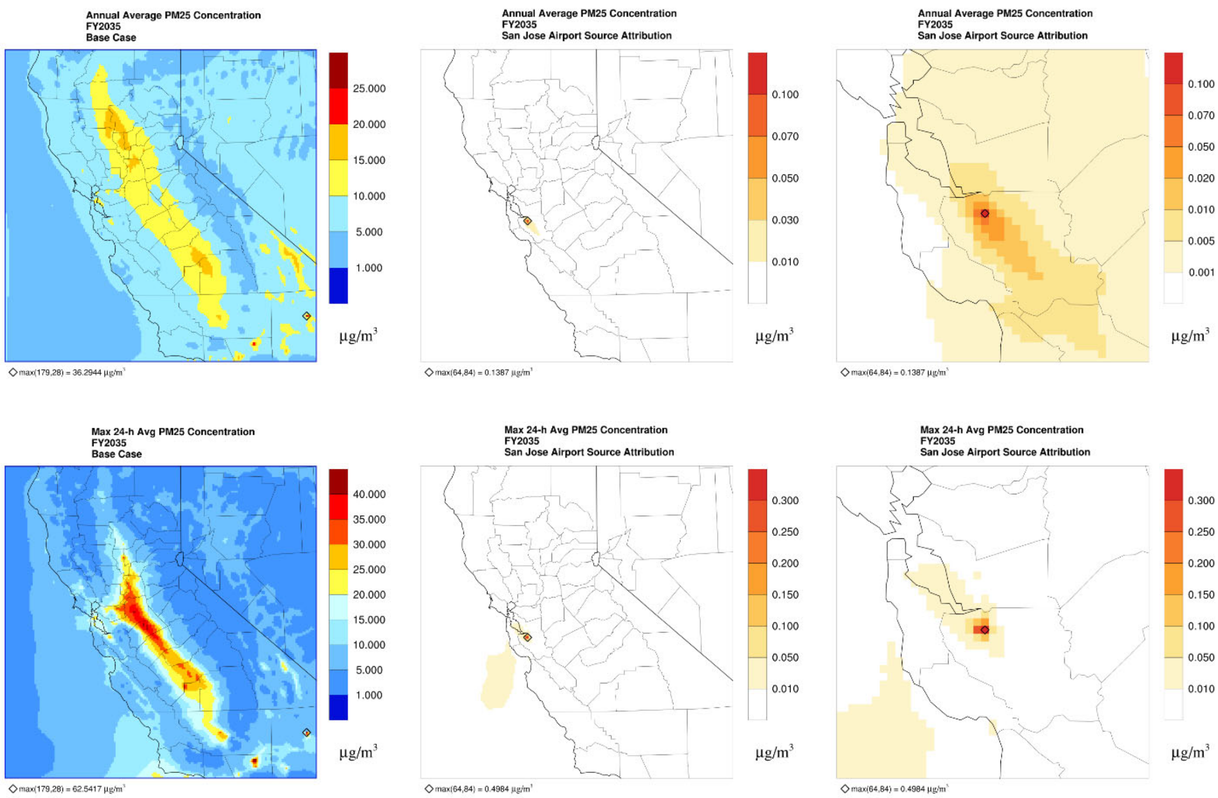
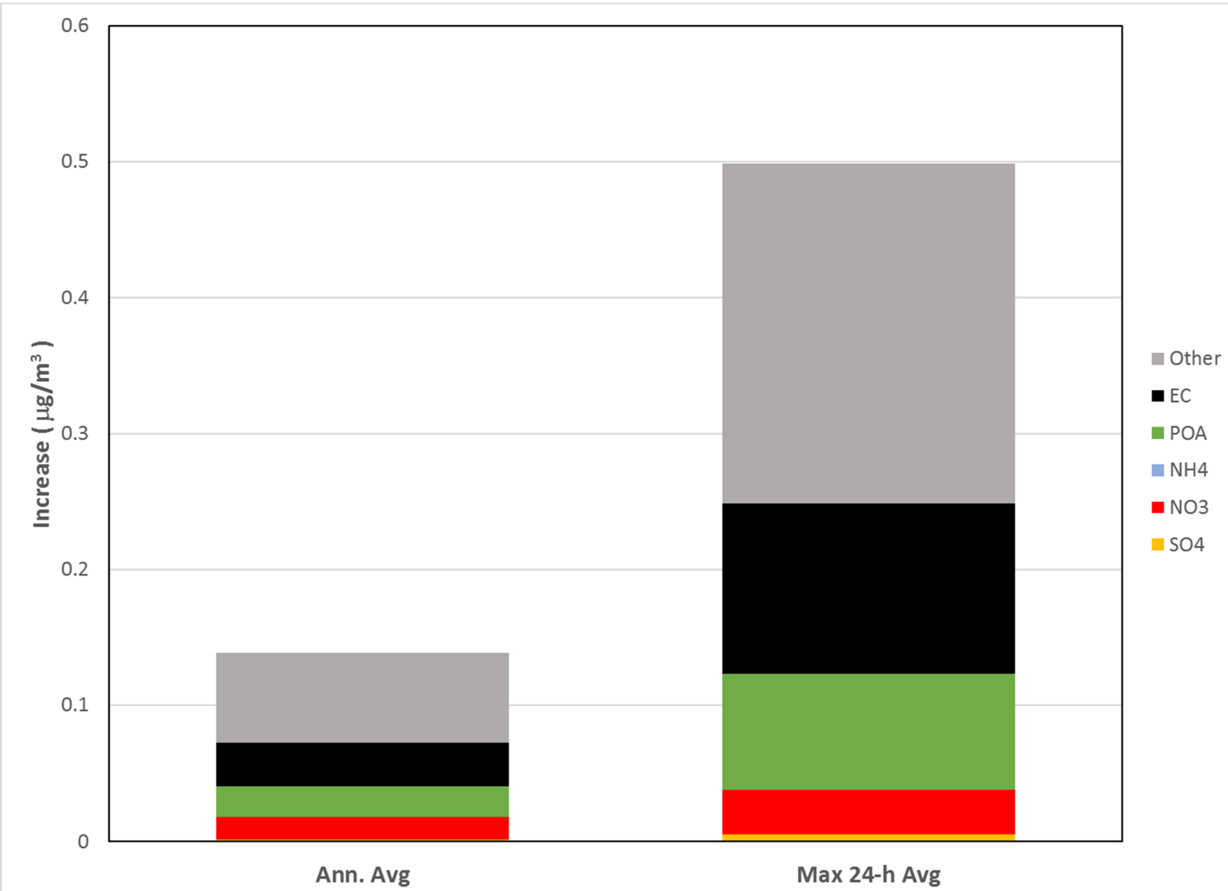


Figure 2-2. Increases in Annual Average and Episode Maximum 24-hour Average $PM_{2.5}$ Concentrations due to the Proposed Project by $PM_{2.5}$ Component: fine particulate sulfate (SO4), nitrate (NO3), ammonium (NH4), primary organic aerosol (POA), elemental carbon (EC), and other primary PM (Other); Where the Maximum Impact of the Proposed Project's Emissions Occurred



The metrics relevant to the ozone health effects selected in this study are consistent with the ozone NAAQS (see **Appendix C**). The model provides hourly concentrations that are further post-processed to produce maximum daily average 8-hour (MDA8) ozone concentrations for each day. **Figure 2-3** displays spatial plots of the annual highest MDA8 ozone for the 2035 emissions scenario and the increases in highest MDA8 ozone concentrations due to the Proposed Project's emissions. In the 2035 base case emissions scenario, Alameda, Santa Clara, San Mateo and Santa Cruz counties show the highest MDA8 ozone concentration between 70 and 80 ppb with isolated regions, mostly in Santa Clara County, of up to 85 ppb. The maximum increase in the highest MDA8 ozone concentrations due to the Proposed Project is 1.86 ppb and occurs in Santa Clara County.

Figure 2-4 displays MDA8 ozone for the base case and increases in MDA8 ozone due to the Proposed Project on August 14th, the day that the Proposed Project has the highest ozone contribution. The highest MDA8 ozone contribution due to the Project is 1.87 ppb (Figure 2-4, right) that occurs in central Santa Clara county, near to the location of the San Jose Airport.

Figure 2-3. Highest MDA8 Ozone Concentrations from the Base Case Scenario (left) and Increases in Highest MDA8 Ozone Concentrations due to the Proposed Project (right) for the Annual Modeling of the 2035 Emissions Scenario

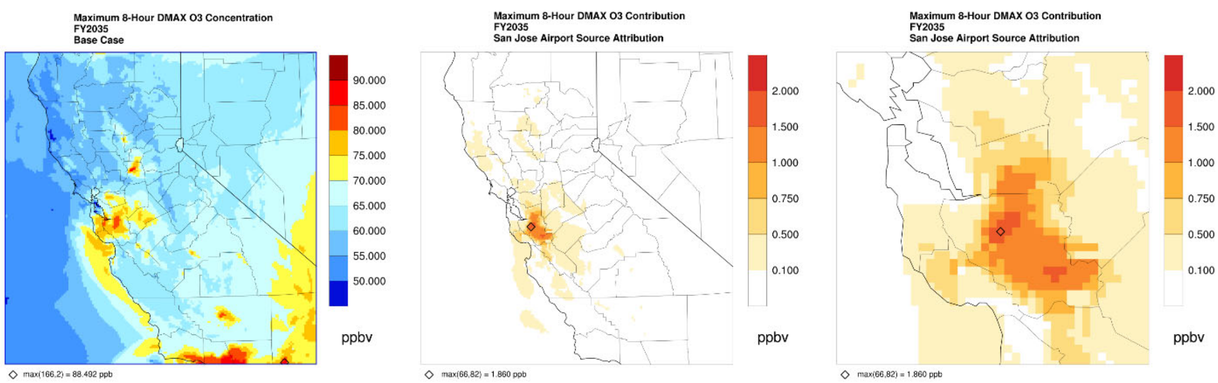
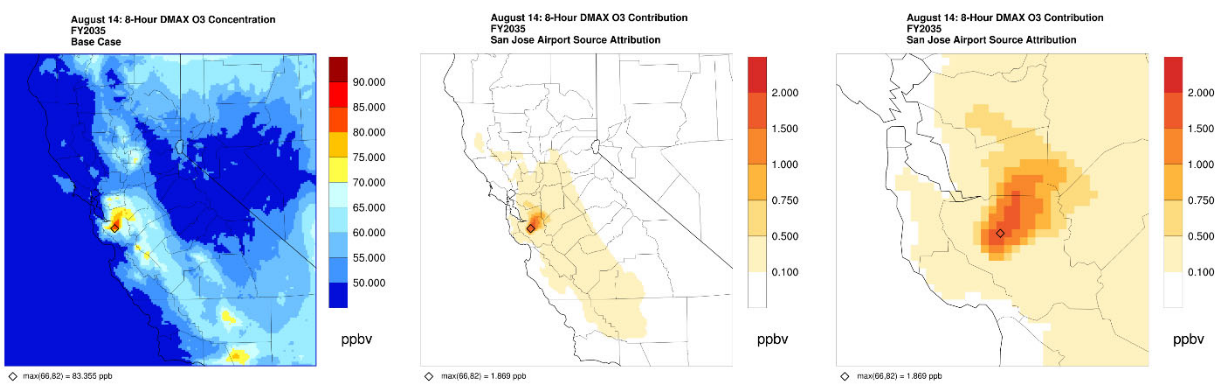


Figure 2-4. MDA8 Ozone Concentrations from the Base Case Scenario (left) and Increases in MDA8 Ozone Concentrations due to the Proposed Project (right) on August 14, the Day with the Highest Proposed Project Ozone Contributions for the Annual Modeling of the 2035 Emissions Scenario



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APPENDIX C

BENMAP AND HEALTH OUTCOMES
MINETA SAN JOSE AIRPORT
SAN JOSE, CALIFORNIA

1. HEALTH IMPACT ANALYSIS

The potential health effects of ozone and Particulate Matter less than 2.5 microns in diameter ($PM_{2.5}$) concentrations due to the Proposed Project's emissions were estimated using the Environmental Benefits Mapping and Analysis Program (BenMAP), Community Edition v1.4 (July 2018).[1] BenMAP, originally developed by the United States Environmental Protection Agency (USEPA), is a powerful and flexible tool that helps users estimate human health impacts and economic benefits resulted from changes in air quality. BenMAP outputs include PM- and ozone-related health endpoints such as premature mortality, hospital admissions, and emergency room visits. BenMAP uses the following simplified formula to relate changes in ambient air pollution to certain health endpoints (AAI, 2018)[2]:

$$\text{Health Effect} = \text{Air Quality Change} \times \text{Health Effect Estimate} \times \text{Exposed Population} \times \text{Background Health Incidence}$$

- Air Quality Change - The difference between the starting air pollution level (the base) and the air pollution level after some change, such as a new source.
- Health Effect Estimate - An estimate of the percentage change in an adverse health effect due to a one unit change in ambient air pollution. Effect estimates, also referred to as concentration-response (C-R) functions, are obtained from epidemiological studies.
- Exposed Population - The number of people affected by the air quality change. The government census office is a good source for this information. This analysis uses data from PopGrid, which is an add-on program to BenMAP that allocates the block-level U.S. Census population to a user-defined grid.[3]
- Background Health Incidence - An estimate of the average number of people that die (or suffer from some adverse health effect) in a given population over a given period of time. For example, the health incidence rate might be the probability that a person will die in a given year. Health incidence rates and other health data are typically collected by the government as well as the World Health Organization.

The health endpoints analyzed in this study and the BenMAP results are presented in Section 2 of this appendix.

2. HEALTH IMPACT ANALYSIS

This section presents the health impact of the Proposed Project emissions on the population in the Northern California domain, estimated by the BenMAP model. The Comprehensive Air Quality Model with extensions (CAMx) modeling results are processed to generate aggregated daily averages $PM_{2.5}$ and maximum daily 8-hour ozone appropriate for various health endpoints. The CAMx simulation results from the full year (January to December) are used to estimate the health effects of $PM_{2.5}$ and ozone. BenMAP translates increases in the pollutant concentration due to the Proposed Project emissions to changes in the incidence rate for each health effect using a C-R function derived from previously published epidemiological studies. BenMAP often provides multiple C-R functions based on

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1 http://www.epa.gov/air/benmap/

2 The common function used for calculating health impacts is the following log-linear function: Health Effect = Background Health Incidence x [1 – exponential (Health Effect Estimate * Air Quality Change)] x Exposed Population

3 https://www.epa.gov/benmap/benmap-community-edition

different epidemiological studies for a given health endpoint. We used the USEPA default C-R functions when evaluating health impacts. This analysis uses population data from PopGrid, which allocates the census population to each modeled 4x4 kilometer (km) grid cell.

The population used for both the quantified health effects and the background health incidence presented here is future year 2037, for consistency with the Proposed Project buildout year. This is conservative compared to utilizing a 2035 population that would have been consistent with the CAMx model year.

2.1 $PM_{2.5}$ Health Impact

Although there are a large number of potential health endpoints that could be included in the analysis as described above, we selected the key health endpoints that have been the focus of recent United States Environmental Protection Agency (USEPA) risk assessments (e.g., USEPA, 2010; USEPA, 2014). For example, the USEPA notes that health endpoints were selected based on consideration of at-risk populations (e.g. asthmatics), endpoints that have public health significance, and endpoints for which information is sufficient to support a quantitative concentration-response relationship (USEPA, 2014).

The health endpoints and associated C-R functions examined in this study are presented in **Table 2-1**. Each C-R function is based on a certain age range for the given health endpoint depending on the underlying epidemiological study on which it is based. Increases in the BenMAP-estimated health effect incidences and percent of background health incidence due to the Proposed Project emissions are presented in **Table 2-2.** These values reflect the total health impact across the Northern California domain.

Table 2-1. Summary of $PM_{2.5}$ Health Endpoints Used in this Study

Health Endpoint	Age Range	Daily Metric	Seasonal Metric	Annual Metric	C-R Function Selected
Emergency Room Visits, Asthma	0-99	24-hr mean			Mar et al., 2010[1]
Mortality, All Cause	30-99	24-hr mean	Quarterly mean	Mean	Krewski et al., 2009[1]
Hospital Admissions, Asthma	0-64	24-hr mean	-	-	Sheppard, 2003[1]
Hospital Admissions, All Cardiovascular (less Myocardial Infarctions)	65-99	24-hr mean	-	-	Bell, 2012[1]
Hospital Admissions, All Respiratory	65-99	24-hr mean	-	-	Zanobetti et al., 2009[1]
Acute Myocardial Infarction, Nonfatal	18-24	24-hr mean	-	-	Zanobetti et al., 2009[1]
Acute Myocardial Infarction, Nonfatal	25-44	24-hr mean	-	-	
Acute Myocardial Infarction, Nonfatal	45-54	24-hr mean	-	-	
Acute Myocardial Infarction, Nonfatal	55-64	24-hr mean	-	-	
Acute Myocardial Infarction, Nonfatal	65-99	24-hr mean	-	-	

[1] C-R functions available in BenMAP (AAI, 2018)

The results show that the highest impact is for all-cause mortality, with an estimated mean increased incidence of 4.46 deaths per year due to the Proposed Project emissions. Smaller mean increased incidences per year were estimated for other relevant $PM_{2.5}$-related health outcomes: 1.89 increase in incidence of asthma related emergency room visits, 0.80 increase in incidence of respiratory hospital admissions, and 0.41 increase in incidence of cardiovascular hospital admissions.

It should be noted, however, that the estimated increased incidence in those health effects are quite minor compared to the background health incidence values (shown in **Table 2-2** as percent of Background Health Incidence). For example, for mortality, the increase of 4.46 deaths per year due to Proposed Project emissions represents 0.0017% of the total all-cause mortality for people ages 30 to 99.

Table 2-2. BenMAP-Estimated Mean $PM_{2.5}$ Health Effects of the Proposed Project Emissions Across the Northern California Domain[1]

Health Endpoint[2]	Incidences (Mean)	Percent of Background Health Incidence (%)
Emergency Room Visits, Asthma [0-99]	1.89	0.0016%
Mortality, All Cause [30-99]	4.46	0.0017%
Hospital Admissions, Asthma [0-64]	0.15	0.0011%
Hospital Admissions, All Cardiovascular (less Myocardial Infarctions) [65-99]	0.41	0.00027%
Hospital Admissions, All Respiratory [65-99]	0.80	0.00060%
Acute Myocardial Infarction, Nonfatal [18-24]	0.00022	0.00077%
Acute Myocardial Infarction, Nonfatal [25-44]	0.012	0.00078%
Acute Myocardial Infarction, Nonfatal [45-54]	0.030	0.00071%
Acute Myocardial Infarction, Nonfatal [55-64]	0.058	0.00083%
Acute Myocardial Infarction, Nonfatal [65-99]	0.21	0.00072%

[1] Health effects are shown terms of incidences of each health endpoint and how it compares to the base (2037 base year health effect incidences) values.

[2] Affected age ranges are shown in square brackets.

2.2 Ozone Health Impact

As noted above, although a larger number of health endpoints could be evaluated, we selected the health endpoints based on recent USEPA risk assessments (USEPA, 2010; USEPA, 2014). The health endpoints and associated C-R functions examined in this study are presented in **Table 2-3.** Each C-R function is associated with a certain age range for the given health endpoint depending on the epidemiological study on which it is based. Increases in the BenMAP-estimated health effect incidences and percent of background health incidence due to the Proposed Project emissions are presented in **Table 2-4.** These values reflect the total health impact in California across the Northern California domain.

Table 2-3. Summary of Ozone Health Endpoints Used in this Study.

Health Endpoint	Age Range	Daily Metric	Seasonal Metric	Annual Metric	C-R Function Selected
Hospital Admissions, All Respiratory	65 - 99	MDA8	-	-	Katsouyanni et al., 2009[1]
Mortality, Non-Accidental	0 - 99	MDA8	-	-	Smith et al., 2009[1]
Emergency Room Visits, Asthma	0 - 17	MDA8	-	-	Mar and Koenig, 2009[1]
Emergency Room Visits, Asthma	18 - 99	MDA8	-	-	Mar and Koenig, 2009[1]

[1] C-R functions available in BenMAP (AAI, 2018)

For the Proposed Project, asthma-related emergency room visits are associated with the highest health impacts due to the Proposed Project emissions in the Northern California domain (14.59 incidences per year for adults ages 18 to 99 and 11.05 incidences per year for children ages 0 to 17). Hospital admissions due to respiratory issues for adults age 65-99 and non-accidental mortality have lower incidence increases (2.07 and 1.11 incidences per year, respectively).

It should be noted, however, that the estimated increases in those health effect incidences are quite minor compared to the background health incidence (shown in **Table 2-4** as percent of Background Health Incidence). For example, the increase in asthma emergency room visits represents 0.028% of the total asthma-related emergency room visits for children.

Table 2-4. BenMAP-Estimated Mean Ozone Health Effects of the Proposed Project Emissions Across the Northern California Domain[1]

Health Endpoint[2]	Incidences (Mean)	Percent of Background Health Incidence (%)
Hospital Admissions, All Respiratory [65-99]	2.07	0.0016%
Mortality, Non-Accidental [0-99]	1.11	0.00062%
Emergency Room Visits, Asthma [0-17]	11.05	0.028%
Emergency Room Visits, Asthma [18-99]	14.59	0.019%

[1] Health effects are shown terms of incidences of each health endpoint and how it compares to the base (2037 base year health effect incidences) values.

[2] Affected age ranges are shown in square brackets.

2.3 Conclusion

The $PM_{2.5}$ and ozone concentration changes modeled by CAMx were converted to impacts on various health endpoints including premature mortality, hospitalizations, and emergency room visits, using the BenMAP health impact assessment model and USEPA defaults for health endpoints. Estimated changes in the health effect incidences are presented across the grids in the Northern California domain. Across the board, the estimated increases in those health effect incidences are quite minor compared to the background health incidence values with the largest $PM_{2.5}$ health impact (all-cause mortality) representing only 0.0017% of the total of all deaths, and the largest impact for ozone (asthma related emergency room visits by adults) representing 0.019% of all emergency room visits. For the $PM_{2.5}$-related health endpoints, the health impact on mortality is the highest (Incidence = 4.46). For ozone-related health endpoints, asthma-related emergency room visits are most affected (Incidence = 14.59 for adults ages 18 to 99 and Incidence = 11.05 for children ages 0 to 17). Other health effect incidences are lower. When taken into context, the small increase in incidences and the very small percent of the number of background incidences indicate that these health impacts are negligible in a developed, urban environment.

Uncertainty

The approach and methodology of this analysis ensures that the uncertainty is of a conservative nature. In addition to the conservative assumptions built into the emissions noted above, there are a number of assumptions built into the application of C-R functions in BenMAP that may lead to an overestimate of health impacts. For example, for all-cause mortality impacts from $PM_{2.5}$, these estimates are based on a single epidemiological study that found an association between $PM_{2.5}$ concentrations and mortality. While similar studies suggest that such an association exists, there remains uncertainty regarding a clear causal link. This uncertainty stems from the limitations of epidemiological studies, such as inadequate exposure estimates and the inability to control for many factors that could explain the association between $PM_{2.5}$ and mortality such as lifestyle factors like smoking. Several reviews have evaluated the scientific evidence of health effects from specific particulate components (e.g., Rohr and Wyzga 2012; Lippmann and Chen, 2009; Kelly and Fussell, 2007). These reviews indicate that the evidence is strongest for combustion-derived components of PM including elemental carbon (EC), organic carbon (OC) and various metals (e.g., nickel and vanadium), however, there is still no definitive data that points to any particular component of PM as being more toxic than other components. The USEPA has also stated that results from various studies have shown the importance of considering particle size, composition, and particle source in determining the health impacts of PM (USEPA, 2009). Further, USEPA (2009) found that studies have reported that particles from industrial sources and from coal combustion appear to be the most significant contributors to PM-related mortality, consistent with the findings by Rohr and Wyzga (2012) and others. This is particularly important to note here, as the majority of PM emissions generated from the Project are from entrained roadway dust (see Appendix A), and not from combustion. Therefore, by not considering the relative toxicity of PM components, the results presented here are conservative.

Another uncertainty highlighted by the USEPA (2012) which applies to potential health impacts from both $PM_{2.5}$ and ozone, is the assumption of a log-linear response between exposure and health effects, without consideration for a threshold below which effects may not be measurable. The issue of a threshold for $PM_{2.5}$ and ozone is highly debated and can have significant implications for health impacts analyses as it requires consideration of current air pollution levels and calculating effects only for areas that exceed threshold levels. Without consideration of a threshold, effects of any change in air pollution below or above the threshold are assumed to impact health. Although the USEPA traditionally does not consider thresholds in its cost-benefit analyses, the NAAQS itself is a health-based threshold level that the USEPA has developed based on evaluating the most current evidence of health effects.

As noted above, the health impacts estimation using this method presumes that impacts seen at large concentration differences can be linearly scaled down to small increases in concentration, with no consideration of potential thresholds below which health impacts may not occur. This methodology of linearly scaling impacts is broadly accepted for use in regulatory evaluations and is considered as being health protective (USEPA, 2010). In summary, health impacts presented in this report are conservatively estimated, and the actual impacts may be zero.

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