APPENDIX B.4

Analysis of Models and Tools to Correlate Project-Generated Pollutants to Health End Points

ANALYSIS OF MODELS AND TOOLS TO CORRELATE PROJECT-GENERATED CRITERIA POLLUTANT EMISSIONS TO HEALTH END POINTS

TOOL	*CREATED BY*	*DESCRIPTION*	*RESOLUTION*	*POLLUTANTS ANALYZED*	*PROJECT-LEVEL CEQA APPLICABILITY*
AERMOD Modeling System[1,2]	AERMIC	A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. The modeling system incorporates air dispersion based on a planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.	Project-level	SO_2, ROG, NO_2, Lead, $PM_{2.5}$, PM_{10}, NH_3	This model operates at the project-level and provides air dispersion modeling of a project's pollutant emissions on the surrounding environment. However, even with supplementary (i.e. additional) software, such as the California Air Resource Board's Hotspots Analysis and Reporting Program (HARP), the model does not estimate specific health effects on receptors from the air dispersion modeling (that is, it is not scientifically feasible to infer individualized health effects on receptors from the pollutant concentrations identified by this model, even in conjunction with other software such as HARP). Moreover, concentration modeling of ozone is not possible with AERMOD (nor any other known model used in conjunction with AERMOD), due to the complex nature of pollution concentration formation and numerous regional influences (multiple emission sources, meteorology, atmospheric chemistry and geography). Therefore, this model is not recommended for correlating project-generated criteria pollutant emissions to health end points.
AirCounts[3]	Abt Assoc.	Online tool that helps large and medium-sized cities quickly estimate the health benefits of $PM_{2.5}$ emission reductions and economic value of those benefits. The tool estimates the number of deaths (mortality) avoided and economic value related to user-specified regional, annual $PM_{2.5}$ emissions reduction.	City-level	Primary $PM_{2.5}$	This tool is only illustrative, as it is limited to certain cities and does not target specific sectors. The tool is not sector-specific, and includes limited California data. It cannot provide results at a development project level. Therefore, the tool is not recommended for project-level CEQA analysis.
Air Pollution Emission Experiments and Policy analysis	Mueller and Mendelsohn 2006, 2009	The Air Pollution Emission Experiments and Policy (APEEP) analysis model (Muller and Mendelsohn 2006, 2009) is a traditional integrated assessment model. Like other integrated assessment models, APEEP connects emissions of air pollution through air-quality modeling to exposures, physical effects, and monetary damages.	National or county-level	SO_2, ROG, NO_x, Ozone, $PM_{2.5}$, PM_{10}	The model operates at the national scale but may be applied at the county-level (although it is not clear how this adjustment should be made). It cannot provide results at a development project-level. The tool is also not commercially available. Therefore, the tool is not recommended for project-level CEQA

[1] See: https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models
[2] Note: May require additional software to estimate the level of each specific pollutant at the modeled receptors.
[3] See: https://www.abtassociates.com/tools

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(APEEP) model[4]		Making these links requires the use of findings reported in the peer-reviewed literature across several scientific disciplines. The air-quality models in APEEP use the emission data provided by EPA to estimate corresponding ambient concentrations in each county in the coterminous states.			analysis.
California Emissions Estimator Model® (CalEEMod)	California Air Pollution Control Officers Association (CAPCOA)	CalEEMod is a statewide land use emissions computer model designed to provide a uniform platform for government agencies, land use planners, and environmental professionals to quantify potential criteria pollutant and greenhouse gas (GHG) emissions associated with both construction and operations from a variety of land use projects.	Project-level	SO_2, ROG, NOx, CO, GHGs, $PM_{2.5}$, PM_{10}	Although CalEEMod is useful in comparing a project's emissions to significance thresholds, it is not able to assess transport of pollutants or the impacts of external factors (weather, terrain, etc.) on pollutant concentrations at particular locations. Therefore, this model is not recommended for estimating the health effects of project-generated criteria pollutants.
CALINE3/ CAL3QHC/ CAL3QHCR[1, 2]	United States Environmental Protection Agency (USEPA)	A steady-state Gaussian dispersion model designed to determine air pollution concentrations at receptor locations downwind of highways located in relatively uncomplicated terrain. CALINE3 is incorporated into the more refined CAL3QHC and CAL3QHCR models. CAL3QHCR is a more refined version based on CAL3QHC that requires local meteorological data.	Project-level	SO_2, ROG, NO_2, Lead, $PM_{2.5}$, PM_{10}	This model operates at the project level and provides air dispersion modeling for a project's transportation emissions on the surrounding environment. However, even with supplementary (i.e. additional software), the model cannot estimate specific health effects on receptors from the air dispersion modeling. Moreover, it cannot model the (complex) chemical reactions that occur between the ozone precursors (e.g. NOx and ROG) that generate ozone. Therefore, this model is not recommended for correlating project-generated criteria pollutant emissions to health end points.
Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations (CTDMPLUS)[1, 2]	USEPA	A refined point source gaussian air quality model for use in all stability conditions for complex terrain. The purpose of the model is to provide a practical, refined plum model for elevated point sources near complex terrain.	Project-level	SO_2, ROG, NO_2, Lead, $PM_{2.5}$, PM_{10}	This model operates at the project-level and provides air dispersion modeling for a project's emissions on the surrounding environment. However, even with supplementary (i.e. additional software), the model cannot estimate specific health effects on receptors from the air dispersion modeling. Moreover, it cannot model the (complex) chemical reactions that occur between the ozone precursors (e.g. NOx and ROG) that generate ozone. Therefore, this model is not recommended for correlating project-generated criteria pollutant emissions to health end points

[4] See: https://public.tepper.cmu.edu/nmuller/APModel.aspx

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Comprehensive Air Quality Model with Extensions (CAMx)[5]	Ramboll	CAMx is a multi-scale, three dimensional photochemical grid model. A photochemical grid model is a computer model designed for simulating air pollution episodes. CAMx is designed for computing hourly ozone concentrations at the regional, mesoscale, and urban scales for periods ranging from days up to months.	Regional, county, or city-levels	Ozone, CO, and secondary PM	CAMx is intended to accurately depict the ways in which air pollution forms, accumulates, and dissipates. However, it cannot provide results at a project-level.
Co-Benefits Risk Assessment (COBRA)[6]	USEPA	Preliminary screening tool that contains baseline emission estimates of a variety of air pollutants for a single year. COBRA is targeted to state and local governments as a screening assessment for clean energy policies. EPA's CO–Benefits Risk Assessment (COBRA) screening model is a free tool that helps state and local governments: • Explore how changes in air pollution from clean energy policies and programs; • Estimate the economic value of the health benefits associated with clean energy policies and programs to compare against program costs; • Map and visually represent the air quality, human health, and health-related economic benefits from reductions in emissions of particulate matter ($PM_{2.5}$), sulfur dioxide ($S0_2$), nitrogen oxides (NO_X), ammonia (NH_3), and volatile organic compounds (VOCs) that result from clean energy policies and programs.	National, regional, state, or county-levels	$PM_{2.5}$, SO_2, NO_x, NH_3, and ROG	COBRA is a preliminary screening tool only and cannot be used at sub-county resolution. It cannot provide results at a project-level. It also does not account for secondary emission changes resulting from market responses. Accordingly, the tool is not recommended for project-level CEQA analysis.
Environmental Benefits and Mapping Program-Community Edition (BenMAP-CE)[7]	USEPA	The USEPA's detailed model for estimating the health impacts from air pollution. It relies on input concentrations and applies concentration-response (C-R) health impact functions, which relate a change in the concentration of a pollutant with a change in the incidence of a health endpoint, including premature mortality, heart attacks, chronic respiratory illnesses, asthma exacerbation and other adverse health effects. Detailed inputs are required for air quality changes (concentrations from AERMOD), population, baseline incidence rates, and effect estimates.	National, County, City, and population levels	Ozone, PM, NO_2, SO_2, CO	This model provides an estimate of and characterizes the general impacts to health functions that relate change in health outcomes (coughs, asthma incidences, premature mortality) that change with small changes in ambient air concentrations. However, this model cannot provide results at a project-level. Accordingly, the tool is not recommended for project-level CEQA analysis.

[5] See: https://www3.epa.gov/scram001/7thconf/information/camx.pdf
[6] See: https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool
[7] See: https://www.epa.gov/benmap

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Fast Scenario Screening Tool (TM5-FASST)[8]	Joint Research Centre (Italy)	A tool that allows users to evaluate how air pollutant emissions affect large scale pollutant concentrations and their impact on human health (mortality and years of life lost) and crop yield from national to regional air quality policies, such as climate policies. The target policy domains are national to regional air quality policies, or air pollutant scenarios linked to other policy domains (e.g. climate policy). The tool is web-based and does not require coding or modelling. Users must gain access through publishers.	Global and national-levels	$PM_{2.5}$, Ozone, NO_x, NH_3, CO, ROG, CH_4, SO_2	This tool is applicable at national to global scales. It cannot provide results a project-level. Accordingly, the tool is not recommended for project-level CEQA analysis.
Hotspots Analysis and Reporting Program (HARP)	California Air Resources Board (CARB)	The Hotspots Analysis and Reporting Program (HARP) is a software suite that addresses the programmatic requirements of the Air Toxics "Hot Spots" Program (Assembly Bill 2588). HARP incorporates the information presented in the 2015 Air Toxics Hotspots Program Guidance Manual for Preparation of Health Risk Assessments. HARP can be used by the air pollution control and air quality management districts (districts), facility operators and other organizations or individuals to promote statewide consistency, efficiency and cost-effective development of facility emission inventories and conducting health risk assessments.	Statewide, Air District, and Project-levels	$PM_{2.5}$, PM_{10}, air toxics, TACs, Ozone, NO_2, CO, SO_2	This model operates at the project-level and provides the ability to combine air dispersion modeling data (e.g. from AERMOD) to conduct health risks assessments and assessment of pollutant concentrations at receptors surrounding a project. This model is often used in conjunction with AERMOD (to incorporate air dispersion modeling data provided by AERMOD). However, the model does not estimate specific health effects on receptors from the air dispersion modeling (that is, it is not scientifically feasible to infer individualized health effects on receptors from the pollutant concentrations identified by this model, even in conjunction with other software such as AERMOD). Moreover, scientifically valid modeling of ozone concentrations is not possible with HARP (nor any other known model used in conjunction with HARP), due to the complex nature of pollution concentration formation and numerous regional influences (multiple emission sources, meteorology, atmospheric chemistry and geography). Therefore, this model is not recommended for estimating the health effects of project-generated criteria pollutants.
Human Exposure Model (HEM)	USEPA	The HEM is used primarily for performing risk assessments for sources emitting air toxics to ambient air. The HEM only addresses the inhalation pathway of exposure, and is designed to predict risks associated with chemicals emitted into the ambient air (i.e., in the vicinity of an emitting facility but beyond the facility's property	Project-level	SO_2, ROG, NO_2, Lead, $PM_{2.5}$, $PM_{10,}$ NH_3	This model does not estimate specific health effects on receptors (that is, it is not scientifically feasible to infer individualized health effects on receptors from the pollutant concentrations identified by this model. Moreover, scientifically valid modeling of ozone concentrations is not possible with HEM, due to the

[8] See: http://tm5-fasst.jrc.ec.europa.eu/

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		boundary). The HEM provides ambient air concentrations, as surrogates for lifetime exposure, for use with unit risk estimates and inhalation reference concentrations to produce estimates of cancer risk and noncancer hazard, respectively, for the air toxics modeled.			complex nature of pollution concentration formation and numerous regional influences (multiple emission sources, meteorology, atmospheric chemistry and geography). Therefore, this model is not recommended for estimating the health effects of project-generated criteria pollutants.
Long-range Energy Alternatives Planning System-Integrated Benefits Calculator (LEAP-IBC)[9]	Climate and Clean Air Coalition (CCAC)	A calculator that allows users to rapidly estimate the impacts of reducing emissions on health, climate, and agriculture. The tool uses sensitivity coefficients that link gridded emissions of air pollutants and precursors to health, climate and agricultural impacts at a national level. The tool is primarily used for policy analysis. The tool is currently Excel-based and is available through the developers only. A web-based interface is currently under development.	National-level	$PM_{2.5}$, Ozone, NO_2	This tool is applicable at national scale. Accordingly, the tool is not recommended for project-level CEQA analysis.
Methodology for Estimating Premature Deaths Associated with Long-Term Exposure to Fine Airborne Particulate Matter in California[10]	CARB	The staff report identifies a relative risk of premature death associated with $PM_{2.5}$ exposure based on a review of all relevant scientific literature, and a new relative risk factor was developed. This new factor is a 10% increase in risk of premature death per 10 $\mu g/m^3$ increase in exposure to $PM_{2.5}$ concentrations (uncertainty interval: 3% to 20%)	National	$PM_{2.5}$	The primary author of the CARB staff report notes that the analysis method is not suited for small projects and may yield unreliable results due to various uncertainties. The tool also cannot provide results on a project-level. Accordingly, the tool is not recommended for project-level CEQA analysis.
Multi-Pollutant Evaluation Method (MPEM)[11]	Bay Area Air Quality Management District (BAAQMD)	Estimates the impacts of control measures on pollutant concentration, population exposures, and health outcomes for criteria, toxic, and GHG pollutants. Monetizes the value of total health benefits from reductions in $PM_{2.5}$, ozone, and certain carcinogens, and the social value of GHG reductions. MPEM was designed for development of a Clean Air Plan for the San Francisco Bay Area. The inputs are specific to the SF region and are not appropriate for projects outside BAAQMD.	Regional level in the SFBAAB	Ozone, PM, air toxics, GHG	This tool is designed to support the BAAQMD in regional planning and emissions analysis within the San Francisco Bay Area Air Basin (SFBAAB). The model applies changes in pollutant concentrations over a four-square kilometer grid. The tool also cannot provide results on a project-level. Additionally, this tool is only applicable for the SFBAAB. Accordingly, the tool is not recommended for project-level CEQA analysis. This project is also not

[9] See: https://www.ccacoalition.org/en/resources/long-range-energy-alternatives-planning-integrated-benefits-calculator-leap-ibc-factsheet

[10] See: https://ww3.arb.ca.gov/research/health/pm-mort/pmmortalityreportfinalr10-24-08.pdf

[11] See: http://www.baaqmd.gov/~/media/files/planning-and-research/plans/2017-clean-air-plan/mpem_nov_dec_2016-pdf.pdf?la=en

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					recommended for projects outside of the SFBAAB.
Offshore and Coastal Dispersion Model Version 5 (OCD)[1, 2]	USEPA	A straight-line Gaussian model developed to determine the impact of offshore emissions from point, area or line sources on the air quality of coastal regions. OCD incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shoreline. Hourly meteorological data are needed from both offshore and onshore locations.	Project-level	SO_2, ROG, NO_2, Lead, $PM_{2.5}$, PM_{10}	This model operates at the project-level and provides air dispersion modeling for a project's emissions on the surrounding environment. However, even with supplementary (i.e. additional software), the model cannot estimate specific health effects on receptors from the air dispersion modeling. Moreover, it cannot model the (complex) chemical reactions that occur between the ozone precursors (e.g. NOx and ROG) that generate ozone. This tool is used to address offshore emissions on coastal regions and is not appropriate for project-level CEQA analysis for inland locations.
Response Surface Model (RSM)-based Benefit-per-Ton Estimates[12]	USEPA	Consists of tables reporting the monetized $PM_{2.5}$-related health benefits from reducing $PM_{2.5}$ precursors from certain source types nationally and for 9 US cities/regions. Applying these estimates simply involves multiplying the emissions reduction by the relevant benefit per-ton metric. The resulting value is the PM mortality risk estimate at a 3% discount rate.	National or regional (San Joaquin County only) levels	SOx, VOC, NH_3, NO_x	RSM includes regional values specific to San Joaquin County and does not address development project-scale emissions. The values are also outdated. Accordingly, the tool is not recommended for project-level CEQA analysis.
Sector-based Benefit-per-Ton Estimates[13]	USEPA	Two specific sets of Benefit-per-ton (BPT) estimates for 17 key source categories are available. Both are a reduced-form approach based on BenMAP modeling. Applying these factors involves multiplying the emissions reduction (in tons) by the relevant benefit (economic value) or incidence (rates of mortality and morbidity) per-ton metric. The resulting value is the economics, mortality, and morbidity of direct and indirect $PM_{2.5}$ emissions.	National-scale	$PM_{2.5}$, SO_2, NO_x	The BPT estimates do not account for project-specific emissions or receptor locations, local dispersion characteristics, or regional photochemistry. The resultant health effects are therefore reflective of national averages and would not reflect localized conditions necessary to address impacts at the project-level. Accordingly, the tool is not recommended for project-level CEQA analysis.

[12] See: https://www.epa.gov/benmap/response-surface-model-rsm-based-benefit-ton-estimates

[13] See: https://www.epa.gov/benmap/sector-based-pm25-benefit-ton-estimates. The updated Technical Support Document (February 2018) is available at: https://www.epa.gov/sites/production/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf