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Prepared By
Ramboll Environ US Corporation
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AIR QUALITY TECHNICAL REPORT

BIOSOLIDS DIGESTER FACILITIES PROJECT DRAFT EIR

RAMBOLL ENVIRON

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ACRONYMS AND ABBREVIATIONS

AERMOD	Atmospheric Dispersion Modeling System
AQTR	Air Quality Technical Report
ARB	Air Resources Board
aREL	Acute Reference Exposure Level
ASF	Age Sensitivity Factor
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
BDFP	Biosolids Digester Facilities Project
CalEEMod®	California Emission Estimator Model
Cal/EPA	California Environmental Protection Agency
CAPCOA	California Air Pollution Control Officer's Association
CAPs	Criteria Air Pollutants
CEQA	California Environmental Quality Act
CER	Conceptual Engineering Report
CO_2e	Carbon Dioxide Equivalents
CPF	Cancer Potency Factor
CRAF	Cancer Risk Adjustment Factor
cREL	Chronic Reference Exposure Level
CRRP	Community Risk Reduction Plan
DEIR	Draft Environmental Impact Report
DPM	Diesel Particulate Matter
DPF	Diesel Particulate Filters
EMFAC2014	Emissions Estimator Model (2014 version)
GHG	Greenhouse Gas
g/s	Gram Per Second
HHDT	Heavy-Heavy Duty Trucks
HI	Hazard Index
HP	Horsepower
HRA	Health Risk Assessment
HQ	Hazard Quotient
IARC	International Agency For Research On Cancer
KM	Kilometer

lbs	Pounds
LCFS	Low Carbon Fuel Standard
MEI	Maximally Exposed Individual
MEISR	Maximally Exposed Individual Sensitive Receptor
MHDT	Medium Heavy Duty
MT	Metric Tons
NED	National Elevation Dataset
NOP	Notice of Preparation
NO_X	Nitrogen Oxides ($NO + NO_2$)
NSR	New Source Review
OEHHA	Office of Environmental Health Hazard Assessment
$PM_{2.5}$	Particulate Matter Less Than 2.5 Micrometers in Aerodynamic Diameter
PM_{10}	Particulate Matter Less Than 10 Micrometers in Aerodynamic Diameter
REL	Reference Exposure Level
RMP	Risk Management Policy
ROG	Reactive Organic Gas
SEP	Southeast Water Pollution Control Plant (or Southeast Plant)
SF DOE	San Francisco Department of Environment
SF DPH	San Francisco Department of Public Health
SFEP	San Francisco Planning Department’s Environmental Planning
SFPUC	San Francisco Public Utilities Commission
SSIP	Sewer System Improvement Program
TACs	Toxic Air Contaminants
THC	Total Hydrocarbon
TOG	Total Organic Gases
TSD	Technical Support Document
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VDEC	Verified Diesel Emission Control Strategy
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
WHO	World Health Organization
yr	Year
$\mu g/m^3$	Microgram per Cubic Meter

1. INTRODUCTION

At the request of ESA+Orion, Ramboll Environ US Corporation ("Ramboll Environ," formerly ENVIRON International Corporation) prepared this air quality technical report (AQTR) to analyze criteria air pollutants (CAPs), greenhouse gases (GHGs), and toxic air contaminants (TACs), as well as local health impacts, associated with the proposed San Francisco Public Utilities Commission (SFPUC) Biosolids Digester Facilities Project (BDFP) in San Francisco, CA ("Project" or the "Site"). This analysis is being performed to support the Project's California Environmental Quality Act (CEQA) documentation and per the request of the San Francisco Planning Department's Environmental Planning (SFEP) Division. This report comprises the complete Cumulative Health Risk Assessment (HRA) documentation to satisfy SFEP requirements for CEQA analyses.

This report discusses the construction and operational emissions sources, methodology for calculating emissions, methodology for calculating the health risk, and the cumulative risk results of the HRA.

1.1 Project Understanding

SFPUC proposes to replace existing facilities at the Southeast Water Pollution Control Plant (SEP). As described in the Notice of Preparation (NOP) and Project Description of the Draft Environmental Impact Report (DEIR), the Project would construct new solids treatment, odor control, energy recovery, and associated facilities as part of improvements to the wastewater treatment facilities at the SFPUC's SEP, which is located in the Bayview District of San Francisco. The proposed Project is identified in the SFPUC's Sewer System Improvement Program (SSIP), a 20-year, multi-billion dollar citywide investment to upgrade the aging sewer infrastructure to ensure a reliable and seismically safe system.

The existing digesters at the SEP are over 60 years old and are operating well beyond their useful life which requires significant maintenance. The SFPUC is proposing new facilities to provide a modern and efficient solids treatment system to ensure treatment reliability, maintain regulatory compliance, protect public health and safety, meet current seismic standards, and provide advanced odor control.

Since the SEP facilities were constructed, newer and more efficient wastewater treatment technologies have been developed. The SFPUC plans to construct new solids treatment facilities including new digesters, an odor control facility, and an energy recovery system. Compared with the existing processes, these future facilities would produce a higher quality and reduced volume of biosolids which have a beneficial reuse (e.g., for soil conditioning or fertilizer), capture and treat odors more effectively, and maximize biogas[1] use for production of heat, steam, and energy at the SEP.

1.1.1 Construction

The Project would require demolition of currently occupied structures owned by the SFPUC and located within the SEP boundaries, including office trailers, a service building, pump stations, and an electrical substation. The Project would also demolish buildings and belowground structures not owned by SFPUC at two areas within the Project site (referred to as the Central Shops and the Asphalt Plant) and at a potential staging site at 1550 Evans Avenue. New solids treatment facilities including new digesters, an odor control facility, and an energy recovery building would then be constructed. The Project would also require up to

[1] Biogas is a byproduct of the bacterial digestion process and comprised mostly of methane and carbon dioxide (CO_2).

12 acres for equipment staging and construction employee parking. SFPUC has identified three potential construction staging areas: Pier 94/96 Staging Areas (including Pier 94 Backlands, Pier 94, and Pier 96), 1550 Evans Avenue, and the site of the Southeast Greenhouses. **Figure 1: Project Site** shows the current SEP boundary, the Project boundary, and the potential construction staging locations.

The Piers 94/96 Staging Areas are located about one mile northeast of SEP and would require minimal construction activities.[2] The 1550 Evans Avenue property potential staging area may require demolition of the two current buildings located on the property and paving on areas currently landscaped. As part of a separate project, the existing buildings at the Southeast Greenhouses site will be removed prior to implementation of the Project; thus, construction emissions from the demolition of the Southeast Greenhouses are not included in this analysis. Since it has not yet been determined which of these areas would be utilized, construction emissions from the 1550 Evans Avenue and Piers 94/96 Staging Areas are taken into account in the CAP and GHG emissions analysis as a conservative measure. Additionally, emissions from the potential construction activities at the 1550 Evans Avenue property were conservatively included in the HRA analysis, based on the close proximity to sensitive receptors; this is further discussed in **Section 2.1** and **Section 4** below. Traffic emissions from deliveries to and from the staging areas are discussed further in **Sections 2.1.3** and **2.1.4** below.

The Project would be constructed over a five-year period (60 months), with approximately 260 working days per year[3] (see ***Table 1*** below*)*. Following substantial completion and sludge introduction into the system, the contractor and SFPUC personnel would conduct performance testing for six months, described in **Section 1.1.2** below.

Table 1. Estimated Project Construction Timeline

Year	Dates	Duration (months)	Activities
Year 1	February 1, 2018 – January 31, 2019	12	Construction Activities (off-road and on-road equipment)
Year 2	February 1, 2019 – January 31, 2020	12	
Year 3	February 1, 2020 – January 31, 2021	12	
Year 4	February 1, 2021 – January 31, 2022	12	
Year 5	February 1, 2022 – January 31, 2023	12	

1.1.2 Operations

Following construction there would be a transition period to phase out existing facilities and bring new facilities online. During the first six months of this transition period, performance testing (start up) of the new facilities would be conducted. After performance testing, the new facilities would then be ready for its intended use and SFPUC would start the full facility commissioning and process stabilization which would last up to approximately two years. During full facility commissioning, both old and new biosolids treatment systems would

[2] Initial planning indicated that SFPUC would install a ¾ inch potable water pipeline for bathroom and kitchen faucets at the Piers 94/96 staging area if this location is available. A 2 feet by 2 feet trench approximately 500-1,000 feet long would be dug to accommodate this pipe. Additionally, 18-foot electric poles with a diameter of 12 inches would be put 5 feet into the ground at the staging area.

[3] The construction would typically occur 5 days per week and Saturdays as needed. Work could occur on Sundays, holidays and 24 hours per day only if needed for critical facility connections.

operate concurrently. As the new systems are tested, stabilized, and optimized, the BDFP would gradually increase its share of the solids treatment, while the old systems would be phased out. Project operations are expected to begin in 2023 ("Project build-out") with full facility commissioning between 2023 and 2025; for purposes of this analysis, Ramboll Environ assumed that the new and old waste gas burners would each combust 50 percent of the biogas production during the six-month period after construction of the Project but prior to the full Project build-out.[4] The performance testing and full facility commissioning period are collectively referred to as the "transition period." After full facility commissioning, operations of the new equipment would largely remain the same over time, with the exception of the future operation of microturbines, which would begin in approximately 2031 in order to accommodate an increased volume of biogas produced and to meet a goal of utilizing 100% of the biogas. Finally, a horizon year of 2045, representing full capacity of the Project, is also analyzed in this report.

1.2 Objective

The purpose of the air quality analysis is to assess potential criteria pollutant and health impacts that would result from construction and operation of the Project, consistent with guidelines and methodologies from the Bay Area Air Quality Management District (BAAQMD), California Air Resources Board (ARB), California Office of Environmental Health Hazard Assessment (OEHHA), and United States Environmental Protection Agency (USEPA). Consistent with the methods recommended in those guidelines, the HRA evaluates the estimated excess lifetime cancer risk, chronic and acute non-cancer hazard indices (HI), and particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$) concentrations from operational and construction activities. The cumulative analysis estimates excess lifetime cancer risks and $PM_{2.5}$ concentrations that are attributable to other mobile and stationary sources within the Project vicinity, in addition to impacts from the Project.

The San Francisco City-wide HRA evaluates the cumulative cancer risks and $PM_{2.5}$ concentrations from existing known sources of air pollution as part of the development of a Community Risk Reduction Plan (CRRP). For the purposes of this report, the database developed for that effort is referred to as the CRRP-HRA. The modeling is documented in *The San Francisco Community Risk Reduction Plan: Technical Support Documentation* (BAAQMD 2012c).

In accordance with CEQA requirements and consistent with the CRRP-HRA, which was developed in consultation with the BAAQMD, this AQTR evaluates:

[4] Performance testing (start up) of the new facilities was modeled in this analysis by assuming that (a) neither the existing cogeneration engines nor the proposed turbine would operate, but that 50 percent of the existing digester gas production would be burned using the existing waste gas burners and 50 percent would be burned through the proposed waste gas burners; and (b) the backup boiler would operate on natural gas instead of digester gas. Full facility commissioning (the period when both existing and project biosolids treatment systems would operate concurrently) was not explicitly modelled since the amount of digester gas (which powers energy recovery equipment and attendant emissions) remains fixed. The assumption that the BDFP facilities would process 100 percent of the digester gas is conservative since NO_x and PM emissions from the project equipment are assumed to be greater than from the existing equipment. Full facility commissioning is expected to be complete in 2025. Although the transition period could last up to three years, emissions modeling was completed only for the performance testing period. Assuming six months of performance testing and six months of full project operation for 2023 is a conservative but realistic scenario that reflects the highest expected emissions for the one year that any performance testing occurs. If the performance testing were to occur over a period longer than six months, emissions would be lower than those presented here. This assumption was based on direction from the BDFP consultant design team.

1. Mass emissions of CAPs from both construction and operational sources (including construction traffic generated from the Project);
2. Excess lifetime cancer risks, non-cancer chronic and acute HI, and $PM_{2.5}$ concentrations from both construction and operational emissions to sensitive off-site populations; and
3. Cumulative excess lifetime cancer risks and $PM_{2.5}$ concentrations to off-site sensitive receptors resulting from the Project in addition to other stationary and mobile emission sources included in the CRRP-HRA model within the vicinity of the Project, and cumulative projects identified in the DEIR as those recently completed, currently under construction or planned to be constructed.

1.3 Methodology

The Project would generate traffic-related and off-road construction emissions as well as stationary sources of operational emissions including biogas turbine(s), future microturbines, boilers, waste gas burners, and an emergency standby diesel generator. Consistent with the CRRP-HRA methodology, Ramboll Environ evaluated cancer risks from TACs, including diesel and gasoline speciated total organic gases (TOG) and Diesel Particulate Matter (DPM), and plant operational TAC emissions, in addition to $PM_{2.5}$ concentrations.

The HRA was conducted consistent with the following guidance:

- Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA 2015);
- BAAQMD Recommended Methods for Screening and Modeling Local Risks and Hazards (BAAQMD 2012a);
- BAAQMD CEQA Air Quality Guidelines (BAAQMD 2012b);
- The San Francisco Community Risk Reduction Plan: Technical Support Documentation, December (BAAQMD 2012c);
- BAAQMD Proposed Health Risk Assessment Guidelines. Air Toxics New Source Review (NSR) program (BAAQMD 2016a); and
- California Air Pollution Control Officer's Association (CAPCOA) Health Risk Assessment for Proposed Land Use Projects (CAPCOA 2009).

Ramboll Environ prepared a Scope of Work for this AQTR which detailed the methods used in this analysis. The Scope of Work was approved by SFEP on July 15, 2015 and is included as Appendix A of the AQTR.

1.4 Report Organization

This technical report is divided into eight sections as follows:

Section 1.0 – Introduction: describes the purpose and scope of this technical report, the objectives and methodology used in this technical report and outlines the report organization.

Section 2.0 – Emission Estimation Methods: describes the methods used to estimate the emissions of CAPs, TACs, and GHGs from the Project.

Section 3.0 – Air Concentration Estimation Methods: discusses the air dispersion modeling, the selection of the dispersion models, the data used in the dispersion models (e.g., terrain, meteorology, source characterization), and the identification of residential and sensitive locations evaluated in this technical report.

Section 4.0 – Risk Characterization Methods: provides an overview of the methodology for conducting the HRA.

Section 5.0 – Results from Project Analysis: presents the average daily and maximum annual CAP emissions, total annual GHG emissions, estimated excess lifetime cancer risks, chronic and acute non-cancer HIs, and $PM_{2.5}$ concentrations for the Project.

Section 6.0 – Results from Cumulative Analysis: summarizes the approach used in the cumulative analysis and presents the estimated cumulative excess lifetime cancer risks, chronic non-cancer HIs, and $PM_{2.5}$ concentrations for the cumulative analysis.

Section 7.0 – Uncertainties: identifies and describes the uncertainties associated with the risk estimates and discusses how these uncertainties may affect the risk assessment conclusions.

Section 8.0 – References: includes a listing of all references cited in this report.

2. EMISSIONS ESTIMATION METHODS

Ramboll Environ evaluated the Project and net incremental (Project minus Existing) CAP, GHG, and TAC construction and operational emissions. **Table 1: Emissions Calculations Methodology** describes the methodology used for calculating the construction and operational emissions.

As detailed below, the Project on-road and off-road construction emissions were calculated using methodology consistent with the 2014 version of the Emissions Estimator Model (EMFAC2014)[5] and the California Emission Estimator Model (CalEEMod®), respectively. Sources of construction emissions are off-gassing from architectural coating and paving, off-road equipment exhaust, and on-road equipment exhaust. All DPM emissions were conservatively assumed to be equal to respirable particulate matter less than 10 micrometer in diameter (PM_{10}) from diesel exhaust. Construction equipment lists and construction traffic data are included in Appendix B.

Project operational emissions were provided by the BDFP consultant design team (Brown and Caldwell, CH2M, and Black & Veatch), with the exception of the turbine emissions, which were calculated with manufacturer-provided emission factors. The operational emissions were calculated based on reasonably foreseeable 2023 and 2045 operating conditions, as provided by the BDFP consultant design team. Historical actual emissions estimates from the BAAQMD for calendar year 2014 were used as an estimate of existing operational emissions for the cogeneration engine and boilers. Existing operational CAP emissions from waste gas burners, which are not included in BAAQMD emissions estimates, were calculated using the volume of biogas sent to the waste gas burners in calendar year 2014 and the BAAQMD emission factors (for nitrogen oxides [NOx] and reactive organic gases [ROG]), as well as the AP-42 emission factors (for PM_{10}). The existing CAP emissions were subtracted from the Project emissions to determine the net change in operational emissions after the Project is in place. This is also discussed further below.

TAC emissions were calculated for both the existing operational sources being replaced by the Project and Project operational sources, and these emissions were used to calculate risks and hazards for both existing and Project scenarios. Net risk and hazards were then calculated, which is discussed further in **Sections 3** and **5** below.

The CAP, GHG, and TAC emissions, discussed below, are analyzed in this report to be consistent with the BAAQMD 2011 CEQA Guidelines. The risk and hazards calculations are based wholly on TAC emissions, including DPM, diesel and gasoline TOG, and plant operational TAC emissions. Only the TAC emissions directly impact the location and magnitude of the Maximally Exposed Individual Sensitive Receptor (MEISR) and Maximally Exposed Individual (MEI)[6], as CAP and GHG emissions are evaluated at regional and global scales, respectively.

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5 Heavy-Heavy Duty Diesel Truck (HHDT) trip counts are not available in EMFAC2014, and thus emission factors in units of emissions per trip could not be calculated. Therefore, idling emissions from HHDT are calculated using the emission factors from CAlEEMod®, which rely on EMFAC2011 data.

6 Long-term health impacts (cancer risk, chronic HI, and $PM_{2.5}$ concentrations) are evaluated at sensitive receptors, and the maximum impact for each is called the MEISR. Short-term health impacts (acute HI) is evaluated for all receptors since it is based on a one-hour exposure; the location of maximum impact is referred to as the MEI.

2.1 Calculation Methodologies for Construction Emissions

2.1.1 Architectural Coating and Asphalt Paving

ROG off-gassing from architectural coating was calculated based on the square footage of the new buildings, an assumed volatile organic compound (VOC) content of the paint, and an application rate, as shown in **Table 2: Architectural Coating Emissions**. The VOC content of the paint is assumed to be consistent with the limits set in BAAQMD Regulation 8, Rule 3 (BAAQMD 2009).

Similarly, ROG off-gassing from paving is calculated based on the paved area, which is assumed to be the Project area minus the building square footages (including the digesters), and the VOC emission factor per acre of parking area, as described in **Table 3: Asphalt Paving Off-Gassing Emissions**. Paving of the areas currently landscaped at the potential staging area at 1550 Evans Avenue is also included in this analysis.

2.1.2 Off-road Equipment

Ramboll Environ received a project-specific construction equipment list provided in the Conceptual Engineering Report (CER), which is included in **Appendix B** (BDFP Consultant Design Team 2015). The BDFP consultant design team also provided additional information on pile driving equipment that was incorporated in this analysis. For construction off-road equipment, including diesel and gasoline fueled equipment, Ramboll Environ used methodologies consistent with CalEEMod® to estimate emissions (CAPCOA 2013). Load factors for each piece of equipment were based on the default load factor in ARB's 2011 Off-Road Equipment Model, which are included in CalEEMod®. The equations used to calculate emissions from off-road equipment are presented in **Table 1**.

CAP and GHG emissions from trenching and excavating at the Piers 94/96 Staging Area and from the potential demolition of two buildings at the 1550 Evans Avenue Staging Area are also included in this analysis and estimated using CalEEMod®. TAC emissions from trenching and excavating activities are not estimated or included in the HRA based on the distance of the Piers 94/96 Staging Area to sensitive receptors; however, TAC emissions from the 1550 Evans Avenue construction activity is included in the HRA based on its close proximity to sensitive receptors.

Consistent with the San Francisco Clean Construction Ordinance (Ordinance No. 28-15) (San Francisco Department of the Environment [SF DOE], SF Department of Public Health [SF DPH], and SF Planning 2015), uncontrolled emissions were calculated assuming Tier 2 emissions standards plus diesel particulate filters (DPFs) for all engines. Two additional scenarios were also calculated for CAP emissions: the first assumes Tier 4 Final Engines on all off-road equipment and renewable diesel[7] in all off-road equipment and on-road haul trucks (All Tier 4 Final Scenario), and the second assumes Tier 4 Final Engines on all equipment with engines greater than or equal to 140 horsepower (hp) and renewable diesel in all off-road equipment and on-road haul trucks (Controlled Scenario). Detailed CAP emissions for each of the three scenarios are presented in **Table 4a: Construction CAP Emissions (Uncontrolled Scenario), Table 4b: Construction CAP Emissions (All Tier 4 Final Scenario)**, and **Table 4c: Construction CAP Emissions (Controlled Scenario)**, respectively. GHG emissions for all scenarios are presented in **Table 5: Construction GHG Emissions.** GHG emissions are the same for all scenarios as additional control devices or

[7] The percent reductions for each pollutant from renewable diesel vary by test conditions. To be conservative, the lowest reduction for each pollutant was chosen independently, as opposed to selecting the results from a single test method. The reductions in on-road emissions from renewable diesel are 1.1% for ROG, 24.5% for PM, and 9.9% for NOx (California Environmental Protection Agency [Cal/EPA] 2015).

higher tier engines do not generally have greater fuel efficiency. TAC emissions were only calculated for the Uncontrolled and Controlled Scenarios, after consultation with the SFEP; these are shown in **Table 6a: Construction TAC Emissions (Uncontrolled Scenario)** and **Table 6b: Construction TAC Emissions (Controlled Scenario)**.

2.1.3 Construction On-road haul trucks and delivery trucks

On-road truck emissions were calculated using monthly vehicle counts and trip lengths provided by the Project's transportation engineer (see **Appendix C**). Haul and delivery trucks trips account for the transportation of equipment, materials, and soil to and from the Project site. Ramboll Environ was provided with various scenarios for the use of staging areas; truck trip lengths would change based on the staging area used. To account for this in the CAP and GHG emissions inventories, Ramboll Environ conservatively assumed that all staging would occur at the Piers 94/96 area, since this area is the furthest from the Project site and thus produces the largest emissions from truck trips. For TAC emissions used in the HRA, it was assumed that half of all staging would occur at the Pier 94/96 Staging Area and half would occur at the Southeast Greenhouses, as indicated by the Project's transportation engineer. Although no staging (for traffic purposes) is explicitly assumed to occur at the 1550 Evans Avenue area, the route to the Piers 94/96 Staging Area passes immediately adjacent to the 1550 Evans Avenue area, and therefore would account for any trips to and from the 1550 Evans Avenue area.

The criteria pollutant emission factors for running emissions were generated with the most recent approved version of ARB's EMission FACtor model (EMFAC2014), approved by the USEPA on December 14, 2015. This version reflects the emissions benefits of ARB's recent rulemakings including on-road diesel fleet rules, Pavley Clean Car Standards[8], and the Low Carbon Fuel Standard (LCFS)[9]. The model also includes updated information on California's car and truck fleets and travel activity. An emission factor profile for Heavy-Heavy Duty Trucks (HHDTs) was conservatively applied to all on-road trucks. CAP and GHG emissions from on-road trucks[10] are included in **Tables 4a – 4c**, and **Table 5**, respectively. TAC emissions from this source are included in **Table 6a – 6b**.

Emissions reported by the model were converted to units of grams of pollutant emitted per vehicle mile traveled (VMT) or trip using the daily VMT or trips. The methodology used to calculate emissions is presented in **Table 1**.

2.1.4 Construction worker commuting vehicles

Monthly worker counts, shuttle bus trips, and trip lengths were provided by the Project's transportation engineer (see **Appendix C**). Shuttle trips account for the transportation of construction workers from the potential off-site parking area to the Project site; the parking area is assumed to be located at Piers 94/96 since this is the furthest potential parking area from the Site and therefore, produces the highest emissions as a conservative estimate. Shuttles are assumed to be 50-passenger buses. Worker counts were converted to number

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8 Assembly Bill 1493 ("the Pavley Standard" or AB 1493) required ARB to, among other things, adopt regulations by January 1, 2005, to reduce GHG emissions from non-commercial passenger vehicles and light-duty trucks of model year 2009 through 2016. More information is available online at: http://www.arb.ca.gov/cc/ccms/ccms.htm.

9 Executive Order S-1-07, the LCFS, issued on January 18, 2007, calls for a reduction of at least 10 percent in the carbon intensity of California's transportation fuels by 2020. More information is available online at: http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

10 On-road construction emissions shown in Tables 4a-4c, 5, and 6 include emissions from haul and delivery trucks as well as construction worker commuting vehicles.

of worker automobile trips using the same methodology applied by the transportation engineer.[11] This method adjusts for alternative transportation (such as public transit) and carpooling (20.2% and 21.9% reductions, respectively (see **Appendix C**). As with on-road trucks, emission factors were taken from EMFAC2014. Worker vehicle emissions were calculated using an emission factor profile for a light-duty auto mix, and shuttles were assumed to be medium-heavy duty trucks (MHDT). CAP and GHG emissions from these on-road vehicles[10] are included in **Tables 4a – 4c** and **Table 5**, respectively. TAC emissions from this source are included in **Table 6a – 6b**.

2.2 Calculation Methodologies for Operational Emissions

As discussed above, Ramboll Environ evaluated the Project and net (Project minus Existing) CAP, TAC, and GHG construction and operational emissions. **Table 7: Emissions Calculation Methods for Existing and Project Operational CAP Emissions** details the source of emission factors used for each piece of equipment for both the existing and Project cases, as well as the calculation methodology for each CAP. **Table 8: Emissions Calculation Methods for Existing and Project Operational TAC Emissions** details the source of emission factors used for each piece of equipment for both the existing and Project cases, as well as the calculation methodology for each TAC.

2.2.1 Existing Stationary Sources

Nine existing permitted stationary sources would be decommissioned as a result of the Project, consisting of a cogeneration engine (Source #10), sludge handling process unit(s) (2 gravity belt thickeners, Source #171, abated by A785 adsorption unit), nine anaerobic digesters (collectively Source #180), two waste gas burners (A7003 and A7004), a sludge dewatering facility (Source #840, abated by A841 and A860 adsorption units), and three hot water boilers (Sources #8201, 8202, and 8203).[12] Actual 2014 emissions calculated by BAAQMD were used as the existing emissions for all of these sources except the two waste gas burners. Emissions from the two waste gas burners are not included in BAAQMD permitted emissions calculations, and therefore had to be calculated separately using 2014 digester gas throughput in order to make a direct comparison between new and existing waste gas burners. Three of the emissions sources that would be removed for this Project are part of the entire Municipal Wastewater Treatment Plant operations, namely the Sludge Handling Process Unit, Anaerobic Digesters, and Sludge Dewatering Facility. The BAAQMD only estimated the total organics emissions from all wastewater treatment plant operations, and did not estimate the emissions for individual operations. Therefore, the emissions associated with Sludge Handling Process Unit, Anaerobic Digesters, and Sludge Dewatering Facility were assumed to be zero for the existing operating scenario. This method is conservative as it leads to lower existing operational emissions and a higher net increase of Project emissions. Existing source CAP emissions are shown in **Table 9: Existing Operational CAP Emissions.**

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[11] Adavant. SEP Biosolids Project VMT v7 for ESA. July 2015.

[12] These sources correspond to the following emission source numbers in the facility's current BAAQMD permit: Source #10, 171, 180, 840, 8201, 8202, and 8203 and Abatement units A785, A7003, A7004, A841, and A860. Waste gas burners are referred to as waste gas flares in the BAAQMD permit. Several other small sources, such as two generators, a storage tank, and steam boilers, were not included in this analysis as they are too small to require an air permit; this is conservative since these emissions would not be subtracted from the Project emissions for the net emissions.

Additionally, non-biogenic GHGs[13] are calculated using 2014 natural gas throughput use in the plant, which is mostly used as a backup in the cogeneration engine. Biogenic GHG emissions are calculated using 2014 digester gas throughput in the cogeneration engine, boilers, and waste gas burners. These emissions are shown in **Table 10: Existing Operational GHG Emissions.**

As described above, existing operational TAC emissions were also calculated; this includes the cogeneration engine, boilers, and the waste gas burners. These emissions are shown in **Table 11: Existing Operational TAC Emissions**.

2.2.2 Project Stationary Sources

The Project includes eight stationary emission sources, consisting of one gas turbine, two backup steam boilers (both standby), one emergency diesel engine, two enclosed waste gas burners (both standby), and two odor control systems. Additionally, the facility is planning to add one standby turbine and four microturbines (three duty/one standby) in the future. For the purpose of this analysis, the future equipment would be accounted for in the 2045 horizon year. Odor control systems are omitted from this analysis as these sources do not emit CAPs, but they are included in the HRA for other types of emissions.

As discussed previously, operations commence in 2023 (except for microturbine operations, which commence in 2031 as discussed in Project Understanding). According to the BDFP consultant design team, there would be a transition period of up to 30 months after construction for all of the equipment in the Project to be brought online and operating normally. For calculation purposes, we assumed that during the first six months neither the existing cogeneration engine nor the Project turbine would be operating, but that 50% of the estimated biogas production in year 2023 (estimated to be equivalent to the 2014 biogas production) would be combusted using the existing waste gas burners, and 50% would be combusted through the new waste gas burners. It is also assumed that the two boilers would operate on natural gas instead of biogas during this time. CAP emissions from this six-month transition period are shown in **Table 12a: Project Operational CAP Emissions for the Transition Period in 2023.** GHG emissions from this transition period are shown in **Table 13a: Project Operational GHG Emissions for the Transition Period in 2023** and TAC emissions from this transition are shown in **Table 16a: Project Operational TAC Emissions for the Transition Period in 2023.**

Full operational emissions are assumed to begin in 2023 (after the six-month transition), and a Project horizon year of 2045 is also included in this analysis. According to the BDFP consultant design team, due to the redundancy built into the system design, not all equipment would be running at full capacity at all times. For example, the boilers, which are back-up systems for the gas turbine, would only operate when the gas turbine is: 1) not operating, 2) being tested, or 3) starting up. Therefore, the BDFP consultant design team provided Ramboll Environ with hours of operation for a typical operational scenario for 2023 and 2045. Ramboll Environ used these hours of operation to calculate emissions for both scenarios, which are shown in **Tables 12b** and **12c: Project Operational CAP Emissions for Full Operation in 2023** and **2045,** respectively and **Tables 13b** and **13c: Project Operational GHG Emissions for Full Operation in 2023** and **2045,** respectively. TAC

[13] ARB defines non-biogenic GHG emissions as CO_2 emissions from the combustion of fossil fuels, CO_2 emissions from use of sorbent, CO_2 emissions from other non-combustion processes covered under Federal Mandatory Greenhouse Gas Reporting requirements (40 CFR Part 98), and the portion of CO_2 from fuels with a fossil and biomass component (i.e., municipal solid waste and tires) that is considered fossil in origin.

emissions for 2023 and 2045 are shown in **Table 16b** and **16c: Project Operational TAC Emissions in 2023** and **2045**, respectively.

2.2.3 Mobile Sources

Based on information provided by the transportation engineer[14], average operational vehicle trips (i.e., biosolids, screenings, and chemical deliveries, as well as worker trips), would change minimally (approximately 3-5 trucks per day increase compared to 2014 conditions) between existing operations and operations after the Project implementation. Based on this information, Ramboll Environ did not calculate emissions from mobile sources due to the minimal increase in truck trips.

2.2.4 Net Operational CAP and GHG Emissions

As discussed above, the Project would replace existing solids processing facilities emissions sources with new equipment. Therefore, total operational emissions associated with the Project are the difference between emissions from the new sources and emissions from existing sources, which would be decommissioned. The estimates for existing sources are actual emissions as calculated annually by the BAAQMD, whereas the Project emissions are based on estimated hours of operations for 2023 and 2045, as well as emission factors from various sources, which are cited in **Appendix D**. A summary of CAP emissions from operations are presented in **Table 14: Summary of Net Operational CAP Emissions**. A summary of GHG emissions from operations are presented in **Table 15: Summary of Net Operational GHG Emissions**.

2.3 Calculation Methodologies for Cumulative DPM and $PM_{2.5}$ Emissions

According to BAAQMD CEQA guidelines, impacts from off-site sources within the "zone of influence" of the off-site MEISR should be evaluated. Consistent with the CRRP methodology, this evaluation accounted for stationary sources (such as diesel-fueled standby emergency generators) surrounding the Project, and major roadways (as defined by BAAQMD with traffic greater than 10,000 vehicles per day) within 1 kilometer (km) (1000 meters). Off-site source impacts for existing off-site sources in the vicinity of the Project (e.g., Interstate 280 and permitted stationary sources such as emergency generators and gasoline stations) have already been incorporated into the CRRP-HRA in 2012. Therefore, these do not need to be calculated.

New sources not included in the CRRP-HRA, however, needed to be calculated and added into this analysis. SFPUC identified 11 on-site SEP projects, in addition to the BDFP, that have either been completed since 2014, that are currently being constructed, or that are planned for construction in the near future; these are referred to as "on-site cumulative sources" and are shown in **Figure 5a: Modeled On-site Cumulative Sources**. As shown in the figure, the projects were grouped into four areas (Area A, Area B, Area C, and Area D) for modeling purposes. This is discussed further in the sections below. Additionally, the SFPUC identified 10 off-site projects within 1 km of the Project that are being constructed or are planned to be constructed in the near future. These projects are referred to as "off-site cumulative sources" and are shown in **Figure 5b: Modeled Off-site Cumulative Sources**; descriptions and modeled construction schedules are shown in **Table 17: Cumulative Projects and Schedules**.

To obtain emissions from the on-site cumulative projects, Ramboll Environ was provided with construction data (i.e, construction schedules, equipment lists, and truck trips) from SFPUC.

[14] Adavant/LCW Consulting. SFPUC BDFP Data for Traffic Analysis rev 3 31 16.xlsx. March 2016.

Ramboll Environ used a screening tool developed for SFPUC to estimate DPM and $PM_{2.5}$ emissions from each of these on-site cumulative projects. This screening tool employs methodologies consistent with CalEEMod® (CAPCOA 2013); based on the assumptions used in this tool (equipment is used for entire length of phase provided and hauling uses default trip lengths), these results should be conservative. Because City-sponsored Projects must comply with the San Francisco Clean Construction Ordinance, Tier 2 engines plus DPF were assumed in the tool. The on-site cumulative construction emissions methodology and emissions are summarized in **Table 18a: Cumulative Project Diesel Particulate Matter (DPM) Emissions** and **Table 18b: Cumulative Project $PM_{2.5}$ Emissions**.

In addition to the construction emissions from on-site cumulative projects, three on-site cumulative projects would have emergency generators as part of project operations. The size of the generators was provided by SFPUC, and, because the generators are smaller than the Project generator, Ramboll Environ assumed emission factors for the generators were compliant with BAAQMD Best Available Control Technology (BACT) emission limits. The on-site cumulative operational emissions methodology and emissions are summarized in **Tables 18a** and **18b**.

For off-site cumulative projects, Ramboll Environ used existing CEQA documentation where available to obtain PM_{10} and $PM_{2.5}$ emissions from the off-site projects; PM_{10} emissions were assumed to be equal to DPM for this analysis. Where this information was not available, Ramboll Environ used construction data provided by SFPUC and the same screening tool described above to estimate emissions. For all San Francisco City-sponsored projects, which are required to comply with the San Francisco Clean Construction Ordinance (SF DOE, SF DPH, and SF Planning 2015), Ramboll Environ assumed Tier 2 engines with DPF, as required. Non-city projects are not subject to the San Francisco Clean Construction Ordinance and thus assume conventional construction equipment without filters, although mitigation measures may be required for these projects as a result of the environmental review process and project approvals. Construction data was not available for the Quint Street Bridge Replacement project; for this project, Ramboll Environ used the Sacramento Road Construction Emissions Model to estimate emissions from a bridge construction project. Finally, CEQA documentation was available for the 1995 Evans Avenue Project; however, construction emissions were not estimated in that documentation. Therefore, Ramboll Environ ran CalEEMod® for the project using the square footage of the new construction, site area, and construction schedule to estimate emissions. The off-site cumulative construction emissions methodology and emissions are summarized in **Tables 18a and 18b**.

3. AIR CONCENTRATIONS ESTIMATION METHODS

Consistent with the CRRP-HRA, the air toxics analysis evaluated excess lifetime cancer risks and $PM_{2.5}$ concentrations from the Project on the surrounding community. Additionally, consistent with the BAAQMD HRA guidelines (BAAQMD 2016a), Chronic and Acute HI for the surrounding community were also calculated for the Project; however, these are not included in the CRRP-HRA. The Project includes construction and operational emissions in 2023 (including the transition period) and 2045 (Project horizon year). Additionally, existing operational emissions were modeled in order to get net risk and hazards; for those sources already included in the CRRP-HRA, the sources were re-modeled in their actual locations[15] and with building downwash to get an adjusted risk. This is discussed further below. Finally, cumulative construction emissions from on-site projects not included in BDFP and off-site projects within 1 km of the Project were included in this analysis.

The methodologies used to evaluate emissions for the Project construction, Project operations, and cumulative HRA were based on the most recent BAAQMD Recommended Methods for Screening and Modeling Local Risks and Hazards (BAAQMD 2012a).

3.1 Chemical Selection

The excess lifetime cancer risk analysis in the HRA was based on DPM concentrations and TOGs from diesel equipment and on-road vehicles during construction,[16] as well as operational TAC emissions from stationary sources.

Diesel exhaust, a complex mixture that includes hundreds of individual constituents (Cal/EPA 1998), is identified by the State of California as a known carcinogen (Cal/EPA 2016). Under California regulatory guidelines, DPM is used as a surrogate measure of carcinogen exposure for the mixture of chemicals that make up diesel exhaust as a whole (Cal/EPA 2016). Cal/EPA and other proponents of using the surrogate approach to quantifying excess lifetime cancer risks associated with the diesel mixture indicate that this method is preferable to use of a component-based approach because it provides a protective approach to estimating health risks. A component-based approach involves estimating risks for each of the individual components of a mixture. Critics of the component-based approach believe it would underestimate the risks associated with diesel as a whole mixture because the identity of all chemicals in the mixture may not be known and/or exposure and health effects information for all chemicals identified within the mixture may not be available. Furthermore, Cal/EPA has concluded that "potential cancer risk from inhalation exposure to whole diesel exhaust would exceed the multi-pathway cancer risk from the speciated components (OEHHA 2003)." These analyses were based on the surrogate approach, as recommended by Cal/EPA.

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[15] In conducting the modeling for the CRRP, BAAQMD modeled all sources at the Southeast Plant at a single point source location. To provide a more accurate reflection of the baseline condition, the impacts from these existing sources at the "single location" were removed from the CRRP and added back in at their actual locations.

[16] Toxicity values for DPM as well as the individual components speciated from diesel TOGs from construction equipment as provided by the BAAQMD are included in Table 12. Both construction and operational diesel emissions were quantified for total hydrocarbons (THC). A conversion factor is used to convert the THC to TOG. See Appendix J of this memorandum or http://www.epa.gov/oms/models/nonrdmdl/p03002.pdf.

Because a surrogate approach has not been recommended for effects from gasoline-fueled equipment or natural gas-fired equipment to Ramboll Environ's knowledge at the time of this report, the component based approach was used to estimate the effects from the gasoline and natural gas equipment. The speciation profile for gasoline was obtained from the BAAQMD Recommended Method for Screening and Modeling Local Risk and Hazards[17] and the speciation profile for natural gas was obtained from the 2015 version of the ARB Organic Profile 719, the organic profile for Reciprocating Internal Combustion Engines that run on Natural Gas.

There is currently no acute non-cancer toxicity value available for DPM. Thus, speciated components of diesel TOGs with acute toxicity values were included in the acute non-cancer hazard analysis. TOGs from gasoline-fueled equipment and on-road vehicles were also speciated and included in the acute non-cancer hazard analysis. Finally, TACs from operational sources at the site were also included.

3.2 Model Selection and Parameters

Consistent with the CRRP-HRA, near-field air dispersion modeling of DPM, $PM_{2.5,}$ gasoline TOGs, and other TACs from Project construction and operational (Project and existing) sources, as well as cumulative sources, was conducted using the USEPA's atmospheric dispersion modeling system (AERMOD) model. For each receptor location, the model generated average air concentrations (or air dispersion factors as unit emissions) that result from emissions from multiple sources.

Air dispersion models such as AERMOD require a variety of inputs such as source parameters, meteorological parameters, topography information, and receptor parameters. When site-specific information was unknown, Ramboll Environ used the same assumptions used in the CRRP-HRA, when available, or the default parameter sets that are designed to produce conservative (i.e. overestimates of) air concentrations.

Meteorological data: Air dispersion modeling applications require the use of meteorological data that ideally are spatially and temporally representative of conditions in the immediate vicinity of the site under consideration. For this HRA, BAAQMD's Mission Bay meteorological data for year 2008 was used, which aligns with the San Francisco CRRP-HRA Methodology (BAAQMD 2012b).

Terrain considerations: Elevation and land use data was imported from the National Elevation Dataset (NED) maintained by the United States Geological Survey (USGS). An important consideration in an air dispersion modeling analysis is the selection of rural or urban dispersion coefficients. Based on the urban area in which the Project site is located, Ramboll Environ used urban dispersion coefficients.

Emission rates: The BDFP construction schedule assumes 5 days/week, one 8-hour work shift and up to 500 workers on-site. However, two work shifts and weekend activities may be necessary to perform critical activities in 2020 through 2022. To account for the potential longer construction days, construction emitting activities were modeled to reflect typical hours of construction, from 7am to 3:30pm (which includes a half hour lunch break), for the entire construction period, except August 2020 through March 2022, when the construction

[17] BAAQMD. Recommended Methods for Screening and Modeling Local Risks and Hazards. May 2011. Table 14. Available online at http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20Modeling%20Approach.ashx?la=en. Accessed September 2015.

emitting activities were modeled for daily construction occurring between 7am to 8pm.[18] Construction may not actually occur with these extended hours during the entire time between August 2020 and March 2020, but this analysis conservatively assumes it will. This is a conservative assumption because the dispersion factors for the 7am to 8pm period are higher at the MEISR than the 7am to 3:30pm period. Operational emissions were assumed to occur 24 hours per day, 7 days per week, and 365 days per year.

Emissions were modeled using the χ/Q ("chi over q") method, such that each phase had unit emission rates (i.e., 1 gram per second [g/s] for volume sources or 1 g/s per square meter [m^2] for area sources), and the model estimated dispersion factors (with units of microgram per cubic meter [$\mu g/m^3$]/[g/s]).

On-site and off-site cumulative source emissions were modeled similarly to Project emissions. On- and off-site cumulative construction was assumed to follow the same construction schedule as the Project typical schedule (7am – 3pm), with the exception of SFPUC Headworks (SEP-1), for which a separate construction schedule was provided by SFPUC (7am – 8pm). Emission rates were calculated separately for each cumulative project by month, according to the schedules shown in **Table 17**. Construction emissions for both on-site and off-site cumulative sources are shown in **Tables 18a** and **Table 18b.** Emission rates for cumulative projects are shown in **Appendix E, Table E-8a through E-8d**.

For annual average ambient air concentrations, the estimated annual average dispersion factors were multiplied by the annual average emission rates. For acute non-cancer hazard analyses, the 1-hour maximum dispersion factor estimates were used. These dispersion factors were multiplied by the maximum 1-hour emission rate. For simplicity, the construction and operational Project models assumed a constant emission rate for every day of the year.

Source parameters: Source location and parameters are necessary to model the dispersion of air emissions. For construction, the duration of the construction period is anticipated to be 60 months. At any given time there would be multiple emissions sources associated with construction equipment within the construction zone. Construction equipment was modeled as an area source encompassing the entire Project site, following CRRP-HRA Methodology. For area source modeling, emissions from equipment were distributed uniformly throughout the area source representing construction of that phase. For the construction dispersion model, emission sources were assumed to have a release height[19] of 5 meters with an initial vertical dimension[20] of 1.4 meters which is consistent with the values used in the CRRP-HRA. An additional area source was added for the 1550 Evans Avenue potential construction staging area with construction activities (demolition and paving) in the close proximity to the Project boundary. The Project boundary and the potential construction staging areas are shown in **Figure 1**. The potential staging area at the Piers 94/96 is not included as a construction area source due to its distance from the Project boundary (and residential receptors) and it's relatively minor construction activity. The Southeast Greenhouses site is also not included as a construction area source since demolition of the greenhouses is a

[18] From August 2020 through March 2022, a second shift of construction will potentially take place at the Project site from 2:30pm to 11pm. Emissions were modeled only until 8pm since it is assumed that the majority of off-road construction equipment will not operate after 8pm, and that work done after 8pm will largely remain indoors.

[19] The release height of a plume is the height above ground that the emissions are released to the atmosphere.

[20] The initial vertical dimension of an area source is defined as the initial spread or loft of the plume from the source.

separate project. However, greenhouse demolition is considered in the cumulative analysis and use of the site as a construction staging area is analyzed for this Project. All of the modeled area sources for construction are shown in **Figure 2: Construction Model Sources**.[21]

Off-site trucks (trucks going to and from construction zones) were modeled as adjacent volume sources, but the initial lateral dimensions were calculated by dividing the width of the roadway by 2.15, consistent with USEPA guidance (USEPA 1995) for modeling adjacent volume sources as a line source. These sources are also shown in **Figure 2**. Details of the construction source parameters to be used for this HRA are presented in **Appendix E, Table E-1: Modeling Parameters for Construction Sources.**

For operation, both the proposed Project operational sources and the existing sources at the facility that would be replaced by the Project were modeled. The locations of the Project stationary sources were provided by the BDFP consultant design team. Existing sources modeled in the CRRP-HRA were modeled from one point source location at the SEP without building downwash (discussed further below). In order to get a more realistic existing emissions baseline, Ramboll Environ re-modeled the existing sources (flares, boilers, and cogeneration engine) that would be replaced as part of the Project, in their actual locations provided by SFPUC and with building downwash. The impacts from these adjusted sources, referred to here as the "adjusted existing sources," were subtracted from the Project source impacts in order to get more realistic net impacts. **Figure 3: Operational Model Sources** shows the modeled locations of the existing flares, boilers, and cogeneration engine, as well as the proposed turbine(s), boilers, waste gas burners, emergency generator, and odor control systems.

Each stationary source was modeled as a point source, with various stack heights, temperatures, velocities, and diameters, as shown in **Appendix E, Table E-2: Modeling Parameters for Existing Operational Sources** and **Table E-3: Modeling Parameters for Project Operational Sources**. The source parameters for the existing operational sources were provided by SFPUC, and Project operational source parameters were provided by BDFP consultant design team (BDFP Consultant Design Team 2015).

Cumulative construction concentrations were modeled using the same assumptions as the Project construction concentrations. **Appendix E, Table E-4: Modeling Parameters for Cumulative Sources** details the modeling parameters used in the cumulative analysis. Cumulative construction schedules used for modeling are shown in **Table 17**.

Building Downwash: Turbulent eddies can form on the downwind side of buildings, and may cause a plume from a stack or point source located near the building to be drawn towards the ground to a greater degree than if the building were not present. This is referred to as the "building downwash" effect. The effect can increase the resulting ground-level pollutant concentrations downwind of a building. Ramboll Environ used the dimensions and locations of nearby buildings, to allow AERMOD to incorporate algorithms to evaluate the downwash effect on point source dispersion. Point sources were only used to model the Project and existing operational emissions sources, so building downwash was only evaluated in the Project operational models. The modeled building locations are presented in **Figure 3**.

[21] Traffic emissions from Amador Street were modeled along Cargo Way, since Cargo Way is not included in the CRRP-HRA. This approximation is conservative since Cargo Way is closer to sensitive receptors impacted by the Project.

Receptors: In order to evaluate health impacts to onsite and off-site receptors, receptors were modeled at locations collocated with the receptors used in the CRRP-HRA and within one kilometer of the Project site. Receptors were modeled at a height of 1.8 meters above terrain height (i.e., the default breathing height for ground-floor receptors) which is consistent with the CRRP-HRA methodology. As discussed previously, maximum average annual dispersion factors were estimated for each receptor location. Modeled receptors are shown in **Figure 4: Modeled Off-site Receptor Locations**. These figures also show sensitive versus non-sensitive receptors, based on publicly available land use/parcel maps.[22]

Modeling Adjustment Factors: OEHHA (2015) recommends applying an adjustment factor to the annual average concentration modeled assuming continuous emissions (i.e., 24 hours per day, 7 days per week), when the actual emissions are less than 24 hours per day and exposures are concurrent with construction and operation activities occurring as part of the Project.

Residents were assumed to be exposed to annual construction emissions (averaged from actual construction hours[23]) and operational emissions 24 hours per day, 7 days per week. This assumption is consistent with the modeled annual average air concentration (24 hours per day, 7 days per week). Thus, the annual average concentration was not adjusted and results are conservative, as discussed further in **Section 7**.

The AERMOD modeling files for the Project construction and operation, adjusted existing operation, as well as cumulative construction and operation, are included in **Appendix F**.

[22] Google Earth Pro.

[23] Construction is assumed to occur up to 8 hours per day for the Project for the entire construction period, except August 2020 through March 2022, when the construction emitting activities were modeled for daily construction occurring between 7am to 8pm.

4. RISK CHARACTERIZATION METHODS

In February 2015, OEHHA released the updated Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA 2015), which combines information from previously-released and adopted technical support documents to delineate OEHHA's revised risk assessment methodologies based on current science. This updated Guidance Manual supersedes the 2003 Guidance Manual (OEHHA 2003) that previously provided methodologies for conducting health risk assessments under the Air Toxics Hot Spots Program (AB2588). The BAAQMD has issued Draft Guidelines on adopting the OEHHA 2015 Guidance Manual; however, the 2015 OEHHA has not yet been formally adopted. This evaluation utilized the 2015 methodology in anticipation of its adoption; details of this methodology are discussed below.[24]

4.1 Sources Evaluated

Ramboll Environ evaluated excess lifetime cancer risks, $PM_{2.5}$ concentrations, and chronic and acute non-cancer health effects for the listed emission sources, which reflect the largest estimated impacts from Project construction and operations.

1. Project construction equipment for the construction duration (February 2018 - January 2023).
2. Project construction traffic emissions, which includes worker trips, shuttle bus trips, vendor trips, and material hauling trips during the duration of construction activities. The transportation engineer provided construction traffic volumes and routes for this source.[25]
3. Project stationary operational sources of emissions, which have been provided by the BDFP consultant design team, with the exception of turbine emissions, which have been recalculated using manufacturer-provided emission factors.
4. Onsite new emissions sources not included in the Project, including the Headworks and other SFPUC projects planned to occur at SEP within the next several years (i.e., onsite cumulative projects).
5. Off-site new emissions sources within 1,000 meters of the Project, not already included in the CRRP-HRA (see **Table 17**).

Current SFPUC onsite operational sources of emissions that would be replaced by the Project were also modeled (as described in **Section 3** above) in order to determine the net risk between existing and proposed Project operations. Additionally, this analysis incorporates estimated risks from the off-site operational emissions sources within a 1,000-meter zone of influence around the Project site, such as Interstate 280, which are included in the CRRP-HRA model.

4.2 Exposure Assessment

Ramboll Environ conservatively modeled all existing CRRP-HRA grid (20-meter spacing) receptors within 1 km of the Project site, Southeast Greenhouses potential staging area, and 1550 Evans Avenue potential staging area. Emissions from the potential off-site staging area located at Piers 94/96 are not included in the HRA modeling since construction activity at the

[24] Note: the health risks associated with naturally occurring asbestos are analyzed in the Hazardous Materials section of the DEIR. Therefore, naturally occurring asbestos analysis is not included in the scope of this air quality technical report.

[25] Adavant. SEP Biosolids Project VMT v11 – CONSTRUCTION DATA ONLY. February 2016.

Piers is less intensive than activity at the other locations, and the Piers are located further from the Project boundary and residential receptors with the largest impacts from the Project. As part of a separate project, the existing buildings at the Southeast Greenhouses site will be removed prior to implementation of the Project; thus, construction emissions from the demolition of the Southeast Greenhouses are not included in this analysis but are considered in the cumulative analysis. Modeled receptors were conservatively evaluated as residents which are expected to have the highest impacts from the Project in this HRA.

Potentially Exposed Populations: This analysis conservatively evaluates the following receptor populations based on OEHHA 2015 guidelines, which are expected to have the highest impacts from the Project:

- **Scenario 1**: 30-year resident commencing[26] at the time of Project construction in 2018 and continuing after construction to include exposure to operational impacts; and
- **Scenario 2**: 30-year resident commencing at the time of Project operations in 2023.

Because the 30-year residential exposure risk (used in both Scenario 1 and 2) also takes into account child exposure parameters, this is a conservative and health protective approach. The residential exposure assumptions are more conservative than those for other sensitive receptor types as residential uses have the longest exposure duration, the highest breathing rate by applicable age group, and the highest exposure frequency and exposure time. A conservative approach of considering all sensitive receptors as residential receptors is used in this portion of the analysis.

Exposure Assumptions: The exposure parameters used to estimate excess lifetime cancer risks for all potentially exposed populations for the construction and operation scenarios for this analysis were obtained using risk assessment guidelines from OEHHA (2015, BAAQMD 2016a), unless otherwise noted, and are presented in **Table 19: Exposure Parameters**.

As discussed above, Project operational conditions were provided by the BDFP consultant design team, along with assumptions for the operational emissions including the 30-month transition period from the existing equipment to Project equipment, full operation of Project equipment in 2023, and a Project horizon year of 2045. The production of biogas, and thus the operational emissions, is projected to increase linearly between these two years. In order to account for this gradual increase in the calculation of risk, the average of 2023 and 2045 emissions was used for the time period between 2023 and 2045, and 2045 emissions were used for 2045 and beyond. This method would overestimate emissions during the beginning of the 2023-2045 span, but would underestimate emissions in the later years, essentially canceling each other out. Further, because emissions are overestimated in earlier years when the exposure assumptions and age sensitivity factors for younger age groups are more conservative and produce higher risks, this method is conservative.

Calculation of Intake: The dose estimated for each exposure pathway is a function of the concentration of a chemical and the intake of that chemical. The intake factor for inhalation, IF_{inh}, can be calculated as follows:

[26] A 30-year lifetime exposure is assumed to begin in the last trimester of pregnancy and continue through the 30-year exposure duration. Scenario 1 lifetime exposure assumes 5 years of construction and 25 years of operations for a total of 30 years.

$$IF_{inh} = \frac{DBR * FAH * EF * ED * CF}{AT}$$

Where:

IF_{inh}	=	Intake Factor for Inhalation (m^3/kg-day)
DBR	=	Daily Breathing Rate (L/kg-day)
FAH	=	Frequency of time at Home (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
AT	=	Averaging Time (days)
CF	=	Conversion Factor, 0.001 (m^3/L)

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

4.3 Toxicity Assessment

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

Following CRRP-HRA methodology for cancer risk calculations, Ramboll Environ included the carcinogenic toxicity for carcinogenic chemicals emitted from onsite stationary sources, DPM from on-road and off-road equipment, and additional organic gases from on-road gasoline-powered vehicles.

Acute and chronic hazard quotient (HQs) calculations for both Project construction and operation utilized toxicity values for chemicals emitted from these same sources. Acute HQ calculations additionally utilized the toxicity values for TACs from speciated diesel TOG for all source categories. This analysis utilizes available toxicity values including inhalation cancer potency factors (CPFs), chronic inhalation reference exposure levels (RELs), and acute RELs approved by Cal/EPA (2016).

Toxicity values are summarized in **Table 20a: Toxicity Values – Construction Sources**, **Table 20b: Toxicity Values – Existing Operational Sources,** and **Table 20c: Toxicity Values – Project Operational Sources**.

4.4 Age Sensitivity Factors

The estimated excess lifetime cancer risks for a resident child were adjusted using age sensitivity factors (ASFs) that account for an "anticipated special sensitivity to carcinogens" of infants and children as recommended in the OEHHA Technical Support Document (TSD) (Cal/EPA 2009) and OEHHA 2015 guidance. Cancer risk estimates were weighted by a factor of 10 for exposures that occur from the third trimester of pregnancy to two years of age and by a factor of three for exposures that occur from two years through 15 years of age. No weighting factor (i.e., an ASF of one, which is equivalent to no adjustment) was applied to ages 16 and older. This approach is consistent with the cancer risk adjustment factor (CRAFs) calculations recommended by BAAQMD (BAAQMD 2010).

As presented in **Table 21: Age Sensitivity Factors**, analyses conducted under the OEHHA 2015 guidance incorporate age groupings that align with the age breakouts discussed for the application of ASFs. Therefore, CRAFs do not need to be calculated as the ASFs can be applied directly to each age grouping. The ASFs used to evaluate off-site child residents as well as off-site 30-year residents under the 2015 OEHHA methodology are summarized in **Table 21**.

4.5 Risk Characterization

4.5.1 Estimation of Cancer Risks

Excess lifetime cancer risks are estimated as the upper-bound incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens. The estimated risk is expressed as a unitless probability. The cancer risk attributed to a chemical is calculated by multiplying the chemical intake or dose at the human exchange boundaries (e.g., lungs) by the chemical-specific CPF.

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

$$Risk_{inh} = C_i \times CF \times IF_{inh} \times CPFi \times (CRAF \text{ or } ASF)$$

Where:

$Risk_{inh}$	=	Cancer Risk; the incremental probability of an individual developing cancer as a result of inhalation exposure to a particular potential carcinogen (unitless)
C_i	=	Annual Average Air Concentration for Chemical i (μg/m^3)
CF	=	Conversion Factor (mg/μg)
IF_{inh}	=	Intake Factor for Inhalation (m^3/kg-day)
CPF_i	=	Cancer Potency Factor for Chemical i (mg chemical/kg body weight-day)$^{-1}$
CRAF or ASF	=	Cancer Risk Adjustment Factor or Age Sensitivity Factor (unitless)

4.5.2 Estimation of Chronic and Acute Non-cancer Hazard Indices

4.5.2.1 Chronic hazard Index (HI)

The potential for exposure to result in adverse chronic non-cancer effects is evaluated by comparing the estimated annual average air concentration (which is equivalent to the average daily air concentration) to the non-cancer chronic reference exposure level (cREL) for each chemical. When calculated for a single chemical, the comparison yields a ratio termed an HQ. To evaluate the potential for adverse chronic non-cancer health effects from simultaneous exposure to multiple chemicals, the HQs for all chemicals are summed, yielding an HI.

$$HQ_i = C_i / cREL_i$$

$$HI = \sum HQ_i$$

Where:

HQ_i	=	Chronic hazard quotient for chemical_i
HI	=	Hazard index
C_i	=	Annual average concentration of chemical_i (μg/m^3)
$cREL_i$	=	Chronic non-cancer reference exposure level for chemical_i (μg/m^3)

4.5.2.2 Acute HI

The potential for exposure to result in adverse acute effects is evaluated by comparing the estimated one-hour maximum air concentration of chemical to the acute reference exposure level (aREL) for each chemical evaluated in this analysis. When calculated for a single chemical, the comparison yields an HQ. To evaluate the potential for adverse acute health effects from simultaneous exposure to multiple chemicals, the HQs for all chemicals are summed, yielding an HI.

$$HQ_i = C_i / aREL_i$$

$$HI = \sum HQ_i$$

Where:

HQ_i	=	Acute hazard quotient for chemical_i
HI	=	Hazard index
C_i	=	One-hour maximum concentration of chemical_i (μg/m^3)
$aREL_i$	=	Acute reference exposure level for chemical_i (μg/m^3)

5. RESULTS FROM PROJECT ANALYSIS

This Section presents the Project CAP emissions as well as Project impact results for off-site residents. Emission calculation methodologies were discussed in **Section 2** above. The risk calculation databases and results are provided in **Appendix G**.

5.1 CAP Emissions

5.1.1 Construction Sources

Tables 4a - 4c show the Uncontrolled scenario, all Tier 4 Final scenario, and the Controlled scenario construction CAP emissions from the Project by year. As discussed above, uncontrolled construction emissions assume Tier 2 + Level 3 Verified Diesel Emission Control Strategy (VDEC), as required by the San Francisco Clean Construction Ordinance for all off-road equipment (SF DOE, SF DPH, and SF Planning 2015). For this analysis, DPF are the Level 3 VDEC, which reduce PM emissions by 85% and ROG emissions by 90%, consistent with CalEEMod® methodology (CAPCOA 2013). As shown in **Table 4a**, during the year of maximum construction emissions, uncontrolled construction emissions are predicted to equal the following: ROG (11 lbs/day, occurs in Year 4); NOx (281 lbs/day, occurs in Year 1); PM_{10} exhaust (1.2 lbs/day, occurs in Year 1); $PM_{2.5}$ exhaust (1.2 lbs/day, occurs in Year 1). The all Tier 4 Final scenario assumes the use Tier 4 Final Engines for all off-road equipment, which satisfies the San Francisco Clean Construction Ordinance requirement for a Level 3 or higher VDEC (SF DOE, SF DPH, and SF Planning 2015); additionally, the all Tier 4 Final scenario assumes renewable diesel is used for all off-road sources and on-road haul trucks. As shown in **Table 4b**, during the year of maximum construction emissions, all Tier 4 Final construction emissions are predicted to equal the following: ROG (13 lbs/day, occurs in Year 4); NOx (57 lbs/day, occurs in Year 1); PM_{10} exhaust (0.62 lbs/day, occurs in Year 1); $PM_{2.5}$ exhaust (0.61 lbs/day, occurs in Year 1). The Controlled scenario assumes all off-road equipment greater than or equal to 140 horsepower are Tier 4 Final Engines and all off-road equipment less than 140 horsepower are Tier 2 engines with a DPF; the Controlled scenario also assumes renewable diesel is used for all off-road sources and on-road haul trucks. As shown in **Table 4c**, during the year of maximum construction emissions, controlled construction emissions are predicted to equal the following: ROG (13 lbs/day, occurs in Year 4); NOx (72 lbs/day, occurs in Year 1); PM_{10} exhaust (0.68 lbs/day, occurs in Year 1); $PM_{2.5}$ exhaust (0.67 lbs/day, occurs in Year 1). As shown above, ROG emissions can be slightly higher for the Controlled cases than for the Uncontrolled cases. This is due to the ROG reduction of 90% that is applied with the use of a DPF in the Uncontrolled case; this reduction is not applied for the Controlled cases as the model used to estimate emissions for Tier 4 Final Engines is reflective of actual predicted emissions. In reality, the ROG emissions from a Tier 4 Final Engine are very similar to a Tier 2 engine + DPF.

5.1.2 Operational Sources

In order to calculate the **net** operational emissions for the Project, Ramboll Environ evaluated both the existing and Project operational emissions. **Table 7** describes the emissions calculation methodology for the existing and Project operational CAP emissions. **Table 9** displays the calculated existing operational CAP emissions by equipment, and **Table 10** shows the calculated existing operational GHG emissions by equipment. As shown in **Tables 9** and **10**, the existing operational CAP and GHG emissions equal the following: ROG (28 lbs/day); NOx (118 lbs/day); PM_{10} (9.3 lbs/day); $PM_{2.5}$ (9.3 lbs/day); non-biogenic carbon dioxide equivalents (CO_2e) (234 metric tons [MT] CO_2e/yr).

Project operational CAP emissions, shown in **Tables 12a – 12c**, include emissions for the transition period in 2023, the full build-out in 2023, and a horizon year of 2045. As shown in **Table 12a** and **13a**, operational CAP and GHG emissions in the 2023 transition period equal the following: ROG (54 lbs/day); NOx (76 lbs/day); PM_{10} (20 lbs/day); $PM_{2.5}$ (20 lbs/day); non-biogenic CO_2e (212 MT CO_2e/yr). When the Project is fully built out and operating in 2023, operational CAP and GHG emissions equal the following (shown in **Table 12b** and **13b**): ROG (11 lbs/day); NOx (128 lbs/day); PM_{10} (25 lbs/day); $PM_{2.5}$ (25 lbs/day); non-biogenic CO_2e (198 MT CO_2e/yr). Finally, operational CAP and GHG emissions in 2045 equal the following (shown in **Table 12c** and **13c**): ROG (3.8 lbs/day); NOx (133 lbs/day); PM_{10} (25 lbs/day); $PM_{2.5}$ (25 lbs/day); non-biogenic CO_2e (207 MT CO_2e/yr).

Net operational CAP emissions are shown in **Table 14** and net operational GHG emissions are shown in **Table 15**. Net emissions in 2045 equal the following: ROG (-24 lbs/day); NOx (14 lbs/day); PM_{10} (16 lbs/day); $PM_{2.5}$ (16 lbs/day); non-biogenic CO_2e (-27 MT CO_2e/yr).

5.2 Risk and $PM_{2.5}$ Results

5.2.1 Off-site Risks and $PM_{2.5}$ Concentrations

A Project MEISR has been identified for both Scenario 1 (Uncontrolled and Controlled) and Scenario 2 for each long-term health impact evaluated. The Scenario 1 Project MEISR (both Uncontrolled and Controlled) is identified as the sensitive receptor location of the maximum net risk: Scenario 1 cancer risks minus the adjusted existing operational risk of sources planned for removal. Similarly, the Scenario 2 Project MEISR is identified as the sensitive receptor location of the maximum net risk: Scenario 2 cancer risks minus the adjusted existing operational risk of sources planned for removal. The cancer risk from Scenario 1 (Uncontrolled) is 4.2 in a million (3.8 from construction and 0.41 from operational), from Scenario 1 (Controlled) is 2.0 in a million (1.7 from construction and 0.31 for operational), and from Scenario 2 is 0.08 in a million (operational only). An adjusted risk of 0.74 in a million from Scenario 1 (Uncontrolled), 0.38 in a million from Scenario 1 (Controlled), and 0.06 from Scenario 2[27] from existing sources planned to be removed as part of the Project was subtracted from the respective Scenario 1 and 2 risks to get total net Project risk of 3.4 in a million for Scenario 1 (Uncontrolled), 1.7 in a million for Scenario 1 (Controlled), and 0.022 in a million for Scenario 2 at the Off-site MEISR.[28] A breakdown of excess lifetime cancer risk from off-road and on-road equipment for construction and each stationary source for operations is shown in **Table 22: Net Project Cancer Risk at Off-site MEISR**.[29]

The total $PM_{2.5}$ concentration at the off-site MEISR location for Project construction is 0.024 μg/m^3 for the Uncontrolled scenario and 0.017 μg/m^3 for the Controlled scenario, as shown in **Table 23a: Chronic and Acute Health Impacts from Project Construction at Off-site MEISR and MEI (Uncontrolled Scenario)** and **Table 23b: Chronic and Acute Health Impacts from Project Construction at Off-site MEISR and MEI (Controlled Scenario)**, respectively. The total $PM_{2.5}$ concentration at the off-site MEISR location for Project operations is 0.39 μg/m^3, as shown in **Table 24: Chronic and Acute Health**

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27 Adjusted cancer risk from existing sources planned to be removed are different for the two scenarios because the exposure parameters for the resident are different based on when the 30-year exposure is assumed to have begun (2018 versus 2023). For Scenario 1, construction occurs for the first five years and operational exposure is 25 years, compared with Scenario 2, which has 30 years of operational exposure.

28 Values presented here are for the sensitive receptor with the highest net project impacts; however, the net impacts vary across all sensitive receptors within 1-km from the Project. The range of net project cancer risk for Scenario 1 (Uncontrolled) is <0.1 to 3.4 in a million and for Scenario 1 (Controlled) is <0.1 to 1.7 in a million. The net project cancer risk for Scenario 2 is <0.1 for all receptors within the 1-km buffer.

29 Results shown are for uncontrolled emissions only.

Impacts from Project Operation at Off-site MEISR and Off-site MEI. The total $PM_{2.5}$ concentration at the off-site MEISR location for the existing stationary sources that would be replaced by the Project is 0.30 µg/m^3; subtracting this from the Project operational $PM_{2.5}$ concentrations gives a net total $PM_{2.5}$ concentration at the off-site MEISR location for Project operations of 0.090 µg/m^3, as shown in **Table 24**.

The Chronic HI at the Project Off-site MEISR associated with Project construction is 0.0049 (Uncontrolled) and 0.0036 (Controlled) and the Chronic HI for Project operations is 0.0067. The Acute HI associated with Project construction is 0.10 (Uncontrolled) and 0.20 (Controlled) and the Acute HI for Project operations is 0.083. As discussed above, ROG emissions can be slightly higher for the Controlled cases than for the Uncontrolled cases; this results in a slightly higher Acute HI for the Uncontrolled Scenario with respect to the Controlled Scenario. The health impacts from Project construction are detailed in **Table 23a-23b** and the health impacts from Project operation are detailed in **Table 24**.

6. RESULTS FROM CUMULATIVE ANALYSIS

6.1 Methodology

A cumulative analysis of all TAC emissions sources within 1,000 feet of the Project boundary is typically required to be evaluated at the MEISR for a Project (BAAQMD 2012b). However, to be consistent with the CRRP methodology, this evaluation includes stationary sources (such as diesel-fueled standby emergency generators) within 1 km (3,280 feet) surrounding the Project, and major roadways (as defined by BAAQMD with traffic greater than 10,000 vehicles per day) within 1 km of the Project.

As discussed above in **Section 2**, the SFPUC has identified several new or planned projects within 1 km of the Project boundary which are not included in the CRRP-HRA database. Eleven of these identified projects are SFPUC-sponsored projects and are located within the SEP plant boundary ("on-site cumulative projects"). In addition, there are 10 more projects that are located outside of the SEP plant boundary, but are within the 1 kilometer buffer ("off-site cumulative projects").

6.1.1 Existing Stationary Sources (from CRRP-HRA)

The risks and $PM_{2.5}$ concentrations provided in the CRRP-HRA database for stationary sources were used to evaluate excess lifetime cancer risks and $PM_{2.5}$ concentrations from other permitted stationary sources within 1 km of the Project. These were first scaled by a factor of 1.3744 to account for the change from OEHHA 2003 to OEHHA 2015 health risk guidelines (ARB Risk Management Policy [RMP], OEHHA 2015). This value was calculated by Ramboll Environ using the OEHHA 2003 and OEHHA 2015 exposure parameters and confirmed by the BAAQMD.[30] The cancer risks and $PM_{2.5}$ concentrations obtained from the CRRP-HRA database for the off-site MEISR location are reported in **Table 26: Cumulative Lifetime Excess Cancer Risk at MEISR** and **Table 27: Cumulative $PM_{2.5}$ Concentration at MEISR**. The range of existing background excess cancer risk at sensitive receptors within 1-km of the Project is from 7 to 143 cases per million, and the range of existing background $PM_{2.5}$ concentration at sensitive receptors is from 8.1 to 10.6 µg/m^3. The predicted excess lifetime cancer risk at the off-site MEISR from existing, neighboring stationary sources is 102 in a million for Scenario 1 (Uncontrolled), 85 in a million for Scenario 1 (Controlled), and 10 in a million for Scenario 2; the $PM_{2.5}$ concentration during construction is 9.1 µg/m^3 (both Uncontrolled and Controlled) and 8.9 µg/m^3 during operations.

6.1.2 New Stationary Sources (from Cumulative Projects)

DPM and $PM_{2.5}$ emissions from three backup generators, which are part of the on-site cumulative operational sources (discussed in **Section 2.3** above), were modeled to determine concentrations at each receptor location. Air dispersion modeling parameters for these generators are shown in **Appendix E.** Risks were then calculated using the methods described in **Section 4** above.

On-site cumulative project stationary sources together result in a lifetime excess cancer risk of 0.10 in a million for Scenario 1 (Uncontrolled), 0.25 in a million for Scenario 1 (Controlled), and 0.022 in a million for Scenario 2, as shown in **Table 25: Chronic Health Impacts from Cumulative Sources at MEISR**. $PM_{2.5}$, chronic HI, and acute HI results from this equipment are also shown in **Table 25**.

[30] Confirmed via email to Shari Libicki, Ramboll Environ, by Virginia Lau, BAAQMD, on February 3, 2016.

6.1.3 Other Construction Sources (from Cumulative Projects)

DPM and $PM_{2.5}$ emissions from both on-site cumulative construction sources and off-site cumulative construction sources (discussed in **Section 2** above) were modeled to determine concentrations at each receptor location. Air dispersion modeling parameters for cumulative projects were generally consistent with Project construction modeling parameters, and shown in **Appendix E, Table E-4: Modeling Parameters for Cumulative Sources**. Risks were then calculated using the methods described in **Section 4** above.

On-site cumulative projects and off-site cumulative construction projects together result in a lifetime excess cancer risk of 61 in a million for Scenario 1 (Uncontrolled), 24 in a million for Scenario 1 (Controlled), and 0.12 in a million for Scenario 2, as shown in **Table 25**. $PM_{2.5}$, chronic HI, and acute HI results from this equipment are also shown in **Table 25**.

6.2 Cumulative Risk Results – Construction and Operations

The lifetime excess cancer risk from each source is summarized and summed together to get cumulative risk in **Table 26**. The estimated excess lifetime cancer risk from controlled construction emissions and operational emissions (Scenario 1) for a resident at the off-site MEISR location is 166 in a million (Uncontrolled) and 111 in a million (Controlled)[31]; the estimated excess lifetime cancer risk from operational emissions (Scenario 2) for a resident at the off-site MEISR location is 10 in a million. The $PM_{2.5}$ concentrations are presented in **Table 27**; the $PM_{2.5}$ concentration at the Off-site MEISR is 9.2 $\mu g/m^3$ during the construction period (both Uncontrolled and Controlled) and 9.0 $\mu g/m^3$ during the operational period.[32]

The cumulative Chronic and Acute HIs are shown in **Table 28: Cumulative Chronic Hazard Index at Off-site MEISR** and **Table 29: Cumulative Acute Hazard Index at Off-site MEI**, respectively. The cumulative Chronic HI is 0.010 (Uncontrolled) and 0.0089 (Controlled) from cumulative Project construction and 0.0087 from cumulative Project operations. As shown in **Table 29**, there are no acute health impacts included in the CRRP-HRA and this analysis did not estimate acute health impacts from other on- and off-site cumulative projects. Therefore, the cumulative Acute HI is equal to the Project Acute HI for construction and operations.

Locations of all MEISRs and MEIs discussed above are shown in **Figure 6: Location of Maximally Exposed Individual Sensitive Receptor (MEISR) and Maximally Exposed Individual (MEI)**. [33] The MEISR for cancer risk is the sensitive receptor with the highest risk over a 30-year exposure time. The MEISR for Chronic HI and $PM_{2.5}$ concentrations is the sensitive receptor with the maximum annual average hazard index or concentration, respectively. The MEI for acute HI is the location where the maximum one-hour exposure occurs. Because of the different exposure periods and the various locations of different sources of emissions that go into each of these impacts, the location of the MEISR and MEI are not always coincident.

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[31] The range of cumulative results for the receptor with the minimum net project cancer risk to the receptor with the maximum net project cancer risk is 70 to 166 in a million for Scenario 1 (Uncontrolled), and 70 to 111 in a million for Scenario 1 (Controlled).

[32] The range of cumulative results for the receptor with the minimum net project $PM_{2.5}$ concentration to the receptor with the maximum net project $PM_{2.5}$ concentration is 8.2 to 9.2 $\mu g/m^3$ for construction and 8.9 to 9.0 $\mu g/m^3$ for operations.

[33] Scenario 2 Cancer Risk MEISR is located further away from the Project than the other identified MEISRs as the Project cancer risk is very low for this Scenario. As the MEISR is determined based on the maximum net risk (Project minus existing), the sensitive receptors closer to the site have higher relative existing risk and therefore lower net risk.

7. UNCERTAINTIES

The following sections summarize the critical uncertainties associated with the emissions estimation, air dispersion modeling, and risk estimation components of the risk assessment.

Estimation of Emissions: There are uncertainties associated with the usage of construction equipment, as well as the estimation of emissions from construction equipment. Estimates of equipment usage were provided by the BDFP consultant design team in the Conceptual Engineering Report (CER) (BDFP Consultant Design Team 2016); however actual equipment use would likely be slightly less than the projected use. Where Project-specific data are not available, CalEEMod® default assumptions were used. These assumptions result in a conservative estimate of overall construction emissions. There are also uncertainties associated with the estimation of emissions from construction traffic, since routes and trip numbers were estimated by the transportation engineer; however, conservative assumptions were generally used.

In addition, there are uncertainties associated with the estimation of emissions from operational activities onsite. The BDFP consultant design team provided assumptions for hours of operation for each piece of equipment; however, the equipment may run more or less than expected. Additionally, for operational equipment such as the turbines, boilers and waste gas burners, $PM_{2.5}$ was assumed to be equal to PM_{10}, which is a conservative assumption. Further, emission factors for the Project turbines are manufacturer guaranteed emission factors (i.e., never to be exceeded values); therefore, actual emissions are likely lower than estimated in this analysis.

Additionally, there is uncertainty regarding the emissions from the cumulative sources both on- and off-site included in this analysis. Many of these cumulative projects did not yet have detailed CEQA documentation; therefore, Ramboll Environ had to rely largely on emissions screening methods for construction emissions, which are conservative.

Estimation of Exposure Concentrations: In addition to uncertainty associated with emission estimates, there is also uncertainty associated with the estimated exposure concentrations. The limitations of the air dispersion model provide a source of uncertainty in the estimation of exposure concentrations. According to USEPA, errors due to the limitation of the algorithms implemented in the air dispersion model in the highest estimated concentrations of ±10 percent to 40 percent are typical (USEPA 2005). Ramboll Environ's methodologies consistently produce conservative results; thus predicted exposure concentrations are likely to be at or above actual exposure concentrations.

Source Representation: The source parameters used to model emission sources add uncertainty. For all emission sources, Ramboll Environ used source parameters which are either recommended as defaults, consistent with the CRRP-HRA methodology (construction modeled as area sources and initial vertical dimension for construction sources), or expected to produce more conservative (i.e., overestimation of) results. Discrepancies might exist between the actual emissions characteristics of a source and its representation in the model; exposure concentrations used in this assessment represent approximate exposure concentrations.

Exposure Assumptions: Numerous assumptions must be made in order to estimate human exposure to chemicals. These assumptions include parameters such as breathing rates, exposure time and frequency, exposure duration, and human activity patterns. While a mean value derived from scientifically defensible studies is the best estimate of central tendency, many of the exposure variables used in this HRA under both 2003 and 2015 OEHHA guidelines are high-end estimates. For example, OEHHA 2003 guidance assumes residential receptor exposure to operational and cumulative emission sources occurs 24 hours per day; although OEHHA 2015 guidance recommends assuming a period of time spent out of the home each day, this analysis conservatively makes the same 24-hour daily exposure assumption as under OEHHA 2003 guidance. Additionally, under both guidelines it is assumed that residential receptor exposure (beginning at the third trimester of life through the 30th year) to Project construction emissions occurs during the entire construction duration and exposure to Project construction, operation and cumulative emissions sources occur for 350 days per year. These are highly conservative assumptions since most residents do not remain in their homes all day, every day, for these periods of time. The combination of several high-end estimates used as exposure parameters may substantially overestimate chemical intake. The excess lifetime cancer risks calculated in this assessment are therefore likely to be overestimated.

Toxicity Assessment: Standard RELs and CPFs established by Cal/EPA were used to estimate potential carcinogenic and non-cancer health effects from exposures to compounds emitted from the Project Site. These values are derived by applying conservative assumptions and are intended to protect the most sensitive individuals in the potentially exposed populations.

To derive the toxicity values, Cal/EPA makes several assumptions that tend to overestimate the actual hazard or risk to human health. Because data from human studies are generally unavailable, RELs are typically derived from animal studies. Uncertainty factors and modifying factors are then applied to these data to ensure that the RELs are adequately protective of human health. For many compounds, it is anticipated that this approach overestimates the potential for non-cancer effects.

CPFs used to estimate carcinogenic risk are also typically derived based on data from animal studies. These data are based on studies in which high doses of a test chemical were administered to laboratory animals, and the reported response is extrapolated to the much lower doses typical of human exposure. Very little experimental data are available on the nature of the dose-response relationship at low doses, such as whether a threshold exists or if the dose-response curve passes through the origin. Because of this uncertainty, a conservative model is used to estimate the low-dose relationship, and uses an upper bound estimate (the 95 upper confidence limit of the slope predicted by the extrapolation model) as the CPF. With this factor, an upper-bound estimate of potential cancer risks is obtained.

The Cal/EPA CPF for DPM is used to estimate cancer risks associated with exposure to DPM from the Project construction and off-site emissions. However, the CPF derived by Cal/EPA for DPM is highly uncertain in both the estimation of response and dose. In the past, due to inadequate animal test data and epidemiology data on diesel exhaust, the International Agency for Research on Cancer (IARC), a branch of the World Health Organization (WHO), had classified DPM as Probably Carcinogenic to Humans (Group 2); the USEPA had also concluded that the existing data did not provide an adequate basis for quantitative risk assessment (USEPA 2002). However, based on two recent scientific studies (Attfield 2012, Benbrahim-Tallaa 2012, Silverman 2012), IARC recently re-classified DPM as Carcinogenic to Humans to Group 1 (IARC 2012), which means that the agency has determined that there is “sufficient evidence of carcinogenicity” of a substance in humans and represents the strongest weight-of-evidence rating in IARC’s carcinogen classification scheme. This determination by the IARC may provide additional impetus for the USEPA to identify a quantitative dose-response relationship between exposure to DPM and cancer.

Additionally, for certain existing and proposed Project equipment running on digester gas, emission factors for natural gas were used when emission factors for digester gas were unavailable. For example, TAC emissions from the existing cogeneration engine, which is primarily fueled by digester gas, were calculated using the ARB 2015 organics speciation profile for reciprocating internal combustion engines that run on natural gas (Organic Profile 719). Natural gas emission factors were also used for the boilers fired on digester gas. This is an approximation of emissions from the digester gas; however, this assumption adds additional uncertainty to the analysis.

Risk Calculations: The USEPA notes that the conservative assumptions used in a risk assessment are intended to assure that the estimated risks do not underestimate the actual risks posed by a source and that the estimated risks do not necessarily represent actual risks experienced by populations at or near a site (USEPA 1989).

The estimated risks in this HRA are based primarily on a series of conservative assumptions related to predicted environmental concentrations, exposure, and chemical toxicity. The use of conservative assumptions tends to produce upper-bound estimates of risk. Although it is difficult to quantify the uncertainties associated with all the assumptions made in this risk assessment, the use of conservative assumptions is likely to result in substantial overestimates of exposure, and hence, risk. BAAQMD acknowledges this uncertainty by stating: “the methods used [to estimate risk] are conservative, meaning that the real risks from the source may be lower than the calculations, but it is unlikely that they will be higher” (BAAQMD 2016b).

8. REFERENCES

Attfield MD, Schleiff PL, Lubin JH, Blair A, Stewart PA, Vermeulen R, Coble JB, Silverman DT. 2012. The Diesel Exhaust in Miners Study: A Nested Case-Control Study of Lung Cancer and Diesel Exhaust. J Natl Cancer Inst.

Bay Area Air Quality Management District (BAAQMD). 2009. Regulation 8 Organic Compounds Rule 3 Architectural Coatings. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Rules%20and%20Regs/reg%2008/rg0803_0709.ashx?la=en

BAAQMD. 2010. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. January.

BAAQMD. 2012a. California Environmental Quality Act Air Quality Guidelines. May. Available online at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_Final_May%202012.ashx?la=en

BAAQMD. 2012b. Recommended Methods for Screening and Modeling Local Risks and Hazards. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/Risk%20Modeling%20Approach%20May%202012.ashx?la=en

BAAQMD. 2012c. The San Francisco Community Risk Reduction Plan (CRRP): Technical Support Documentation. December.

BAAQMD. 2012d. California Environmental Quality Act Air Quality Guidelines. May.

BAAQMD. 2016a. Proposed Health Risk Assessment Guidelines. Air Toxics NSR program. January. Available at: http://www.baaqmd.gov/~/media/files/planning-and-research/rules-and-regs/workshops/2016/reg-2-5/hra-guidelines_clean_jan_2016-pdf.pdf?la=en

BAAQMD. 2016b. Frequently Asked Questions – Toxic Air Contaminants. Available at: http://hank.baaqmd.gov/pmt/air_toxics/faq.htm

Benbrahim-Tallaa, L. et al. 2012. Carcinogenicity of Diesel-engine and Gasoline-engine Exhausts and Some Nitroarenes, Lancet Oncology. July 2012

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell with CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

California Air Pollution Control Officers Association (CAPCOA). 2009. Health Risk Assessment for Proposed Land Use Projects.

CAPCOA. 2013. CalEEMod User's Guide. Available at: http://www.caleemod.com

California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment (OEHHA). 1998a. Findings of the Scientific Review Panel on The Report on Diesel Exhaust, as adopted at the Panel's April 22, 1998, meeting.

Cal/EPA. 2009. Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustment to Allow for Early Life Stage Exposures. May. Available online at: http://oehha.ca.gov/air/hot_spots/2009/TSDCancerPotency.pdf. Accessed February 2013.

Cal/EPA. 2015. "Staff Report: Multimedia Evaluation of Renewable Diesel." May. Available at: http://www.calepa.ca.gov/CEPC/2015/RenDieselRpt.pdf.

International Agency for Research on Cancer (IARC). 2012. Press Release No. 213. IARC: Diesel Engine Exhaust Carcinogenic. June. Available at: http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

OEHHA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August. Available at: http://www.oehha.ca.gov/air/hot_spots/pdf/HRAguidefinal.pdf

OEHHA. 2015. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August. Available at: http://www.oehha.ca.gov/air/hot_spots/pdf/HRAguidefinal.pdf

San Francisco Department of the Environment (SF DOE), San Francisco Department of Public Health (SF DPH), and San Francisco Planning Department (SF Planning). 2015. San Francisco Clean Construction Ordinance: Implementation Guide for San Francisco Public Projects. https://www.sfdph.org/dph/EH/Air/CleanConstruction.asp. August. Accessed March 2016.

Silverman DT, Samanic CM, Lubin JH, Blair AE, Stewart PA, Vermeulen R, Coble JB, Rothman N, Schleiff PL, Travis WD, Ziegler RG, Wacholder S, Attfield MD. 2012. The Diesel Exhaust in Miners Study: A Cohort Mortality Study With Emphasis on Lung Cancer. J Natl Cancer Inst.

United States Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund Human Health Risk Assessment: U.S. EPA Region IX Recommendations (Interim Final). San Francisco, CA. December.

USEPA. 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models. Volume II - Description of Model Algorithms. September. Available at http://www.epa.gov/scram001/userg/regmod/isc3v2.pdf. Accessed February 2013.

USEPA. 2002. Health Assessment Document for Diesel Engine Exhaust. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. EPA/600/8-90/057F. May. Available at: http://www.cdc.gov/niosh/nas/RDRP/appendices/chapter6/a6-110.pdf

USEPA. 2005. Guideline on Air Quality Models (Revised). 40 Code of Federal Regulations, Part 51, Appendix W. Office of Air Quality Planning and Standards. November. Available at: https://www.epa.gov/ttn/scram/guidance_permit.htm#appw

United States Geological Survey (USGS). 2013. National Elevation Dataset. Available at: http://viewer.nationalmap.gov/viewer/.

TABLES

Table 1
Emissions Calculations Methodology
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Type	Source	Methodology and Formula	Reference
Construction Equipment[1]	Off-Road Equipment	$Ec = \Sigma(EFc * HP * LF * Hr * Red * C)$	CalEEMod 2013.2.2
Construction On-Road Trucks and Vehicles[2,3]	Exhaust – Running	$E_R = \Sigma(EF_R * VMT * C)$, where VMT = Trip Length * Trip Number	EMFAC2011
	Exhaust – Idling	$E_I = \Sigma(EF_I * \text{Idle Time} * \text{Trip Number})$	EMFAC2011
Operational Emissions[4]	Stationary Source	$E_{SS} = EF_{SS} * Hr * C$	Brown and Caldwell (see Appendix D)

Notes:

1. Emissions associated with off-road equipment were calculated using the following formulas:

Ec: off-road equipment exhaust emissions (lb)

EFc: emission factor (g/hp-hr). Emission factors for diesel equipment associated with ARB Tier standards were used. Emission factors for gasoline equipment are from AP-42.

HP: equipment horsepower. Project-specific or CalEEMod 2013.2.2 defaults

LF: equipment load factor. Project-specific or CalEEMod 2013.2.2 defaults

Hr: equipment hours

Red: reduction from Diesel Particulate Filter (DPF), as applicable

C: unit conversion factor

2. Emissions associated with on-road trucks were calculated using the following formulas:

E_R: running exhaust emissions (lb)

EF_R: running emission factor (g/mile). From EMFAC2011 for T7 Single Construction vehicle type for calendar year 2015. T7 Single Construction vehicle type is the most conservative appropriate vehicle in EMFAC2011.

VMT: vehicle miles traveled

C: unit conversion factor

Trip Length: provided by the traffic engineer

Trip Number: Where site specific data was not known, CalEEMod 2013.2.2 defaults were used based on site size and expected grading level.

E_I: vehicle idling emissions (lb)

EF_I: vehicle idling emission factor (g/hr-vehicle). From EMFAC2011 idling rates for HHDT vehicle type. HHDT is the most conservative appropriate vehicle type for idling because EMFAC2011 idling rates do not break down further by vehicle type.

Idle Time: assumed 5 minutes of idling per one-way trip, consistent with California ATCM to Limit Diesel-Fueled Commercial Motor Vehicle Idling (Title 13, CCR, section 2485).

Trip Number: Where site specific data was not known, CalEEMod 2013.2.2 defaults were used based on site size and expected grading level.

3. Construction trip rates and trip lengths used to calculated construction on-road truck and vehicle emissions were provided by Brown and Caldwell and are shown in Appendix C.

4. See Appendix B for detailed information on the emissions calculations for each operational stationary source of emissions.

E_{SS}: Stationary Source emissions.

EF_{SS}: Stationary Source emission factor

Hr: hours of operation per year (hr)

C: unit conversion factor

Abbreviations:

ARB - California Air Resources Board
ATCM - Airborne Toxic Control Measure
CalEEMod® - California Emissions Estimator MODel
DPM - Diesel Particulate Filter
EMFAC - EMission FACtor Model
MMBTU - one millioin British thermal unit
HHDT - heavy heavy duty trucks
lb - pound
mi - mile
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
USEPA - United States Environmental Protection Agency

References:

ARB/USEPA. Table 1: ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards. http://www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls

ARB. ATCM §2485 Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling. Title 13, CCR, section 2485. Available at: http://www.arb.ca.gov/msprog/truck-idling/2485.pdf

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell with CH2M and Black & Veatch. 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com

Table 2
Architectural Coating Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Land Use	Building Footprint[1]	Surface Area to be Painted[2]	Surface Type	Fraction of Surface Area[3]	VOC Content of Paint[4]	Emission Factor[5]	ROG Emissions
	sq ft	sq ft			g/L	lb/sq ft	lb
Industrial	214,000	428,000	Interior	75%	100	0.0046	1,487
			Exterior	25%	150	0.0069	743
						Total (lb)	2,230
						Total (tons)	1.1

Notes:

1. Building footprint provided by SFPUC.
2. Surface area to be painted was calculated as 2 times the building footprint for non-residential buildings, consistent with CalEEMod® methodology.
3. 75% of the wall surface area for interior and 25% for exterior were assumed, consistent with CalEEMod® methodology.
4. VOC content of paint is assumed to be consistent with BAAQMD Regulation 8, Rule 3. ROG and VOC can be used interchangeably for CEQA analysis.
5. Emission factors were calculated using VOC content and assuming 180 sq ft/gal of paint application based on methodology used in CalEEMod® 2013.2.2.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
CalEEMod® - California Emissions Estimator MODel
CEQA - California Environmental Quality Act
g - gram
gal - gallons
L - liters
lb - pounds
ROG - reactive organic gas
SFPUC - San Francisco Public Utilities Commission
sq ft - square feet
VOC - volatile organic compound

References:

BAAQMD. 2009. Regulation 8 Rule 3 Architectural Coatings. July.
California Air Pollution Control Officers Association (CAPCOA). 2013. Appendix A. Available at: http://www.caleemod.com

Table 3
Asphalt Paving Off-Gassing Emissions[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Land Use	Paved Area[2]	Area of Paving	VOC Emission Factor[3]	ROG Emissions
	sq ft	acres	lb/acre	lb
Industrial	201,000	4.6	2.6	12
Parking Lot	161,172	3.7	2.6	10
			Total (lb)	22

Notes:

1. VOC emissions from paving the parking areas were calculated consistent with CalEEMod® methodology.
2. Total paved area based on a total area of the site of 415,000 square feet (provided by SFPUC). This assumes all area not covered by buildings is paved. Parking lot area estimated as total area unoccupied by buildings at the potential staging area at 1550 Evans.
3. VOC emission factor consistent with the emission factor used in CalEEMod®. ROG and VOC can be used interchangeably for CEQA analysis.

Abbreviations:

CalEEMod® - California Emissions Estimator MODel
CEQA - California Environmental Quality Act
lb - pound
ROG - reactive organic gas
SFPUC - San Francisco Public Utilities Commission
sq ft - square feet
VOC - volatile organic compound

References:

California Air Pollution Control Officers Association (CAPCOA). 2013. Appendix A. Available at: http://www.caleemod.com

Table 4a
Construction CAP Emissions (Uncontrolled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Total CAP Emissions					
Year	**Source**	**Emissions[2,3]**			
		ROG[4]	**NO_x**	**PM_{10}[4]**	**$PM_{2.5}$**
		lbs			
Year 1	Off-road Equipment[4]	1,033	60,933	261	261
Year 2		1,358	54,385	253	253
Year 3		1,250	49,566	230	230
Year 4		1,061	37,147	180	180
Year 5		559	25,337	119	119
Year 1	On-road Trucks and Vehicles	677	12,233	50	48
Year 2		562	3,073	16	15
Year 3		770	7,829	31	29
Year 4		794	4,222	25	24
Year 5		648	3,768	21	20
Architectural Coating[5]	Off-Gassing	2,230	--	--	--
Paving[6]	Off-Gassing	22	--	--	--
	Total Emissions (lbs)	10,963	258,494	1,187	1,179

Average Daily Emissions					
Year	**Days of Construction Per Year[7]**	**Emissions[2,3]**			
		ROG[4]	**NO_x**	**PM_{10}[4]**	**$PM_{2.5}$**
		lbs/day			
Year 1	260	6.6	281	1.2	1.2
Year 2	260	7.4	221	1.0	1.0
Year 3	260	7.8	221	1.0	1.0
Year 4	260	11	159	0.79	0.78
Year 5	260	9.0	112	0.54	0.54
Total Length of Construction for the Project[7] (days)		1,300			
Daily Emissions Averaged Over All Construction Years (lb/day)		8.4	199	0.91	0.91

Notes:

1. "Uncontrolled" emissions shown here represent emissions using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance.
2. Emissions were estimated using methodology consistent with CalEEMod® and Table 1.
3. A construction equipment list and hours of operation for each piece of equipment for each year were provided in the 2016 Conceptual Engineering Report (CER) for the SFPUC BDFP (Appendix B). Construction activity associated with the potential construction staging areas, including paving at 1550 Evans and trenching and excavating at Piers 94/96, was estimated in CalEEMod® by Ramboll Environ.
4. Emissions from off-road construction equipment were calculated assuming an 85% reduction in PM and a 90% reduction in ROG from the Diesel Particulate Filters (DPF), which is consistent with CalEEMod® methodology.
5. Architectural Coating was assumed to occur during Years 4 and 5 based on the preliminary construction schedule provided by SFPUC.
6. Paving at 1550 Evans was assumed to occur in Year 1. On-site paving was assumed to occur during Year 5 based on the preliminary construction schedule provided by SFPUC.
7. Construction duration is expected to be 60 months consistent with the BDFP Consultant Design Team CER (2016).

Abbreviations:

MMBTU - one millioin British thermal unit
BDFP - Biosolids Digester Facilities Project
CAP - criteria air pollutant
CalEEMod® - California Emissions Estimate Model
DPF - Diesel Particulate Filters
lb - pound
NOx - nitrogen oxide compounds ($NO + NO_2$)
PM_{10} - particulate matter less than 10 micrometers

Table 4a
Construction CAP Emissions (Uncontrolled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

CAPCOA - California Air Pollution Control Officers Association
CEQA - California Environmental Quaility Act
CER - Conceptual Engineering Report
PM2.5 - particulate matter less than 2.5 micrometers
ROG - reactive organic gas
SFPUC - San Francisco Public Utilities Commission

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_May%202011_5_3_11.ashx. Accessed 7/14/2015.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com. Accessed 7/14/2015.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

SFPUC, 2016. Revised Air Quality Table A-5, August 11, 2016.

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Table 4b
Construction CAP Emissions (All Tier 4 Final[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Total CAP Emissions					
Year	**Source**	**Emissions[2,3]**			
		ROG	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
		lbs			
Year 1	Off-road Equipment	1,758	4,509	132	132
Year 2		2,001	4,171	138	138
Year 3		1,831	3,760	126	126
Year 4		1,494	3,045	100	100
Year 5		862	2,354	60	60
Year 1	On-road Trucks and Vehicles	551	10,355	28	27
Year 2		529	3,377	14	13
Year 3		729	6,986	25	23
Year 4		781	3,842	23	22
Year 5		639	3,514	20	19
Architectural Coating[4]	Off-Gassing	2,230	--	--	--
Paving[5]	Off-Gassing	22	--	--	--
	Total Emissions (lbs)	13,426	45,911	667	661

Average Daily Emissions					
Year	**Days of Construction Per Year[6]**	**Emissions[2,3]**			
		ROG	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
		lbs/day			
Year 1	260	8.9	57	0.62	0.61
Year 2	260	10	29	0.59	0.58
Year 3	260	10	41	0.58	0.58
Year 4	260	13	26	0.47	0.47
Year 5	260	10	23	0.31	0.30
Total Length of Construction for the Project[6] (days)		1,300			
Daily Emissions Averaged Over All Construction Years (lb/day)		10	35	0.51	0.51

Notes:

1. "All Tier 4 Final" emissions shown here represent emissions using all Tier 4 Final equipment and renewable diesel for all diesel on-road haul trucks. The percent reductions for each pollutant from renewable diesel vary by test conditions. To be conservative, the lowest reduction for each pollutant was chosen independently, as opposed to selecting the results from a single test method. The reductions used in on-road emissions from renewable diesel are 1.1% for ROG, 24.5% for PM_{10} and $PM_{2.5}$, and 9.9% for NOx.
2. Emissions were estimated using methodology consistent with CalEEMod® and Table 1.
3. A construction equipment list and hours of operation for each piece of equipment for each year were provided in the Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. April. (Appendix B). Construction activity associated with the potential construction staging areas, including paving at 1550 Evans and trenching and excavating at Piers 94/96, was estimated in CalEEMod® by Ramboll Environ.
4. Architectural Coating was assumed to occur during Years 4 and 5 based on the preliminary construction schedule provided by SFPUC.
5. Paving at 1550 Evans was assumed to occur in Year 1. On-site paving was assumed to occur during Year 5 based on the preliminary construction schedule provided by SFPUC.
6. Construction duration is expected to be 60 months consistent with the BDFP Consultant Design Team CER (2016).

Table 4b
Construction CAP Emissions (All Tier 4 Final[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
MMBTU - one millioin British thermal unit
CAP - criteria air pollutant
CalEEMod® - California Emissions Estimate Model
CAPCOA - California Air Pollution Control Officers Association
CEQA - California Environmental Quaility Act
CER - Conceptual Engineering Report
DPF - Diesel Particulate Filters
lb - pound
NOx - nitrogen oxide compounds (NO + NO_2)
PM_{10} - particulate matter less than 10 micrometers
PM2.5 - particulate matter less than 2.5 micrometers
ROG - reactive organic gas
SFPUC - San Francisco Public Utilities Commission

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_May%202011_5_3_11.ashx. Accessed 7/14/2015.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com. Accessed 7/14/2015.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

SFPUC, 2016. Revised Air Quality Table A-5, August 11, 2016.

Table 4c
Construction CAP Emissions (Controlled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Total CAP Emissions					
Year	**Source**	**Emissions[2,3]**			
		ROG[4]	**NO_x**	**PM_{10}[4]**	**$PM_{2.5}$**
		lbs			
Year 1	Off-road Equipment[4]	1,714	8,270	148	148
Year 2		1,958	8,355	154	154
Year 3		1,795	7,437	140	140
Year 4		1,455	6,455	113	113
Year 5		819	4,967	73	73
Year 1	On-road Trucks and Vehicles	551	10,355	28	27
Year 2		529	3,377	14	13
Year 3		729	6,986	25	23
Year 4		781	3,842	23	22
Year 5		639	3,514	20	19
Architectural Coating[5]	Off-Gassing	2,230	--	--	--
Paving[6]	Off-Gassing	22	--	--	--
	Total Emissions (lbs)	13,222	63,559	738	731

Average Daily Emissions					
Year	**Days of Construction Per Year[7]**	**Emissions[2,3]**			
		ROG[4]	**NO_x**	**PM_{10}[4]**	**$PM_{2.5}$**
		lbs/day			
Year 1	260	8.7	72	0.68	0.67
Year 2	260	10	45	0.65	0.64
Year 3	260	10	55	0.63	0.63
Year 4	260	13	40	0.52	0.52
Year 5	260	10	33	0.36	0.35
Total Length of Construction for the Project[7] (days)		1,300			
Daily Emissions Averaged Over All Construction Years (lb/day)		10	49	0.57	0.56

Notes:

1. "Controlled" emissions shown here represent emissions using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks. The percent reductions for each pollutant from renewable diesel vary by test conditions. To be conservative, the lowest reduction for each pollutant was chosen independently, as opposed to selecting the results from a single test method. The reductions used in on-road emissions from renewable diesel are 1.1% for ROG, 24.5% for PM_{10} and $PM_{2.5}$, and 9.9% for NOx. In addition, haul trucks were assumed to be 80% engine model year 2010 or newer.
2. Emissions were estimated using methodology consistent with CalEEMod and Table 1.
3. A construction equipment list and hours of operation for each piece of equipment for each year were provided in the 2016 Conceptual Engineering Report (CER) for the SFPUC BDFP (Appendix B). Construction activity associated with the potential construction staging areas, including paving at 1550 Evans and trenching and excavating at Piers 94/96, was estimated in CalEEMod® by Ramboll Environ.
4. Emissions from off-road construction equipment were calculated assuming an 85% reduction in PM and a 90% reduction in ROG from the Diesel Particulate Filters (DPF), which is consistent with CalEEMod® methodology.
5. Architectural Coating was assumed to occur during Years 4 and 5 based on the preliminary construction schedule provided by SFPUC.
6. Paving at 1550 Evans was assumed to occur in Year 1. On-site paving was assumed to occur during Year 5 based on the preliminary construction schedule provided by SFPUC.
7. Construction duration is expected to be 60 months consistent with the BDFP Consultant Design Team CER (2016).

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Table 4c
Construction CAP Emissions (Controlled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Abbreviations:

MMBTU - one millioin British thermal unit
BDFP - Biosolids Digester Facilities Project
CAP - criteria air pollutant
CalEEMod® - California Emissions Estimate Model
CAPCOA - California Air Pollution Control Officers Association
CEQA - California Environmental Quaility Act
CER - Conceptual Engineering Report
DPF - Diesel Particulate Filters
lb - pound
NOx - nitrogen oxide compounds (NO + NO_2)
PM_{10} - particulate matter less than 10 micrometers
PM2.5 - particulate matter less than 2.5 micrometers
ROG - reactive organic gas
SFPUC - San Francisco Public Utilities Commission

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_May%202011_5_3_11.ashx. Accessed 7/14/2015.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com. Accessed 7/14/2015.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

SFPUC, 2016. Revised Air Quality Table A-5, August 11, 2016.

Table 5
Construction GHG Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source	GHG Emissions[1,2]		
		CO_2	CH_4	CO_2e[3]
		MT		
Non-Biogenic GHG Emissions				
Year 1	Off-road Equipment	3,523	1.1	3,545
Year 2		3,087	1.0	3,107
Year 3		2,761	0.86	2,780
Year 4		2,093	0.62	2,106
Year 5		1,449	0.41	1,458
Year 1	On-road Trucks	1,624	0.22	1,629
Year 2		796	0.05	797
Year 3		1,561	0.16	1,565
Year 4		1,430	0.10	1,432
Year 5		1,244	0.10	1,246
			Total CO_2e Emissions (MT)	19,664

Notes:

1. The construction GHG emissions are the same for the uncontrolled, all Tier 4 final, and controlled scenarios because the use of different engine Tiers does not change the greenhouse gas emission factors from the engine.
2. Emissions were estimated using methodology consistent with CalEEMod® and Table 1.
3. Global warming potential values of 1 for CO_2 and 21 for CH_4 from 40 CFR Part 98 Table A-1 (2011 version) as referenced in the California Mandatory Reporting Regulation (MRR) were used to convert emissions to metric tons of carbon dioxide equivalents in accordance with 40 CFR Part 98.2.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CalEEMod® - California Emissions Estimate Model
CEQA - California Environmental Quality Act
CFR - Code of Federal Regulations
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gases
MRR - California Mandatory Reporting Regulation
MT - metric tonne (1,000 kilograms)
SFPUC - San Francisco Public Utilities Commission

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_May%202011_5_3_11.ashx. Accessed 7/14/2015.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com. Accessed 7/14/15.

Code of Federal Regulations (CFR). 2011. 40 CFR 98. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/mrr-regulation.htm. Accessed 02/16/16.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Table 6a
Construction TAC Emissions (Uncontrolled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source	TAC Emissions[2,3]		
		TOG[4]	TOG	DPM
		(lbs/hr)	(lbs/yr)	
Year 1	Off-road Diesel Equipment Exhaust	0.02	--	222
Year 2		0.02	--	203
Year 3		0.02	--	180
Year 4		0.01	--	136
Year 5		0.01	--	97
Year 1	Off-road Gasoline Equipment Exhaust	0.10	833	--
Year 2		0.13	1,180	--
Year 3		0.12	1,088	--
Year 4		0.11	939	--
Year 5		0.05	473	--
Year 1	On-road Diesel Trucks and Vehicles Exhaust	0.85	--	5.86
Year 2		0.32	--	4.03
Year 3		0.32	--	3.42
Year 4		0.25	--	1.20
Year 5		0.17	--	0.97
Year 1	On-road Gasoline Vehicles Exhaust	0.40	77.0	--
Year 2		0.49	135.5	--
Year 3		0.51	155.4	--
Year 4		0.59	175.1	--
Year 5		0.53	130.6	--
Year 1	On-road Gasoline Vehicles Evaporation	0.64	115	--
Year 2		0.84	235	--
Year 3		0.95	289	--
Year 4		1.17	348	--
Year 5		1.12	278	--
Total Emissions (lbs)		9.74	6,451	854

Notes:

1. "Uncontrolled" emissions shown here represent emissions using Tier 2 equipment wih diesel particulate filters (DPFs).
2. Emissions estimated using methodology consistent with CalEEMod® and Table 1. Detailed emissions by source group are provided in Appendix E.
3. A construction equipment list and hours of operation for each piece of equipment for each year were provided in the BDFP Consultant Design Team 2016 Conceptual Engineering Report (CER) (Appendix B). Construction activity associated with the potential construction staging areas including paving at 1550 Evans and trenching at Piers 94/96, was estimated in CalEEMod® by Ramboll Environ.
4. This analysis conservatively assumes ROG is equal to TOG. Emissions from off-road construction equipment were calculated assuming an 85% reduction in PM and a 90% reduction in ROG from the Diesel Particulate Filters (DPF), which is consistent with CalEEMod® methodology.

Abbreviations:

MMBTU - one milliion British thermal unit
BDFP - Biosolids Digester Facilities Project
CalEEMod® - California Emissions Estimator Model
CAP - criteria air pollutant
CAPCOA - California Air Pollution Control Officers Association
CER - Conceptual Engineering Report
CEQA - California Environmental Quality Act
DPF - diesel particulate filters
DPM - diesel particulate matter
hr - hour
lbs - pounds
SFEP - San Francisco Planning Department's Environmental Planning
SFPUC - San Francisco Public Utilities Commission
TAC - toxic air contaminant
TOG - total organic gas
yr - year

Table 6a
Construction TAC Emissions (Uncontrolled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_May%202011_5_3_11.ashx. Accessed 7/14/2015.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com. Accessed 7/14/2015.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell with CH2M and Black & Veatch. 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

SFPUC, 2016. Revised Air Quality Table A-5, August 11, 2016.

Table 6b
Construction TAC Emissions (Controlled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source	TAC Emissions[2,3]		
		TOG[4]	TOG	DPM
		(lbs/hr)	(lbs/yr)	
Year 1	Off-road Diesel Equipment Exhaust	0.10	--	109
Year 2		0.09	--	102
Year 3		0.08	--	90
Year 4		0.06	--	69
Year 5		0.04	--	51
Year 1	Off-road Gasoline Equipment Exhaust	0.10	833	--
Year 2		0.13	1,180	--
Year 3		0.12	1,088	--
Year 4		0.11	939	--
Year 5		0.05	473	--
Year 1	On-road Diesel Trucks and Vehicles Exhaust	0.45	--	7.44
Year 2		0.20	--	5.97
Year 3		0.23	--	5.12
Year 4		0.20	--	1.91
Year 5		0.14	--	1.58
Year 1	On-road Gasoline Vehicles Exhaust	0.40	77.0	--
Year 2		0.49	135.5	--
Year 3		0.51	155.4	--
Year 4		0.59	175.1	--
Year 5		0.53	130.6	--
Year 1	On-road Gasoline Vehicles Evaporation	0.64	115	--
Year 2		0.84	235	--
Year 3		0.95	289	--
Year 4		1.17	348	--
Year 5		1.12	278	--
Total Emissions (lbs)		9.35	6,451	443

Notes:

1. "Controlled" emissions shown here represent emissions using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks, and 80% of haul trucks are model year 2010 or newer. TAC emissions were not calculated for the "All Tier 4 Final" scenario, after consultation with San Francisco Environmental Planning (SFEP).
2. Emissions estimated using methodology consistent with CalEEMod® and Table 1. Detailed emissions by source group are provided in Appendix E.
3. A construction equipment list and hours of operation for each piece of equipment for each year were provided in the BDFP Consultant Design Team 2016 Conceptual Engineering Report (CER) (Appendix B). Construction activity associated with the potential construction staging areas including paving at 1550 Evans and trenching at Piers 94/96, was estimated in CalEEMod® by Ramboll Environ.
4. This analysis conservatively assumes ROG is equal to TOG. Emissions from off-road construction equipment were calculated assuming an 85% reduction in PM and a 90% reduction in ROG from the Diesel Particulate Filters (DPF), which is consistent with CalEEMod® methodology.

Abbreviations:

MMBTU - one millioin British thermal unit
BDFP - Biosolids Digester Facilities Project
CalEEMod® - California Emissions Estimator Model
CAP - criteria air pollutant
CAPCOA - California Air Pollution Control Officers Association
CER - Conceptual Engineering Report
CEQA - California Environmental Quality Act
DPF - diesel particulate filters
DPM - diesel particulate matter
hr - hour
lbs - pounds
SFEP - San Francisco Planning Department's Environmental Plannir
SFPUC - San Francisco Public Utilities Commission
TAC - toxic air contaminant
TOG - total organic gas
yr - year

Table 6b
Construction TAC Emissions (Controlled[1] Scenario)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_May%202011_5_3_11.ashx. Accessed 7/14/2015.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com. Accessed 7/14/2015.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell with CH2M and Black & Veatch. 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

SFPUC, 2016. Revised Air Quality Table A-5, August 11, 2016.

Table 7
Emissions Calculation Methods for Existing and Project Operational CAP Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source[1]	Existing	Project
Cogeneration Engine	**BAAQMD 2014 Emissions (lbs/day)** Emissions = (lbs/day)*(365 days/yr)	--
Turbines	--	**Manufacturer Specifications (PM_{10}, NOx, NMHC)** *PM_{10}:* Emissions = (lb/MMBtu)*(MMBtu/hr)*(hrs/yr) *NOx, NMHC:* Emissions = (ppm)*(Molecular Weight)*dscfm* (unit conversions)*(hrs/yr)
Future Microturbines	--	**Manufacturer Specifications** *PM_{10}:* Emissions = (lb/MMBtu)*(MMBtu/hr)*(hrs/yr) *NOx, NMHC:* Emissions = (lb/MWh)*(MW)*(hrs/yr)
Boilers[2]	**BAAQMD 2014 Emissions (lbs/day)** Emissions = (lbs/day)*(365 days/yr)	**AP-42 (PM_{10}, NMHC)** **BACT (NOx)** *NMHC, PM_{10}:* Emissions = (lb/MMscf)*(MMscf/hr)*(hrs/yr) *NOx:* Emissions = (ppm)*(Molecular Weight)*dscfm* (unit conversions)*(hrs/yr)
Emergency Engine	--	**BAAQMD BACT** Emissions = (g/kWh)*(kWm)*(hrs/yr)*(unit conversions)
Waste Gas Burners	**BAAQMD PN568 2014 (NOx, Organics)** **AP-42 (PM_{10})** Emissions = (lbs/ 1000 ft^3) * (ft^3/day)*(365 days/yr) Throughput (ft^3/day): Actual 2014 digester gas throughput to the waste gas burners. ☐	**Vendor Specification (NOx)** **AP-42 (NMHC, PM_{10})** *NOx, NMHC:* Emissions = (lb/MMBtu) * (scf/hr) * (Btu/scf)* (hrs/yr) * (unit conversions) *PM_{10}:* Emissions = (lb/MMscf) * (MMScf/hr) * (hrs/yr)
Odor Control System[3]	--	--

Notes:

1. For existing emissions, the 2014 actual throughput values were used. For Project emissions, projected throughput values provided by the BDFP Consultant Team in the Conceptual Engineering Report (CER) were used.
2. Boiler emission factors and calculations presented in the table are for the boiler fired on digester gas because it has higher emissions than the boiler fired on natural gas based on emissions provided in the BDFP Consultant Design Team 2016 Conceptual Engineering Report (CER) (Appendix B). The health risk assessment conservatively assumes all hours of boiler operation for the 2023 and 2045 scenarios have the emissions of the boiler fired on digester gas.
3. According to the BDFP Consultant Team, the Odor Control System does not emit any CAP emissions. Methods for calculating other emissions (TACs) from the Odor Control System are shown in Table 8.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BACT - Best Available Control Technology
BDFP - Biosolids Digester Facilities Project
CAP - criteria air pollutant
CER - Conceptual Engineering Report
dscfm - dry standard cubic feet per minute
BTU - British thermal unit
kWh - kilowatt hour
g - gram
lbs - pounds
MW - megawatt
MWh - megawatt hour
NOx - nitrogen oxide compounds (NO + NO2)
PPM - parts per million
TAC - toxic air containment
scf - standard cubic feet
SFPUC - San Francisco Public Utilities Commission
yr - year

References

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March

AP-42, Fifth Edition, Volume I. http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf

Witherspoon, Leslie. Solar Turbines Incorporated. RE: PM10/2.5 Emissions Warranty for the Digester Gas Fired Mercury™ 50. Letter to Steven Scott (Black & Veatch) dated February 6, 2017.

Clark, Robert. Engineered Boiler Systems. RE: SFPUC HRSG Emergency Cases CS-235. Email to Lori Overhaug dated January 25, 2017.

Table 8
Emissions Calculation Methods for Existing and Project Operational TAC Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source[1]	Existing	Project
Cogeneration Engine	Not modeled in SF CRRP. **Used BAAQMD 2014 organics emissions** (lbs/day) - Speciated based on the CARB 2015 organics speciation profile for reciprocating internal combustion engines that run on natural gas (Organic Profile 719).	--
Turbines	--	**AP-42 for Turbine fired on Digester Gas** Emissions = (lb/MMBtu) * (MMBtu/hr) * (hrs/yr)
Microturbines	--	**AP-42** Emissions = (lb/MMBtu) * (MMBtu/hr) * (hrs/yr)
Boilers[2]	**Modeled in SF CRRP:** Multiplied risk-weighted emissions provided by BAAQMD in units of risk*[(g/s)/(ug/m3)] by the dispersion factors to calculate risk directly. **Adjusted Existing Risk (for Net Risk Calculations): AP-42** Emissions = (lbs/MMscf) * (MMscf/hr) * (hrs/yr)	**AP-42** Emissions = (lbs/MMscf) * (MMscf/hr) * (hrs/yr)
Emergency Engine	--	**BAAQMD BACT (PM10 = DPM)** Emissions = (g/kWh)*(kWm)*(hrs/yr)*(conversion) **BAAQMD BACT (NMHC)** Converted NMHC to TOG and speciated Diesel TOG using USEPA Speciation Profile 3161 (Diesel TOG).
Waste Gas Burners	Not modeled in SF CRRP. **Used Ventura County APCD EF** Emissions = (lbs/MMscf) * (MMScf/hr) * (hrs/yr) Throughput (ft^3/day): Actual 2014 digester gas throughput to the waste gas burners.	**Ventura County APCD** Emissions = (lbs/MMscf) * (MMscf/hr) * (hrs/yr)
Odor Control System	--	**Final CER (March 2016)** Emissions = (ppm)*(Molecular Weight)*dscfm* (unit conversions)*(hrs/yr)

Notes:

1. For existing emissions, the 2014 actual throughput values were used. For Project emissions, projected throughput values provided by the BDFP Consultant Team in the CER were used.
2. Boiler emission factors and calculations presented in the table are for the boiler fired on digester gas because it has higher emissions than the boiler fired on natural gas based on emissions provided in the 2016 CER (Appendix B). The health risk assessment conservatively assumes all hours of boiler operation for the 2023 and 2045 scenarios have the emissions of the boiler fired on digester gas.

Abbreviations:

APCD - Air Pollution Control District
BAAQMD - Bay Area Air Quality Management District
BACT - Best Available Control Technology
BDFP - Biosolids Digester Facilities Project
CARB - California Air Resources Board
CER - Conceptual Engineering Report
CRRP - Community Risk Reduction Plan
DPM - Diesel Particulate Matter
dscfm - dry standard cubic feet per minute
g/s - grams per second
lbs - pounds
m^3 - cubic meter
MMBTU - one millioin British thermal unit
NMHC - Non-methane hydrocarbons
PPM - parts per million
scf - standard cubic feet
SFPUC - San Francisco Public Utilities Commission
TAC - toxic air contaminant
TOG - total organic gas
µg - microgram
USEPA - United States Environmental Protection Agency

Table 8
Emissions Calculation Methods for Existing and Project Operational TAC Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

References:

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

AP-42, Fifth Edition, Volume I. http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf

Table 9
Existing Operational CAP Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source Name[1]	Source No.	Emission Factor (lbs/thou cu ft)			Emissions (lbs/day)			
		Organics[2]	NO_X[2]	PM_{10}[3]	ROG	NO_X	PM_{10}	$PM_{2.5}$[4]
Waste Gas Burners	A7003/ A7004	0.0030	0.11	0.017	0.94	34	5.3	5.3
Cogeneration Engine	10	-	-	-	26	76	3.0	3.0
Sludge Handling Process Unit (2 Gravity Belt Thickeners) (Abated by A785)	171	-	-	-	0	0	0	0
Anaerobic Digesters (Abated by Waste Gas Flares A7003 and A7004)	180	-	-	-	0	0	0	0
Sludge Dewatering Facility (Abated by A841 and A860)	840	-	-	-	0	0	0	0
Hot Water Boiler - 10.5 MMBtu/hr	8201	-	-	-	0.50	3.9	0.49	0.49
Hot Water Boiler - 10.5 MMBtu/hr	8202	-	-	-	0.50	3.9	0.49	0.49
Hot Water Boiler	8203	-	-	-	0	0	0	0
				Total (tons/yr)	5.0	22	1.7	1.7
				Total (lbs/day)	28	118	9.3	9.3

Notes:

1. Sources and abatement devices listed represent those that would be replaced by the Project.
2. Emission factors for organics and NO_x are from the BAAQMD (PN568 document dated May 28, 2014).
3. PM_{10} emissions calculated using emission factor from AP-42, Table 2.4-5, and total 2014 digester gas throughput to the waste gas burners, shown in Table 7.
4. $PM_{2.5}$ emissions are assumed to be equal to PM_{10} emissions.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
CAP - criteria air pollutants
hr - hour
lb - pounds
MMBtu - million British Thermal Units
NO_X - nitrogen oxide compounds ($NO + NO_2$)
PM_{10} - particulate matter less than 10 micrometers
$PM_{2.5}$ - particulate matter less than 2.5 micrometers
ROG - reactive organic gas
SFPUC - San Francisco Public Utilities Commission
thou cu ft - thousand cubic feet
yr - year

References:

AP-42, Fifth Edition, Volume I. http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf
BAAQMD Source Emissions Plant #568. June 3, 2015.

Table 10
Existing Operational GHG Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source or Abatement Device Name[1]	Source No.	Digester Gas Throughput[2] (scf / yr)	Natural Gas Throughput[2] (scf / yr)	Emissions[3] (MT / yr)			
				CO_2	CH_4	N_2O	CO_2e[4]
Biogenic GHG Emissions							
Waste Gas Burners[5,6]	A7003/ A7004	113,778,784	-	3,741	-	-	3,741
Cogeneration Engine -Digester Gas[6]	10	181,278,590	-	5,975	-	-	5,975
Sludge Handling Process Unit (2 Gravity Belt Thickeners) (Abated by A785)	171	-	-	-	-	-	-
Anaerobic Digesters (Abated by Waste Gas Burners A7003 and A7004)	180	-	-	-	-	-	-
Sludge Dewatering (Abated by A841 and A860)	840	-	-	-	-	-	-
Hot Water Boiler - 10.5 MMBtu/hr[6]	8201	128,252,914	-	4,214	-	-	4,214
Hot Water Boiler - 10.5 MMBtu/hr[6]	8202						
Hot Water Boiler[6]	8203						
Total Biogenic GHG Emissions (MT CO_2e / year)							**13,931**
Non-Biogenic GHG Emissions							
Cogeneration Engine[6]	10	181,278,590	3,009,707	164	0.0031	3.1E-04	164
Utility-Provided Electricity[7]	-	-	-	0.0	0.0	0.0	0.0
Waste Gas Burners[5,6]	A7003/ A7004	113,778,784	-	-	0.23	0.045	19
Cogeneration Engine -Digester Gas	10	181,278,590	-	-	0.37	0.072	30
Hot Water Boiler - 10.5 MMBtu/hr[6]	8201	128,252,914	-	-	0.26	0.051	21
Hot Water Boiler - 10.5 MMBtu/hr[6]	8202						
Hot Water Boiler[6]	8203						
Total Non-Biogenic GHG Emissions (MT CO_2e / year)							**234**

Notes:

1. Sources and abatement devices listed represent those that would be replaced by the Project.
2. Fuel throughputs are 2014 throughputs as provided by SFPUC.
3. Emissions were calculated by SFPUC based on throughput. Emission factors are from 40 CFR Part 98, Table C-1 and C-2 (2011 version), as referenced in the California Mandatory Reporting Regulation (CA MRR).
4. Global warming potential values of 1 for CO_2, 21 for CH_4, and 310 for N_2O from 40 CFR Part 98 Table A-1 (2011 version) as referenced in the CA MRR, were used to convert emissions to metric tones of carbon dioxide equivalents in accordance with 40 CFR Part 98.2.
5. Waste gas burners are not required to be reported in the Facility's California GHG Emissions Data Report pursuant to the CA MRR (17 California Code of Regulations, Sections 95100-95158).
6. CO2 emissions from biogas combustion in the waste gas burners, cogeneration engine, and boilers are considered biogenic emissions by the California Air Resources Board (ARB); however, the CH4 and N2O emissions are considered non-biogenic emissions.
7. Based on Table 2-9 of the Project Description, the existing Biosolids Facility power demand is estimated to be 1.0 MW. In 2014, 0.66 MW was generated from the cogeneration engine run on biogas and 0.02 MW was generated from the cogeneration run on natural gas. The remaining 0.32 MW of electricity was from the Hetch Hetchy Hydropower Dam (through the PG&E grid). According to the San Francisco Public Utilities Commission website, the electricity from the Hetch Hetchy Hydropower Dam releases no greenhouse gas emissions.

Abbreviations:

ARB - California Air Resources Board
BAAQMD - Bay Area Air Quality Management District
CEQA - California Environmental Quality Act
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - Greenhouse gas
hr - hour
MMBTU - one millioin British thermal unit
MMBtu - million British Thermal Units
MRR - Mandatory Reporting Regulation
MSW - Municipal Solid Waste
MT - metric tons (1000 kilograms)
N_2O - nitrous oxide
PG&E - Pacific Gas & Electric Company
scf - standard cubic feet
yr - year

Table 10
Existing Operational GHG Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_May%202011_5_3_11.ashx. Accessed 7/14/2015.

California Air Pollution Control Officers Association (CAPCOA). 2013. CalEEMod. Available at: http://www.caleemod.com

Code of Federal Regulations (CFR). 2011. 40 CFR 98. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/subpart_c_rule_part98.pdf

San Francisco Public Utilities Commission (SFPUC). Clean Hydroelectric Energy: Generating Clean Energy for Vital Services. Available at: http://www.sfwater.org/index.aspx?page=207. Accessed February 2016.

Table 11
Existing Operational TAC Emissons
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Source No.	Chemical	CAS Number	Throughput Data (mmscf/yr)	Emission Factor	Emissions
					lb/mmscf	lb/yr
Emergency Waste Gas Burners[1]	A7003 and A7004	Benzene	71432	113.8	0.16	18
		Formaldehyde	50000		1.2	133
		PAHs	1150		0.014	1.6
		Naphthalene	91203		0.011	1.3
		Acetaldehyde	75070		0.043	4.9
		Acrolein	107028		0.010	1.1
		Propylene	115071		2.4	278
		Toluene	108883		0.058	6.6
		Xylenes	1330207		0.029	3.3
		Ethylbenzene	100414		1.4	164
		Hexane	110543		0.029	3.3
		$PM_{2.5}$	--		17	1,934
Cogeneration Engine[2]	S10	Formaldehyde	50000	184.3	--	76
		Acetaldehyde	75070		--	2.8
		Benzene	71432		--	10
		Ethylbenzene	100414		--	0.93
		$PM_{2.5}$	--		--	1,099
Hot Water Boilers[3]	8201 and 8202	Benzene	71432	128.3	0.0021	0.27
		PAH's	1150		0.0010	0.13
		1,4 Dichlorobenzene	106467		0.0012	0.15
		Formaldehyde	50000		0.075	9.6
		Hexane	110543		1.8	231
		Naphthalene	91203		0.00061	0.078
		Toluene	108883		0.0034	0.44
		$PM_{2.5}$	--		0.98	126

Notes:

1. The existing waste gas burners were not modeled for the CRRP-HRA. The toxic air contaminant (TAC) emissions for the existing waste gas burners were calculated using the emission factors used by Brown and Caldwell to calculate the TAC emissions for the Project waste gas burners. The $PM_{2.5}$ emissions from the existing waste gas burners were calculated using the PM_{10} emission factor from AP-42, Table 2.4-5, and total 2014 digester gas throughput to the waste gas burners, as provided by SFPUC and shown in Table 8. These emissions were used to calculate the cancer risk from the existing waste gas burners.
2. The cogeneration engine was not modeled for the CRRP-HRA. The organics emissions from the cogeneration engine are from the 2015 BAAQMD Source Emissions for the Plant (No. 568). The organics emissions were speciated based on the CARB 2015 organics speciation profile for reciprocating internal combustion engines that run on natural gas (Organic Profile 719). These emissions were used to calculate the cancer risk from the existing cogeneration engine.
3. The hot water boilers were modeled for the CRRP-HRA; however, the modeling was refined to account for more exact source locations and building downwash. The organics emissions from the boilers are from the 2015 CER, and PAHs were combined using BAAQMD Toxic Air Contaminant Trigger Levels Table 2-5-1. These emissions were used to calculate the adjusted existing cancer risk from the existing boilers.

Table 11
Existing Operational TAC Emissons
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
CARB - California Air Resources Board
CAS - chemical abstracts service
CRRP - Community Risk Reduction Plan
g/s - grams per second
HRA - health risk assessment
lb - pounds
MMBTU - one millioin British thermal unit
mmscf - million standard cubic feet
N/A - not applicable
PAH - polycyclic aromatic hydrocarbon
$PM_{2.5}$ - particulate matter less than 2.5 microns
SFPUC - San Francisco Public Utilities Commission
TAC - toxic air contaminant
yr - year

References:

BAAQMD. 2010. Table 2-5-1 Toxic Air Contaminant Trigger Levels. January 6. Available online at: http://www.baaqmd.gov/~/media/files/engineering/air-toxics-programs/table_2-5-1.pdf?la=en

Table 12a
Project Operational CAP Emissions for the Transition Period in 2023[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Hours of Operation per Piece of Equipment[2] (hrs/yr)	Throughput (scf/yr)	Percentage of Throughput	Project Emissions[2]			
				ROG[3]	NO_X[4]	PM_{10}	$PM_{2.5}$[5]
				(tons/year)			
Two Turbines (1 duty/1 future standby)[6]	-	-	-	-	-	-	-
Four 200 kW Microturbines (future: 3 duty/1 standby)[7]	-	-	-	-	-	-	-
Two Backup Boilers (two standby)[8,9]	40	-	-	0.0044	0.020	0.0061	0.0061
One Emergency Diesel Engine[10]	50	-	-	0.028	0.50	0.017	0.017
Two Waste Gas Burners (two standby)[11]	-	423,310,288	50%	9.6	1.7	1.8	1.8
Existing Waste Gas Burners[12]	-		50%	0.32	12	1.8	1.8
Total Emissions (tons/year)				**9.9**	**14**	**3.6**	**3.6**
Total Emissions (lbs/day)				**54**	**76**	**20**	**20**

Notes:

1. The 2023 Transition Period reflects the emissions generated during the 6 to 12 month period of bringing the equipment online for the BDFP. During the first 6 months, it is assumed that neither the cogeneration engines nor turbine are operating, but that 50% of the existing biogas production will be burned using the existing waste gas burners, and 50% will be burned through the new waste gas burners. Additionally, for start-up, the back-up boiler will operate on natural gas instead of digester gas. (Assumptions based on the Start-Up Narrative provided in an email from Sue Chau on November 12, 2015.)
2. Operational emissions were calculated by the BDFP Consultant Team for the Project (Appendix D); these emissions were re-calculated here using the operational conditions provided for the transition period.
3. ROG emissions were calculated using nonmethane hydrocarbons (NMHC) conversion factors from the USEPA Conversion Factors for Hydrocarbon Emission Components document. ROG and VOC can be used interchangeably for CEQA analysis.
4. As per BAAQMD policy, when NMHC+NOx emissions were reported together for the diesel emergency engine, the emissions were calculated as 5% NMHC and 95% NOx.
5. $PM_{2.5}$ emissions were not calculated by the BDFP Consulting Team, so $PM_{2.5}$ emissions were conservatively assumed to be equal to the PM_{10} emissions.
6. The turbine was assumed to not yet be operating during the transition period. Therefore, emissions are zero.
7. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2023 scenarios, no microturbine emissions were calculated.
8. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. During the start up of the facility, the backup steam boilers will be fired on natural gas. However, during full operation, the primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies.
9. The NOx emissions for the boiler burning natural gas assumes compliance with BAAQMD Regulation 9, Rule 7 (9-7-307).
10. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
11. Project waste gas burner emissions were calculated using the emission factors used by the 2016 Conceptual Engineering Report (CER) prepared for the SFPUC BDFP (Appendix B).
12. Existing waste gas burner emissions were calculated using the methodology described in Table 7.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
CAP - criteria air pollutants
CEQA - California Environmental Quality Act
hr - hour
kW - kilowatt
NMHC - nonmethane hydrocarbons
NO_X - nitrogen oxide compounds ($NO + NO_2$)
PM_{10} - particulate matter less than 10 micrometers
$PM_{2.5}$ - particulate matter less than 2.5 micrometers
ROG - Reactive Organic Gas
scf - standard cubic feet
USEPA - United States Environmental Protection Agency
VOC - Volatile Organic Compound
yr - year

References:

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components NR-002d. Available at: www.epa.gov/otaq/models/nonrdmdl/nonrdmdl2010/420r10015.pdf. July.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Witherspoon, Leslie. (2011) Solar Turbines Product Information Letter 173: Emissions Signatures for Landfill and Digester Gas Fuels. February 3.

Table 12b
Project Operational CAP Emissions for Full Operation in 2023[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Hours of Operation per Piece of Equipment[2] (hrs/yr)	Project Emissions[2]			
		ROG[3]	NO_X[4]	PM_{10}	$PM_{2.5}$[5]
		(tons/year)			
Two Turbines (1 duty/1 future standby)[6]	8,760	0.086	23	4.1	4.1
Four 200 kW Microturbines (future: 3 duty/1 standby)[7]	--	--	--	--	--
Two Backup Boilers (two standby)[8,9]	40	0.0071	0.026	0.010	0.010
One Emergency Diesel Engine[10]	50	0.028	0.50	0.017	0.017
Two Waste Gas Burners (two standby)[11]	300	1.8	0.33	0.34	0.34
Total Emissions (tons/yr)	-	**2.0**	**23**	**4.5**	**4.5**
Total Emissions (lbs/day)	-	**11**	**128**	**25**	**25**

Notes:

1. The Full Operation 2023 scenario assumes all Project emission sources are fully operational, with the exception of the future equipment and the microturbines, which are not expected to operate until future years.
2. Operational emissions were calculated by the BDFP Consultant Team for the Project (Appendix D); these emissions were re-calculated here using the hours of operations provided. Turbine emissions were re-calculated using manufacturer guaranteed emission factors.
3. ROG emissions were calculated using NMHC conversion factors from the USEPA Conversion Factors for Hydrocarbon Emission Components document. ROG and VOC can be used interchangeably for CEQA analysis.
4. As per BAAQMD policy, when NMHC+NOx emissions were reported together for the diesel emergency engine, the emissions were calculated as 5% NMHC and 95% NOx.
5. $PM_{2.5}$ emissions were not calculated by the BDFP Consultant Team, so $PM_{2.5}$ emissions were conservatively assumed to be equal to the PM_{10} emissions.
6. Emissions were calculated for one turbine; in the future, a second turbine will likely be added as a standby turbine. Only one turbine will operate at a time.
7. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2023 scenario, no microturbine emissions were calculated.
8. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. The primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies or for start-up.
9. The NOx emissions for the boiler fired on digester gas assume BAAQMD Best Available Control Technology of a Selective Non-Catalytic Reduction Technology or an ultra-low NOx burner.
10. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
11. Emissions were calculated for two waste gas burners that are expected to operate 3% of the time (300 hours/year).

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CAP - criteria air pollutants
CEQA - California Environmental Quality Act
hrs - hours
kW - kilowat
lb - pounds
NMHC - nonmethane hydrocarbons
NO_X - nitrogen oxide compounds (NO + NO_2)
PM_{10} - particulate matter less than 10 micrometers
$PM_{2.5}$ - particulate matter less than 2.5 micrometers
ROG - Reactive Organic Gas
SFPUC - San Francisco Public Utilities Commission
USEPA - United States Environmental Protection Agency
VOC - volatile organic compound
yr - year

References:

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components NR-002d. Available at: www.epa.gov/otaq/models/nonrdmdl/nonrdmdl2010/420r10015.pdf. July.

Witherspoon, Leslie. 2011. Solar Turbines Product Information Letter 173: Emissions Signatures for Landfill and Digester Gas Fuels. February 3.

Table 12c
Project Operational CAP Emissions in 2045[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Hours of Operation per Piece of Equipment[2] (hrs/yr)	Project Emissions[2]			
		ROG[3]	NO_X[4]	PM_{10}	$PM_{2.5}$[5]
		(tons/year)			
Two Turbines (1 duty/1 future standby)[6]	8,760	0.086	23	4.1	4.1
Four 200 kW Microturbines (future: 3 duty/1 standby)[7]	8,760	0.26	1.1	0.36	0.36
Two Backup Boilers (2 standby)[8,9]	50	0.0089	0.033	0.012	0.012
One Emergency Diesel Engine[10]	50	0.028	0.50	0.017	0.017
Two Waste Gas Burners (2 standby)[11]	50	0.31	0.055	0.057	0.057
Total Emissions (tons/year)	-	**0.69**	**24**	**4.6**	**4.6**
Total Emissions (lbs/day)	-	**3.8**	**133**	**25**	**25**

Notes:

1. The 2045 scenario shows increased emissions because the hours of operation of some of the stationary sources are expected to increase as the biogas production increases at the plant. The hours of operation of the waste gas burners decreases because the addition of a future standby turbine and the microturbines are expected to handle all the biogas generated at the facility. By 2045, the waste gas burners are expected to only operate in emergency situations.
2. Hours of operation and operational emissions were estimated by the BDFP Consultant Design Team for the Project (Appendix D). Turbine emissions were re-calculated using manufacturer guaranteed emission factors.
3. ROG emissions were calculated using NMHC conversion factors from the USEPA Conversion Factors for Hydrocarbon Emission Components document. ROG and VOC can be used interchangeably for CEQA analysis.
4. As per District policy, when NMHC+NOx emissions were reported together for the diesel emergency engine, the emissions were calculated as 5% NMHC and 95% NOx.
5. $PM_{2.5}$ emissions were not calculated by the BDFP Consultant Team, so $PM_{2.5}$ emissions were conservatively assumed to be equal to the PM_{10} emissions.
6. Emissions were calculated for one turbine; in the future, a second turbine will likely be added as a standby turbine. Only one turbine will operate at a time.
7. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2045 scenario, emissions were calculated assuming all three microturbines would be in operation. The fourth microturbine is a backup turbine, so only three turbines would operate at one time.
8. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. The primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies or for start-up.
9. The NOx emissions for the Boiler fired on digester gas assume that a Selective Non-Catalytic Reduction Technology or an ultra-low NOx burner would be used as a control device.
10. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
11. Emissions were calculated for two waste gas burners that are expected to operate only if the biogas production exceeds the volume that can be used to fuel the turbines and microturbines. By 2045, a standby turbine will be installed and the waste gas burners will operate only during emergency situations.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CAP - criteria air pollutant
CEQA - California Environmental Quality Act
hrs - hours
kW - kilowat
lb - pounds
NMHC - Non-methane hydrocarbons
NO_X - nitrogen oxide compounds ($NO + NO_2$)
PM_{10} - particulate matter less than 10 micrometers
$PM_{2.5}$ - particulate matter less than 2.5 micrometers
ROG - Reactive Organic Compound
SFPUC - San Francisco Public Utilities Commission
USEPA - United States Environmental Protection Agency
VOC - volatile organic compound
yr - year

References:

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components NR-002d. Available at: www.epa.gov/otaq/models/nonrdmdl/nonrdmdl2010/420r10015.pdf. July.

Witherspoon, Leslie. 2011. Solar Turbines Product Information Letter 173: Emissions Signatures for Landfill and Digester Gas Fuels. February 3.

RAMBOLL ENVIRON

Table 13a
Project Operational GHG Emissions for the Transition Period in 2023[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source or Abatement Device	Throughput[2] (scf/yr)	Hours of Operation per Piece of Equipment[3] (hrs/yr)	Percentage of Throughput	Project GHG Emissions[3,4,5] MT CO_2e/yr
Biogenic GHG Emissions				
Two Turbines (1 duty/1 future standby)[6]	-	-	-	-
Four 200 kW Microturbines (future: 3 duty/1 standby)[7]	-	-	-	-
Existing Waste Gas Burners[8,9]	423,310,288	-	50%	7,131
Two Waste Gas Burners (2 standby)[8,9]		-	50%	7,131
Total Biogenic Emissions for Stationary Sources (MT CO_2e/yr)				**14,261**
Non-Biogenic GHG Emissions				
One Emergency Diesel Engine[10]	-	50	-	50
Two Backup Steam Boilers (2 standby)[11]	-	40	-	89
Existing Waste Gas Burners[8,9]	423,310,288	-	50%	36
Two Waste Gas Burners (2 standby)[8,9]		-	50%	36
Utility Provided Electricity[12]	-	-	-	-
Total Non-Biogenic Emissions for Stationary Sources (MT CO_2e/yr)				**212**

Notes:

1. The 2023 Transition Period reflects the emissions generated during the period of up to 30 months after construction bringing the equipment online for the Project. This period was assumed to be 6 months for calculation purposes. During this time, it is assumed that neither the cogeneration engine nor turbine are operating, but that 50% of the existing biogas production will be burned using the existing waste gas burners, and 50% will be burned through the new waste gas burners. Additionally, for start-up, the back-up boiler will operate on natural gas instead of digester gas. (Assumptions based on the Start-Up Narrative provided in an email from Sue Chau on November 12, 2015.)
2. Existing biogas throughput (2014) was provided by SFPUC.
3. Operational emissions were calculated by the BDFP Consultant Team for the Project (Appendix D). These emissions were re-calculated here using the operational conditions provided for the transition period.
4. Global warming potential values of 1 for CO_2, 21 for CH_4, and 310 for N_2O are from 40 CFR Part 98 Table A-1 (2011 version) as referenced in the California Mandatory Reporting Regulation (MRR) were used to convert emissions to metric tones of carbon dioxide equivalents (CO_2e) in accordance with 40 CFR Part 98.2.
5. GHG emissions were converted from the units of short tons per year, which are shown in Appendix D, to metric tons per year in order to compare the operational GHG emissions with the BAAQMD operational GHG thresholds, which are in units of Metric Tons of CO_2e per year.
6. The turbine was assumed to not yet be operating during the transition period. Therefore, emissions are zero.
7. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2023 scenarios, no microturbine emissions were calculated.
8. During the transition period, 50% of the existing facility biogas production will be burned in the existing waste gas burners, and 50% will be burned in the new waste gas burners. The existing facility biogas production is the sum of the 2014 biogas throughput from the existing waste gas burners, the existing boilers, and the existing the cogeneration engine.
9. CO2 emissions from biogas combustion in the waste gas burners are considered biogenic emissions by the California Air Resources Board (ARB); however, the CH4 and N2O emissions are considered non-biogenic emissions.
10. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
11. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. During the start up of the facility, the backup steam boilers will be fired on natural gas. However, during full operation, the primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies.
12. Based on The RFI Response email from 10/16/2015 to RFI #9-1 & 12-1, the 2023 project power demand is estimated to be 4.4 MW. For 2023, 0.2 MW of the total 4.4 MW power demand are estimated to come from Hetch Hetchy Hydropower electricity through the PG&E grid. According to the SFPUC website, the electricity from the Hetch Hetchy Hydropower Dam releases no greenhouse gas emissions. The remaining 4.2 MW of electricity demand will be generated onsite.

Table 13a
Project Operational GHG Emissions for the Transition Period in 2023[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Abbreviations:

ARB - California Air Resources Board
BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CER - Conceptual Engineering Report
CFR - Code of Federal Regulation
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
MMBTU - one millioin British thermal unit
kW - kilowatt
MRR - California Mandatory Reporting Regulation
MT - metric ton
MW - molecular weight
N_2O - nitrogen dioxide
PG&E - Pacific Gas & Electric
scf - standard cubic feet
SFPUC - San Francisco Public Utilities Commission
yr - year

References:

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Code of Federal Regulations (CFR). 2011. 40 CFR 98. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/subpart_c_rule_part98.pdf

San Francisco Public Utilities Commission (SFPUC). Clean Hydroelectric Energy: Generating Clean Energy for Vital Services. Available at: http://www.sfwater.org/index.aspx?page=207. Accessed February 2016.

Table 13b
Project Operational GHG Emissions for Full Operation in 2023[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source or Abatement Device	Hours of Operation per Piece of Equipment[2] (hrs/yr)	Project GHG Emissions[2,3,4]
		MT CO_2e/yr
Biogenic GHG Emissions		
Two Turbines (1 duty/1 future standby)[5,6]	8,760	27,824
Four 200 kW Microturbines (future: 3 duty/1 standby)[7]	--	--
Two Backup Steam Boilers (2 standby)[6,8]	40	87
Two Waste Gas Burners (2 standby)[6,9]	300	1,364
Total Biogenic Emissions for Stationary Sources (MT CO_2e/yr)		**29,276**
Non-Biogenic GHG Emissions		
Two Turbines (1 duty/1 future standby)[5,6]	8,760	140
Four 200 kW Microturbines (future: 3 duty/1 standby)[7]	--	--
Two Backup Steam Boilers (2 standby)[6,8]	40	0.44
Two Waste Gas Burners (2 standby)[6,9]	300	6.88
One Emergency Diesel Engine[10]	50	50
Utility Provided Electricity[11]	-	0.0
Total Non-Biogenic Emissions for Stationary Sources (MT CO_2e/yr)		**198**

Notes:

1. The Full Operation 2023 scenario assumes all project emission sources are fully operational, with the exception of the future equipment and the microturbines, which are not expected to be installed or operate until future years.
2. Hours of operation and operational emissions were estimated by the BDFP Consultant Team for the Project (Appendix D). Refer to Appendix D for a breakdown of the amount of GHG emissions from CO_2, CH_4, and N_2O for each stationary source.
3. Global warming potential values of 1 for CO_2, 21 for CH_4, and 310 for N_2O from 40 CFR Part 98 Table A-1 (2011 version) as referenced in the California Mandatory Reporting Regulation (MRR) were used to convert emissions to metric tons of carbon dioxide equivalents (CO_2e) in accordance with 40 CFR Part 98.2.
4. GHG emissions were converted from the units of short tons per year, which are shown in Appendix D, to metric tons per year in order to compare the operational GHG emissions with the BAAQMD operational GHG thresholds, which are in units of Metric Tons of CO_2e per year.
5. Emissions were calculated for one turbine; in the future, a second turbine will likely be added as a standby turbine. Only one turbine will operate at a time.
6. CO2 emissions from biogas combustion in the turbines, boilers, and waste gas burners are considered biogenic emissions by the California Air Resources Board (ARB); however, the CH4 and N2O emissions from these sources are considered non-biogenic emissions.
7. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2023 scenario, no microturbine emissions were calculated.
8. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing.The primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies or for start-up.
9. Emissions were calculated for two waste gas burners that are expected to operate approximately 3% of the year (300 hours/year). This operation is expected to decrease once a future standby turbine is installed.
10. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
11. Based on The RFI Response email from 10/16/2015 to RFI #9-1 & 12-1, the 2023 project power demand is estimated to be 4.4MW. For 2023, 0.2 MW of the total 4.4 MW power demand are estimated to come from Hetch Hetchy Hydropower electricity through the PG&E grid. According to the SFPUC website, the electricity from the Hetch Hetchy Hydropower Dam releases no greenhouse gas emissions. The remaining 4.2 MW of electricity demand will be generated onsite.

Abbreviations:

ARB - California Air Resources Board
BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CER - Conceptual Engineering Report
CFR - Code of Federal Regulation
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
MMBTU - one milliion British thermal unit
kW - kilowatt
MRR - California Mandatory Reporting Regulation
MT - metric ton
MW - molecular weight
N_2O - nitrogen dioxide
PG&E - Pacific Gas & Electric
scf - standard cubic feet
SFPUC - San Francisco Public Utilities Commission
yr - year

Table 13b
Project Operational GHG Emissions for Full Operation in 2023[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

References:

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Code of Federal Regulations (CFR). 2011. 40 CFR 98. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/subpart_c_rule_part98.pdf

San Francisco Public Utilities Commission (SFPUC). Clean Hydroelectric Energy: Generating Clean Energy for Vital Services. Available at: http://www.sfwater.org/index.aspx?page=207. Accessed February 2016.

Table 13c
Project Operational GHG Emissions in 2045[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source or Abatement Device	Hours of Operation per Piece of Equipment[2] (hrs/yr)	Project GHG Emissions[2,3,4] MT CO_2e/yr
Biogenic GHG Emissions		
Two Turbines (1 duty/1 future standby)[5,6]	8,760	27,824
Four 200 kW Microturbines (future: 3 duty/1 standby)[6,7]	8,760	2,874
Two Backup Steam Boilers (2 standby)[6,8]	50	109
Two Waste Gas Burners (2 standby)[6,9]	50	227
Total Biogenic Emissions for Stationary Sources (MT CO_2e/yr)		**31,035**
Non-Biogenic GHG Emissions		
Two Turbines (1 duty/1 future standby)[5,6]	8,760	140
Four 200 kW Microturbines (future: 3 duty/1 standby)[6,7]	8,760	14
Two Backup Steam Boilers (2 standby)[6,8]	50	0.55
Two Waste Gas Burners (2 standby)[6,9]	50	1.1
One Emergency Diesel Engine[10]	50	50
Utility Provided Electricity[11]	-	0
Total Non-Biogenic Emissions for Stationary Sources (MT CO_2e/yr)		**207**

Notes:

1. The 2045 scenario shows increased biogenic emissions because the hours of operation of some of the stationary sources are expected to increase as the biogas production increases at the plant. The hours of operation of the waste gas burners decreases because the addition of a future standby turbine and the microturbines are expected to handle all the biogas generated at the facility. By 2045, the waste gas burners are expected to only operate in emergency situations.
2. Hours of operation and operational emissions were estimated by the BDFP Consultant Team for the Project (Appendix D). Refer to Appendix D for a breakdown of the amount of GHG emissions from CO_2, CH_4, and N_2O for each stationary source.
3. Global warming potential values of 1 for CO_2, 21 for CH_4, and 310 for N_2O from 40 CFR Part 98 Table A-1 (2011 version) as referenced in the California Mandatory Reporting Regulation (MRR) were used to convert emissions to metric tons of carbon dioxide equivalents (CO2e) in accordance with 40 CFR Part 98.2.
4. GHG emissions were converted from the units of short tons per year, which are shown in Appendix D, to metric tons per year in order to compare the operational GHG emissions with the BAAQMD operational GHG thresholds, which are in units of Metric Tons of CO_2e per year.
5. Emissions were calculated for one turbine; in the future, a second turbine is expected to be added as a standby turbine. Only one turbine is expected to operate at a time.
6. CO_2 emissions from biogas combustion in the turbines, microturbines, boilers, and waste gas burners are considered biogenic emissions by the California Air Resources Board (ARB); however, the CH_4 and N_2O emissions from these sources are considered non-biogenic emissions.
7. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2045 scenario, emissions were calculated assuming all three microturbines would be in operation. The fourth microturbine is a backup turbine, so only three turbines would operate at one time.
8. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. The primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies or for start-up.
9. Emissions were calculated for two waste gas burners that are expected to operate only if the biogas production exceeds the volume that can be used to fuel the turbines and microturbines. By 2045, the future standby turbine is expected to have been installed and the waste gas burners are expected to operate only during emergency situations.
10. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
11. Based on The RFI Response email from 10/16/2015 to RFI #9-1 & 12-1, the 2045 project power demand is estimated to be 4.9 MW. For 2045, 0 MW power demand are estimated to come from Hetch Hetchy Hydropower electricity through the PG&E grid. BDFP is expected to generate 5.2 MW ofelectricity onsite, so the electricity generated onsite will satisfy the electricity demand and produce an extra 0.3 MW of electricity available to other Southeast Plant facilities.

Table 13c
Project Operational GHG Emissions in 2045[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Abbreviations:

ARB - California Air Resources Board
BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CER - Conceptual Engineering Report
CFR - Code of Federal Regulation
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - greenhouse gas
MMBTU - one millioin British thermal unit
kW - kilowatt
MRR - California Mandatory Reporting Regulation
MT - metric ton
MW - molecular weight
N_2O - nitrogen dioxide
PG&E - Pacific Gas & Electric
scf - standard cubic feet
SFPUC - San Francisco Public Utilities Commission
yr - year

References:

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Code of Federal Regulations (CFR). 2011. 40 CFR 98. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/subpart_c_rule_part98.pdf

San Francisco Public Utilities Commission (SFPUC). Clean Hydroelectric Energy: Generating Clean Energy for Vital Services. Available at: http://www.sfwater.org/index.aspx?page=207. Accessed February 2016.

Table 14
Summary of Net Project Operational CAP Emissions
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Emissions Scenario		Project Emissions (lbs/day)[1,2]			
		ROG	NO_X	PM_{10}	$PM_{2.5}$[3]
Existing - 2014[4]	**Total**	28	118	9.3	9.3
Project Transition Period - 2023[5]	**Total**	54	76	20	20
	Net[6]	**27**	**(42)**	**11**	**11**
Project Full Operation - 2023[7]	**Total**	11	128	25	25
	Net[6]	**(17)**	**10**	**15**	**15**
Project Full Operation - 2045[8]	**Total**	3.8	133	25	25
	Net[6]	**(24)**	**14**	**16**	**16**

Emissions Scenario		Project Emissions (tons/year)[1,2]			
		ROG	NO_X	PM_{10}	$PM_{2.5}$[3]
Existing - 2014[4]	**Total**	5.0	22	1.7	1.7
Project Transition Period - 2023[5]	**Total**	9.9	14	3.6	3.6
	Net[6]	**4.9**	**(7.7)**	**1.9**	**1.9**
Project Full Operation - 2023[7]	**Total**	2.0	23	4.5	4.5
	Net[6]	**(3.1)**	**1.8**	**2.8**	**2.8**
Project Full Operation - 2045[8]	**Total**	0.69	24	4.6	4.6
	Net[6]	**(4.3)**	**2.6**	**2.9**	**2.9**

Notes:

1. The existing operational scenario is based on the emissions during the 2014 year of operation of the existing facility. The 2023 transition period represents emissions during the commissioning of the new facility, which involves emissions from both the existing and new waste gas burners. The 2023 full operational scenario represents emissions from sources that are fully operational, with the exception of future equipment and the microturbines. The 2045 operational scenario has increased emissions due to the addition of 3 microturbines and increased hours of operation of the boilers to handle the projected increase in biogas production (despite a reduction in the two waste gas burner usage).
2. Hours of operation and operational emissions were estimated by the BDFP Consultant Team for the Project (Appendix D). Turbine emissions were re-calculated using manufacturer guaranteed emission factors.
3. $PM_{2.5}$ emissions were not calculated by the BDFP Consultant Team, so $PM_{2.5}$ emissions were conservatively assumed to be equal to the PM_{10} emissions.
4. Existing emissions are from Table 9.
5. Project Transition Period - 2023 emissions are from Table 12a.
6. The net operational emissions shown here are the existing 2014 emissions subtracted from the Project Emissions for each annual scenario. Numbers in parentheses denote negative values.
7. Project Full Operation - 2023 emissions are from Table 12b.
8. Project Full Operation - 2045 emissions are from Table 12c.

Abbreviations:

CAP - criteria air pollutants
CAPCOA - California Air Pollution Control Officers Association
MMBTU - one millioin British thermal unit
PM_{10} - particulate matter less than 10 micrometers
$PM_{2.5}$ - particulate matter less than 2.5 micrometers
ROG - reactive organic gas
SFPUC - San Francisco Public Utilities Commission
USEPA - United States Environmental Protection Agency

References:

CAPCOA. 2013. CalEEMod. Available at: http://www.caleemod.com

USEPA. 2010. Conversion Factors for Hydrocarbon Emission Components NR-002d. Available at: www.epa.gov/otaq/models/nonrdmdl/nonrdmdl2010/420r10015.pdf. July.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Table 15
Summary of Net Project Operational GHG Emissions[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Emissions Type	GHG Emissions[2,3] ($MT CO_2e / yr$)			
	Existing 2014[4]	Project Transition Period 2023[4]	Project Full Operation 2023[4]	Project Full Operation 2045[4]
Total Biogenic Emissions	13,931	14,261	29,276	31,035
Total Non-Biogenic Emissions	234	212	198	207
Net Operational Non-Biogenic Emissions[5]	--	(23)	(36)	(27)

Notes:

1. The existing operational scenario is based on the emissions during the 2014 year of operation of the existing facility. The 2023 transition period represents emissions during the commissioning of the new facility, which involves emissions from both the existing and new waste gas burners. The 2023 full operational scenario represents emissions from sources that are fully operational, with the exception of future equipment and the microturbines. The 2045 operational scenario has increased emissions due to the addition of 3 microturbines and increased hours of operation of the boilers to handle the projected increase in biogas production (despite a reduction in the two waste gas burner usage).
2. Hours of operation and operational emissions were estimated by the BDFP Consultant Team for the Project (Appendix D).
3. Global warming potential values of 1 for CO_2, 21 for CH_4, and 310 for N_2O from 40 CFR Part 98 Table A-1 (2011 version) as referenced in the California Mandatory Reporting Regulation (MRR) were used to convert emissions to MT CO_2e in accordance with 40 CFR Part 98.2.
4. Existing, Transition Period, Full Operation 2023 and Full Operation 2045 GHG emissions are from Tables 10, 13a, 13b, and 13c, respectively.
5. The net operational non-biogenic emissions shown here are the existing 2014 non-biogenic emissions subtracted from the Project emissions for each annual scenario. Numbers in parentheses denote negative values.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CAPCOA - California Air Pollution Control Officers Association
CFR - Code of Federal Regulations
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
GHG - Greenhouse gas
MRR - California Mandatory Reporting Regulation
MT - metric tons (1000 kilograms)
N_2O - nitrogen dioxide
SFPUC - San Francisco Public Utilities Commission
yr - year

References:

BAAQMD. 2011. CEQA Air Quality Guidelines. May.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

CAPCOA. 2013. CalEEMod. Available at: http://www.caleemod.com

CFR. 2011. 40 CFR 98. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/subpart_c_rule_part98.pdf

Table 16a
Project Operational TAC Emissions for the Transition Period[1] in 2023
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source[1]	Chemical	Hours of Operation (hours/year)[2]	Digester Gas Throughput (scf/year)[2]	Emissions (lbs/year)[2]
Two Turbines (1 duty/ 1 future standby)[3]	1,3 Butadiene	-	-	-
	1,4 Dichlorobenzene			-
	Acetaldehyde			-
	Carbon tetrachloride			-
	Chlorobenzene			-
	Chloroform			-
	Ethylene Dichloride			-
	Formaldehyde			-
	Methylene chloride			-
	Tetrachloroethylene			-
	Trichloroethylene			-
	Vinyl chloride			-
	Vinylidene chloride			-
One Emergency Diesel Engine[4]	Diesel PM	50	-	33
	TOG			58
Two Waste Gas Burners (2 standby)[5]	Benzene	-	211,655,144	34
	Formaldehyde			247
	PAHs (including Naphthalene)			3.0
	Naphthalene			2.3
	Acetaldehyde			9.1
	Acrolein			2.1
	Propylene			516
	Toluene			12
	Xylenes			6.1
	Ethylbenzene			306
	Hexane			6.1
Existing Waste Gas Burners[5]	Benzene	-	211,655,144	34
	Formaldehyde			247
	PAHs (including Naphthalene)			3.0
	Naphthalene			2.3
	Acetaldehyde			9.1
	Acrolein			2.1
	Propylene			516
	Toluene			12
	Xylenes			6.1
	Ethylbenzene			306
	Hexane			6.1
Two Backup Steam Boilers (2 standby)[6]	2-Methylnaphthalene	40	-	2.4E-05
	3-Methylcholanthrene			1.8E-06
	7,12-Dimethylbenz(a)anthracene			1.6E-05
	Acenaphthene			1.8E-06
	Acenaphthylene			1.8E-06
	Anthracene			2.4E-06
	Benz(a)anthracene			1.8E-06
	Benzene			2.1E-03
	Benzo(a)pyrene			1.2E-06
Two Backup Steam Boilers (2 standby)[6] (continued)	Benzo(b)fluoranthene	40	-	1.8E-06
	Benzo(g,h,i)perylene			1.2E-06
	Benzo(k)fluoranthene			1.8E-06
	Butane			2.1
	Chrysene			1.8E-06
	Dibenzo(a,h)anthracene			1.2E-06
	1,4 Dichlorobenzene			1.2E-03
	Ethane			3.1

Table 16a
Project Operational TAC Emissions for the Transition Period[1] in 2023
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source[1]	Chemical	Hours of Operation (hours/year)[2]	Digester Gas Throughput (scf/year)[2]	Emissions (lbs/year)[2]
Two Backup Steam Boilers (2 standby)[6]	Fluoranthene	40	-	3.0E-06
	Fluorene			2.8E-06
	Formaldehyde			7.6E-02
	Hexane			1.8
	Indeno(1,2,3-cd)pyrene			1.8E-06
	Naphthalene			6.2E-04
	Pentane			2.6
	Phenanathrene			1.7E-05
	Propane			1.6
	Pyrene			5.1E-06
	Toluene			3.4E-03
Solids Odor Control (4 stacks)	Hydrogen Sulfide	8,760	-	132

Notes:

1. The 2023 Transition Period reflects the emissions generated during the 6 to 12 month period of bringing the equipment online for the Project. During the first 6 months, it is assumed that neither the cogeneration engine nor turbine are operating, but that 50% of the existing biogas production will be burned using the existing waste gas burners, and 50% will be burned through the new waste gas burners. Additionally, for start-up, the back-up boiler will operate on natural gas instead of digester gas. (Assumptions based on the Start-Up Narrative provided in an email from Sue Chau on November 12, 2015.)

2. Operational emissions were calculated by the BDFP Consultant Team for the Project (Appendix D). These emissions were re-calculated here using the operational conditions provided for the transition period.

3. The turbines were assumed to not yet be operating during the transition period. Therefore, emissions are zero.

4. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.

5. During the transition period, 50% of the existing facility biogas production will be burned in the existing waste gas burners, and 50% will be burned in the new waste gas burners. The existing facility biogas production is the sum of the 2014 biogas throughput from the existing waste gas burners, the existing boilers, and the existing the cogeneration engine.

6. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. During the start up of the facility, the backup steam boilers will be fired on natural gas. However, during full operation, the primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies.

Abbreviations:

BAAQMD: Bay area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CER - Conceptual Engineering Report
lbs - pound
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
scf - standard cubic feet
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

References:

BAAQMD. 2012. Recommended Methods for Screening and Modeling Local Risks and Hazards, Version 3.0. May.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Table 16b
Project Operational TAC Emissions for Full Operation[1] in 2023
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Chemical	Hours of Operation (hours/year)[2]	Emissions (lbs/year)[2]
Two Turbines (1 duty/ 1 future standby)[3,4]	1,3 Butadiene	8,760	5.2
	1,4 Dichlorobenzene		11
	Acetaldehyde		28
	Carbon tetrachloride		11
	Chlorobenzene		8.6
	Chloroform		9.1
	Ethylene Dichloride		8.0
	Formaldehyde		102
	Methylene chloride		7.0
	Tetrachloroethylene		11
	Trichloroethylene		10
	Vinyl chloride		19
	Vinylidene chloride		8.0
One Emergency Diesel Engine[5]	Diesel PM	50	33
	TOG		58
Two Waste Gas Burners (2 standby)[6]	Benzene	300	6.4
	Formaldehyde		47
	PAHs (including Naphthalene)		0.57
	Naphthalene		0.45
	Acetaldehyde		1.7
	Acrolein		0.41
	Propylene		99
	Toluene		2.4
	Xylenes		1.2
	Ethylbenzene		59
	Hexane		1.2
Two Backup Steam Boilers (2 standby)[7]	2-Methylnaphthalene	40	6.2E-05
	3-Methylcholanthrene		4.7E-06
	7,12-Dimethylbenz(a)anthracene		4.2E-05
	Acenaphthene		4.7E-06
	Acenaphthylene		4.7E-06
	Anthracene		6.2E-06
	Benz(a)anthracene		4.7E-06
	Benzene		0.0054
	Benzo(a)pyrene		3.1E-06
	Benzo(b)fluoranthene		4.7E-06
	Benzo(g,h,i)perylene		3.1E-06
	Benzo(k)fluoranthene		4.7E-06
	Butane		5.4
	Chrysene		4.7E-06
	Dibenzo(a,h)anthracene		3.1E-06
	1,4 Dichlorobenzene		0.0031
	Ethane		8.0
	Fluoranthene		7.8E-06
	Fluorene		7.3E-06
	Formaldehyde		0.19
	Hexane		4.7
	Indeno(1,2,3-cd)pyrene		4.7E-06
	Naphthalene		0.0016
	Pentane		6.8
	Phenanathrene		4.4E-05
	Propane		4.2
	Pyrene		1.3E-05
	Toluene		0.0088
Solids Odor Control (4 stacks)	Hydrogen Sulfide	8,760	132

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Table 16b
Project Operational TAC Emissions for Full Operation[1] in 2023
SFPUC Biosolids Digester Facilities Project

Notes:

1. The Full Operation 2023 scenario assumes all project emission sources are fully operational, with the exception of the future equipment and the microturbines, which are not expected to operate until future years.
2. Hours of operation and operational emissions were estimated by the BDFP Consultant Team for the Project (Appendix D).
3. Emissions were calculated for one turbine because only one turbine can operate at a time.
4. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2023 scenario, no microturbine emissions were calculated.
5. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
6. Emissions were calculated for two waste gas burners that are expected to operate 3% of the time (300 hours/year).
7. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. The primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies or for start-up.

Abbreviations:

BAAQMD: Bay area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
lbs: pounds
PAHs: polycyclic aromatic hydrocarbons
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

References:

BAAQMD. 2012. Recommended Methods for Screening and Modeling Local Risks and Hazards, Version 3.0. May.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Table 16c
Project Operational TAC Emissions in 2045[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Chemical	Hours of Operation (hours/year)[2]	Emissions (lbs/year)[2]
Two Turbines (1 duty/1 future standby)[3]	1,3 Butadiene	8,760	5.2
	1,4 Dichlorobenzene		11
	Acetaldehyde		28
	Carbon tetrachloride		11
	Chlorobenzene		8.6
	Chloroform		9.1
	Ethylene Dichloride		8.0
	Formaldehyde		102
	Methylene chloride		7.0
	Tetrachloroethylene		11
	Trichloroethylene		10
	Vinyl chloride		19
	Vinylidene chloride		8.0
Four (4) 200 kW microturbines (future: 3 duty/ 1 standby)[4]	1,3 Butadiene	8,760	0.54
	1,4 Dichlorobenzene		1.1
	Acetaldehyde		2.9
	Carbon tetrachloride		1.1
	Chlorobenzene		0.88
	Chloroform		0.94
	Ethylene Dichloride		0.83
	Formaldehyde		11
	Methylene chloride		0.72
	Tetrachloroethylene		1.2
	Trichloroethylene		1.0
	Vinyl chloride		2.0
	Vinylidene chloride		0.83
One Emergency Diesel Engine[5]	Diesel PM	50	33
	TOG		58
Two Waste Gas Burners (2 standby)[6]	Benzene	50	1.1
	Formaldehyde		7.9
	PAHs (including Naphthalene)		0.095
	Naphthalene		0.074
	Acetaldehyde		0.29
	Acrolein		0.068
	Propylene		17
	Toluene		0.39
	Xylenes		0.20
	Ethylbenzene		10
	Hexane		0.20
Two Backup Steam Boilers (2 standby)[7]	2-Methylnaphthalene	50	7.8E-05
	3-Methylcholanthrene		5.8E-06
	7,12-Dimethylbenz(a)anthracene		5.2E-05
	Acenaphthene		5.8E-06
	Acenaphthylene		5.8E-06
	Anthracene		7.8E-06
	Benz(a)anthracene		5.8E-06
	Benzene		0.0068
	Benzo(a)pyrene		3.9E-06
	Benzo(b)fluoranthene		5.8E-06
	Benzo(g,h,i)perylene		3.9E-06
	Benzo(k)fluoranthene		5.8E-06
	Butane		6.8
	Chrysene		5.8E-06
	Dibenzo(a,h)anthracene		3.9E-06
	1,4 Dichlorobenzene		0.0039

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Table 16c
Project Operational TAC Emissions in 2045[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Chemical	Hours of Operation (hours/year)[2]	Emissions (lbs/year)[2]
Two Backup Steam Boilers (2 standby)[7]	Ethane	50	10
	Fluoranthene		9.8E-06
	Fluorene		9.1E-06
	Formaldehyde		0.24
	Hexane		5.8
	Indeno(1,2,3-cd)pyrene		5.8E-06
	Naphthalene		0.0020
	Pentane		8.4
	Phenanathrene		5.5E-05
	Propane		5.2
	Pyrene		1.6E-05
	Toluene		0.011
Solids Odor Control (4 stacks)	Hydrogen Sulfide	8,760	132

Notes:

1. The 2045 scenario shows increased emissions because the hours of operation of some of the stationary sources are expected to increase as the biogas production increases at the plant. The hours of operation of the waste gas burners decreases because the addition of a future standby turbine and the microturbines are expected to handle all the biogas generated at the facility. By 2045, the waste gas burners are expected to only operate in emergency situations.

2. Hours of operation and operational emissions were estimated by the BDFP Consultant Team for the Project (Appendix D).

3. Emissions were calculated for one turbine because only one turbine can operate at a time.

4. The first, second, and third future microturbines are expected to start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2045 scenario, emissions were calculated assuming all three microturbines will be in operation. The fourth microturbine is a backup turbine, so only three turbines would operate at one time.

5. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.

6. Emissions were calculated for two waste gas burners that are expected to operate only if the biogas production exceeds the volume that can be used to fuel the turbines and microturbines. By 2045, a standby turbine will be installed and the waste gas burners will operate only during emergency situations.

7. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. The primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies or for start-up.

Abbreviations:

BAAQMD: Bay area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
Kw - kilowatt
lbs - pounds
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas
PAHs: polycyclic aromatic hydrocarbons
PM: particulate matter
SFPUC: San Francisco Public Utilities Commission
TAC: toxic air contaminant

References:

BAAQMD. 2012. Recommended Methods for Screening and Modeling Local Risks and Hazards, Version 3.0. May.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Table 17
Cumulative Projects and Schedules
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

	Cumulative Project[1]	Modeled Area	Emissions Data Source[2]	Modeled Construction Schedule[3]
On-site Cumulative Projects[4]				
SEP-1	SEP New Headworks (Grit) Replacement	AreaA[5]	SFPUC-provided Construction Equipment List and Construction Traffic Data	Jan 2017 - Dec 2021
SEP-2	(SFPUC) Chemical System Relocation and Facilities Upgrade Project	AreaB	SFPUC Construction Emissions Screening Tool	Mar 2014 - Jun 2016
SEP-3	(SFPUC) SEP Existing Digester Roof Repairs	AreaC		Apr 2013 - Dec 2015
SEP-4	(SFPUC) SEP Existing Digester Gas Handling Improvements	AreaC		May 2016 - Mar 2018
SEP-5	(SFPUC) SEP Building 521 Replacement/ 522 Disinfection Upgrade	AreaB		Apr 2016 - Jul 2018
SEP-6	(SFPUC) SEP Power Feed and Primary Switchgear Upgrades	AreaB		Nov 2017 - Jan 2020
SEP-7	(SFPUC) SEP Primary/ Secondary Clarifier Upgrades	AreaB		Mar 2016 - Oct 2017
SEP-8	(SFPUC) SEP Seismic Reliability and Condition Assessment Improvements	50% AreaB, 50% AreaC		May 2016 - Aug 2019
SEP-10	(SFPUC) SEP Oxygen Generation Plant Replacement	AreaB		Jan 2013 - Jan 2018
SEP-12	(SFPUC) Demolition of the Existing SEP Digesters and Southside Renovation Project	AreaC		Jan 2025 - Aug 2025
--	(SFPUC) Demolition of the Existing Greenhouses located to the south of the Project	AreaD	SFPUC-provided Construction Equipment List and Construction Traffic Data	Apr 2017 - May 2017
Off-site Cumulative Projects[5]				
1	Central Bayside System Improvement Project (SFPUC)	OFF01a and OFF01b	SFPUC Construction Emissions Screening Tool	Jan 2018 - Oct 2022
2	Central Shops Relocation and Land Reuse - 1800 Jerrold Aven	OFF02a and OFF02b	CEQA Categorical Exemption	Jan 2018 - Dec 2019
3	Land Reuse - 1801 Jerrold Avenue (SFPUC and DPW)	OFF003	SFPUC Construction Emissions Screening Tool	Jan 2018 - Dec 2019
4	Kansas and Marin Streets Sewer Improvements (SFPUC)	OFF004	SFPUC Construction Emissions Screening Tool	Jan 2018 - Dec 2019
6	Southeast Outfall Underwater Crossing Replacement (SFPUC)	OFF006	SFPUC Construction Emissions Screening Tool	Jan 2018 - Dec 2019
9	Quint Street Bridge Replacement Project (Caltrain)	OFF009	Estimation using Sacramento Road Construction Emissions Model	Jan 2018 - Dec 2019
10	Quint-Jerrold Connector Road (San Francisco County Transpor	OFF010	CEQA Mitigated Negative Declaration	Jan 2018 - Dec 2019
11	San Francisco Wholesale Produce Market Expansion (City and County of San Francisco Market Corporation)	OFF011	CEQA Mitigated Negative Declaration	Jan 2018 - Jun 2023
12	1995 Evans Avenue (SF Police Department)	OFF012	CEQA Mitigated Negative Declaration; CalEEMod®	Jan 2018 - Dec 2019
20	Quint Street Lead Track (Port of San Francisco and Federal Railroad Administration)	OFF020	CEQA Categorical Exemption	Jan 2018 - Dec 2019

Notes:

1. Cumulative projects shown here are the recently constructed or planned projects within 1,000 meters of the Project boundary not currently included in the C
2. Emissions were collected from CEQA documentation, when available, or were estimated using CalEEMod®, the Sacramento Road Construction Emissions Model, or the SFPUC Construction Emissions Screening Tool.
3. Planned construction schedules were provided by SFPUC for on-site cumulative projects, but modeled schedules may differ slightly for simplicity. Construction schedules for off-site cumulative projects shown were simplified from actual construction schedules (provided by SFPUC or found in CEQA documentation for the projects, when available) for each project for modeling purposes, with the exception of Off-site Project 1 and Off-site Project 11 due to their longer construction durations. All other off-site cumulative projects were assumed to begin at the same time as SFPUC BDFP and last two years. This is generally conservative, since emissions during the first years of exposure cause higher risk.
4. On-site cumulative projects are located within the SFPUC SEP.
5. Construction off-road emissions were modeled as source "AreaA." On-road sources for SEP-1 were modeled as well; for a list of these modeled source groups, please see Appendix Table E-7.
6. Off-site cumulative projects are located outside of the SEP boundary but within 1000 meters. The project-sponsors are shown in parentheses after the project names.

Table 17
Cumulative Projects and Schedules
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Abbreviations:

BDFP - Biosolids Digester Facilities Project
CEQA - California Environmental Quality Act
CRRP - Community Risk Reduction Plan
DPW - Department of Public Works
HRA - health risk assessment
SEP - Southeast Plant
SFPUC - San Francisco Public Utilities Commission
MMBTU - one millioin British thermal unit

References:

Sacramento Metropolitan Air Quality Management District. Road Construction Emissions Model Version 8.1.0. Available online at: http://www.airquality.org/LandUseTransportation/Documents/RoadConstructionEmissionsModelVer8_1_0_locked_05262016.xls

San Francisco Planning Department. CEQA Categorical Exemption Determination. 2013. Quint Street Rail Repair. March 29. Case No. 2013.0427E.

San Francisco Planning Department. CEQA Categorical Exemption Request. 2015. Central Shops Relocation and Land Transfer Project. October 28. Case No. 2015-004781ENV.

San Francisco Planning Department. Final Mitigated Negative Declaration. 2011. San Francisco Wholesale Market Project. May 11; amended July 5. Case No. 2009.1153E.

San Francisco Planning Department. Final Mitigated Negative Declaration. 2013. 1995 Evans Avenue / San Francisco Police Department (SFPD) Forensic Service Division (FSD) & Traffic Company (TC). October 2; amended November 15. Case No. 2013.0342E.

San Francisco Planning Department. Final Mitigated Negative Declaration. 2015. Quint-Jerrold Connector Road Project. August 5. Case No. 2013.0858E.

Table 18c
Cumulative Project Operational Emissions and Modeled Emission Rates[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

On-site Cumulative Project	Modeled Source Group	Maximum Engine Power (kW)[2]	Hours of Operation (hrs/yr)[3]	PM Emission Factor (g/kW-hr)[4]	Total Project Operational Emissions		Modeled Emission Rate	
					DPM	$PM_{2.5}$[5]	DPM	$PM_{2.5}$[5]
					(lbs/yr)		(g/s)	
SEP-1	HW_02	750	50	0.2	17	17	2.4E-04	2.4E-04
SEP-5	ON_G01	150	50	0.2	3.3	3.3	4.8E-05	4.8E-05
SEP-2	ON_G02	80	50	0.2	1.8	1.8	2.5E-05	2.5E-05

Notes:

1. Emissions were calculated using the methodology outlined in Table 1.
2. Maximum engine power was provided by SFPUC.
3. The California Airborne Toxic Control Measure (ATCM) for Stationary CI Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel-fueled CI engines to a maximum of 50 hours per year.
4. Emission factors are based on the BAAQMD Best Available Control Technology (BACT)emission limits, which are based on the ARB ATCM, for a stationary emergency standby diesel-fueled compression ignition (CI) engine.
5. $PM_{2.5}$ emissions were conservatively assumed to be equal to the PM_{10} emissions.

Abbreviations:

ATCM - Airborne Toxic Control Measure
BAAQMD - Bay Area Air Quality Management District
CCR - California Code of Regulations
CEQA - California Environmental Quality Act
CI - compression ignition
DPM - diesel particulate matter
hp - horsepower
hrs - hours
kW - kilowatt
lbs - pounds
PM - particulate matter
yr - year

References:

ARB. 2011. Amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (17 CCR 93115.6(3)(1)(c)). May 19. Available at: http://www.arb.ca.gov/diesel/documents/FinalReg2011.pdf.

BAAQMD. 2010. Best Available Control Technology (BACT) Guideline for IC Engine-Compression Ignition Stationary Emergency, non-Agricultural, non-direct drive fire pump. December 22. Available at: http://www.baaqmd.gov/~/media/files/engineering/bact-tbact-workshop/combustion/96-1-3.pdf?la=en.

BAAQMD. 2007. Regulation 9 - Inorganic Gaseous Pollutants, Rule 8 - Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines (9-8-330.3). July 25. Available at: http://www.baaqmd.gov/~/media/files/planning-and-research/rules-and-regs/reg-09/rg0908.pdf?la=en.

Table 19
Exposure Parameters
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Receptor Type	Period	Receptor Age Group	Exposure Parameters					
			Daily Breathing Rate (DBR)[1] [L/kg-day]	Exposure Duration (ED)[2] [years]	Fraction of Time at Home (FAH)[3] [unitless]	Exposure Frequency (EF)[4] [days/year]	Averaging Time (AT) [years]	Intake Factor, Inhalation (IF_{inh}) [m^3/kg-day]
Resident	Construction	3rd Trimester	361	0.25	1	350	25550	0.0012
		Age 0-<2 Years	1090	2				0.030
		Age 2-<9 Years	631	2.75				0.024
	Operation	3rd Trimester	361	0.25	1	350	25550	0.0012
		Age 0-<2 Years	1090	2				0.030
		Age 2-<16 Years	572	14				0.11
		Age 16-30 Years	261	14				0.050

Notes:

1. Daily breathing rates reflect default breathing rates from OEHHA 2015 as follows: 95th percentile for 3rd trimester and age 0-<2 years; 80th percentile for ages 2-<9 years, 2-<16 years, and 16-30 years.
2. The exposure duration for construction reflects the most-conservative proposed construction schedule of 60 months; the exposure duration for operation reflects the default residential exposure duration from OEHHA 2015.
3. Fraction of time spent at home is conservatively assumed to be 1 (i.e. 24 hours/day).
4. Exposure frequency reflects default exposure frequency from OEHHA 2015.

Calculation:

IF_{inh} = DBR * FAH * EF * ED * CF / AT

CF = 0.001 (m^3/L)

Abbreviations:

AT - average timing
DBR - daily breathing rate
ED - exposure duration
EF - exposure frequency
FAH - fraction of time at home
IF - intake factor
kg - kilogram
L - liter
m3 - cubic meter
OEHHA - Office of Environmental Health Hazard Assessment
SFPUC - San Francisco Public Utilities Commission

Reference:

OEHHA. 2015. Air Toxics Hot Spots Program Risk Assessment Guidelines. Guidance Manual for Preparation of Health Risk Assessments. February.

Table 20a
Toxicity Values[1] - Construction Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Chemical[1]	CAS Number	Cancer Potency Factor (CPF)[2] [mg/kg-day]$^{-1}$	Chronic Reference Exposure Level (REL)[2] (µg/m^3)	Acute Reference Exposure Level (REL)[2] (µg/m^3)
On-site Construction Emissions (Diesel off-road equipment)	Diesel PM[3]	9901	1.1	5	--
	1,3-butadiene	106990	--	--[4]	660
	Acetaldehyde	75070	--[4]	--[4]	470
	Benzene	71432	--[4]	--[4]	27
	Formaldehyde	50000	--[4]	--[4]	55
	Methanol	67561	--	--[4]	28000
	Methyl Ethyl Ketone	78933	--	--	13000
	m-Xylene	108383	--	--[4]	22000
	o-Xylene	95476	--	--[4]	22000
	p-Xylene	106423	--	--[4]	22000
	Styrene	100425	--	--[4]	21000
	Toluene	108883	--	--[4]	37000
Off-site Construction Traffic (Diesel on-road vehicles)	Diesel PM[3]	9901	1.1	5	--
	Acetaldehyde	75070	--[4]	--[4]	470
	Benzene	71432	--[4]	--[4]	27
	Formaldehyde	50000	--[4]	--[4]	55
	Methyl Ethyl Ketone	78933	--	--	13000
	o-Xylene	95476	--	--[4]	22000
	Toluene	108883	--	--[4]	37000
	Xylene, m- & p-	108383	--	--[4]	22000
On-site Construction Emissions (Gasoline off-road equipment)	1,3-Butadiene	106990	0.6	2	660
	Acetaldehyde	75070	0.01	140	470
	Benzene	71432	0.1	3	27
	Ethylbenzene	100414	0.0087	2000	--
	Formaldehyde	50000	0.021	9	55
	Methanol	67561	--	4000	28000
	Methyl Ethyl Ketone	78933	--	--	13000
	Naphthalene	91203	0.12	9	--
	n-Hexane	110543	--	7000	--
	Propene	115071	--	3000	--
	Styrene	100425	--	900	21000
	Toluene	108883	--	300	37000
	Xylenes	1330207	--	700	22000
Off-site Construction Traffic (Gasoline on-road vehicles)	1,3-Butadiene	106990	0.6	2	660
	Acetaldehyde	75070	0.01	140	470
	Benzene	71432	0.1	3	27
	Ethylbenzene	100414	0.0087	2000	--
	Formaldehyde	50000	0.021	9	55
	Methanol	67561	--	4000	28000
	Methyl Ethyl Ketone	78933	--	--	13000
	Naphthalene	91203	0.12	9	--
	n-Hexane	110543	--	7000	--
	Propene	115071	--	3000	--
	Styrene	100425	--	900	21000
	Toluene	108883	--	300	37000
	Xylenes	1330207	--	700	22000

Notes:

1. Values presented in this table reflect values used in this analysis. If a chemical does not have a cancer potency factor, acute reference level, or chronic reference level, it was not included in the analysis.
2. The cancer potency factors, chronic reference levels, and acute reference levels were obtained from Cal/EPA 2016.
3. The acute effect for DPM is evaluated based on individual constitutes included in the speciation profile for diesel TOG, which is shown in Appendix E.

Table 20a
Toxicity Values[1] - Construction Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, California

4. The chemical shown has a cancer potency factor and/or chronic reference level; however, it is not shown here because cancer risk and chronic hazard index are calculated using the cancer potency factor and chronic reference level from DPM instead of the individual chemicals in the speciation profile for diesel on-road and off-road TOG.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
Cal/EPA - California Environmental Protection Agency
CAS - chemical abstract services
CPF - cancer potency factor
kg - kilogram
m^3 - cubic meter
mg - miligram
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
REL - reference exposure level
SFPUC - San Francisco Public Utilities Commission
µg - microgram

Reference:

BAAQMD. 2010. Regulation 2: Permits, Rule 5: New Source Review of Toxic Air Contaminants, Table 2-5-1: Toxic Air Contaminant Trigger Levels. January 6. Available online at http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx. Accessed October 2015.

Cal/EPA. 2016. OEHHA/ARB Consolidated Table of Approved Risk Assessment Health Values. March. Available at: http://www.arb.ca.gov/toxics/healthval/contable.pdf Accessed May 2016.

RAMBOLL ENVIRON

Table 20b
Toxicity Values[1] - Existing Operational Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Chemical	CAS Number	Cancer Potency Factor (CPF)[2]	Chronic Reference Exposure Level (REL)[2]	Acute Reference Exposure Level (REL)[2]
			[mg/kg-day]$^{-1}$	(µg/m^3)	(µg/m^3)
Existing Cogeneration Engine	Formaldehyde	50000	0.021	9.0	55
	Acetaldehyde	75070	0.010	140	470
	Benzene	71432	0.1	3	27
	Ethylbenzene	100414	0.0087	2,000	--
Existing Waste Gas Burners	Benzene	71432	0.1	3	27
	Formaldehyde	50000	0.021	9	55
	PAHs (including Naphthalene)[5]	1150	3.9	--	--
	Naphthalene	91203	0.12	9	--
	Acetaldehyde	75070	0.010	140	470
	Propylene	115071	--	3000	--
	Toluene	108883	--	300	37,000
	Xylenes	1330207	--	700	22,000
	Ethylbenzene	100414	0.0087	2000	--
	Hexane	110543	--	7000	--
Existing Boilers	2-Methylnaphthalene	91-57-6	--	--	--
	3-Methylchloranthrene	56495	22	--	--
	7,12-Dimethylbenz(a)anthracene	57976	250	--	--
	Acenaphthene	83-32-9	--	--	--
	Acenaphthylene	208-96-8	--	--	--
	Anthracene	120-12-7	--	--	--
	Benz(a)anthracene	56553	0.39	--	--
	Benzene	71432	0.10	3	27
	Benzo(a)pyrene	50328	3.9	--	--
	Benzo(b)fluoranthene	205992	0.39	--	--
	Benzo(g,h,i)perylene	191-24-2	--	--	--
	Benzo(k)fluoranthene	207089	0.39	--	--
	Butane	106-97-8	--	--	--
	Chrysene	218019	0.039	--	--
	Dibenzo(a,h)anthracene	53703	--	--	--
	1,4 Dichlorobenzene	106467	0.040	800	--
	Ethane	74-84-0	--	--	--
	Fluoranthene	206-44-0	--	--	--
	Fluorene	86-73-7	--	--	--
	Formaldehyde	50000	0.021	9	55
	Hexane	110543	--	7000	--
	Indeno(1,2,3-cd)pyrene	193395	--	--	--
	Naphthalene	91203	0.12	9	--
	Pentane	109-66-0	--	--	--
	Phenanathrene	--	--	--	--
	Propane	74-98-6	--	--	--
	Pyrene	129-00-0	--	--	--
	Toluene	108883	--	300	37,000

Table 20b
Toxicity Values[1] - Existing Operational Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Notes:

1. Values presented in this table reflect values used in this analysis. If a chemical does not have a cancer potency factor, acute reference level, or chronic reference level, it was not included in the analysis.
2. The cancer potency factors, chronic reference levels, and acute reference levels were obtained from Cal/EPA 2016.
3. The acute effect for DPM is evaluated based on individual constitutes included in the speciation profile for diesel TOG, which is shown in Appendix E.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
Cal/EPA - California Environmental Protection Agency
CAS - chemical abstract services
CPF - cancer potency factor
kg - kilogram
m^3 - cubic meter
mg - miligram
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
REL - reference exposure level
SFPUC - San Francisco Public Utilities Commission
µg - microgram

Reference:

BAAQMD. 2010. Regulation 2: Permits, Rule 5: New Source Review of Toxic Air Contaminants, Table 2-5-1: Toxic Air Contaminant Trigger Levels. January 6. Available online at http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx. Accessed October 2015.

Cal/EPA. 2016. OEHHA/ARB Consolidated Table of Approved Risk Assessment Health Values. March. Available at: http://www.arb.ca.gov/toxics/healthval/contable.pdf Accessed May 2016.

Table 20c

Toxicity Values[1] - Project Operational Sources

SFPUC Biosolids Digester Facilities Project

San Francisco, California

Source	Chemical	CAS Number	Cancer Potency Factor (CPF)[2]	Chronic Reference Exposure Level (REL)[2]	Acute Reference Exposure Level (REL)[2]
	-		[mg/kg-day]$^{-1}$	(µg/m^3)	(µg/m^3)
Two Turbines (1 duty/1 future standby)	1,3-Butadiene	106990	0.6	2	660
	1,4 Dichlorobenzene	106467	0.04	800	--
	Acetaldehyde	75070	0.01	140	470
	Carbon tetrachloride	56235	0.15	40	1,900
	Chlorobenzene	108907	--	1000	--
	Chloroform	67663	0.019	300	150
	Ethylene Dichloride	107062	0.072	400	--
	Formaldehyde	50000	0.021	9	55
	Methylene chloride	75092	0.0035	400	14,000
	Tetrachloroethylene	127184	0.021	35	20,000
	Trichloroethylene	79016	0.007	600	--
	Vinyl chloride	75014	0.27	--	180,000
	Vinylidene chloride	75354	--	70	--
Four (4) 200 kW Microturbines (future: 3 duty/ 1 standby)	1,3-Butadiene	106990	0.6	2	660
	1,4 Dichlorobenzene	106467	0.04	800	--
	Acetaldehyde	75070	0.01	140	470
	Carbon tetrachloride	56235	0.15	40	1,900
	Chlorobenzene	108907	--	1000	--
	Chloroform	67663	0.019	300	150
	Ethylene Dichloride	107062	0.072	400	--
	Formaldehyde	50000	0.021	9	55
	Methylene chloride	75092	0.0035	400	14,000
	Tetrachloroethylene	127184	0.021	35	20,000
	Trichloroethylene	79016	0.007	600	--
	Vinyl chloride	75014	0.27	--	180,000
	Vinylidene chloride	75354	--	70	--
One Emergency Diesel Engine	Diesel PM[3]	9901	1.1	5	--
	1,3-butadiene	106990	--	--[4]	660
	Acetaldehyde	75070	--[4]	--[4]	470
	Benzene	71432	--[4]	--[4]	27
	Formaldehyde	50000	--[4]	--[4]	55
	Methanol	67561	--	--[4]	28000
	Methyl Ethyl Ketone	78933	--	--[4]	13000
	m-Xylene	108383	--	--[4]	22000
	o-Xylene	95476	--	--[4]	22000
	p-Xylene	106423	--	--[4]	22000
	Styrene	100425	--	--[4]	21000
	Toluene	108883	--	--[4]	37000
Two Waste Gas Burners (2 standby)	Benzene	71432	0.1	3	27
	Formaldehyde	50000	0.021	9	55
	PAHs (including Naphthalene)[5]	1150	3.9	--	--
	Naphthalene	91203	0.12	9	--
	Acetaldehyde	75070	0.01	140	470
	Propylene	115071	--	3000	--
	Toluene	108883	--	300	37,000
	Xylenes	1330207	--	700	22,000
	Ethylbenzene	100414	0.0087	2000	--
	Hexane	110543	--	7000	--

Table 20c

Toxicity Values[1] - Project Operational Sources

SFPUC Biosolids Digester Facilities Project

San Francisco, California

Source	Chemical	CAS Number	Cancer Potency Factor (CPF)[2]	Chronic Reference Exposure Level (REL)[2]	Acute Reference Exposure Level (REL)[2]
			[mg/kg-day]$^{-1}$	(µg/m^3)	(µg/m^3)
Two Backup Steam Boilers (2 standby)	2-Methylnaphthalene	91-57-6	--	--	--
	3-Methylchloranthrene	56495	22	--	--
	7,12-Dimethylbenz(a)anthracene	57976	250	--	--
	Acenaphthene	83-32-9	--	--	--
	Acenaphthylene	208-96-8	--	--	--
	Anthracene	120-12-7	--	--	--
	Benz(a)anthracene	56553	0.39	--	--
	Benzene	71432	0.10	3	27
	Benzo(a)pyrene	50328	3.9	--	--
	Benzo(b)fluoranthene	205992	0.39	--	--
	Benzo(g,h,i)perylene	191-24-2	--	--	--
	Benzo(k)fluoranthene	207089	0.39	--	--
	Butane	106-97-8	--	--	--
	Chrysene	218019	0.039	--	--
	Dibenzo(a,h)anthracene	53703	--	--	--
	1,4 Dichlorobenzene	106467	0.040	800	--
	Ethane	74-84-0	--	--	--
	Fluoranthene	206-44-0	--	--	--
	Fluorene	86-73-7	--	--	--
	Formaldehyde	50000	0.021	9	55
	Hexane	110543	--	7000	--
	Indeno(1,2,3-cd)pyrene	193395	--	--	--
	Naphthalene	91203	0.12	9	--
	Pentane	109-66-0	--	--	--
	Phenanathrene	--	--	--	--
	Propane	74-98-6	--	--	--
	Pyrene	129-00-0	--	--	--
	Toluene	108883	--	300	37,000
Solids Odor Control (4 stacks)	Hydrogen Sulfide	7783064	--	10	42

Notes:

1. Values presented in this table reflect values used in this analysis. If a chemical does not have a cancer potency factor, acute reference level, or chronic reference level, it was not included in the analysis.
2. The cancer potency factors, chronic reference levels, and acute reference levels were obtained from Cal/EPA 2016.
3. The acute effect for DPM is evaluated based on individual constitutes included in the speciation profile for diesel TOG, which is shown in Appendix E.
4. The chemical shown has a cancer potency factor and/or chronic reference level; however, it is not shown here because cancer risk and chronic hazard index are calculated using the cancer potency factor and chronic reference level from DPM instead of the individual chemicals in the speciation profile for diesel on-road and off-road TOG.
5. The value for Benzo(a)pyrene was selected to represent PAHs for this analysis as a conservative approach, since it has the highest cancer potency factor.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
Cal/EPA - California Environmental Protection Agency
CAS - chemical abstract services
CPF - cancer potency factor
kg - kilogram
m^3 - cubic meter
mg - miligram
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
REL - reference exposure level
SFPUC - San Francisco Public Utilities Commission
µg - microgram

Reference:

BAAQMD. 2010. Regulation 2: Permits, Rule 5: New Source Review of Toxic Air Contaminants, Table 2-5-1: Toxic Air Contaminant Trigger Levels. January 6. Available online at http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx. Accessed October 2015.

Cal/EPA. 2016. OEHHA/ARB Consolidated Table of Approved Risk Assessment Health Values. March. Available at: http://www.arb.ca.gov/toxics/healthval/contable.pdf Accessed May 2016.

Table 21
Age Sensitivity Factors
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Receptor Age Group	Age Sensitivity Factor (ASF)[1]
3rd Trimester	10
Age 0-<2 Years	10
Age 2-<9 Years[2] Age 2-<16 Years	3
Age 16-30 Years	1

Notes:

1. Based on OEHHA 2015.
2. Age group 2-<9 years used for construction analysis because construction duration is less than 9 years.

Abbreviations:

ASF: Age sensitivity factor
OEHHA: Office of Environmental Health Hazard Assessment
SFPUC - San Francisco Public Utilities Commission

Reference:

OEHHA. 2015. Air Toxics Hot Spots Program Risk Assessment Guidelines. Guidance Manual for Preparation of Health Risk Assessments. February.

Table 22
Net Project Cancer Risk at MEISR[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Phase	Source	Lifetime Excess Cancer Risk[2]		
		Scenario 1 (Uncontrolled)[3]	Scenario 1 (Controlled)[3]	Scenario 2
		in a million	in a million	in a million
Project Construction	Off-road Construction Equipment	3.5	1.6	--
	On-road Construction Vehicles	0.31	0.14	--
	Total	**3.8**	**1.7**	**--**
Project Operation	Existing Waste Gas Burners (A7003 and A7004)[4]	0.017	0.011	0.004
	Turbine (one duty/ one future standby)	0.09	0.08	0.02
	Microturbines	0.021	0.013	0.002
	Two Backup Boilers	4.3E-04	3.8E-04	0.0000
	Emergency Diesel Engine	0.3	0.2	0.1
	Two Waste Gas Burners	0.0004	0.0006	0.001
	Solids Odor Control System	--	--	--
	Total	**0.41**	**0.31**	**0.08**
Existing Operation	Waste Gas Burners (A7003 and A7004)[5]	(0.41)	(0.27)	(0.04)
	Cogeneration Engine (S10)[6]	(0.184)	(0.067)	(0.01)
	Industrial Boilers (S8201, S8202, and S8203)[7]	(0.139)	(0.042)	(0.004)
	Total	**(0.74)**	**(0.38)**	**(0.06)**
Net Project Lifetime Excess Cancer Risk[8]		**3.4**	**1.7**	**0.022**

Notes:

1. The Project off-site MEISR for lifetime excess cancer risk for Scenario 1 (Uncontrolled) is located at Universal Transverse Mercator coordinates 553,640 m and 4,177,120 m, and Scenario 1 (Controlled) is located at coordinates 553,820 m and 4,177,180 m. The MEISR for Scenario 2 is located at coordinates 554,280 m and 4,176,620 m.

2. This table presents the lifetime excess cancer risk from Project construction on-road traffic and off-road construction equipment as well as Project operation at the off-site MEISR locations. In Scenario 1, exposure begins at the start of construction, followed by 25 years of exposure to operational emissions. Scenario 2 considered exposure to operational emissions for 30 years. Because of this, adjusted cancer risk from existing sources planned to be removed are different for the two scenarios because the exposure parameters for the resident are different based on when the 30-year exposure is assumed to have begun. For Scenario 1, construction occurs for the first five years, and operational exposure is 25 years, compared with Scenario 2, which has 30 years of operational exposure.

3. The "Uncontrolled" case shown here represents the scenario using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance. The "Controlled" case shown here represent the scenario using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.

4. The existing waste gas burners will operate as part of the Project during the transition period in 2023 (up to 30 months, but assumed to be six months for calculation purposes).

5. The existing waste gas burners were not modeled for the CRRP-HRA. The toxic air contaminant (TAC) emissions for the existing waste gas burners were calculated using the emission factors used by the BDFP Consultant Team to calculate the TAC emissions for the Project waste gas burners. The $PM_{2.5}$ emissions from the existing flares were calculated using the PM_{10} emission factor from AP-42, Table 2.4-5, and total 2014 digester gas throughput to the flares, as provided by SFPUC. These emissions were used to calculate the cancer risk from the existing waste gas burners.

6. The cogeneration engine was not modeled for the CRRP-HRA. The organics emissions from the cogeneration engine are from the 2015 BAAQMD Source Emissions for the Plant (No. 568). The organics emissions were speciated based on the ARB 2015 organics speciation profile for reciprocating internal combustion engines that run on natural gas (Organic Profile 719). These emissions were used to calculate the cancer risk from the existing cogeneration engine.

7. The industrial boilers (S8201, S8202, and S8203) were modeled for the CRRP-HRA; however, the modeling was refined to account for a more realistic existing emissions baseline. The organics emissions from the boilers are from the 2015 CER, and PAHs were combined using BAAQMD Toxic Air Contaminant Trigger Levels Table 2-5-1. These emissions were used to calculate the adjusted existing cancer risk from the existing boilers.

8. Net Project operation is the difference between the excess cancer risk from the Project and the excess cancer risk from the existing operation sources that will be replaced with the Project.

Abbreviations:

ARB - California Air Resources Board
BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CER - Conceptual Engineering Report
CRRP - Community Risk Reduction Plan
HRA - health risk assessment
m - meter
MEISR - maximally exposed individual sensitive receptor
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TAC - toxic air contaminant

References:

BAAQMD Source Emissions Plant #568. June 3, 2015.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

California Air Resources Board (ARB). 2015. Organic Chemical Profiles for Source Categories. February 11. Available at: http://arb.ca.gov/ei/speciate/speciate.htm. Accessed September 2015.

Table 23a
Chronic and Acute Health Impacts from Project Construction at MEISR and MEI
(Uncontrolled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Phase	Source[2]	$PM_{2.5}$ Concentration[3]	Chronic HI[4]	Acute HI[5]
		µg/m³	--	--
Project Construction	Off-road Construction Equipment	0.019	0.0041	0.10
	On-road Construction Vehicles	4.8E-03	7.9E-04	0.0026
Total From Construction		**0.024**	**0.0049**	**0.10**

Notes:

1. The "Uncontrolled" case shown here represents the scenario using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance.
2. This table presents the chronic and acute health impacts from Project construction on-road traffic and off-road construction equipment at the off-site MEISR and MEI.
3. The Project off-site MEISR for the Project construction $PM_{2.5}$ concentration is located at Universal Transverse Mercator coordinates 553,640 m and 4,177,120 m.
4. The Project off-site MEISR for the Project construction chronic HI is located at Universal Transverse Mercator coordinates 553,640 m and 4,177,120 m.
5. The Project off-site MEI for the Project construction acute HI is located at Universal Transverse Mercator coordinates 553,420 m and 4,177,520 m.

Abbreviations:

DPF - diesel particulate filter
HI - hazard index
m - meter
m^3 - cubic meter
MEI - maximally exposed individual
MEISR - maximally exposed individual sensitive receptor
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
µg - microgram

Table 23b
Chronic and Acute Health Impacts from Project Construction at MEISR and MEI
(Controlled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Phase	Source[2]	$PM_{2.5}$ Concentration[3]	Chronic HI[4]	Acute HI[5]
		μg/m³	--	--
Project Construction	Off-road Construction Equipment	0.012	0.0027	0.19
	On-road Construction Vehicles	5.0E-03	8.3E-04	0.0019
Total From Construction		**0.017**	**0.0036**	**0.20**

Notes:

1. The "Controlled" case shown here represent the scenario using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.
2. This table presents the chronic and acute health impacts from Project construction on-road traffic and off-road construction equipment at the off-site MEISR and MEI.
3. The Project off-site MEISR for the Project construction $PM_{2.5}$ concentration is located at Universal Transverse Mercator coordinates 553,640 m and 4,177,120 m. Onroad concentrations in the Controlled Scenario are greater than the Uncontrolled Scenario as a result of mitigation measures designed to reduce NO_X emissions, but results in increased particulate emissions.
4. The Project off-site MEISR for the Project construction chronic HI is located at Universal Transverse Mercator coordinates 553,640 m and 4,177,120 m. Onroad chronic HI in the Controlled Scenario are greater than the Uncontrolled Scenario as a result of mitigation measures designed to reduce NO_X emissions, but results in increased particulate emissions.
5. The Project off-site MEI for the Project construction acute HI is located at Universal Transverse Mercator coordinates 553,420 m and 4,177,520 m. Offroad Acute HI results are higher in the controlled scenario compared with the uncontrolled scenario, because the ROG emissions can be slightly higher for the Controlled cases than for the Uncontrolled cases. This is due to the ROG reduction of 90% that is applied with the use of a DPF in the Uncontrolled case; this reduction is not applied for the Controlled cases as the model used to estimate emissions for Tier 4 Final Engines is reflective of actual predicted emissions. In reality, the emissions from a Tier 4 Final Engine are very similar to a Tier 2 engine + DPF.

Abbreviations:

DPF - diesel particulate filter
HI - hazard index
m - meter
m^3 - cubic meter
MEI - maximally exposed individual
MEISR - maximally exposed individual sensitive receptor
NO_x - nitrogen oxide compounds (NO + NO2)
PM - particulate matter
ROG - reactive organic gases
SFPUC - San Francisco Public Utilities Commission
μg - microgram

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Table 24
Chronic and Acute Health Impacts from Project Operation at MEISR and MEI[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Phase	Source	$PM_{2.5}$ Concentration[2]	Chronic HI[3]	Acute HI[4]
		μg/m³	--	--
Project Operation	Existing Waste Gas Burners (A7003 and A7004)[5]	0.39	0.0057	0.020
	Turbine (one duty/ one future standby)	--	--	--
	Microturbines	--	--	--
	Two Backup Boilers (two standby)	0.00032	3.7E-07	1.2E-03
	Emergency Diesel Engine	0.00023	1.0E-04	0.053
	Two Waste Gas Burners	0.0023	2.6E-05	0.0038
	Solids Odor Control System	--	0.0009	0.0044
	Total	**0.39**	**0.0067**	**0.083**
Existing Operation	Waste Gas Burners (A7003 and A7004)[5]	(0.21)	NC	NC
	Cogeneration Engine (S10)[6]	(0.061)	NC	NC
	Industrial Boilers (S8201, S8202, and S8203)[7]	(0.031)	NC	NC
	Total	**(0.30)**	NC	NC
Total Health Impacts from Project Operation		**0.090**	**0.0067**	**0.083**

Notes:

1. This table presents the chronic and acute health impacts from the proposed Project operational sources at the off-site MEISR and MEI. $PM_{2.5}$ and chronic HI are for the year with the maximum impact and the acute HI is for the maximum one-hour impact. Therefore, sources of operation only show a contribution to the health impact if they are operating during the maximum year or maximum one-hour impact.
2. The Project off-site MEISR for the Project operational $PM_{2.5}$ concentration is located at Universal Transverse Mercator (UTM) coordinates 553,580 m and 4,177,040 m.
3. The Project off-site MEISR for the Project operational chronic HI is located at UTM coordinates 553,600 m and 4,177,080 m.
4. The Project off-site MEI for the Project operation acute HI is located at UTM coordinates 553,440 m and 4,177,200 m.
5. The existing waste gas burners were not modeled for the CRRP-HRA. The toxic air contaminant (TAC) emissions for the existing waste gas burners were calculated using the emission factors used by the BDFP Consultant Team to calculate the TAC emissions for the Project waste gas burners. The $PM_{2.5}$ emissions from the existing waste gas burners were calculated using the PM_{10} emission factor from AP-42, Table 2.4-5, and total 2014 digester gas throughput to the waste gas burners, as provided by SFPUC.
6. The cogeneration engine was not modeled for the CRRP-HRA. The organics emissions from the cogeneration engine are from the 2015 BAAQMD Source Emissions for the Plant (No. 568). The organics emissions were speciated based on the ARB 2015 organics speciation profile for reciprocating internal combustion engines that run on natural gas (Organic Profile 719). These emissions were used to calculate the cancer risk from the existing cogeneration engine.
7. The industrial boilers (S8201, S8202, and S8203) were modeled for the CRRP-HRA; however, the modeling was refined to account for a more realistic existing emissions baseline. The organics emissions from the boilers are from the 2015 CER, and PAHs were combined using BAAQMD Toxic Air Contaminant Trigger Levels Table 2-5-1. These emissions were used to calculate the adjusted existing cancer risk from the existing boilers.

Abbreviations:

ARB - California Air Resources Board
BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CER - Conceptual Engineering Report
CRRP - Community Risk Reduction Program
HI - hazard index
HRA - health risk assessment
m - meter
m^3 - cubic meter
MEI - maximally exposed individual
MEISR - maximally exposed individual sensitive receptor
NC - not calculated
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
UTM - Universal Transverse Mercator
TAC - toxic air contaminant
μg - microgram

References:

BAAQMD Source Emissions Plant #568. June 3, 2015.

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

California Air Resources Board (ARB). 2015. Organic Chemical Profiles for Source Categories. February 11. Available at: http://arb.ca.gov/ei/speciate/speciate.htm. Accessed September 2015.

Table 25
Chronic Health Impacts from Cumulative Sources at MEISR
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Cumulative Sources	Source Group[1]	Lifetime Excess Cancer Risk[2,3]			$PM_{2.5}$ Concentration[4] (Construction)	$PM_{2.5}$ Concentration[4] (Operation)	Chronic HI[5] (Construction)	Chronic HI[5] (Operation)
		Scenario 1 (Uncontrolled)	Scenario 1 (Controlled)	Scenario 2				
		in a million	in a million	in a million	$\mu g/m^3$	$\mu g/m^3$	--	--
Construction On-site Cumulative Sources[6]	AreaA	0.26	0.35	0.0029	7.0E-04	0.00014	1.3E-04	3.3E-05
	AreaB	1.7	1.7	--	--	--	--	--
	AreaC	29	3.7	0.0082	--	--	--	--
	AreaD	--	--	--	--	--	--	--
Construction Off-site Cumulative Sources	OFF001	0.67	0.64	--	0.0015	--	3.3E-04	--
	OFF002	0.20	0.26	--	--	--	--	--
	OFF003	2.4	1.2	--	--	--	--	--
	OFF004	0.0024	0.0026	--	--	--	--	--
	OFF006	0.054	0.050	--	--	--	--	--
	OFF009	15	5.9	--	--	--	--	--
	OFF010	0.80	0.41	--	--	--	--	--
	OFF011	10	9.3	0.089	0.0077	0.0025	0.0048	0.0020
	OFF012	0.31	0.29	--	--	--	--	--
	OFF020	--	--	--	--	--	--	--
Operational Emergency Diesel Engines	HW_G02	0.037	0.038	0.014	--	7.9E-05	--	1.8E-05
	ON_G01	0.056	0.20	0.0063	7.4E-05	3.6E-05	1.5E-05	8.9E-06
	ON_G02	0.010	0.011	0.0027	1.3E-05	1.1E-05	2.6E-06	2.4E-06
Total		**61**	**24**	**0.12**	**0.010**	**0.0027**	**0.0053**	**0.0021**

Notes:

1. The source groups of the on-site and off-site cumulative projects are described in Table 17.
2. The Project off-site MEISR for lifetime excess cancer risk for Scenario 1 (Uncontrolled) is located at Universal Transverse Mercator (UTM) coordinates 553,640 m and 4,177,120 m and Scenario 1 (Controlled) is located at coordinates 553,820 m and 4,177,180 m. The MEISR for Scenario 2 is located at coordinates 554,280 m and 4,176,620 m.
3. Scenario 1 assumes exposure begins at the start of construction, followed by 25 years of exposure to operational emissions. Scenario 2 assumes 30 years of exposure to operational emissions. Sources of operation only show a contribution to the health impact if they operate during any years included in each scenario.
4. The Project off-site MEISR for the Project construction $PM_{2.5}$ concentration is located at UTM coordinates 553,640 m and 4,177,120 m for both controlled and uncontrolled scenarios, and operational $PM_{2.5}$ concentration is located at UTM coordinates 553,580 m and 4,177,040 m. Sources of operation only show a contribution to the health impact if they are operating during the maximum year of $PM_{2.5}$ impact.
5. The Project off-site MEISR for the Project construction chronic HI is located at UTM coordinates 553,640 m and 4,177,120 m for both controlled and uncontrolled scenarios, and the MEISR for operational chronic HI is located at coordinates 553,600 m and 4,177,080 m. Sources of operation only show a contribution to the health impact if they are operating during the maximum year of chronic HI impact.
6. Construction off-road emissions for SEP-1 were modeled as source "AreaA." On-road sources for SEP-1 were modeled as well; for a list of these modeled source groups, please see Appendix Tables E-8a through E-8d.

Abbreviations:

HI - hazard index
m - meter
m^3 - cubic meter
MEISR - maximally exposed individual sensitive receptor
PM - particulate matter
SEP - Southeast Plant
SFPUC - San Francisco Public Utilities Commission
UTM - Universal Transverse Mercator
µg - microgram

Table 26
Cumulative Lifetime Excess Cancer Risk at MEISR[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Lifetime Excess Cancer Risk[2,3]		
	Scenario 1 (Uncontrolled)[4]	Scenario 1 (Controlled)[4]	Scenario 2
	in a million	in a million	in a million
Net Project Risk (Construction + Operation - Existing)[5]	3.4	1.7	0.022
Cumulative Projects[6]	61	24	0.12
Adjusted CRRP-HRA Background[7,8]	102	85	10
Total	**166**	**111**	**10**

Notes:

1. The Project off-site MEISR for lifetime excess cancer risk for Scenario 1 (Uncontrolled) is located at Universal Transverse Mercator coordinates 553,640 m and 4,177,120 m, and Scenario 1 (Controlled) is located at coordinates 553,820 m and 4,177,180 m. The MEISR for Scenario 2 is located at coordinates 554,280 m and 4,176,620 m.

2. Excess lifetime cancer risks are estimated as the upper-bound incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens. The estimated risk is expressed as a unitless probability. The cancer risk attributed to the emissions associated with the Project was calculated based on the modeled annual average pollutant concentrations, the intake factor for resident child, the Cancer Potency Factors (CPF) for all toxic pollutants emitted, and the Age Sensitivity Factors (ASF).

3. This table presents the long-term health impacts from Project construction on-road traffic and off-road construction equipment as well as Project operation at the off-site MEISR locations. In Scenario 1, exposure begins at the start of construction, followed by 25 years of exposure to operational emissions. Scenario 2 considered exposure to operational emissions for 30 years. Because of this, adjusted cancer risk from existing sources planned to be removed are different for the two scenarios because the exposure parameters for the resident are different based on when the 30-year exposure is assumed to have begun. For Scenario 1, construction occurs for the first five years, and operational exposure is 25 years, compared with Scenario 2, which has 30 years of operational exposure.

Calculation: $Risk_{inh} = \Sigma Risk_{inh,i} = \Sigma C_i \times CF \times IF_{inh} \times CPF_i \times ASF$

Where:

$Risk_{inh}$: Cancer Risk; the incremental probability of an individual developing cancer as a result of inhalation exposure to a potential carcinogen

$Risk_{inh,i}$: Cancer Risk for Chemical i

C_i: Modeled Annual Average Concentration in air for Chemical i ($\mu g/m^3$)

CF: Conversion Factor (mg/µg)

CPF_i: Cancer Potency Factor for Chemical i (mg chemical/kg body weight-day)

ASF: Age Sensitivity Factor

4. The "Uncontrolled" case shown here represents the scenario using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance. The "Controlled" case shown here represent the scenario using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a DPF. "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.

5. The adjusted cancer risk from the existing operational sources that will be replaced with the Project was subtracted from the risk from both Scenario 1 and Scenario 2 to calculate net Project cancer risks for both scenarios.

6. The excess lifetime cancer risk from additional projects at the Southeast Plant (SEP) and in the surrounding area (within 1,000 meters) that will be under construction during the construction and operation of the BDFP were estimated.

7. The Community Risk Reduction Plan - Health Risk Assessment (CRRP-HRA) cancer risk values were calculated with the 2003 OEHHA health risk assessment guidance. The CRRP-HRA risk shown here was scaled by a calculated factor of 1.3744 to account for the revised 2015 OEHHA guidance for calculating excess cancer risk for a residential receptor.

8. The background cancer risk from existing nearby stationary sources was obtained from the CRRP-HRA geodatabase. The CRRP-HRA cancer risk was adjusted to include existing stationary sources at the SEP that were not modeled in the CRRP-HRA, but will be removed with this Project, including waste gas flares and the cogeneration engine. Additionally, the boilers, which are already in the CRRP-HRA, were remodeled in their exact locations and with building downwash to get an adjusted existing risk that is more comparable to Project calculated risks. The background risk is different foreach case since the MEISRs are each at different locations.

Abbreviations:

ASF - Age Sensitivity Factor
BDFP - Biosolids Digester Facilities Project
CPF - cancer potency factor
CRRP - Community Risk Reduction Plan
DPF - diesel particulate filter
HRA - health risk assessment
MEISR - maximally exposed individual sensitive receptor
OEHHA - Office of Environmental Health Hazard Assessment
SEP - Southeast Plant
SFPUC - San Francisco Public Utilities Commission
m - meter

References:

OEHHA. 2015. Air Toxics Hot Spots Program Risk Assessment Guidelines. Guidance Manual for Preparation of Health Risk Assessments. February.

Table 27
Cumulative $PM_{2.5}$ Concentration at MEISR[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Maximum Annual $PM_{2.5}$ Concentration ($\mu g/m^3$)		
	Construction (Uncontrolled)[2]	Construction (Controlled)[2]	Operation
Net Project[3]	0.024	0.017	0.090
Cumulative Projects[4]	0.010	0.010	2.7E-03
CRRP-HRA Background[5]	9.1	9.1	8.9
Total	**9.2**	**9.2**	**9.0**

Notes:

1. The Project off-site MEISR for the Project construction $PM_{2.5}$ concentration is located at Universal Transverse Mercator (UTM) coordinates 553,640 m and 4,177,120 m for both uncontrolled and controlled scenarios, and operational $PM_{2.5}$ concentration is located at UTM coordinates 553,820 m and 4,177,180 m.
2. The "Uncontrolled" case shown here represents the scenario using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance. The "Controlled" case shown here represent the scenario using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.
3. The $PM_{2.5}$ from the existing operational sources was adjusted from the value calculated in the San Francisco Community Risk Reduction Plan (CRRP-HRA) by modeling the existing operational sources in their actual locations and adding buliding downwash. These sources will be replaced with the Project; therefore, this adjusted value was subtracted from the Project concentration to calculate a net Project concentration.
4. The chronic health impacts of additional projects at the Southeast Plant (SEP) and in the surrounding area that will be under construction during the construction and operation of the BDFP were estimated. The construction of the modeled cumulative projects was assumed to occur during the both construction and operation of the Project, so the health impacts were added to both Project construction and operational impacts.
5. The background $PM_{2.5}$ concentration from existing nearby stationary sources was obtained from the CRRP-HRA geodatabase. It is different for Construction and Operations since the MEISRs are at different locations.

Abbreviations:

BDFP - Biosolids Digester Facilities Project
CRRP - Community Risk Reduction Plan
DPF - diesel particulate filter
HRA - health risk assessment
m - meter
m^3 - cubic meter
MEISR - maximally exposed individual sensitive receptor
PM - particulate matter
SEP - Southeast Plant
SFPUC - San Francisco Public Utilities Commission
UTM - Universal Transverse Mercator
µg - microgram

Table 28
Cumulative Chronic Hazard Index at MEISR[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Chronic Hazard Index[2]		
	Construction (Uncontrolled)[3]	Construction (Controlled)[3]	Operation
Project	0.0049	0.0036	0.0067
Cumulative Projects[4]	0.0053	0.0053	0.0021
CRRP-HRA Background[5]	--	--	--
Total	**0.010**	**0.0089**	**0.0087**

Notes:

1. The Project off-site MEISR for the Project construction chronic HI is located at Universal Transverse Mercator coordinates 553,640 m and 4,177,120 m for both the controlled and uncontrolled scenarios, and the MEISR for operational chronic HI is located at coordinates 553,600 m and 4,177,080 m. Sources of operation only show a contribution to the health impact if they are operating during the maximum year of chronic HI impact.

2. The potential for exposure to result in adverse chronic non-cancer effects is evaluated by comparing the estimated annual average air concentration (which is equivalent to the average daily air concentration) to the non-cancer chronic Reference Exposure Level (REL) for each chemical. When calculated for a single chemical, the comparison yields a ratio termed a hazard quotient. To evaluate the potential for adverse chronic non-cancer health effects from simultaneous exposure to multiple chemicals, the hazard quotients for all chemicals are summed, yielding a hazard index (HI).

   Calculation: Chronic HI = ΣChronic HQ_i = Σ [C_i / $cREL_i$]

   Where:

   HI: Hazard Index

   HQ_i: Hazard Quotient for Chemical i

   C_i: Average Daily Air Concentration for Chemical i ($\mu g/m^3$)

   $cREL_i$: Non-cancer Chronic Reference Exposure Level for Chemical i ($\mu g/m^3$)

3. The "Uncontrolled" case shown here represents the scenario using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance. The "Controlled" case shown here represent the scenario using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.

4. The chronic health impacts of additional SFPUC projects at the Southeast Plant (SEP) and in the surrounding area that will be under construction during the construction and operation of the BDFP were estimated. The construction of the modeled surrounding projects will occur during the construction and operation of the Project, so the health impacts were only added to both Project construction and operational impacts.

5. The San Francisco Community Risk Reduction Plan (CRRP-HRA) does not estimate cumulative chronic HI; therefore, this was not included in the cumulative chronic HI evaluation.

Abbreviations:

BDFP - Biosolids Digester Facilities Project
CRRP - Community Risk Reduction Plan
DPF - diesel particulate filter
HI - hazard index
HRA - health risk assessment
m - meter
MEISR - maximally exposed individual sensitive receptor
REL - reference exposure level
SEP - Southeast Plant
SFPUC - San Francisco Public Utilities Commission

Table 29
Cumulative Acute Hazard Index at MEI[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Acute Hazard Index[2]		
	Construction (Uncontrolled)[3]	Construction (Controlled)[3]	Operation
Project	0.10	0.20	0.083
Cumulative Projects[4]	--	--	--
CRRP-HRA Background[4]	--	--	--
Total	**0.10**	**0.20**	**0.083**

Notes:

1. The Project off-site MEI for the Project Construction acute HI is located at Universal Transverse Mercator (UTM) coordinates 553,420 m and 4,177,520 m for both the uncontrolled and controlled scenarios. The Project off-site MEI for the Project operation acute HI is located at UTM coordinates 553,420 m and 4,177,060 m. The acute HI is based on a one-hour maximum air concentration so it is evaluated for all receptors as opposed to only sensitive receptors.

2. The potential for exposure to result in adverse acute effects is evaluated by comparing the estimated one-hour maximum air concentration of a chemical to the acute REL for each chemical. When calculated for a single chemical, the comparison yields an hazard quotient. To evaluate the potential for adverse acute health effects from simultaneous exposure to multiple chemicals, the hazard quotients for all chemicals are summed, yielding a hazard index.

   Calculation: $\text{Acute HI} = \Sigma \text{Acute HQ}_i = \Sigma [C_i / aREL_i]$

   Where:

   HI: Hazard Index

   HQ_i: Hazard Quotient for Chemical i

   C_i: Estimated One-Hour Maximum Air Concentration for Chemical i ($\mu g/m^3$)

   $aREL_i$: Noncancer Acute Reference Exposure Level for Chemical i ($\mu g/m^3$)

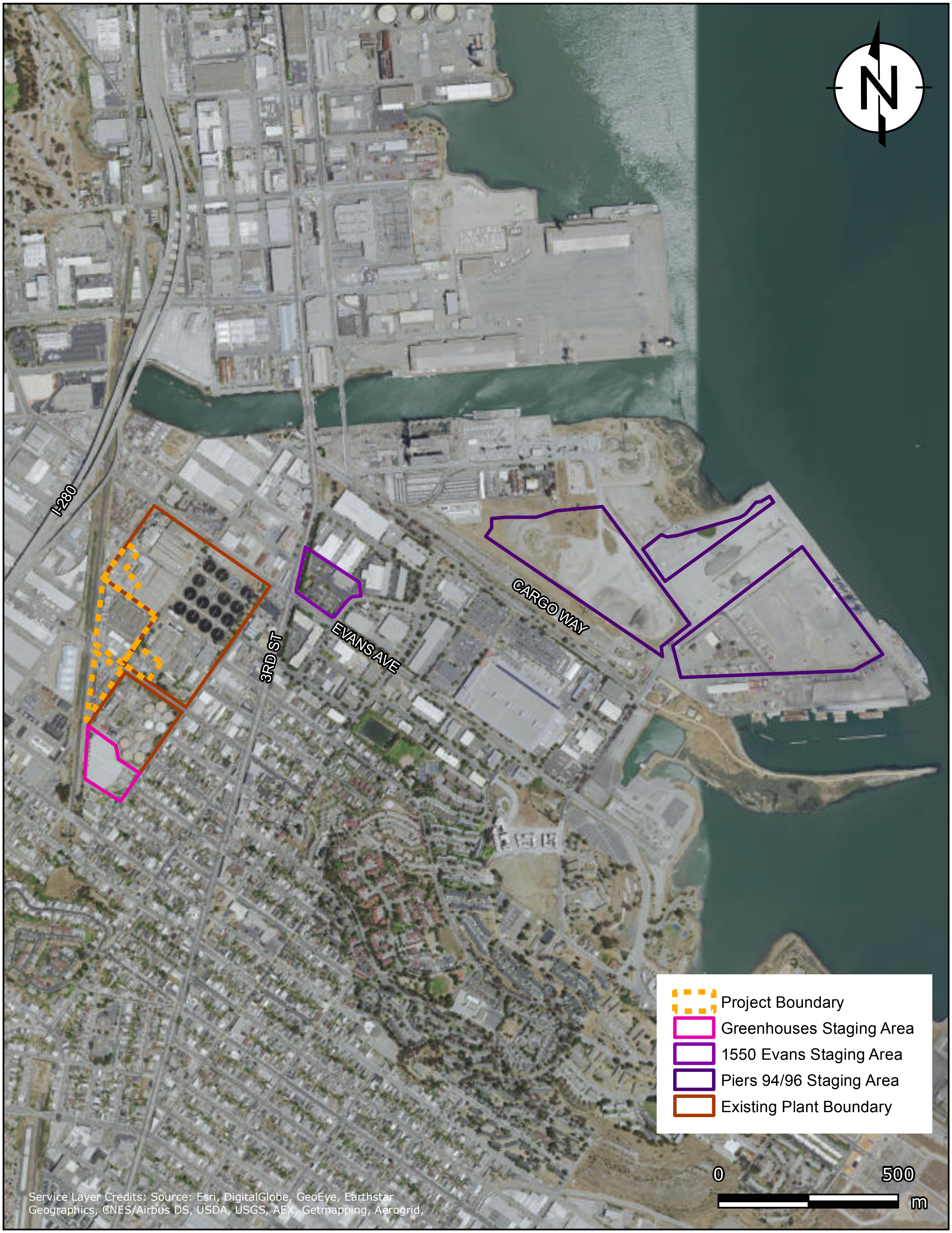
3. The "Uncontrolled" case shown here represents the scenario using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance. The "Controlled" case shown here represent the scenario using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.

4. Since the acute HI is based on a one-hour maximum air concentration, it is not typically evaluated on a cumulative basis for CEQA analyses. The BAAQMD 2011 CEQA Guidelines do not have a cumulative threshold for acute HI; therefore, the acute HI for cumulative projects was not analyzed. Additionally, the San Francisco Community Risk Reduction Plan (CRRP-HRA) does not estimate a background acute HI.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
CEQA - California Environmental Quality Act
CRRP - Community Risk Reduction Plan
DPF - diesel particulate filter
HI - hazard index
HRA - health risk assessment
m - meter
MEI - maximally exposed individual
REL - reference exposure level
SFPUC - San Francisco Public Utilities Commission
UTM - Universal Transverse Mercator

FIGURES



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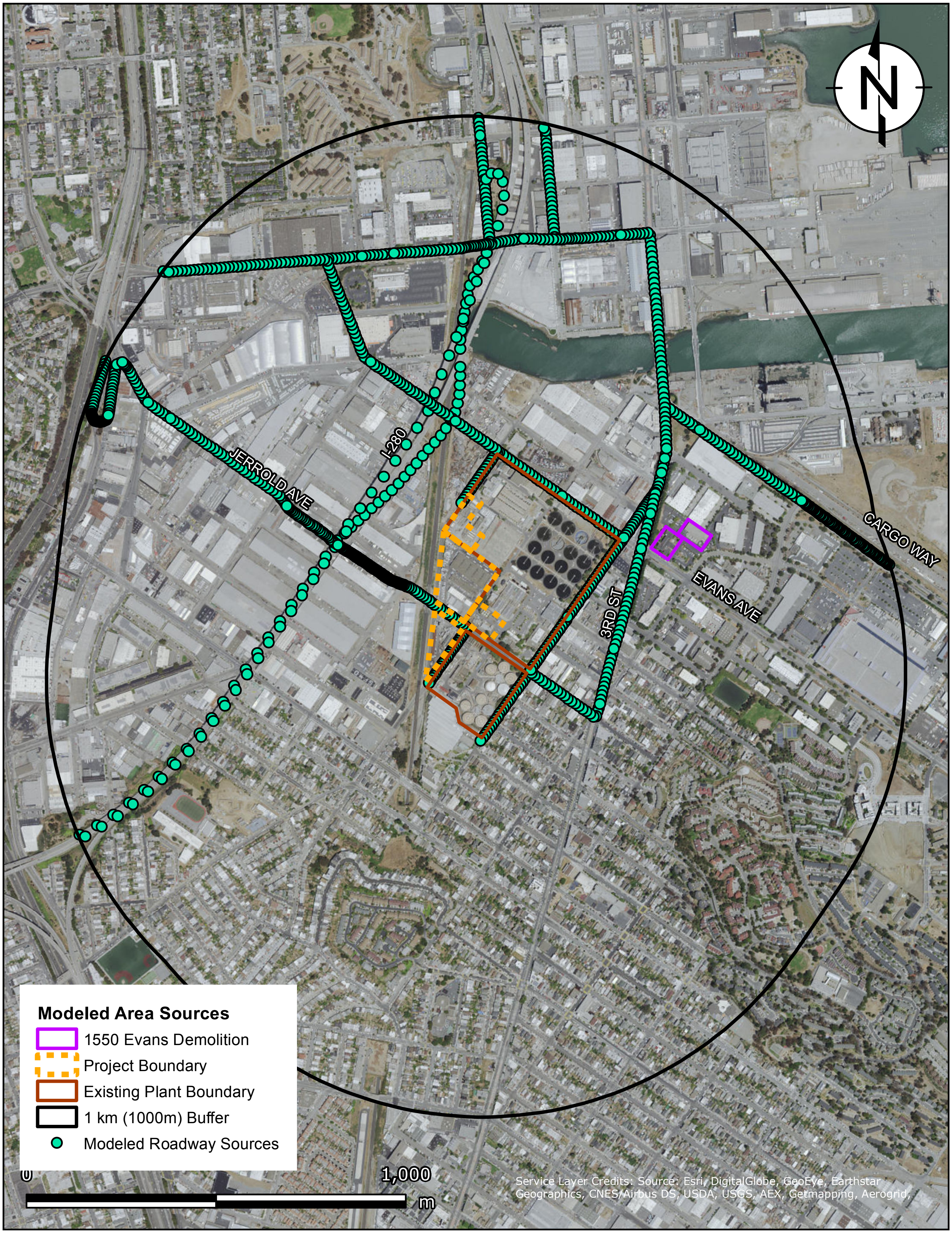
Project Site and Potential Staging Areas
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

FIGURE 1

Date: 2/16/2017

03-36893A



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Date: 2/16/2017

Construction Model Sources

SFPUC Biosolids Digester Facilities Project

San Francisco, CA

FIGURE

2

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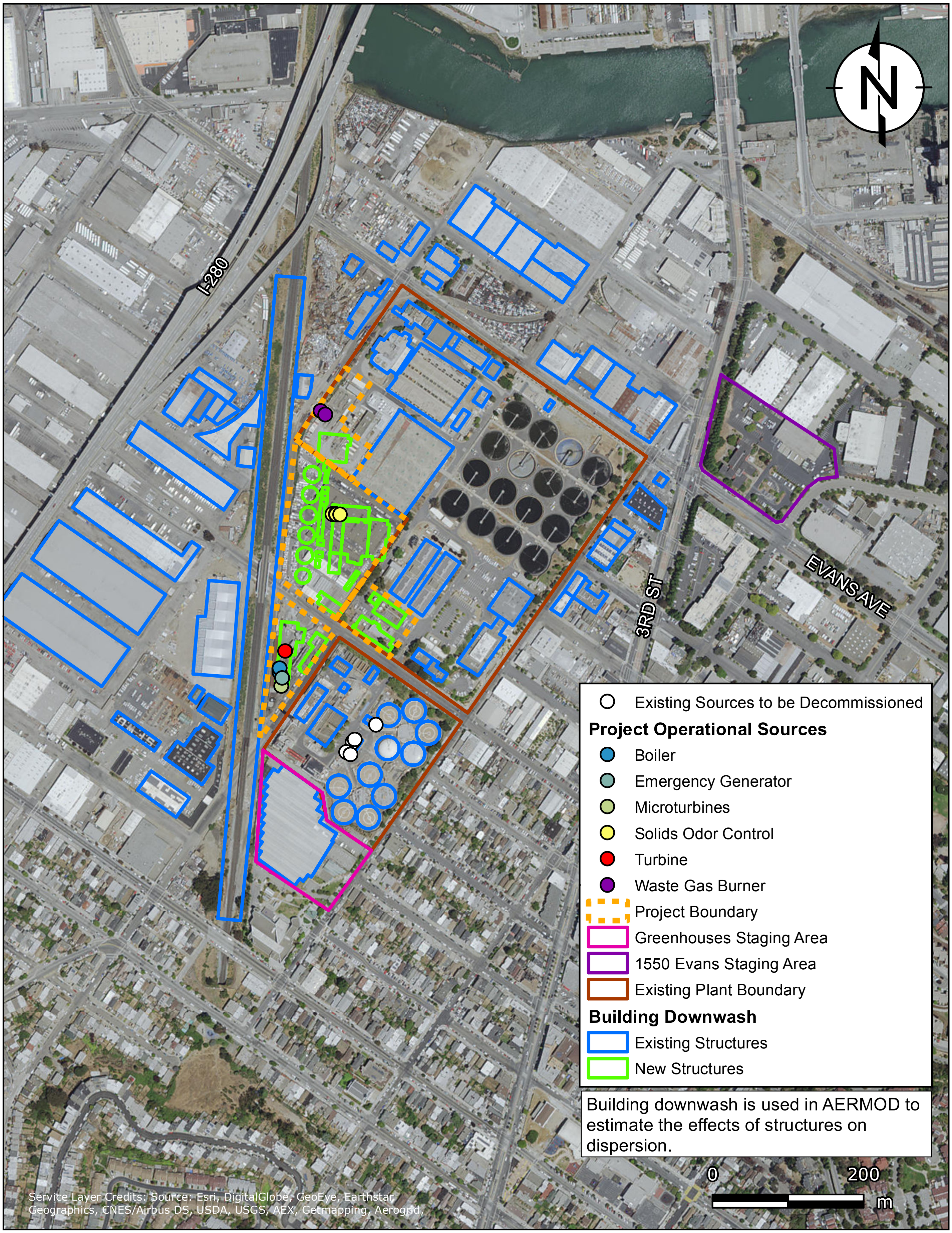

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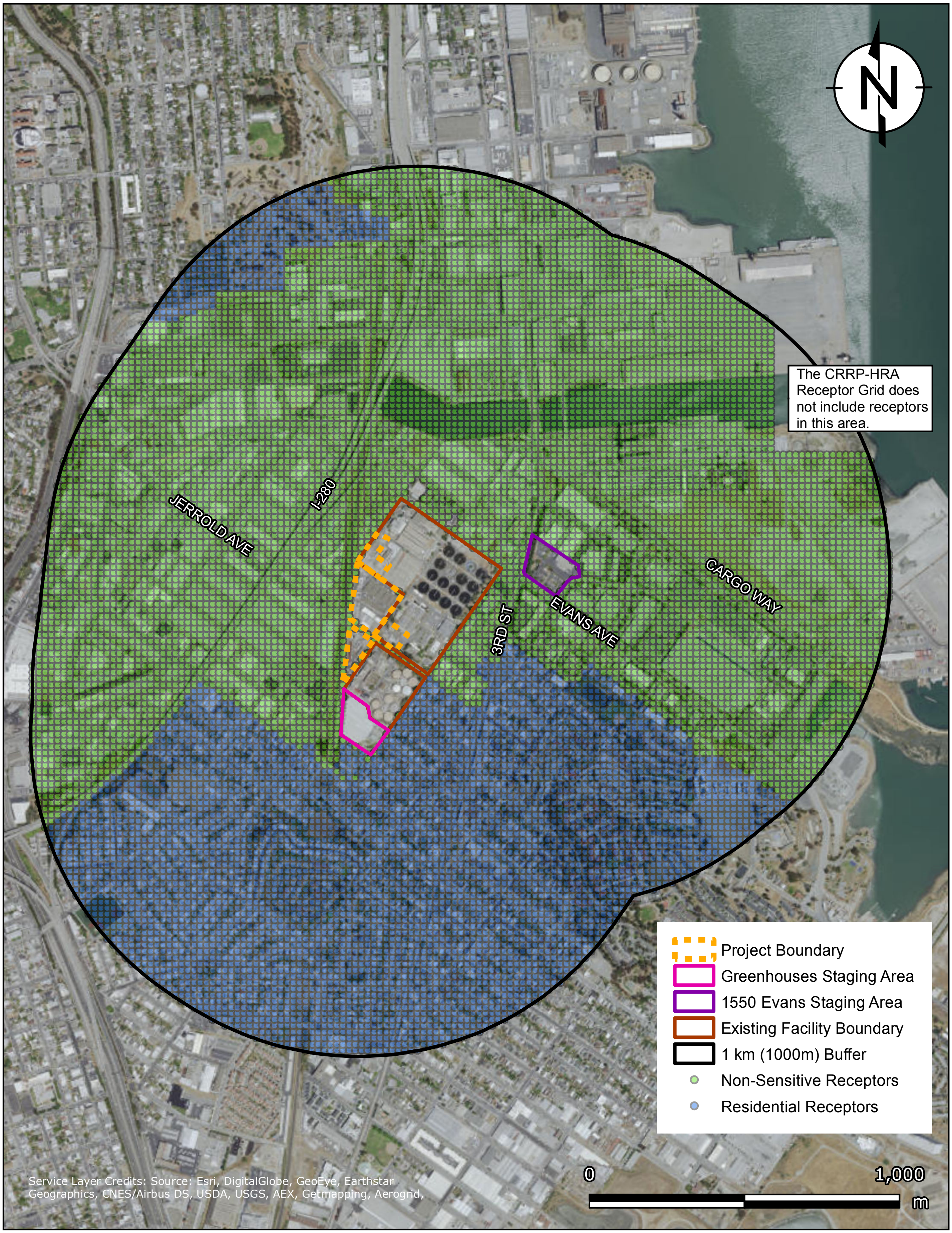
Operational Source Model Setup
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

FIGURE
3

Date: 2/16/2017

03-36893A



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Modeled Off-Site Receptor Locations

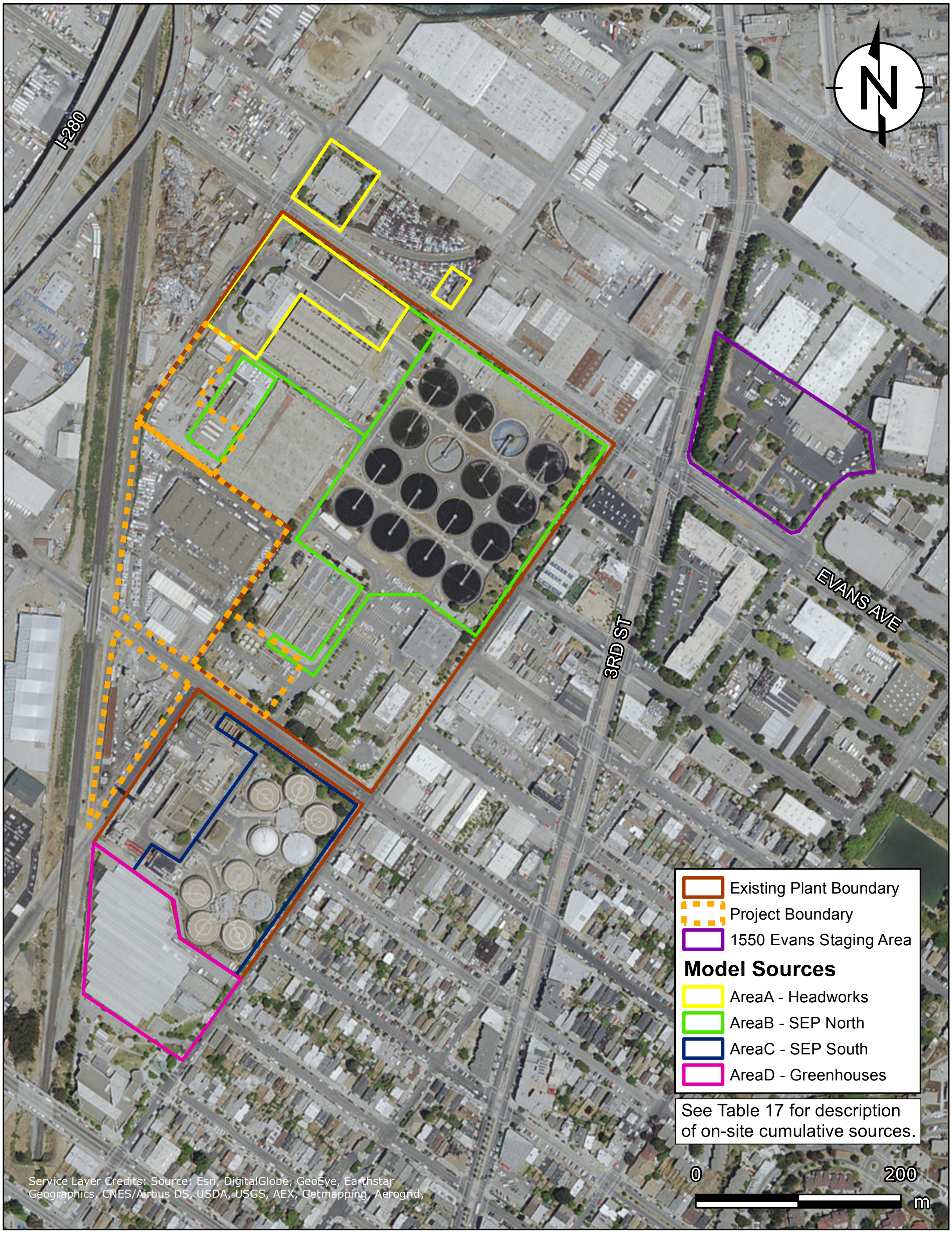
SFPUC Biosolids Digester Facilities Project

San Francisco, CA

FIGURE 4

Date: 2/16/2017

03-36893A



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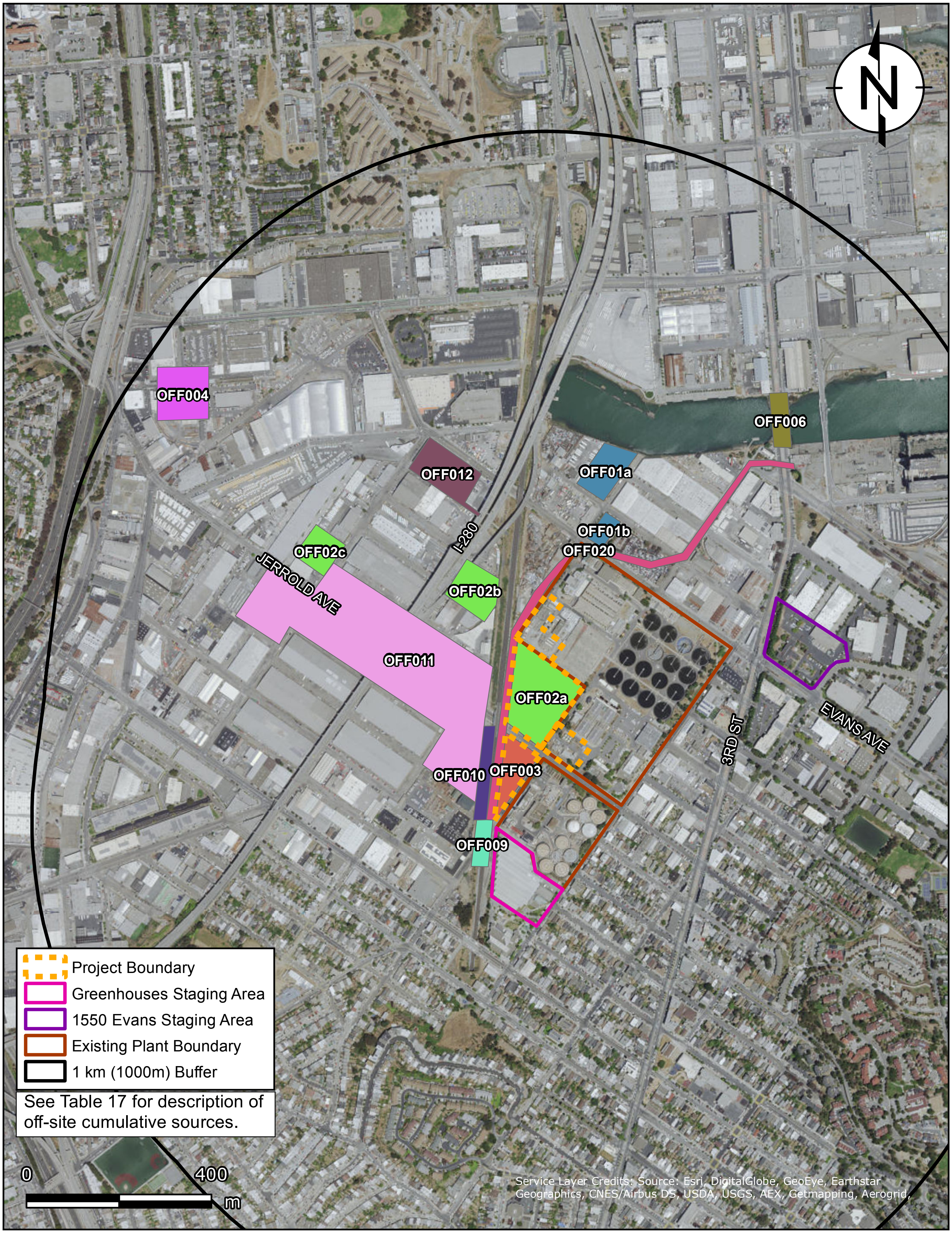
Date: 2/16/2017

Modeled On-Site Cumulative Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

FIGURE
5a

03-36893A



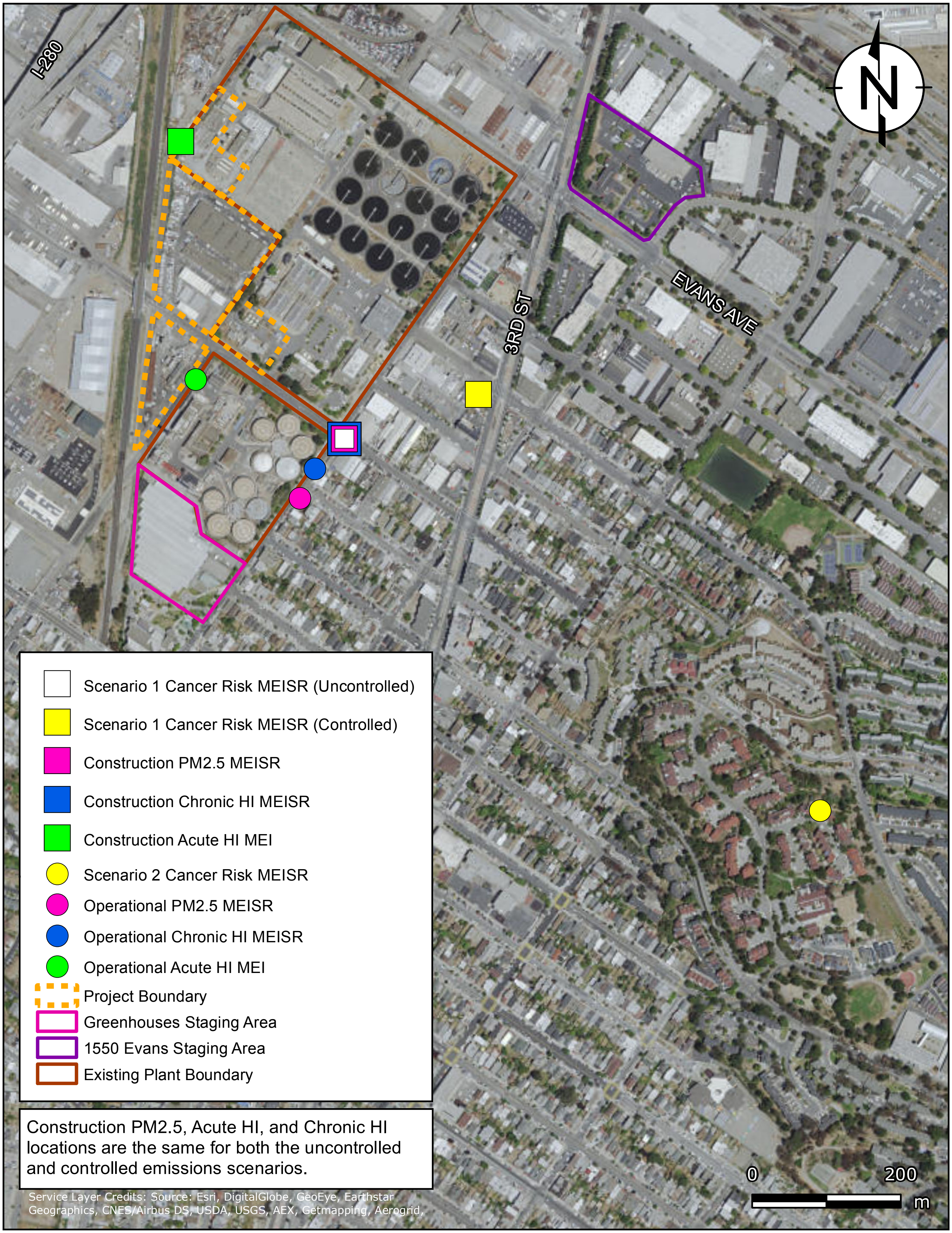
RAMBOLL ENVIRON

Date: 2/16/2017

Modeled Off-Site Cumulative Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

FIGURE
5b

03-36893A



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Locations of MEIs and MEISRs

SFPUC Biosolids Digester Facilities Project

San Francisco, CA

FIGURE 6

Date: 2/16/2017

03-36893A

APPENDIX A
RAMBOLL ENVIRON SCOPE OF WORK

Via Electronic Mail

Jill Hamilton
ESA | Water
350 Frank Ogawa Plaza, Suite 300
Oakland, CA 94612
JHamilton@esassoc.com

PROPOSAL FOR CEQA AIR QUALITY AND GREENHOUSE GAS ANALYSES SFPUC SEP BIOSOLIDS DIGESTER FACILITIES PROJECT DRAFT ENVIRONMENTAL IMPACT REPORT, SAN FRANCISCO, CALIFORNIA

June 26, 2015

Ramboll Environ
201 California Street
Suite 1200
San Francisco, CA 94111
USA

T +1 415 796 1950
F +1 415 398 5812
www.ramboll-environ.com

Dear Ms. Hamilton:

Ramboll Environ US Corporation ("Ramboll Environ," formerly ENVIRON International Corporation) is pleased to present this proposal to ESA+Orion to perform California Environmental Quality Act (CEQA) analyses of criteria air pollutants and precursors and local risk and hazard impacts related to the San Francisco Public Utilities Commission (SFPUC) SEP Biosolids Digester Facilities Project in San Francisco, CA ("Project" or the "Site"). This proposal provides our understanding of the Project, regulatory background, and a description of the scope of work proposed, along with the cost estimate and schedule. This change order builds upon the project delineation phase of our analysis as documented in the subcontract agreement dated March 17, 2015.

Project Understanding

We understand that the SFPUC proposes a Biosolids Digester Facilities Project (BDFP) to upgrade existing facilities at the Southeast Water Pollution Control Plant (SEP).

As described in the draft Notice of Preparation (NOP), the project would construct new solids treatment, odor control, energy recovery, and associated facilities at the SFPUC's SEP, which is located in the Bayview District of San Francisco. The existing solids treatment facilities at the SEP are operating beyond their design life (some facilities are over 60 years old), rely on outdated technologies, and are prone to disrepair. The existing digesters and other solids handling facilities are not designed to withstand the maximum credible earthquake on local faults, and failure of these systems could be catastrophic, resulting in severe public health and safety and environmental impacts. The SFPUC is proposing new facilities to provide a reliable solids treatment system that would comply with present and projected future regulations and seismic standards, and would be equipped with advanced odor control. As part of the project, the SFPUC also proposes beneficial reuse of all of the biosolids (e.g., for soil conditioning or fertilizer) and biogas (for heat and power generation at the plant) produced from the proposed solids treatment process.

Regulatory Background

The City of San Francisco has developed an approach to implement the Bay Area Air Quality Management District (BAAQMD) CEQA Guidelines to evaluate air quality (AQ) and greenhouse gas (GHG) impacts of projects and plans proposed in its jurisdiction. The Guidelines provide recommended procedures for evaluating potential AQ and GHG impacts during the environmental review process consistent with CEQA requirements, which include:

1. Evaluation of emissions of criteria air pollutants (CAP) and GHG from both construction and operational emissions (including traffic generated from the proposed Project);
2. Evaluation of cancer risk impacts and fine particulate matter ($PM_{2.5}$) concentrations for construction and operational emissions on sensitive offsite populations for incorporation into their City-wide Health Risk Assessment (HRA), as discussed below.

It is our understanding that there will be traffic-related operational emissions related to the Project as well as stationary sources of emissions such as water treatment systems. We also understand that the City of San Francisco, in conjunction with the BAAQMD, has recently completed a City-wide HRA to evaluate cumulative cancer risks and $PM_{2.5}$ concentrations from existing stationary and mobile sources.

Proposed Technical Approach

Ramboll Environ proposes to conduct the following technical analyses to estimate emissions and health risk impacts from construction and operation of the Project. Ramboll Environ will use the most up-to-date tools and methods to assess Project impacts. Individual tasks are described in detail below.

Task 1. Emission Sources and Methodology

Construction Project Emission Sources (including GHGs)

For the purposes of this proposal, Ramboll Environ assumes that SFPUC's design engineer, Brown and Caldwell, will provide a complete list of construction equipment, as well as a construction phasing schedule in response to a request for information (RFI) that we prepared during the first phase of this task order. We also assume that construction trips, including haul trips, vendor trips, and worker trips will also be provided. Using this construction equipment list, Ramboll Environ proposes to use CalEEMod® (California Emissions Estimator Model), or equivalent methods, for the development of the construction-related CAP and GHG emissions inventory.[1] Additionally, Ramboll Environ will estimate emissions for pollutants for conformity with the Clean Air Act Conformity Thresholds. If non-diesel equipment is proposed, toxic air contaminants (TACs) will also be quantified. In addition to a construction equipment list and construction phasing schedule, we assume Brown and Caldwell will also provide locations of construction sources and construction parameters such as time of day and days per week that construction will occur. These emission

[1] Software and User's Guide available publically at www.caleemod.com. Version 2013.2.2.

sources and source parameters will determine how the construction model will be set up, the methodology of which will be detailed in this Section.

Operational Emission Sources (including GHGs)

Ramboll Environ will identify emissions sources of CAPs, TACs, and GHGs, from both existing and Project operations. Additionally, Ramboll Environ will estimate emissions for pollutants for conformity with the Clean Air Act Conformity Thresholds. First, we will describe existing operational emissions including both current SFPUC sources included in the Project area as well as those outside the Project area. Current SFPUC emissions will be extracted and quantified from either the City-wide HRA model (as provided by the BAAQMD), the most recent AB2588 report for the facility, or the current BAAQMD emissions inventory.[2]

Next, Ramboll Environ will identify Project operational emission sources, including stationary and mobile sources of emissions. For the purposes of this proposal, Ramboll Environ assumes that Brown and Caldwell will provide a complete list of emissions associated with the project operation for the project build-out year of 2022 and for the horizon year of 2045.[3] Ramboll Environ assumes that in addition to these emissions, Brown and Caldwell will also provide locations of operational sources and operational modelling parameters such stack heights and temperatures. We have already submitted an RFI to Brown and Caldwell for this information. We also assume that a Traffic Impact Study for operations at the site will also be provided. To the extent that project-specific vehicle miles travelled (VMT) data are available from the Transportation Impact Study, Ramboll Environ will incorporate them.

These parameters will determine how the operational model will be set up; a methodology describing this process will be documented in this report.

This task is estimated to cost [cost removed] ([cost removed] for Construction and [cost removed] for Operational Emissions), which includes drafting and finalizing an Emissions Sources and Methodology Memo, two conference calls with San Francisco Environmental Planning (SF EP)/SFPUC to discuss comments and revisions, and one work session with SF EP/SFPUC.

Task 2. HRA Methodology

Ramboll Environ will also draft an HRA methodology report that will discuss the methodology and assumptions for estimating health risks ($PM_{2.5}$ concentrations and cancer risk) based on emissions from both Project construction and operations at Project build-out in 2022. We understand the San Francisco Planning Department would also like to evaluate risks and hazards for a horizon year of 2045; the methodology for this will be discussed in this report.

This task is estimated to cost [cost removed], which includes drafting and finalizing an HRA Methodology report and two conference calls with SF EP/SFPUC to discuss comments and revisions.

[2] The overall cost for this task assumes that the decision of how to best quantify current SFPUC emissions will be discussed during one meeting or teleconference, and will not exceed [cost removed]. Additional discussions about this topic may require additional budget.

[3] Project emissions are expected to increase over time; therefore, emissions will be quantified for 2022 and 2045.

Task 3. Cumulative Risk Results

Construction Risk and $PM_{2.5}$ Concentration Results

This task includes estimating health risks based on emissions from Project construction. Ramboll Environ will base the health risk assessment on the total PM_{10} (assuming all PM_{10} from construction equipment is diesel particulate matter, or DPM) and $PM_{2.5}$ emissions from exhaust attributable to onsite equipment during the construction of the Project. Risks from TACs will also be considered if non-diesel equipment is proposed.

For the construction health risk assessment, potential receptors evaluated will include offsite sensitive receptors using the same grid as in the City-wide HRA. To estimate ambient air concentrations of DPM and $PM_{2.5}$ from diesel exhaust from onsite construction activity, Ramboll Environ will use the most recent version of the American Meteorological Society/Environmental Protection Agency regulatory air dispersion model (AERMOD). We will use meteorological data collected and processed for use in AERMOD from the Mission Bay - SF station, the same dataset used in the City-wide HRA.

The unmitigated annual concentration of $PM_{2.5}$ and health indices, described below, at the maximum offsite sensitive receptor will be calculated. The maximum annual concentration of DPM will be used to estimate excess lifetime cancer risks. Estimated unmitigated cancer risks and noncancer chronic HI will be calculated according to the current BAAQMD Guidance and using default BAAQMD and California Office of Environmental Health Hazard Assessment (OEHHA) exposure assumptions. In advance of this calculation, Ramboll Environ will gain approval from SF EP for the appropriate risk assessment parameters as OEHHA has released new values but the BAAQMD has yet to adopt them. These unmitigated results will be presented in a summary table for SF EPs/SFPUC review, and will ultimately be combined with the unmitigated operational risks (described in the section below) for comparison to lifetime exposure risk thresholds. Annual PM2.5 concentrations from construction will be compared to $PM_{2.5}$ concentration thresholds. The report will describe how results represent a “reasonably conservative” worst-case scenario and explain the justification for assumptions and methods.

If either the combined risk from construction and operations or the $PM_{2.5}$ annual concentration from constructionexceed significance thresholds, Ramboll Environ will discuss possible mitigation measures with SF EP, and evaluate risks for two mitigated scenarios for construction equipment after discussing technical feasibility with the Project sponsor. One mitigated scenario will represent the mitigation required to achieve the minimum level of compliance and the other will show the mitigation measure required to achieve the maximum level of compliance. An optional task is shown at the end of this proposal which can incorporate additional mitigations and analyses, if required. Mitigated results will then also be summarized in a table. The potential incorporation of operational mitigation measures is discussed in the section below.

This task is estimated to cost [cost removed], which includes preparing unmitigated and mitigated results tables, drafting and finalizing the construction section of the final Cumulative HRA report, as well as one conference call and one work session with SF EP/SFPUC.

Operational Risk and $PM_{2.5}$ Concentration Results

This task includes estimating health risks based on the change in emissions from Project operations relative to existing emissions from the facility. As discussed above, Brown and Caldwell will provide operational emissions from Project operations, and existing operational emissions will be determined in Task 1. Ramboll Environ will base the health risk assessment on the toxic air contaminants and $PM_{2.5}$ emitted from the Project operations.

As with the construction analysis, the operational health risk assessment will evaluate offsite sensitive receptors using the same grid as in the City-wide HRA. To estimate ambient air concentrations of TACs and $PM_{2.5}$ from onsite activity, consistent with the construction modelling discussed above, we will use AERMOD and Mission Bay - SF meteorological data.

As with construction, the estimated unmitigated annual concentration of $PM_{2.5}$ and health impacts discussed below with be calculated at the maximum offsite sensitive receptor. The maximum annual and hourly concentrations of TACs will be used to estimate excess lifetime cancer risks. As discussed for construction, estimated unmitigated cancer risks will be calculated according to the current BAAQMD Guidance and using default BAAQMD and California Office of Environmental Health Hazard Assessment (OEHHA) exposure assumptions pending discussions with SF EP. These unmitigated results will be presented in a summary table for SF EP's/SFPUC review, and will ultimately be combined with the unmitigated construction risks for comparison to lifetime exposure risk thresholds. Annual PM2.5 concentrations from operations will be compared to $PM_{2.5}$ concentration thresholds. The report will describe how results represent a "reasonably conservative" worst-case scenario and explain the justification for assumptions and methods.

If the combined risk from construction and operations or the $PM_{2.5}$ annual concentrations from operations exceed significance thresholds, Ramboll Environ will discuss possible mitigation measures with SF EP, and evaluate risks for two mitigated scenarios for operations after discussing technical feasibility with the Project team. One mitigated scenario will represent the mitigation required to achieve the minimum level of compliance and the other will show the mitigation measure required to achieve the maximum level of compliance. An optional task is shown at the end of this proposal which can incorporate additional mitigations and analyses, if required. Mitigated results will then also be summarized in a table.

This task is estimated to cost [cost removed], which includes preparing unmitigated and mitigated results tables, drafting and finalizing the construction section of the final Cumulative HRA report, as well as one conference call and one work session with SF EP/SFPUC.

<u>Cumulative HRA Results</u>
Ramboll Environ will also draft results tables and a report section discussing the cumulative risks from the Project as well as other SFPUC projects anticipated for the SEP, including Headworks and up to three additional smaller projects. As Ramboll Environ has just received authorization to proceed on developing the CAP emissions inventory for the Headworks project under a separate task order, we hope that schedule will allow us to incorporate those emissions into this cumulative HRA. For the three smaller projects, we plan on developing rough emissions based on project descriptions from the SFPUC and rolling those into the HRA modelling. Risks associated from additional small projects at SFPUC can be evaluated under additional scope, if required.

Results from the Project for Project build-out in 2022 (and any additional SEP projects set to be complete by that time) will be added to the 2014 City-wide HRA grid risks, the closest modelled year available.

Additionally, results from the Project at a time horizon of 2045 (full-capacity) and four ancillary SEP projects will then be added to the 2040 City-wide HRA grid risks and hazards (the closest modelled year available), and provided to SF EP/SFPUC.

This task is estimated to cost [cost removed], which includes the preparation and finalization of a Cumulative Risk Report, as well as one conference call and one work session with SF EP/SFPUC. In addition, there is an optional task for Alternative Scenarios, as needed, which will include an analysis of emissions, risks, and $PM_{2.5}$ concentrations from a Project Alternative. The optional task described above is estimated to cost [cost removed], which includes the analysis and write-up of an alternate project scenario, and one conference call and one work session with SF EP/SFPUC.

The final deliverable for this Project will be one combined report including the three reports described above: the Emissions Sources and Methodology report, the HRA Methodology report, and the Cumulative Risk Results report.

Cost Estimate

The following table describes the cost estimates and scope for each task.

Table 1:	Task List and Cost Estimates	
Task	**Description**	**Estimated Cost**
1	**Emission Sources and Methodology**	

Construction Project Emissions Sources (including GHGs)
- Preparation of Report section including:
  - Project Construction Emissions
  - Emissions Methodology
- Participation in one conference call with SF EP/SFPUC
		[cost removed for business confidentiality]

Operational Emission Sources (including GHGs)
- Preparation of Report section including:
  - Operational Emission Sources
    - Existing Emissions
    - Project Emissions
  - Emissions Methodology
- Participation in one conference call with SF EP/SFPUC
- Participation in one work session with SF EP/SFPUC
		[cost removed for business confidentiality]

2	**Health Risk Assessment Methodology**	
HRA Methodology and Assumptions (Construction and Operational) - Preparation of HRA Methodology Report including Construction and Operational risk assumptions - Participation in two conference calls with SF EP/SFPUC		[cost removed for business confidentiality]
3	**Cumulative Risk Results Memo**	

Construction Risk and $PM_{2.5}$ Concentration Results
- Preparation of Report section including:
  - Unmitigated Construction Results Tables
  - Mitigated Construction Results Tables
  - Construction Mitigation Measures
- Participation in one conference call with SF EP/SFPUC
- Participation in one work session with SF EP/SFPUC
		[cost removed for business confidentiality]

Operational Risk and $PM_{2.5}$ Concentration Results
- Preparation of Report section including:
  - Unmitigated Operational Results Tables
  - Mitigated Operational Results Tables
  - Operational Mitigation Measures
- Participation in one conference call with SF EP/SFPUC
- Participation in one work session with SF EP/SFPUC
		[cost removed for business confidentiality]

Table 1:	**Task List and Cost Estimates**	
Task	**Description**	**Estimated Cost**

Cumulative Health Risk Assessment Results
- Preparation of Report section including:
    - Cumulative cancer risk analysis and results
    - Cumulative $PM_{2.5}$ concentration analysis and results
- Participation in one conference call with SF EP/SFPUC
- Participation in one work session with SF EP/SFPUC
		[cost removed for business confidentiality]

Optional	**Alternative Analysis**	

- Preparation of Alternative scenario analysis and write-up including:
    - Emissions Sources and Methodology
    - $PM_{2.5}$ and Cancer Risk Results
- Participation in one conference call with SF EP/SFPUC
- Participation in one work session with SF EP/SFPUC
		[cost removed for business confidentiality]

Total		**[cost removed]**
Total + Optional Task		**[cost removed]**

The cost estimate for the proposed continued work is approximately [cost removed], with an optional additional task of [cost removed]. Ramboll Environ will conduct this work on a time-and-material basis in accordance with our existing contract with ESA+Orion. This represents our best estimate of the expected cost to complete the evaluation, and is based on the assumptions described above. Ramboll Environ will not exceed the cost estimate listed here without prior authorization from you.

Schedule

Ramboll Environ will complete the above tasks according to the schedule set by ESA+Orion, SFPUC, and SF EP.

Closing

Thank you for the opportunity to assist you with this matter. We look forward to working with you to complete this assignment. If you have any questions or need further information, please contact Michael at 415.796.1934 at your convenience.

Yours sincerely,

Michael Keinath, PE
Principal

D +1 415 796 1934
mkeinath@environcorp.com

RAMBOLL ENVIRON

Authorization to Proceed with Scope of Work for up to [cost removed] for the CEQA Air Quality and Greenhouse Gas Analysis for the SFPUC SEP Biosolids Digester Facilities Project Draft Environmental Impact Report:
Accepted and Agreed to:

Name: ______________________

Signature: ______________________

Title: ______________________

Date: ______________________

APPENDIX B
CONSTRUCTION DATA FROM BDFP CER

Appendix G: Equipment Lists

Operations Equipment list

Construction Equipment List

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Last Revised on March 4, 2016

SFPUC BDFP Preliminary Equipment List

Equipment Description	Horsepower	Fuel Type	Usage Factor (%)	Accoustics 50ft (dBA slow)	Units Used 2018 11 Months	Total hours 2018 Hours	Units Used 2019 12 Months	Total hours 2019 Hours	Units Used 2020 12 Months	Total hours 2020 Hours	Units Used 2021 12 Months	Total hours 2021 Hours	Units Used 2022 12 Months	Total hours 2022 Hours	Units Used 2023 1 Month	Total hours 2023 Hours	Total Hours Feb 2018 - Jan 2023 Total hours
Auger Drill Rig (Bauer BT 85)	475 HP	Diesel	80	85	0	0	2	3328	2	3328	0	0	0	0	0	0	6656
Backhoe (CAT 420F)	93 HP	Diesel	50	80	3	2860	2	2080	2	2080	0	0	0	0	0	0	7020
Bar Bender (Harrison GMS BS 60)	10 HP	Diesel	20	80	3	1144	1	416	2	832	2	832	0	0	0	0	3224
Boring Jack Power Unit (Akkerman P250D)	250 HP	Diesel	50	80	0	0	0	0	0	0	1	1040	1	1040	0	0	2080
Chain Saw (Makita 64cc)	4.7 HP	Gasoline	20	85	0	0	2	832	2	832	2	832	0	0	0	0	2496
Compactor (CAT 815F)	232 HP	Diesel	50	80	2	1907	2	2080	2	2080	2	2080	0	0	0	0	8147
Compressor (DEWALT 8-GALLON)	5.5 HP	Gasoline	80	80	0	0	2	3328	2	3328	2	3328	2	3328	1	139	13451
Concrete Mixer Truck (KENWORTH 350)	350 HP	Diesel	80	85	4	6101	4	6656	4	6656	4	6656	1	1664	1	139	27872
Concrete Pump Truck (PUTZMEISTER 70Z)	100 HP	Diesel	80	82	2	3051	3	4992	2	3328	2	3328	1	1664	0	0	16363
Concrete Saw (HUSQVARNA FS 500)	20 HP	Gasoline	10	90	1	191	2	416	1	208	1	208	0	0	0	0	1023
Tower Crane (LIEBHERR 290HC 230')	100 HP	Diesel	80	85	0	0	2	3328	3	4992	3	4992	2	3328	1	139	16779
Crawler Crane (Liebherr LTR 1060	175 HP	Diesel	80	85	1	1525	0	0	4	6656	4	6656	2	3328	0	0	18165
Dozer (D6M XL)	140 HP	Diesel	50	85	2	1907	2	2080	2	2080	1	1040	1	1040	1	87	8233
Drill Rig Truck (Bauer BT 85)	475 HP	Diesel	50	84	2	1907	1	1040	0	0	0	0	0	0	0	0	2947
Dump Truck (CAT 745C)	511 HP	Diesel	80	84	10	15253	4	6656	4	6656	2	3328	2	3328	1	139	35360
Excavator w/ 4 cubic yard bucket	432 HP	Diesel	80	85	3	4576	4	6656	3	4992	2	3328	1	1664	0	0	21216
Flat Bed Truck (Chevy 6.6L)	397 HP	Diesel	50	84	0	0	2	2080	2	2080	4	4160	4	4160	2	173	12653
Front End Loader (CAT 972H)	311 HP	Diesel	50	80	2	1907	2	2080	2	2080	2	2080	2	2080	1	87	10313
Generator	5 HP	Gasoline	80	82	1	1525	2	3328	1	1664	1	1664	1	1664	0	0	9845
Generator (25KVA) (Doosan G25WMI-2A)	31 HP	Diesel	80	70	1	1525	0	0	0	0	0	0	2	3328	2	277	5131
Gradall 544D	130 HP	Diesel	75	85	0	0	2	3120	2	3120	3	4680	3	4680	1	130	15730
Grader (Volvo G990)	265 HP	Diesel	25	85	0	0	1	520	1	520	0	0	1	520	1	43	1603
Horixontal Boring Hydr. Jack	575 HP	Diesel	25	80	0	0	0	0	0	0	1	520	1	520	0	0	1040
Jackhammer (Pnuematic)	See Compressor	Pneumatic	40	85	4	3051	3	2496	1	832	0	0	0	0	0	0	6379
Man Lift	49 HP	Diesel	40	85	1	763	0	0	0	0	2	1664	2	1664	1	69	4160
Large Backhoe (CAT 235D)	250 HP	Diesel	25	90	2	640	0	0	0	0	0	0	0	0	0	0	640
Demolition Hammer (Indeco 200)	120 HP	Diesel	25	90 to 100	2	640	0	0	0	0	0	0	0	0	0	0	640
Pickup Truck (Chevy 6.6L)	397 HP	Gasoline	80	55	4	6101	2	3328	3	4992	4	6656	4	6656	3	416	28149
Pneumatic Tools	See Compressor	Gasoline	30	85	6	3432	2	1248	3	1872	3	1872	2	1248	1	52	9724
Pumps (Honda GH340)	11 HP	Gasoline	50	77	1	953	3	3120	3	3120	3	3120	2	2080	0	0	12393
Roller	48 HP	Diesel	20	85	0	0	2	832	0	0	0	0	0	0	1	35	867
Scraper (CAT 632)	407 HP	Diesel	75	85	0	0	2	3120	1	1560	0	0	0	0	0	0	4680
Shears (M313D)	128 HP	Diesel	40	85	1	763	1	832	0	0	0	0	0	0	0	0	1595
																	316,573

<u>Assumptions:</u>

EIR certification in Sept. 2017

Construction starts in Feb 2018, with demolition, site preparation, and utility relocation.

Assumed 8 hours/day, 260 days per year.

Usage factor is a fraction of the year.

Total hours per year (except for 2018 and 2023) = 260 days/year * 8 hours/day * usage factors * units used

APPENDIX C
CONSTRUCTION TRUCKS AND VEHICLE TRIP RATES FROM TRANSPORTATION ENGINEER

SEP Biosolids Project

DAILY VEHICLE-TRIPS AND VEHICLE-MILES OF TRAVEL SUMMARY	Existing 2015		Existing plus Construction				2040 or 2045	
			September 2018 [a]		May 2022 [b]			
	Vehicle-trips	Vehicle-Miles	Vehicle-trips	Vehicle-Miles	Vehicle-trips	Vehicle-Miles	Vehicle-trips	Vehicle-Miles
PLANT STAFF AND RELATED VEHICLES TO/FROM SITE	488	16,524	488	16,524	488	16,524	488	16,524
DELIVERY TRUCKS TO/FROM SITE	60	3,000	60	3,000	60	3,000	60	3,000
CONSTRUCTION TRUCKS	----	----	188	7,485	66	2,087	----	----
CONSTRUCTION WORKERS	----	----	221	4,316	685	13,315	----	----
CONSTRUCTION WORKERS SHUTTLE BUS	----	----	----	----	12	12	----	----
TOTAL	548	19,524	957	31,325	1,311	34,938	548	19,524

[a] Month with Highest Construction Total Truck Traffic
[b] Month with Highest Number of Construction Workers

SEP Biosolids Project

DAILY PLANT STAFF AND RELATED VEHICLES TO/FROM SITE

	Origin/Destination	Miles one-way	% of trips [a] Work	% of trips [a] Visitors	Number of Vehicles-trips Plant Staff	Plant Vehicles	Visitors & Tours	Total	Total No. of Vehicle-miles of Travel
SD1	Broadway / Columbus	5.5	8.3%	13.0%	34	7	7	48	528
SD2	Geary / Arguello	6.5	10.6%	14.0%	43	8	8	59	767
SD3	Guerrero / César Chávez	2.5	23.9%	44.0%	97	19	24	140	700
SD4	Taraval / 30th Av	10.5	7.9%	7.0%	32	6	3	41	861
EB	Walnut Creek	27	14.3%	9.0%	58			58	3,132
NB	Petaluma	43	5.6%	1.0%	23			23	1,978
SB	Palo Alto	31	26.9%	9.0%	109			109	6,758
Other	Sacramento	90	2.5%	3.0%	10			10	1,800
TOTAL			100.0%	100.0%	406	40	42	488	16,524

[a] Based on San Francisco Guidelines Tables E-5 Work Trips to SD3 (All) and E-15 Visitor Trips to SD-3 All Other

DAYTIME ONLY PLANT STAFF AND RELATED VEHICLES TO/FROM SITE

	Origin/Destination	Number of Daytime Vehicles-trips Plant Staff	Plant Vehicles	Visitors & Tours	Total
SD1	Broadway / Columbus	32	7	7	39
SD2	Geary / Arguello	40	8	8	53
SD3	Guerrero / César Chávez	91	19	24	137
SD4	Taraval / 30th Av	30	6	3	34
EB	Walnut Creek	54	0	0	38
NB	Petaluma	21	0	0	22
SB	Palo Alto	102	0	0	132
Other	Sacramento	10	0	0	7
TOTAL		380	40	42	462

HOURLY PLANT STAFF AND RELATED VEHICLES TO/FROM SITE

	Origin/Destination	AM PEAK HOUR Inbound	AM PEAK HOUR Outbound	AM PEAK HOUR Total	PM PEAK HOUR Inbound	PM PEAK HOUR Outbound	PM PEAK HOUR Total
SD1	Broadway / Columbus	20	4	23	4	20	23
SD2	Geary / Arguello	24	4	28	4	24	28
SD3	Guerrero / César Chávez	58	10	67	10	58	67
SD4	Taraval / 30th Av	17	3	20	3	17	20
EB	Walnut Creek	27	0	27	0	27	27
NB	Petaluma	11	0	11	0	11	11
SB	Palo Alto	51	0	51	0	51	51
Other	Sacramento	5	0	5	0	5	5
TOTAL		211	20	231	20	211	231

SEP Biosolids Project

CONSTRUCTION WORKERS - Daily

	Origin/Destination	Miles one-way	% of trips [b] Work	Month with Highest Construction Total Trucks: Number of Construction Worrkers [c]	Auto Person Trips [d] 79.8%	Vehicle Trips (Veh.Occ.) [b] 1.28	September 2018: Workers Vehicle-miles of Travel	Month with Highest Construction Workers: Number of Construction Worrkers [c]	Auto Person Trips [d] 79.8%	Vehicle Trips (Veh.Occ.) [b] 1.28	May 2022: Workers Vehicle-miles of Travel
SD1	Broadway / Columbus	5.5	8.3%	15	24	19	103	46	73	57	315
SD2	Geary / Arguello	6.5	10.6%	19	30	24	154	58	93	72	470
SD3	Guerrero / César Chávez	2.5	23.9%	42	67	52	131	131	209	163	408
SD4	Taraval / 30th Av	10.5	7.9%	14	22	17	183	43	69	54	563
EB	Walnut Creek	27	14.3%	25	40	31	841	79	126	98	2,659
NB	Petaluma	43	5.6%	10	16	12	536	31	49	39	1,662
SB	Palo Alto	31	26.9%	48	77	60	1,855	148	236	185	5,720
Other	Sacramento	90	2.5%	5	7	6	513	14	22	17	1,518
TOTAL			100.0%	178	283	221	4,316	550	877	685	13,315

	Scenarios 2 & 6 Highest Construction Total Trucks September 2018: Workers	Vehicle Trips	Peak Park Dmnd	Max Spaces	VMT	Scenarios 3 & 7 Highest Construction Total Trucks September 2018: Workers	Vehicle Trips	Peak Park Dmnd	Max Spaces	VMT
Project Site	40	50	25	40	972	40	50	25	40	972
Greenhouses	138	172	86	215	3,354	---	---	---	---	---
1550 Evans St	---	---	---	---	---	138	172	86	340	3,354
Pier 94	---	---	---	385	---	---	---	---	260	---
Total Workers - Daily	178	222	111	640	4,327	178	222	111	640	4,327

	Scenarios 4 & 8 Highest Construction Workers (1 shift) May 2022: Workers	Vehicle Trips	Peak Park Dmnd	Max Spaces	VMT	Scenarios 5 & 9 Highest Construction Workers (1 shift) May 2022: Workers	Vehicle Trips	Peak Park Dmnd	Max Spaces	VMT
Project Site	40	50	25	40	969	40	50	25	40	969
Greenhouses	310	386	193	215	7,511	---	---	---	---	---
1550 Evans St	---	---	---	---	---	510	636	318	340	12,357
Pier 94	200	249	125	385	4,846	0	0	0	260	0
Construction shuttle [e]		12			12		0			0
Total Workers - Daily	550	698	343	640	13,338	550	686	343	640	13,326

[b] Based on San Francisco Guidelines
[c] Includes construction workers and office staff
[d] Adapted from SF Guidelines; Walk and Other trip % moved to Auto.
[e] 50 passengers per bus; 1 mile from Pier 94 to project site

SEP Biosolids Project

TYPICAL NUMBER OF TRUCKS TO/FROM SITE	Existing Total Monday thru Friday	Existing Average per weekday	Typical Work Hours	Existing Access Points	2045 Average per weekday	Round trip miles per truck	Notes	Daily Vehicle-miles of Travel Existing	Daily Vehicle-miles of Travel 2040
CHEMICALS									
Bisulfite	2	< 1	Daytime (mainly morning)	Jerrold Northside	< 1	50	Richmond, CA (Chevron Facility)	< 50	< 50
Ferric Chloride	2	< 1	Daytime	Jerrold Southside	< 1	100	Based on existing ferric deliveries from Kemira Water Solutions Inc.(45051 Industrial Drive, Fremont, CA 9453	< 100	< 100
Hypochlorite	7	< 2	Daytime (mainly morning)	Jerrodl Northside	< 2	140	Tracy, CA	< 280	< 280
Oxygen	1	< 1		Jerrold Northside	< 1	130	Vacaville (50%), Pittsburg (30%), Sacramento (20%)	< 130	< 130
Polymer	3	< 1	Daytime	Jerrold Southside	< 1	800	Based on existing polymer deliveries from SNF Polydyne Inc. (4690 Worth St, Los Angeles, CA 90063)	< 800	< 800
Subtotal	*15*	< 6			< 6			< 1,360	< 1,360
GRIT	2	< 1	Before Noon	Jerrold Northside; exit to Rankin only on as-needed basis	< 1	60	Ox Mountain Landfill (Half Moon Bay)	< 60	< 60
SCREENINGS									
Coarse screenings (dumptruck)	4	< 1	Morning	Jerrold Northside	incl. below				
Fine screenings	2	< 1	Daytime	Jerrold Northside	incl. below				
	6	< 2			< 1	10	Recology Facility on Tunnel Road, in SF (final location in landfill not included).	< 20	< 10
TRASH, RECYCLE,COMPOST	4	1	Morning	Jerrold Northside;	1	10	Recology Facility on Tunnel Road	10	10
YELLOW GREASE LOADOUT	1	< 1	5:30-7:00	Quint (typically on Friday)	< 1	400	to biodiesel plant; Salem OR; Bakersfield, CA; Selma, CA	< 400	< 400
YELLOW GREASE DROP-OFF	20	4	Trucks leave early morning and return mid-afternoon		4	30	Throughout City (2 round trips)	120	120
BIOSOLIDS	50	10	Very early morning	Quint (in); Jerrold Southside (out)	14	100	To Bay Bridge - during dry weather to Solano and Sonoma Co. In wet weather, at landfill sites in the Bay Area. A small portion is sent to Synargro's Central Valley Compost Facility 13757 Harmon Rd, Dos Palos, CA 93620	1,000	1,400
RECYCLED WATER (for construction)	20	4	Anytime access; number of trucks can vary	Quint	4	30		120	120
OTHER DELIVERIES (from deliveries log, excludes chemicals)	20	4	Daytime		4	30	Throughout City	120	120
TOTAL	138	< 33			< 36			< 3,210	< 3,600

SEP Biosolids Project

CONSTRUCTION TRUCKS - Daily

Type of Truck	Origin/ Destination Location	Miles from Project Site	Round Trip (miles)	Month with Highest Construction Total Truck Traffic September 2018 site prep (incl. utility relocation) Number of trucks per day	Vehicle-miles of Travel	Month with Highest Number of Construction Workers May 2022 site prep (incl utility relocation) Number of trucks per day	Vehicle-miles of Travel
CONCRETE TRUCKS [a]							
- Cemex	500 Amador Street, San Francisco	0.7	1.4	1	1	0	0
- Bode Concrete	450 Amador Street, San Francisco	0.6	1.2	1	1	0	0
- Allied Redy Mix	450 Amador Street, San Francisco	0.6	1.2	0	0	0	0
Subtotal Concrete Trucks				*2*	*3*	*0*	*0*
DUMP TRUCKS							
- Backfill Soil	Assume 50 miles from construction site	50	100	0	0	0	0
- Contaminated Excavated Soil	Port Facility (Cargo Way)	1.1	2.2	21	46	3	7
- Unsuitable Excavated Soil	Altamont Landfill in Livermore	54	108	67	7,236	10	1,080
- Lead/Asbestos Building Materials	Recology Hay Road Landfill in Vacaville	65	130	0	0	0	0
- Recyclable Materials	Republic Ox Mountain Landfill in Half Moon Bay	24	48	0	0	0	0
- Unrecyclable Materials	Republic Ox Mountain Landfill in Half Moon Bay	24	48	0	0	0	0
Subtotal Dump Trucks				*88*	*7,282*	*13*	*1,087*
FLATBED TRUCKS							
- Equipment Deliveries to Pier 94	Origin unknown; assume 50 miles from site	50	100	1	100	5	500
- Equipment Deliveries to Greenhouses	Origin unknown; assume 50 miles from site	50	100	1	100	5	500
Subtotal Flatbed Trucks				*2*	*200*	*10*	*1,000*
SMALL DELIVERY TRUCKS							
- Equipment Deliveries	From Pier 94 to construction site (half size trucks)	1	2	2	4	10	20
TOTAL CONSTRUCTION TRUCKS - Daily				94	7,485	33	2,087

[a] Assume trucks are evenly distributed among three locations

SFPUC BDFP Updates for EIR Team

Prepared for: SFPUC Biosolids Digester Facilities Project

Prepared by: Biosolids Digester Facilities Project Consultant Team

Date: July 25, 2016 2016

Introduction

Per San Francisco Public Utilities Commission's (SFPUC)'s request, the Biosolids Digester Facilities Project (BDFP) Consultant Team has prepared a summary of project updates and revisions to be incorporated into the Administrative Draft Environmental Impact Report (ADEIR) 2 – the next EIR deliverable scheduled for August 2016. This submittal includes demolition estimates for 1550 Evans Avenue and corresponding tuck trip estimates. Per SFPUC's request, the submittal also includes removal of demolition estimates for Southeast Greenhouses. Revised tables A-5 (Construction Total Monthly Trucks) are presented in Attachment A.

1550 Evans Avenue Demolition Estimates

Demolition estimates for buildings sited at 1550 Evans Avenue are based on available property documentation[1]. The project would include the demolition and removal of two buildings. Buildings are slab on grade and no backfill is required. Piping demolition would be capped and filled to be abandoned in place, and all associated utilities would be disconnected. No patching of existing asphalt paving is included in this estimate.

The estimates are based on the following assumptions for each building:

- Building 330 Warehouse
    - Main level area = 16,128 square foot (sf)
    - Mezzanine area = 2,930 sf
    - Building clear height = 20 ft
    - Wall construction is tilt-up concrete with steel columns and wood roof
    - Loading dock floor height is 8 ft above the floor
    - Assume walls, mezzanine floor and roof are all 1-ft thick
- Building 1550 Office
    - First floor area = 15,700 sf
    - Second floor area = 15,700 sf
    - Roof area = 15,700 sf
    - Building clear height = 26 ft
    - Wall construction is wood siding, metal panel and glass
    - Assume walls, elevated floor, and roof are all 1-ft thick

Table 1 summarizes the demolition and associated total truck load estimates.

[1] Document Appraisal for 1550 Evans Avenue and 330 Newhall St. dated July 2007.

Table 1. 1550 Evans Ave. Demolition and Truck Load Estimates [a]

Activity	Demolition Debris, yd^3	Truck Capacity, yd^3	Truck Loads
1550 Evans (Office Bldg.)	1,750	18	98
330 Newhall St. (Warehouse)	2,180	18	122

a. Demolition debris is a mixture of concrete, wood and steel.

The demolition would occur in month 1 of construction. The construction traffic tables (A-5) were updated to reflect these changes.

Construction Truck Trips and Construction Worker Estimates

Construction traffic and air quality analysis are based on BDFP construction schedule and cost estimate[2]. Revised tables A-5 (Construction Total Monthly Trucks) and A-6 (Construction Workers and Shuttle Bus) were submitted in the June submittal to reflect changes to soil excavation volumes and assumption of truck capacity. In this submittal, construction truck trips are revised to reflect demolition estimates for 1550 Evans. In addition, per SFPUC's request, the demolition estimates for the Southeast Greenhouses have been removed from the schedule in months 1 and 2. Attachment A presents revised tables A-5 used for the traffic analysis.

[2] Original estimates are based on Final CER cost estimate and schedule. For EIR purposes, the BDFP construction schedule has been revised to show a start date of February 2018. Construction truck trips and construction worker estimates were revised to show changes of assumptions, but the cost estimate remains unchanged.

Attachment A: Construction Traffic Summary Tables

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Table A-5. Construction Total Monthly Trucks with 1550 Evans (August 2016)													
		Dump Trucks 18 CY[b]								Flatbed Trucks			
	Concrete Trucks[a]	Backfill Soil [b]	Revised Total Excavated Soil Adjust Quantities with 18 cy	Contaminated Excavated Soil[c] Assume Port Facility then to Landfill in Utah[h]	Unsuitable Excavated Soil Assume Altamonte, CA[h]	Demolition Debris, Lead/Asbestos Building Materials[d] Assume Recology Hay Road Landfill in Vacaville [65 miles from site]	Demolition Debris, Recycable Materials[d] Assume Republic Ox Mountain Landfill in Half Moon Bay [24 miles from site]	Demolition Debris, Un-recycable Materials[d] Assume Republic Ox Mountain Landfill in Half Moon Bay [24 miles from site]	Total Dump Trucks (excavated soil plus demo debris)	Total Equipment Deliveries (Undetermined Source)[e]	Equipment Delivered to Pier 94	Equipment Delivered to Greenhouses	Total/ Month
EIR Certification				45000	145000								
Feb-18	0	0	0	0	0	157	157	157	470	0	0	0	470
Mar-18	0	0	0	0	0	108	108	108	325	1	0	0	325
Apr-18	0	0	0	0	0	126	126	126	379	5	2	2	384
May-18	32	0	0	0	0	114	114	114	341	22	11	11	395
Jun-18	158	0	0	0	0	0	0	0	0	88	44	44	246
Jul-18	162	0	0	0	0	0	0	0	0	82	41	41	244
Aug-18	53	0	1,164	276	888	0	0	0	1164	62	31	31	1279
Sep-18	39	0	1,205	285	920	0	0	0	1205	36	18	18	1280
Oct-18	267	0	955	226	729	0	0	0	955	56	28	28	1279
Nov-18	338	0	873	207	666	0	0	0	873	68	34	34	1279
Dec-18	0	0	1,217	288	929	0	0	0	1217	53	27	27	1270
Jan-19	346	0	0	0	0	0	0	0	0	51	25	25	397
Feb-19	328	0	0	0	0	0	0	0	0	51	25	25	378
Mar-19	320	0	0	0	0	0	0	0	0	56	28	28	376
Apr-19	351	0	0	0	0	0	0	0	0	47	23	23	397
May-19	290	0	0	0	0	0	0	0	0	56	28	28	346
Jun-19	351	0	0	0	0	0	0	0	0	50	25	25	401
Jul-19	305	0	0	0	0	0	0	0	0	58	29	29	363
Aug-19	291	0	0	0	0	0	0	0	0	65	33	33	356
Sep-19	274	0	0	0	0	0	0	0	0	59	30	30	334
Oct-19	200	0	4	1	3	0	0	0	4	79	40	40	283
Nov-19	236	0	21	5	16	0	0	0	21	87	43	43	344
Dec-19	264	0	23	6	18	0	0	0	23	90	45	45	377
Jan-20	277	0	1	0	1	0	0	0	1	82	41	41	360
Feb-20	251	0	0	0	0	0	0	0	0	87	43	43	337
Mar-20	221	0	0	0	0	0	0	0	0	91	46	46	313
Apr-20	214	0	24	6	18	0	0	0	24	86	43	43	324
May-20	236	0	86	20	66	0	0	0	86	111	55	55	432
Jun-20	259	0	290	69	221	0	0	0	290	86	43	43	635
Jul-20	214	0	239	57	183	0	0	0	239	91	46	46	545
Aug-20	247	0	287	68	219	0	0	0	287	121	60	60	654
Sep-20	122	0	418	99	319	0	0	0	418	88	44	44	628
Oct-20	47	0	431	102	329	0	0	0	431	126	63	63	604
Nov-20	86	0	377	89	288	0	0	0	377	125	63	63	588
Dec-20	92	0	475	112	362	0	0	0	475	121	61	61	688
Jan-21	64	0	460	109	351	0	0	0	460	124	62	62	648
Feb-21	4	0	342	81	261	0	0	0	342	104	52	52	450
Mar-21	1	0	229	54	175	0	0	0	229	94	47	47	324
Apr-21	0	0	218	52	167	0	0	0	218	114	57	57	333
May-21	144	0	73	17	56	0	0	0	73	161	80	80	377
Jun-21	10.3	0	0	0	0	0	0	0	0	138	69	69	148
Jul-21	0	0	0	0	0	0	0	0	0	153	76	76	153
Aug-21	0	0	0	0	0	0	0	0	0	113	57	57	113
Sep-21	0	0	0	0	0	0	0	0	0	104	52	52	104
Oct-21	0	0	0	0	0	0	0	0	0	128	64	64	128
Nov-21	0	0	0	0	0	0	0	0	0	135	67	67	135
Dec-21	0	0	0	0	0	0	0	0	0	136	68	68	136
Jan-22	0	0	0	0	0	0	0	0	0	156	78	78	156
Feb-22	0	0	0	0	0	0	0	0	0	140	70	70	140
Mar-22	0	0	0	0	0	0	0	0	0	149	74	74	149
Apr-22	0	0	0	0	0	0	0	0	0	155	78	78	155
May-22	0	0	137	32	104	0	0	0	137	179	89	89	316

Table A-5. Construction Total Monthly Trucks with 1550 Evans (August 2016)													
		Dump Trucks 18 CY[g]								Flatbed Trucks			
	Concrete Trucks[a]	Backfill Soil [b]	Revised Total Excavated Soil Adjust Quantities with 18 cy	Contaminated Excavated Soil[c] Assume Port Facility then to Landfill in Utah[h]	Unsuitable Excavated Soil Assume Altamonte, CA[h]	Demolition Debris, Lead/Asbestos Building Materials[d] Assume Recology Hay Road Landfill in Vacaville [65 miles from site]	Demolition Debris, Recycable Materials[d] Assume Republic Ox Mountain Landfill in Half Moon Bay [24 miles from site]	Demolition Debris, Un-recycable Materials[d] Assume Republic Ox Mountain Landfill in Half Moon Bay [24 miles from site]	Total Dump Trucks (excavated soil plus demo debris)	Total Equipment Deliveries (Undetermined Source)[e]	Equipment Delivered to Pier 94	Equipment Delivered to Greenhouses	Total/ Month
Jun-22	0	0	240	57	183	0	0	0	240	160	80	80	400
Jul-22	0	0	228	54	174	0	0	0	228	139	70	70	368
Aug-22	0	0	240	57	183	0	0	0	240	107	53	53	346
Sep-22	0	0	194	46	148	0	0	0	194	87	43	43	281
Oct-22	0	0	103	24	78	0	0	0	103	94	47	47	197
Nov-22	0	0	0	0	0	0	0	0	0	45	23	23	45
Dec-22	0	0	0	0	0	0	0	0	0	28	14	14	28
Jan-23	0	0	0	0	0	0	0	0	0	12	6	6	12
Total	7091	0	10555	2500	8055	505	505	505	12071	5387	2694	2694	24549

a. Source for concrete deliveries has not been determined yet. Potential sources include: Cemex (500 Amadar Street, San Francisco, CA - 0.7 miles), Bode Concrete (450 Amador Street, San Francisco, CA - 0.6 miles) and Allied Redy Mix (450 Amador Street, San Francisco, CA - 0.6 miles).

b. Clean material excavated from digester complex will be used for backfill.

c. Unsuitable soil (due to geotechnical or environmental reaons) will be excavated and hauled off-site. Unsuitable soil destination will depend on soil classification. Assume that contaminated soil will be transported to a landfill in Utah and the remainder will be transported to the Altamonte Landfill outside Livermore/Tracy.

d. Due to limited information, estimates of demolition debris material is assumed to be a third lead/asbestos materials, a third recycable materials and a third un-recyclable materials. Potential locations are listed based on the type of material.

e. Source of equipment has not been determined yet. Assume equipment deliveries will be distributed between the two potential staging areas identified at this time: Pier 94 and Southeast Greenhouses.

f. All quantities and truckload estimates are rough order of magnitude, based on 10% design and class 4 cost estimate. These estimates will be refined during design development.

g. Truck capacity is assumed to be 20 CY, filled to 18 CY capacity (to provide freeboard).

h. The total excavation volumes (and breakdown for hazardous and non-hazardous materials) are based on the *Final Environmental Site Investigation Report for San Francisco Department of Public Health* (May 2016)

Table A-6 Construction Workers and Shuttle Bus[a] (June 2016)								
	Construction Workers Per Day [b] (Adjusted)	Parking stalls needed per day, number of vehicles/stalls (Calculation)[c]	Area needed for workforce parking at Pier 94, in acres (Calculation)[d]	On-site Office Staff (40 people, 40 cars) [e]	Off-site Office Staff (175 max., 175 cars) [f]	office staff and On-site Staff Parking at Greenhouses) Calculation[g]	Shuttles trips at each end of the work shift (construction workers, 50 pax bus) Calculation [h]	Work Shifts
EIR Certification								
February-18	61	49	0.34	40	25	0.4	2	One shift: 7AM-3:30PM
March-18	75	60	0.41	40	25	0.4	2	
April-18	74	59	0.41	40	25	0.4	2	
May-18	77	61	0.42	40	25	0.4	2	
June-18	52	42	0.29	40	25	0.4	2	
July-18	46	37	0.25	40	50	0.6	1	
August-18	58	46	0.32	40	50	0.6	2	
September-18	88	70	0.48	40	50	0.6	2	
October-18	122	97	0.67	40	50	0.6	3	
November-18	149	119	0.82	40	50	0.6	3	
December-18	104	83	0.57	40	50	0.6	3	
January-19	99	79	0.54	40	50	0.6	2	
February-19	99	79	0.54	40	50	0.6	2	
March-19	109	87	0.60	40	50	0.6	3	
April-19	91	73	0.50	40	75	0.8	2	
May-19	110	88	0.61	40	100	1.0	3	
June-19	98	79	0.54	40	125	1.1	2	
July-19	113	90	0.62	40	125	1.1	3	
August-19	132	106	0.73	40	125	1.1	3	
September-19	137	110	0.76	40	125	1.1	3	
October-19	152	122	0.84	40	125	1.1	4	
November-19	167	134	0.92	40	125	1.1	4	
December-19	174	139	0.96	40	125	1.1	4	
January-20	160	128	0.88	40	125	1.1	4	
February-20	170	136	0.94	40	125	1.1	4	
March-20	183	146	1.01	40	125	1.1	4	
April-20	202	161	1.11	40	125	1.1	5	
May-20	210	168	1.16	40	125	1.1	5	
June-20	163	130	0.90	40	125	1.1	4	
July-20	175	140	0.96	40	150	1.3	4	
August-20	221	176	1.21	40	150	1.3	5	
September-20	155	124	0.85	40	150	1.3	4	
October-20	198	158	1.09	40	150	1.3	4	
November-20	181	145	1.00	40	150	1.3	4	
December-20	173	139	0.96	40	150	1.3	4	
January-21	185	148	1.02	40	150	1.3	4	
February-21	198	158	1.09	40	150	1.3	4	
March-21	193	154	1.06	40	150	1.3	4	
April-21	250	200	1.38	40	150	1.3	6	
May-21	319	255	1.76	40	175	1.5	7	Potentially two shifts: 7AM - 3:30 PM and 2:30 PM - 11:00 PM (see Note a)
June-21	327	262	1.80	40	175	1.48	7	See Note (a)
July-21	308	246	1.69	40	175	1.5	7	See Note (a)
August-21	224	179	1.23	40	175	1.5	5	See Note (a)
September-21	192	153	1.05	40	175	1.5	4	See Note (a)
October-21	234	187	1.29	40	175	1.5	5	See Note (a)
November-21	282	226	1.56	40	175	1.5	6	See Note (a)
December-21	280	224	1.54	40	175	1.5	6	See Note (a)
January-22	304	243	1.67	40	175	1.5	7	See Note (a)
February-22	255	204	1.40	40	175	1.5	6	See Note (a)
March-22	270	216	1.49	40	175	1.5	6	See Note (a)
April-22	304	243	1.67	40	175	1.5	7	See Note (a)
May-22	335	268	1.85	40	175	1.5	7	See Note (a)
June-22	303	242	1.67	40	175	1.5	7	One shift: 7AM-3:30PM
July-22	292	234	1.61	40	175	1.5	6	
August-22	185	148	1.02	40	175	1.5	4	
September-22	146	117	0.81	40	175	1.5	3	
October-22	161	129	0.89	40	150	1.3	4	
November-22	83	67	0.46	40	125	1.1	2	
December-22	54	43	0.30	40	100	1.0	2	
January-23	23	19	0.13	40	90	0.9	1	
February-23	3	3	0.02	40	90	0.9	1	
March-23	3	3	0.02	40	90	0.9	1	
April-23	3	3	0.02	40	90	0.9	1	
May-23	3	3	0.02	40	90	0.9	1	
June-23	3	3	0.02	40	90	0.9	1	
July-23	3	3	0.02	40	90	0.9	1	
Maximum	335	268	2	40	175	1.5	4	

a. BDFP estimates for people per day and office staff as shown in Draft CER Construction Staging TM. Standard working hours are assumed (8.5 hours per day, 5 days per week).

While one work shift is assumed for VMT calculations, it is possible that two work shifts could occur during the shaded period shown above (May '21 to May '22). Workshifts are 8.5 hours, which include 1/2 hour lunch.

They are as follows: 7 am - 3:30 pm (1st shift) and 2:30 pm - 11 pm (2nd shift, if needed).

b. Contractor Work Force is based on base case or mid-point of probable range (direct cost plus 15 to 25 percent design contingency).

c. Work force parking is calculated based on 1.25 carpooling ratio.

d. Work force parking area is calculated based on 300-ft2 parking stalls and the estimated number of vehicles.

e. A minimum of 0.5 acres for on-site office trailers is required to allow enough space for the design team field staff, general contractor, major subcontractors, full-time inspectors and meeting rooms. This assumes 40 people (40 cars) will be on-site throughout the period.

f. Off-site office trailers are required to accommodate additional Contractor Manager and General Contractor staff. Estimates are based on 175 people (175 cars). The car pool ratio was not appliedto the off-site office estimate.

g. Off-site office staff parking area is calculated based on 300-ft2 parking stalls and the estimated number of vehicles (175 vehicles x 300 ft2/vehicle / 43560 ft2/acre = 1.2 acres)

h. A shuttle bus with capacity for 50 passengers is assumed during peak of construction. A smaller shuttle bus could be used at other times. Estimate does not include off-site office staff.

APPENDIX D
OPERATIONAL DATA FROM BDFP CER

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

SEWER SYSTEM IMPROVEMENT PROGRAM | Grey. Green. Clean.

CEQA Support Documentation

Technical Memorandum

December 2015

Prepared for:
San Francisco Public Utilities Commission

Authored by:
Biosolids Digester Facilities Project Consultant Team

Contract CS-235 Biosolids Digester Facilities Project

Brown AND Caldwell
with
ch2m
BLACK & VEATCH
and associated firms

FINAL

CEQA Support Documentation

Contract Reference for Deliverables

Task Order 3

Subtask 11

December 2015

Prepared for:
San Francisco Public Utilities Commission

Authored by:
Biosolids Digester Facilities Project Consultant Team

Contract CS-235 Biosolids Digester Facilities Project

Carla De Las Casas, P.E.
California License C 79246
March 31, 2016

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CEQA Support Documentation

Contract Reference for Deliverables

Task Order 3

Subtask 11

Acknowledgements

People listed in the table below have provided significant input on this technical memorandum.

Acknowledgements	
Name	**Organization**
Carla De Las Casas	Brown and Caldwell
Alison Nojima	Brown and Caldwell
Lynnette Gerbert	Brown and Caldwell
Mike Knechtel	Black & Veatch

Program Quality Assurance and Quality Control Review

Reviewers listed in the table below have completed an internal quality review check and approval process that is consistent with procedures and directives previously identified by SFPUC. The table below outlines the reviewers for this document.

Identification of Technical and Administrative Reviewers			
Subtask	**Deliverable (list both Draft and Final versions)**	**Technical Reviewer**	**Complete**
	Draft	Don Trueblood, Brown and Caldwell	7/1/2015
	Draft Final	Don Trueblood, Brown and Caldwell	11/17/2015
	Draft Final	Bruce Chow, Black & Veatch	11/24/2015
	Final	Tracy Stigers, Brown and Caldwell	3/27/2016

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CEQA Support Documentation

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AA	average annual
AAR	Alternatives Analysis Report
APCD	Air Pollution Control District
BAAQMD	Bay Area Air Quality Management District
BACT	best available control technology
BDFP	Biosolids Digester Facilities Project
Btu	British thermal unit(s)
Cal/OSHA	California Division of Occupational Safety and Health
CARB	California Air Resources Board
CCSF	City College San Francisco
CEQA	California Environmental Quality Assessment
CER	Conceptual Engineering Report
cfm	cubic foot/feet per minute
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
d	day(s)
DT	dry ton(s)
D/T	dilution(s) to threshold
EIR	Environmental Impact Report
EMFAC	EMission FACtors
EPA	U.S. Environmental Protection Agency
ft^3	cubic foot/feet
GHG	greenhouse gases
gpd	gallon(s) per day
H_2S	hydrogen sulfide
HHV	higher heating value
hp	horsepower
hr	hour(s)
HRSG	heat recovery steam generator
kW	kilowatt(s)
kWe	kilowatt(s) of electrical energy
lb	pound(s)
LHV	lower heating value
mgd	million gallons per day
mmBtu	million British thermal units
mmBtuh	million British thermal units per hour
MW	megawatt(s)
NA	not applicable
N_2O	nitrous oxide
NMHC	non-methane hydrocarbon
NO_X	nitrous oxides
OPEX	operating expenditure
OSHA	Occupational Safety and Health Administration
PM	particulate matter
ppm	part(s) per million
ppmv	part(s) per million by volume
PTE	potential to emit
scf	standard cubic foot/feet
scfm	standard cubic foot/feet per minute
SEP	Southeast Water Pollution Control Plant
SFPUC	San Francisco Public Utilities Commission
SO_2	sulfur dioxide
SO_x	sulfur oxide
SSIP	Sewer System Improvement Program
TAC	toxic air contaminant
TM	technical memorandum
yd^3	cubic yard(s)
yr	year(s)

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Section 1: Introduction

The San Francisco Public Utilities Commission (SFPUC) proposed Biosolids Digester Facilities Project (BDFP) at the Southeast Water Pollution Control Plant (SEP) could result in potentially significant environment effects. Therefore, the San Francisco Planning Department is preparing an Environmental Impact Report (EIR) to evaluate the physical environmental effects of the proposed BDFP. As required by the California Environmental Quality Act (CEQA) (California Public Resources Code, Sections 21000 et seq.), the CEQA Guidelines, and Chapter 31 of the San Francisco Administrative Code, the EIR will examine potentially significant effects, identify mitigation measures, and analyze whether the proposed mitigation measures would reduce the environmental effects to a less than significant level. The EIR will address several environmental topics, including air quality/odor, traffic, and noise. This technical memorandum (TM) summarizes detailed BDFP estimates for these key environmental topics: air emissions, traffic, and noise.

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Section 2: Air Emissions

The BDFP Consultant Team calculated the operational emissions of the proposed BDFP in support of the preparation of the required CEQA document. The operational emissions sources evaluated in this analysis include stationary sources of air contaminants, as well as mobile sources from employee automobiles and sludge handling/chemical hauling trucks required to operate and support the BDFP. Each of these emissions sources and the assumptions used to derive operation-phase emissions are detailed later in this TM.

Construction emission estimates will be prepared by the CEQA consultant and are therefore not included here. Preliminary construction emission estimates were based on the Alternatives Analysis Report (AAR) construction equipment list. A revised Conceptual Engineering Report (CER) construction equipment list has been prepared and is included in CER Appendix G.

2.1 Sources of Emissions Factors

Criteria pollutant emission factors were compiled from these sources in order of preference: regulatory emission limits such as best available control technology (BACT) and performance standards, manufacturer specifications, and other published values including the U.S. Environmental Protection Agency (EPA) AP-42 database. Sulfur dioxide (SO_2) emissions were calculated based on the sulfur content of the treated digester gas.

Emission factors for most toxic air contaminants (TACs) were obtained from a combination of AP-42 and Ventura County Air Pollution Control District (APCD) AB 2588 Combustion Emission Factors. Emission factors for particulate matter (PM10) for the emergency diesel engine were compiled from BACT. Emission factors for hydrogen sulfide (H_2S) from the odor control system were compiled from preliminary design documentation. Emission factors for greenhouse gases (GHGs) were compiled from the 2015 Climate Registry protocols. Mobile source emission factors were obtained from California Air Resources Board's (CARB's) EMission FACtors (EMFAC) 2014 (V1.0.7) database.

2.2 Input Data and General Assumptions

The various design parameters required to calculate emissions, such as output, heat input, fuel consumption rate, etc., were obtained from preliminary design documentation as well as preliminary vendor information where available. The BDFP emissions calculations conservatively assume that the majority of emissions sources are operated continuously on an annual basis (i.e., 8,760 hours per year per emissions source). A summary of the hours of operation for stationary equipment used in the 2045 estimate is presented in Table 2-1. The BDFP Consultant Team acknowledges that this is not a realistic operating profile for the BDFP as several of the emissions sources are designed for backup/emergency purposes and others may not be operated continuously in practice. However, Bay Area Air Quality Management District (BAAQMD) CEQA guidance requires that a project's operational emissions are calculated in a similar manner to the methodology used in the project's air construction permit application. This is often called potential to emit (PTE).

Source	Number of Units in Operation	Hours of Operation (hr/yr)	Remarks
Two 4.6 MW gas turbines (one duty/one future standby)	1	8,760	Only one turbine can operate at a time.[a] A second turbine will be installed in the future. Emission estimates include duct firing.
Four 200 kW microturbines (future: three duty/one standby)	3	8,760	Microturbines will be provided in the future. The first, second, and third turbines would be needed in years 2032, 2037, and 2042, respectively. The fourth microturbine would be a spare.
Two backup steam boilers (two standby)	2	8,760	Steam boilers are a backup to the turbines (operate only when turbines are not operating or during startup). Each boiler supplies 50% of the steam demand.
One 1.5 MW emergency diesel engine[b]	1	500	BAAQMD approves up to 50 hours per year for non-emergency use for emergency generators. EPA recommends 500 hours for a PTE estimate.
Two waste gas burners (two standby)[c]	2	500	Each waste gas burner (enclosed ground-level type) is sized to accommodate 50% of the maximum gas production rate. EPA recommends 500 hours for a PTE estimate.
Two odor control systems	2	8,760	Estimated to run continuously

Table 2-1. Summary of Stationary Emission Sources (2045, PTE)

a. Turbine uptime is 91% at full capacity; based on Gas Institute Study on actual performance, it may be as high as 97%. Manufacturer will guarantee 95% uptime.

b. Hours of emergency equipment are based on U.S. EPA memorandum dated September 1995.

c. Until a second turbine is installed, excess biogas will be used by the boilers or the waste gas burners. It is assumed that both waste gas burners will operate 5% of the time or up to 500 hours.

hr/yr = hours per year.

kW = kilowatts.

MW = megawatts.

While the methodology used in the BDFP's air construction permit application either has not yet been developed or was not made known to the BDFP Consultant Team, the conservative approach applied in this analysis is a fairly common strategy in air construction permitting and was therefore assumed to be an appropriate starting point. The BDFP Consultant Team can consider other, more realistic operational scenarios using the emissions tool developed for this project.

Mobile-source emissions are based on number of employees (i.e., 35 full-time employees) and hauling trucks for the BDFP only. The number of trucks is projected to increase from 2022 to 2045 because of higher future flows and loads. CER operational truck trip estimates used for mobile-sources estimates are discussed in the Traffic section below.

2.3 Emission Source Information and Assumptions

Key aspects of the calculation methodologies specific to individual emissions sources are highlighted in the following sections.

2.3.1 4.6 MW Midsize Gas Turbine

The following are key aspects of the calculation methodologies specific to the 4.6-megawatt (MW) midsize gas turbine:

- Assumes two Solar Mercury turbines (one duty and one future standby) with one Rentech heat recovery steam generator (HRSG) duct burner coupled to both turbines in the future. Calculations are based on each unit operating at 100 percent load with duct firing.
- Carbon monoxide (CO), nitrogen oxides (NO_x), non-methane hydrocarbon (NMHC), and PM10 emission factors are per the manufacturer's (Solar Mercury) specification. Minor corrections were made to reflect design conditions.
- Sulfur oxides (SO_x) emission factors are based on the sulfur content of treated digester gas (less than 50 parts per million [ppm] as H_2S).
- GHG (carbon dioxide [CO_2], nitrous oxide [N_2O], and methane [CH_4]) emission factors are from the 2015 Climate Registry General Reporting Protocol Tables 12.1 (see factors for wastewater treatment biogas and natural gas 1,025 to 1,050 British thermal units [Btu]) and 12.9.1 (see factors for biogas and natural gas).
- TACs were calculated using AP-42 Table 3.1-7 emission factors.

2.3.2 200 kW Microturbines

The following are key aspects of the calculation methodologies specific to the 200-kilowatt (kW) microturbines:

- Assumes four Capstone C200 microturbines installed in the future starting in 2032 (three duty, one standby in 2045). Three running at 100 percent load.
- CO, NO_x, NMHC, and PM10 emission factors are per manufacturer specifications.
- SO_x emission factors are based on the sulfur content of treated digester gas (50 ppm as H_2S).
- GHG (CO_2, N_2O, and CH_4) emission factors are from the 2015 Climate Registry General Reporting Protocol Tables 12.1 (see factors for wastewater treatment biogas and natural gas 1,025 to 1,050 Btu) and 12.9.1 (see factors for biogas and natural gas).
- TACs were calculated using AP-42 Table 3.1-7 emission factors.

2.3.3 Backup Steam Boilers

The following are key aspects of the calculation methodologies specific to the backup boilers:

- Assumes two firetube packaged steam type Superior Boiler Works Seminole Boilers each with a 21.0-million British thermal unit per hour (MMBtuh) heat input based on a lower heating value (LHV) of the processed digester gas of 647 Btu per standard cubic foot (scf). Each boiler supplies 50 percent of the steam demand. Primary and secondary fuels are digester gas (routine operations) and natural gas (startup and emergencies).
- CO emission factors assume BACT emission targets of 100 ppm for digester gas and 50 ppm for natural gas.
- NO_x emission factors are based on BACT of 20 ppm for digester gas and Regulation 9 Rule 7 of 15 ppm for natural gas.
- PM10 and NMHC emissions were calculated using emission factors obtained from AP-42 Table 1.4-2 (Natural Gas).
- SO_2 emissions were calculated using the sulfur content of treated digester gas (50 ppm as H_2S) for digester gas.

- GHG (CO_2, N_2O, and CH_4) emission factors are from the 2015 Climate Registry General Reporting Protocol Tables 12.1 (see factor for wastewater treatment biogas and natural gas 1,025 to 1,050 Btu) and 12.9.1 (see factors for biogas and natural gas).
- TACs were calculated using emission factors obtained from AP-42 Table 1.4-3.

2.3.4 Emergency Diesel Generator

The following are key aspects of the calculation methodologies specific to the emergency diesel generator:

- Assumes one Caterpillar standby 1,500-kilowatt of electrical energy (kWe) diesel-fired engine-generator.
- Emissions were calculated based on the 500 hour per year limit on non-emergency operations stipulated by EPA for PTE emission calculations.
- NO_x, CO, NMHC, and PM10 are from BAAQMD BACT.
- SO_x emissions assume all sulfur in the fuel is converted to SO_2. Regulations require that the emergency diesel generators fire ultra-low sulfur fuel with a sulfur content of 15 parts per million by volume (ppmv), which per the BAAQMD Permit Handbook, Section 2.3.1 is equivalent to 0.001515 pound (lb)/MMBtu.
- GHG (CO_2, N_2O, and CH_4) emission factors are from the 2015 Climate Registry General Reporting Protocol Tables 12.1 (see factor for distillate fuel oil no. 2) and 12.7 (see factor for large stationary diesel oil engines >600 hp [447 kW]).
- TACs were calculated using AP-42 emission factors from Tables 3.4-3 and 3.4-4.

2.3.5 Waste Gas Burners

The following are key aspects of the calculation methodologies specific to the waste gas burner:

- Assumes that two 1,125-standard-cubic-foot per minute (scfm) waste gas burners (ground enclosed type) can operate at a time at 500 hours per year. Each waste gas burner is sized to accommodate 50 percent of the maximum digester gas production rate.
- NO_x, and CO emissions factors are from vendor specifications.
- NMHC emissions factors are from AP-42 Tables 13.5-1 and 13.5-2.
- PM10 emissions factors are from AP-42 Table 2.4-5.
- SO_x emission factors are based on the sulfur content of treated digester gas (50 ppmv as H_2S).
- GHG (CO_2, N_2O, and CH_4) emission factors are from the 2015 Climate Registry General Reporting Protocol Tables 12.1 (see factor for wastewater treatment biogas) and 12.9.1 (see factor for biogas).
- TACs were calculated using emission factors obtained from Ventura County APCD, AB 2588 Combustion Emission Factors (May 17, 2001).

2.3.6 Odor Control Systems

The following are key aspects of the calculation methodologies specific to the odor control systems:

- Odor control system sizing and maximum H_2S concentration in the foul air are based on preliminary design information for pre- and post-digestion odor control systems.
- The Solids Odor Control 1 (pre-digestion sources) consists of a two-stage odor control system: a long-life engineered media biofilter followed by dry media (activated carbon/potassium permanganate blend) polishing. The total foul airflow rate is 45,300 cubic feet per minute (cfm).
- The Solids Odor Control 2 (post-digestion sources) consists of a three-stage odor control system: an ammonia scrubber, followed by a long-life engineered media biofilter, followed by dry media (activated

carbon/potassium permanganate blend) polishing. The total foul airflow rate is 74,100 cfm (54,100 cfm biofilter, 74,100 cfm polishing stage).

- Based on the preliminary design, the peak inlet H_2S concentration to the control units will be 10 ppmv with a 99 percent removal efficiency through the biofilter. The polishing stage (i.e., carbon vessels) provides an additional 98 percent removal for H_2S. The polishing stage may be bypassed and still meet the 5 dilutions to threshold (D/T) maximum goal at the fence line. Therefore, air emissions were calculated using the H_2S concentration (i.e., 0.1 ppmv) at the biofilter bypass stack.
- Based on the preliminary design, the peak inlet ammonia concentration to Solids Odor Control Unit 2 will be 50 ppmv. The effluent ammonia concentration will range from 5 to 20 ppmv (60 to 90 percent removal) based on actual operating conditions.

2.3.7 Worker Vehicle Emissions

The following are key aspects of the calculation methodologies specific to worker vehicle emissions:

- Emissions calculations are based on 35 employee vehicles per day for the biosolids facilities. The fleet of worker vehicles is assumed to be passenger cars.
- It was conservatively assumed that all employees would travel to/from the project site 250 days per year.
- One round trip was conservatively assumed to be 50 miles.
- Criteria pollutant emission factors are from CARB's EMFAC (V1.0.7) database.
- GHG emission factors are from Tables 13.1 (Gasoline) and 13.4 (Gasoline Passenger Cars, uncontrolled) from the 2015 Climate Registry General Reporting Protocol.

2.3.8 Hauling Trucks

The following are key aspects of the calculation methodologies specific to hauling trucks:

- Number of trips per year and vehicle miles traveled per trip for the chemical and biosolids hauling trucks needed to support the post-project facility were obtained from data provided by the BDFP Consultant Team (Table 3-1).
- Calculations are based on 2045 annual average (AA) loadings from the March 2015 CER Mass Balance.
- Criteria pollutant emission factors are from CARB's EMFAC (V1.0.7) database.
- GHG emission factors are from Tables 13.1 (Gasoline) and 13.4 (Gasoline Passenger Cars, uncontrolled) from the 2015 Climate Registry General Reporting Protocol.

2.4 Summary of Estimate Emissions (2045 PTE)

Based on the assumptions for operational emissions sources presented in Section 2, emissions estimates were calculated for the BDFP. These emissions are summarized in Table 2-2 with supporting calculations included in Attachments A, B, C, and D.

Table 2-2. Summary of Emission Estimates (2045 PTE)									
Source	Criteria Air Pollutants (tons/yr)							Toxic Air Contaminants (lb/yr)	GHG as CO_2e (tons/yr)
	NO_x	NMHC	NO_x + NHMC	CO	PM10	PM2.5	SO_x		
Two 4.6 MW turbines with duct burner (one duty/one future standby)	22.6	0.43	NA	27.5	8.0	NA	3.4	See Table A-1	30,800
Future four 200 kW microturbines (future: three duty/one standby)	1.05	0.26	NA	9.5	0.36	NA	0.35	See Table A-2	3,200
Two backup steam boilers (two standby)	5.8	1.6	NA	17.6	2.2	NA	2.4	See Tables A-6 and A-7	21,500
One 1.5 MW emergency diesel engine	NA	NA	5.3	2.9	0.17	NA	0.005	See Table A-3	600
Two waste gas burners (two standby, enclosed ground-level burners)	0.55	3.1	NA	1.3	0.57	NA	0.28	See Table A-4	2,500
Two odor control systems	NA	NA	NA	NA	NA	NA	NA	462	NA
Hauling trucks	0.032	0.53	NA	0.0021	0.0020	0.0066	0.19	NA	700
Employee vehicles	0.010	0.0017	NA	0.13	0.00033	0.00030	0.00091	NA	150

CO_2e = carbon dioxide equivalents.

NA = not applicable.

2.5 Other Operational Scenarios

Other realistic operational scenarios were considered to support the EIR team air quality analysis. Table 2-3 summarizes hours of operation for typical scenarios in 2022 and 2045. For stationary sources, the main change between 2022 and 2045 is the use of additional microturbines. The first microturbine would be needed in 2032 in order to use 100 percent of the biogas generated. As shown, boilers are assumed to operate when turbines are maintained or during unplanned circumstances. The emergency diesel engine is used when tested (i.e., 50 hours per year).

Because of the lack of a second turbine at the beginning of the project, excess biogas will be used by the boilers and the waste gas burners. It is assumed that the waste gas burners will operate 3 percent of the time (300 hours per year) based on turbine uptime of 97 percent. In 2045, there will a future standby turbine and the waste gas burners will then operate only during maintenance or emergency situations. Operation time per day was varied for the different scenarios considered.

Table 2-3. Stationary Emission Sources: Typical Operational Scenarios

Source	2022 Hours of Operation (hr/yr)	2045 Hours of Operation (hr/yr)	Notes
Two 4.6 MW gas turbines with duct burner (one duty/one future standby)	1x8,760	1x8,760	Without a standby turbine (2022), excess biogas will be sent to either the boilers or the waste gas burners.
Four 200 kW microturbines (future: three duty/one standby)	-	3x8,760	Future microturbines needed starting in 2032.
Two backup steam boilers (two standby)	2x40	2x50	Backup boilers, needed only when turbines are down (i.e., electrical failure) or during testing. 2045 hours increased to account for additional biogas production, thus an increased potential to use the boilers.
One 1.5 MW emergency diesel engine	50	50	Based on BAAQMD approval of up to 50 hours per year for non-emergency use.
Two waste gas burners (two standby)	2x300	2x50	Without a standby turbine, it is assumed that waste gas burners will operate 3% of the time (i.e., 300 hr/yr) based on 97% turbine uptime). By 2045, a second turbine will be installed and the waste gas burners will operate only during emergency situations. 2045 hours of operation are based on 50 hours per year for non-emergency use.
Two odor control systems	2x8,760	2x8,760	

hr/yr = hours per year.

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Section 3: Traffic

Key aspects of the calculation methodologies specific to construction and operational traffic are highlighted in the following sections. The construction truck traffic estimates include excavation and backfill, demolition of existing structures, shuttle service to/from Pier 94/Backlands to BDFP, and construction equipment and materials hauling. Section 3.1 summarizes all traffic associated with the biosolids facilities (e.g., biosolids trucks, chemical deliveries).

3.1 Operational Truck Traffic

Table 3-1 summarizes operational truck trips estimates for BDFP. Other infrequent truck trips were not included.

Table 3-1. Preliminary CER Operational Truck Trips Estimate (2045 AA) for BDFP

Parameter	CER (2045 AA)[a]		Trucks per Day			Truck Type (Capacity)[b]	Round-trip Miles per Truck
	Quantity	Trucks per year	Monday-Friday	Saturday	Sunday		
Biosolids	469,800 lb/d wet solids	3,700	10	10	10	Bulk truck (23.4 tons)	100[c]
Screenings[d]	7.6 wet tons/d	100	1	<1	<1	Bulk truck (23.4 tons)	100
Polymer[e]	3,000 lb/d	33	<1	0	0	Flatbed (22 sacks)	800
Ferric (41% solution)	3,200 gpd	200	1	<1	<1	Tanker truck (5,500 gallons)[f]	100
Total	-	4,000	-	-	-	-	-

a. 2045 AA loadings from CER Mass Balance dated March 2015.

b. Truck capacity from AAR operating expenditure (OPEX) TM.

c. Biosolids round-trip miles based on end uses.

d. Screenings estimates based on 3/8-inch bar spacing, 5-millimeter perforations in sludge screen, 79.3 million gallons per day (mgd) (2045 AA influent flow) and 55 pounds per cubic foot (lb/ft^3) (mid-range density of screenings, MOP8).

e. Polymer dose pounds per dry ton (lb/DT): 10, 6, and 20 for thickening, pre-THP dewatering, and final dewatering. Supersack system: 1,500 lb polymer/Super Sack and 22 sacks per truck delivery. Round-trip mileage based on existing polymer deliveries from SNF Polydyne Inc. (4690 Worth Street, Los Angeles, CA 90063).

f. Truck capacity of 5,500 gallons (AAR OPEX TM assumption for other liquids). Round-trip mileage based on existing ferric deliveries from Kemira Water Solutions Inc. (45051 Industrial Drive, Fremont, CA 94538).

d = day.

gpd = gallons per day.

3.2 Construction Traffic

Construction traffic will consist of excavation hauling, demolition debris hauling, shuttle service to and from Pier 94/Backlands for construction workers, equipment deliveries, concrete trucks, and dump trucks. This subsection summarizes the various sources of traffic during the construction period. Digester pit excavation would take approximately 3 months (January to March 2018), during which time the most intensive construction truck traffic would occur (approximately 200 trucks per day). During peak of construction (October 2020 to December 2021) an average of 450 workers (peak of 500 workers) are estimated to be on-site daily. Construction would occur in two work shifts if more than 500 workers are on-site. Refer to CER Appendix I (*BDFP CER Construction Schedule* TM and *BDFP CER Construction Staging Area Requirements* TM) for additional details.

3.2.1 Excavation and Backfill

The excavation and backfill estimates for the BDFP site (excluding staging areas) are based on the CER design documents. Table 3-2 summarizes excavation volumes and associated truck trips.

Table 3-2. Excavation and Backfill Estimates[a]

Parameter	Quantity, yd^3	Truck Capacity, yd^3	Total Truck Loads	Destination/Source
Excavation of unsuitable soil[b]	213,000	16	13,300	Altamont Landfill, California
Excavation of contaminated soil	34,000	16	2,100	ECDC Landfill, Utah

a. Quantity estimates are based on CER cost estimate and have been rounded to nearest thousand.

b. Includes only excavated soil for off-site hauling; some soil would be reused on-site as backfill material.

yd^3 = cubic yards.

The BDFP design has not been finalized; however, the maximum depth of excavation is estimated to be approximately 40 to 45 feet at the proposed digester location. Several other facilities would require excavation to 25 to 30 feet below existing grade. If feasible, suitable material excavated from the digesters pit will be used as backfill.. An estimated 247,000 cubic yards (yd^3) of unsuitable soil will be removed and hauled off-site. It is assumed that approximately 34,000 yd^3 of the excavated soil will be trucked 1.2 miles from the site via surface streets to the San Francisco Port transfer facility on Cargo Way (near Pier 94), loaded on rail cars, and transported via rail 880 miles to the ECDC landfill in Utah. The remaining quantity of unsuitable soil would be trucked to the Altamont Landfill outside Tracy.

3.2.2 Demolition Debris

In order to make space for the BDFP facilities, approximately 84,000 square feet of existing buildings and structures would be demolished or relocated. In addition, subsurface facilities remaining on the Asphalt Plant site would be removed during excavation for project construction. If the Southeast Greenhouses site becomes available for use as a staging area, the existing greenhouses would also be demolished. Demolition quantities were developed based on available information (i.e., drawings) and site visits. Table 3-3 summarizes demolition debris quantities and truck loads. Quantities shown here do not include demolition of Pier 94/Backlands or existing digesters.

As shown in Table 3-3, it is assumed that one third of the demolition materials will be lead/asbestos-containing building materials, one third will be un-recyclable materials, and one third will be recyclable materials (mostly metal and concrete). Building materials containing asbestos or lead-based paint are assumed to go to Recology Hay Road landfill in Vacaville, which is 65 miles from the BDFP site. The truck route to this landfill is shown in Figure 3-1. Non-hazardous demolition debris will be recycled. The destination of the material will be determined by the contractor, but it can be trucked 24 miles from the site to Republic Ox Mountain Landfill in Half Moon Bay, as shown in Figure 3-2.

Table 3-3. Demolition Debris Truckloads from BDFP Site

Site	Total Quantity, yd^3	Total Truckloads [a]			
		Lead/Asbestos-Building Materials	Recyclable Materials [b]	Un-recyclable Materials	Total
Destination	-	Recology Hay Road Landfill in Vacaville	Republic Ox Mountain Landfill in Half Moon Bay	Republic Ox Mountain Landfill in Half Moon Bay	-
Mileage from project site	-	65	24	24	-
Asphalt Plant: below grade	5,000	100	100	100	300
Central Shops: above grade[c]	11,000	230	230	230	700
Existing SEP facilities: above grade[d]	7,000	130	130	130	400
Southeast Greenhouses	4,000	TBD	100	100	200
Total for BDFP	*27,000*	*460*	*560*	*560*	*1,600*

a. *Truck capacity of 16 yd^3.*
b. *Mostly metal and concrete.*
c. *Central Shops structures proposed for removal: Building A, Building B, and Building C.*
d. *Existing SEP facilities proposed for removal: Building 855 (relocated elsewhere at the SEP prior to construction), Building 870, Building 925, and electrical substations SS5A/5B.*

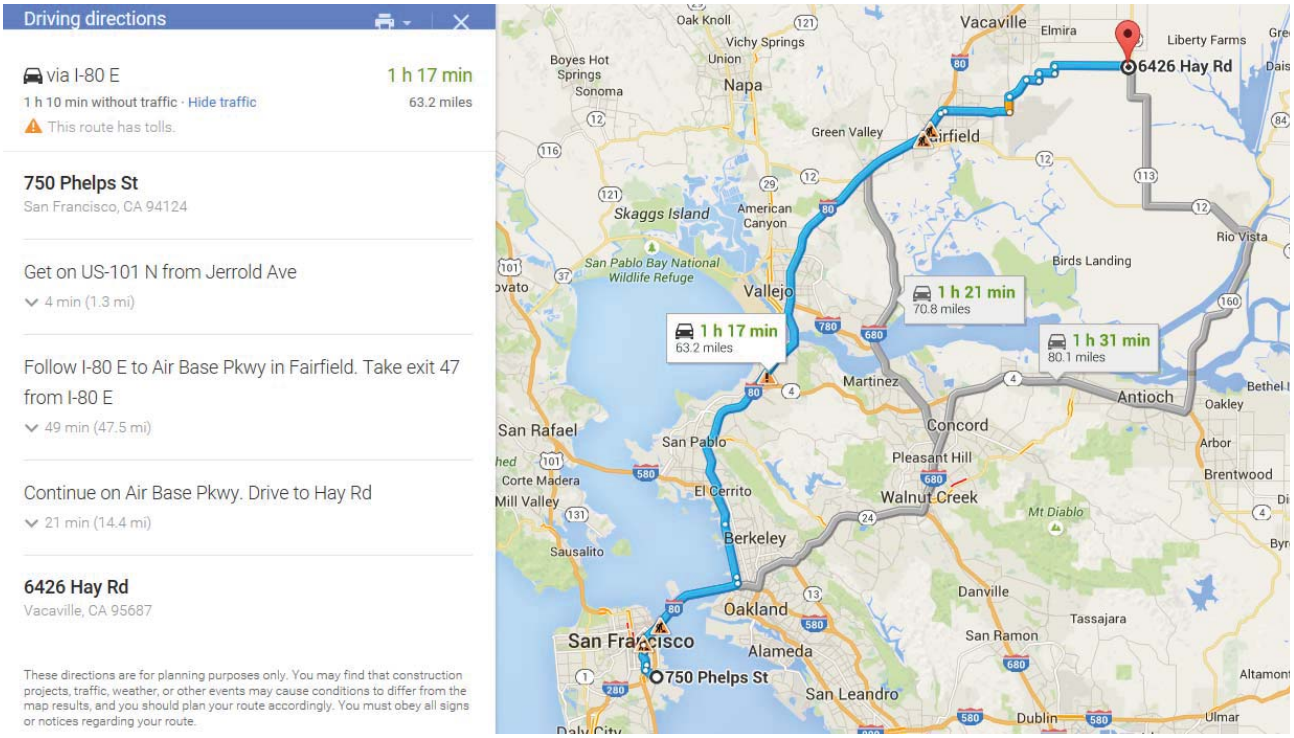

Figure 3-1. Truck route for building materials containing lead or asbestos from BDFP site to Recology Hay Landfill

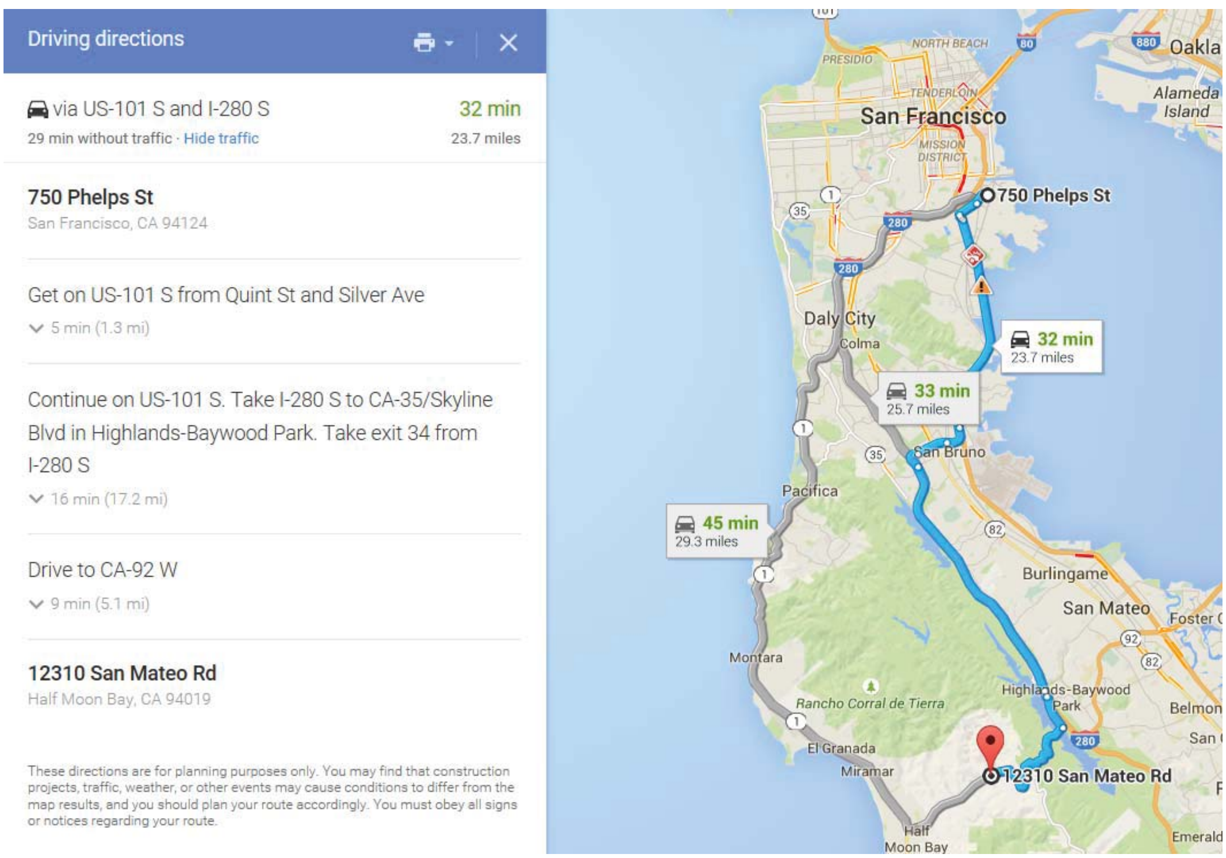

Figure 3-2. Truck route for non-hazardous building materials from site to Republic Ox Mountain Landfill

3.2.3 Shuttle Service to/from Pier 94/Backlands for BDFP

For most of the BDFP construction period, construction activities will occur Monday through Friday (one 8-hour shift [7 a.m. to 3 p.m.]) and Saturdays as needed. Work on Sundays and holidays and 24-hour work will occur only if needed for critical facility connections. Two shifts will be required if there are more than 500 workers on site. If construction workforce parking is available in a construction staging area adjacent to the project site, shuttle service would not be necessary. However, if construction workfoce parking is available at Pier 94, a shuttle service to and from Pier 94/Backlands will be provided during construction.

The CER Staging Area Needs TM (CER Appendix I) includes a shuttle profile created based on the 8-hour (one shift) workforce estimate (see Figure 3-3). The following assumptions were used to create the shuttle profile:

- Peak workforce is 500 workers
- Workforce parking is provided at the Pier 94/Backlands site, 0.9 mile from the construction site
- Shuttle capacity will be 50 people per shuttle (school bus type)
- At peak of construction, assuming one (8-hour) work shift, approximately 10 shuttle trips will be required
- 10 shuttles will each do one round trip (or 5 shuttles, two round trips each) approximately 1 hour before and 1 hour after the construction hours

Additional trips can be considered per shuttle to reduce the number of shuttles required. There is not a significant difference from an emissions standpoint, but this would extend the commuting window.

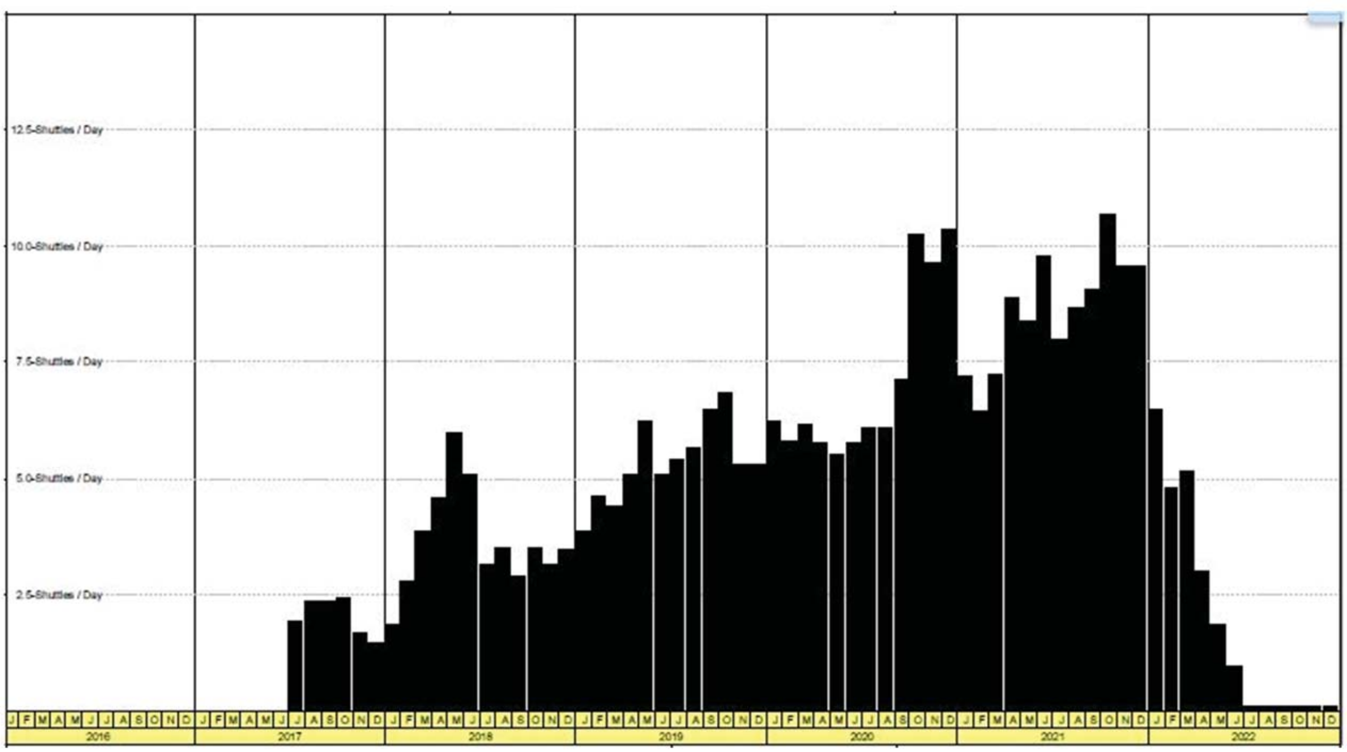

Figure 3-3. Preliminary total passenger shuttles per day (average)

Source: CER Phase Construction Staging Area Needs *TM, dated December 2015.*

3.2.4 Construction Truck Count

The total number of construction trucks throughout the construction period includes concrete trucks, dump (soil and demolition debris) trucks, and flatbed trucks (equipment deliveries) and is based on the CER cost estimate and construction schedule. Construction truck count includes demolition debris for the BDFP site (not including Pier 94, and SEP southside). Figure 3-4 shows the total truck profile during construction. At the peak of construction, it is estimated that there will be roughly 200 trucks per day, on average, including dump trucks, concrete trucks, and flatbed trucks.

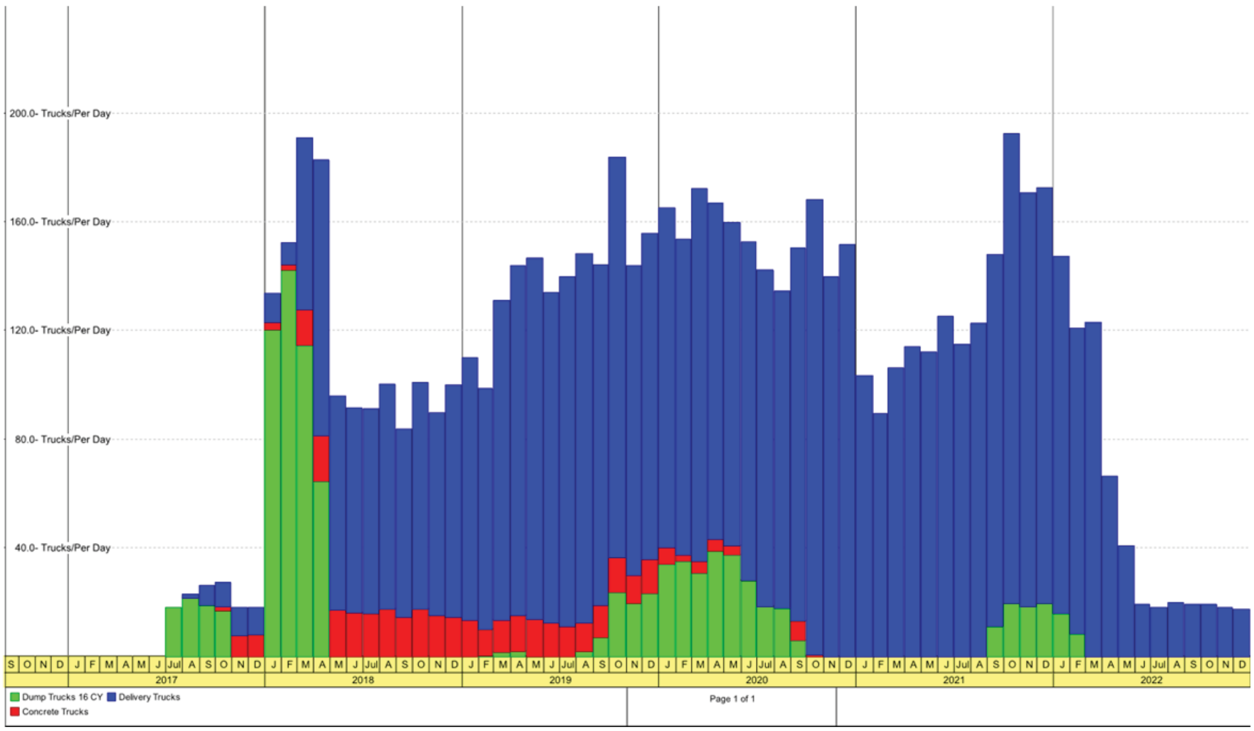

Figure 3-4. Total trucks to the site per day during construction (average)

Section 4: Noise

The EIR will include analysis of noise compatibility standards for residential and other land uses, and will discuss the long-term impacts of noise that could result from the proposed project. Short-term construction-related noise impacts also will be described, and the analysis will evaluate the potential for noise from the BDFP to adversely affect nearby sensitive land uses.

To support the EIR, the BDFP Consultant Team provided on-site and off-site noise data, and manufacturer noise specifications for BDFP equipment including far-field noise estimates. The BDFP Team will set up and run a noise model to evaluate noise levels inside and outside the SEP fence line. Noise results (model and/or calculations) will be used to identify project mitigation measures if needed to provide a safe working environment that meets California Division of Occupational Safety and Health (Cal/OSHA) and SFPUC regulations and guidelines, and to result in no noticeable increase as compared with the existing baseline.

4.1 Noise Model

Because of the complexity of the site, the BDFP Consultant Team will use 3D computer simulations to evaluate project noise levels during construction and operation. The latest version of SoundPlan software will be used to create an SEP Baseline (as built) Environmental Noise Model, Neighborhood-Wide Geographic “Foundation Model,” and BDFP Model to support the BDFP design, EIR, and CEQA analysis. To support the modeling efforts, the team will collect noise data inside and outside the SEP fence line.

To create a Baseline Model, the BDFP Consultant Team will collect as-built (baseline) noise levels at SEP property lines and at adjacent sensitive receptors. The Baseline Model will add existing on-site building masses and noise sources. The analyses for CEQA can also use the baseline noise levels at these locations.

The Foundation Model will include site topography (i.e., ground elevation) and off-site building masses and noise sources (primarily roadway and rail traffic). The model will include traffic noise profiles for surface roads as well as I-280, Caltrain, and the T-Third Muni line. The Foundation Model will be developed to accommodate future noise model efforts.

The BDFP Model will include the proposed new biosolids facilities and will be used to evaluate the effect of the project during construction and operation. The model will be used to identify project-related noise sources at the site as well as project-related noise levels at the property line and noise levels at the closest adjacent noise-sensitive receptors. Project noise levels should account for demolition of intervening structures, removal of some existing facilities, proposed elevation of project-related noise sources, and 2-year startup period when existing and proposed facilities will both be operating. In addition, a cumulative noise model could be used to evaluate the effect of other SFPUC projects (e.g., Headworks) in the vicinity that will contribute to future ambient noise levels during construction and operation. If available, the model could be used to provide an estimate of cumulative (“Existing + Project + Cumulative Projects”) noise levels at the closest adjacent noise-sensitive receptors.

4.2 Project Goals for Noise Control

The project goals for noise control are defined for both inside and outside the SEP fence line as follows:

- "Inside the Fence": minimize future operational noise impact of the BDFP on SEP staff
  - Safe working environment that meets Occupational Safety and Health Administration (OSHA) and SFPUC guidelines at exterior areas and within process buildings
- "Outside the Fence": minimize future operational noise impact of the BDFP on adjacent receptors
  - Provide information needed for the CEQA analysis
  - Meet (CCSF) regulations (Article 29) and Sewer System Improvement Program (SSIP) good-neighbor LOS

4.3 Outside the SEP Fence Line Noise Measurements

In accordance with the approved SEP fenceline noise mesurement workplan, the BDFP Consultant Team collected long-term noise data at multiple locations outside the SEP fence line. Noise data were also collected at the adjacent sensitive receptors, particularly at the residential areas to the west and south of the SEP site. Figure 4-1 shows actual noise measurement locations. Receptor measurement locations were selected to characterize the closest receptors (residencies at Phelps Street, La Salle Avenue, Oakdale Avenue, and Quint Street; CCSF) as well as to characterize the effects of distance and topography (residences along Kirkwood Avenue, Bridgewood Drive, and at Quint Street and Revere Avenue). The data collected by the BDFP Consultant Team have been submitted to the City Planning Department for transmittal to the EIR team. Because the results of these measurements will be used for CEQA analysis, the measurement locations and methodology were approved by the City Planning Department.

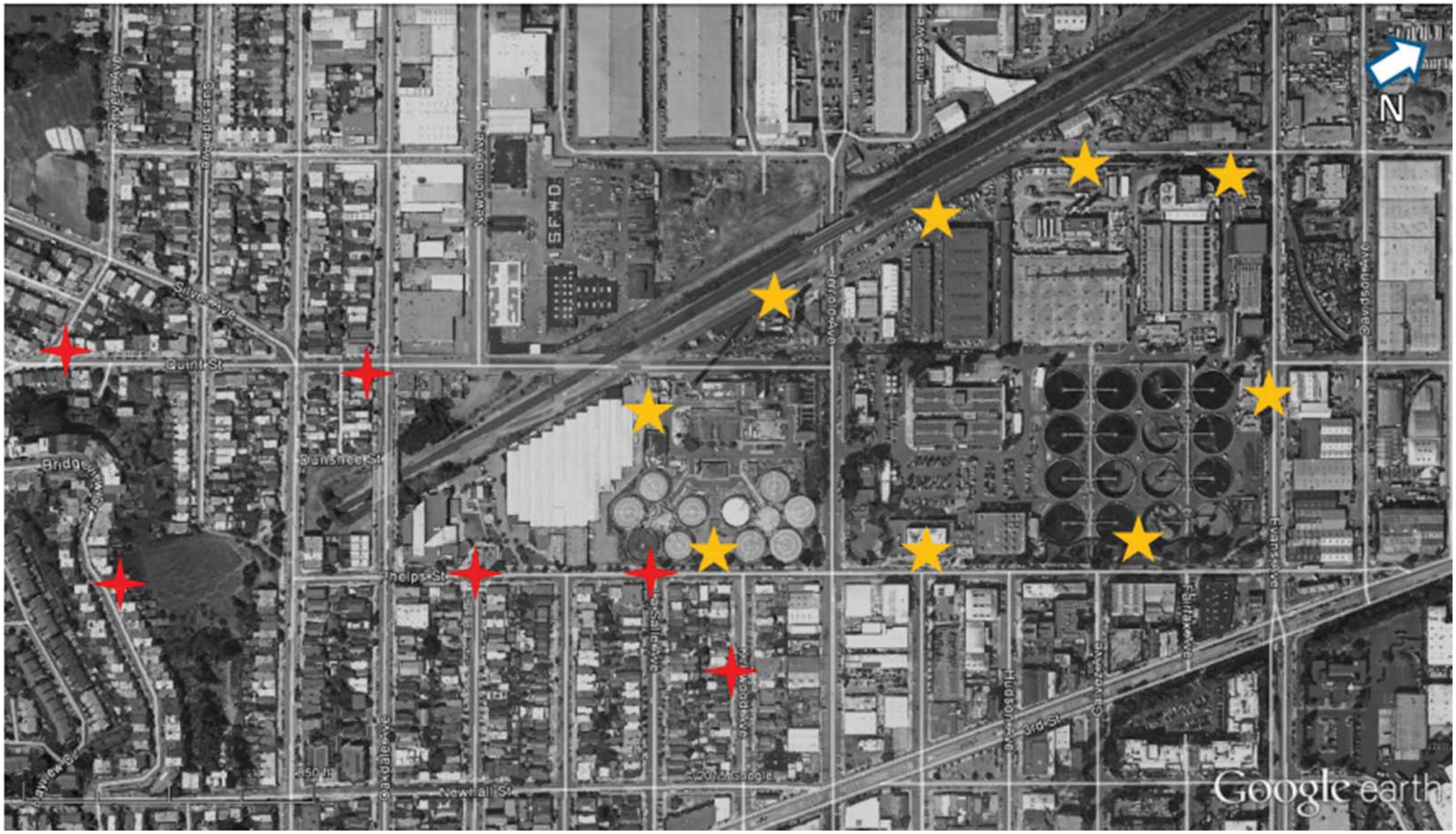

Figure 4-1. Approximate noise measurement locations, September 25 through October 1, 2015

SEP Fenceline Noise Measurement Location

Receptor Noise Measurement Location

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Attachment A: TAC Operational Emissions Calculations Tables A-1 through A-8

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Table A-1. Emissions of Toxic Air Contaminants from Turbine Fired on Digester Gas					
Toxic Air Contaminant	Emission Factor (lb/MMBtu)	Run Time (hr/year)	Fuel Use (MMBtu/hr)	Single Turbine Emissions	
				(lb/hr)	(lb/yr)
1,3-Butadiene	9.80E-06	8760	61.0	5.98E-04	5.24E+00
1,4-Dichlorobenzene	2.00E-05	8760	61.0	1.22E-03	1.07E+01
Acetaldehyde	5.30E-05	8760	61.0	3.23E-03	2.83E+01
Carbon Tetrachloride	2.00E-05	8760	61.0	1.22E-03	1.07E+01
Chlorobenzene	1.60E-05	8760	61.0	9.76E-04	8.55E+00
Chloroform	1.70E-05	8760	61.0	1.04E-03	9.08E+00
Ethylene Dichloride	1.50E-05	8760	61.0	9.15E-04	8.02E+00
Formaldehyde	1.90E-04	8760	61.0	1.16E-02	1.02E+02
Methylene Chloride	1.30E-05	8760	61.0	7.93E-04	6.95E+00
Tetrachloroethylene	2.10E-05	8760	61.0	1.28E-03	1.12E+01
Trichloroethylene	1.80E-05	8760	61.0	1.10E-03	9.62E+00
Vinyl Chloride	3.60E-05	8760	61.0	2.20E-03	1.92E+01
Vinylidene Chloride	1.50E-05	8760	61.0	9.15E-04	8.02E+00

Note:

Only one turbine can operate at a time; therefore the emissions shown here are for one turbine. The second trubine will be installed in the future.

Sources of Emission Factors:

AP-42, Table 3.1-7, when an emission factor was below the detection limit - the detection limit was used

Equations:

Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Fuel Use (MMBtu/hr)

Emissions (lb/yr) = Emissions (lb/hr) x Run Time (hr/year)

Heat Input (61.0 MMBtu/hr) = 41.67 MMBtu/hr (turbine) + 19.3 MMBtu/hr (duct burner)

Turbine heat input from vendor specifications (8,865 Btu/kW-hr x 4,600 kWe = 40.8 MMBtu/hr) adjusted at design conditions.

https://mysolar.cat.com/en_US/products/power-generation/gas-turbine-packages/mercury-50.html

Heat input: 41.67 MMBtu/hr at design conditions (59 deg F and 60 percent RH) for digester gas and 40.12 MMBtu/hr for natural gas at 100 percent load.

Maximum duct burner fuel input (LHV) is 19.3 MMBtu/hr from CER dated December 2015

Table A-2. Emissions of Toxic Air Contaminants from Microturbines Fired on Digester Gas							
Toxic Air Contaminant	Emission Factor (lb/MMBtu)	Run Time (hr/year)	Fuel Use (MMBtu/hr)	Single Turbine Emissions		Three Turbines Emissions	
				(lb/hr)	(lb/yr)	(lb/hr)	(lb/yr)
1,3-Butadiene	9.80E-06	8760	2.1	2.06E-05	1.80E-01	6.17E-05	5.41E-01
1,4-Dichlorobenzene	2.00E-05	8760	2.1	4.20E-05	3.68E-01	1.26E-04	1.10E+00
Acetaldehyde	5.30E-05	8760	2.1	1.11E-04	9.75E-01	3.34E-04	2.92E+00
Carbon Tetrachloride	2.00E-05	8760	2.1	4.20E-05	3.68E-01	1.26E-04	1.10E+00
Chlorobenzene	1.60E-05	8760	2.1	3.36E-05	2.94E-01	1.01E-04	8.83E-01
Chloroform	1.70E-05	8760	2.1	3.57E-05	3.13E-01	1.07E-04	9.38E-01
Ethylene Dichloride	1.50E-05	8760	2.1	3.15E-05	2.76E-01	9.45E-05	8.28E-01
Formaldehyde	1.90E-04	8760	2.1	3.99E-04	3.50E+00	1.20E-03	1.05E+01
Methylene Chloride	1.30E-05	8760	2.1	2.73E-05	2.39E-01	8.19E-05	7.17E-01
Tetrachloroethylene	2.10E-05	8760	2.1	4.41E-05	3.86E-01	1.32E-04	1.16E+00
Trichloroethylene	1.80E-05	8760	2.1	3.78E-05	3.31E-01	1.13E-04	9.93E-01
Vinyl Chloride	3.60E-05	8760	2.1	7.56E-05	6.62E-01	2.27E-04	1.99E+00
Vinylidene Chloride	1.50E-05	8760	2.1	3.15E-05	2.76E-01	9.45E-05	8.28E-01

Note:

Microturbines will be installed in the future (starting in 2032). Only three turbines can operate at a time.

Sources of Emission Factors:

AP-42, Table 3.1-7, when an emission factor was below the detection limit - the detection limit was used

Equations:

Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Fuel Use (MMBtu/hr)

Emissions (lb/yr) = Emissions (lb/hr) x Run Time (hr/year)

Heat Input (2.3 MMbtu/hr) from manufacturer specifications adjusted to f2.1 MMBtu/hr at design conditions.

Fuel consumption per unit at 100% load (LHV) at 59 deg F air temperature and 60 percent relative humidity is 2.1 MMBtu/hr

Table A-3. Emissions of Toxic Air Contaminants During Non-Emergency Use of the Emergency Diesel Engine							
Toxic Air Contaminant	Emission Factor		Mechanical Output	Run Time	Fuel Use	Single Engine Emissions	
	(g/kWh)	(lb/MMBtu)	(kWm)	(hr/year)	(gal/hr)	(lb/hr)	(lb/yr)
Organics							
Benzene		7.76E-04		500	105	1.06E-02	5.30E+00
Toluene		2.81E-04		500	105	3.84E-03	1.92E+00
Xylenes		1.93E-04		500	105	2.63E-03	1.32E+00
Propylene		2.79E-03		500	105	3.81E-02	1.90E+01
Formaldehyde		7.89E-05		500	105	1.08E-03	5.38E-01
Acetaldehyde		2.52E-05		500	105	3.44E-04	1.72E-01
Acrolein		7.88E-06		500	105	1.08E-04	5.38E-02
PAHs							
Naphthalene		1.30E-04		500	105	1.77E-03	8.87E-01
Acenaphthylene		9.23E-06		500	105	1.26E-04	6.30E-02
Acenaphthene		4.68E-06		500	105	6.39E-05	3.19E-02
Fluorene		1.28E-05		500	105	1.75E-04	8.74E-02
Phenanthrene		4.08E-05		500	105	5.57E-04	2.78E-01
Anthracene		1.23E-06		500	105	1.68E-05	8.39E-03
Fluoranthene		4.03E-06		500	105	5.50E-05	2.75E-02
Pyrene		3.71E-06		500	105	5.06E-05	2.53E-02
Benzo(a)anthracene		6.22E-07		500	105	8.49E-06	4.25E-03
Chrysene		1.53E-06		500	105	2.09E-05	1.04E-02
Benzo(b)fluoranthene		1.11E-06		500	105	1.52E-05	7.58E-03
Benzo(k)fluoranthene		2.18E-07		500	105	2.98E-06	1.49E-03
Benzo(a)pyrene		2.57E-07		500	105	3.51E-06	1.75E-03
Indeno(123-cd)pyrene		4.14E-07		500	105	5.65E-06	2.83E-03
Dibenz(ah)anthracene		3.46E-07		500	105	4.72E-06	2.36E-03
Benzo(ghi)perylene		5.56E-07		500	105	7.59E-06	3.79E-03
Inorganics							
Diesel Particulate	0.2		1.50E+03	500		6.61E-01	3.31E+02

Sources of Emission Factors:

AP-42, Tables 3.4-3 and 3.4-4

PM10 was compiled from BAAQMD BACT

Equations:

Emissions (lb/hr) = Emission Factor (lb/MMBtu) x Fuel use (gal/hr) x 0.13 MMBtu/gal

Emissions (lb/hr) = Emission Factor (g/kWh) x Mechanical Output (kWm) x 0.00220462lb/g

Emissions (lb/yr) = Emissions (lb/hr) x 500 hr/year

Fuel use (105 gal/hr) per manufacturer specifications at 100% load

Mechanical input (1500 kWm) per manufacturer specifications

Vendor quote states fuel density 7 lb/gal (18,390 BTU/lb) = 0.13 MMBtu/gal

Assume runtime up to 500 hr/year for emergency use

Table A-4. Emissions of Toxic Air Contaminants from the Waste Gas Burners							
Toxic Air Contaminant	Emission Factor (lb/MMscf)	Run time (hr/yr)	Fuel Use (MMscf/hr)	Single Burner Emissions		Two Burner Emissions	
				(lb/hr)	(lb/yr)	(lb/hr)	(lb/yr)
Benzene	0.159	500	0.0675	1.07E-02	5.37E+00	2.15E-02	1.07E+01
Formaldehyde	1.169	500	0.0675	7.89E-02	3.95E+01	1.58E-01	7.89E+01
PAH's (including Naphthalene)	0.014	500	0.0675	9.45E-04	4.73E-01	1.89E-03	9.45E-01
Naphthalene	0.011	500	0.0675	7.43E-04	3.71E-01	1.49E-03	7.43E-01
Acetaldehyde	0.043	500	0.0675	2.90E-03	1.45E+00	5.81E-03	2.90E+00
Acrolein	0.01	500	0.0675	6.75E-04	3.38E-01	1.35E-03	6.75E-01
Propylene	2.44	500	0.0675	1.65E-01	8.24E+01	3.29E-01	1.65E+02
Toluene	0.058	500	0.0675	3.92E-03	1.96E+00	7.83E-03	3.92E+00
Xylenes	0.029	500	0.0675	1.96E-03	9.79E-01	3.92E-03	1.96E+00
Ethylbenzene	1.444	500	0.0675	9.75E-02	4.87E+01	1.95E-01	9.75E+01
Hexane	0.029	500	0.0675	1.96E-03	9.79E-01	3.92E-03	1.96E+00

Note:

The waste gas burners are expected to be used only druing startup and emergency situations.

Each waste gas burner is sized to accommodate 50 percent of the maximum gas production rate.

Sources of Emission Factors:

Ventura County APCD, AB 2588 Combustion Emission Factors (May 17, 2001)

Equations:

Emission (lb/hr) = Emission Factor (lb/MMscf) x Fuel Use (MMscf/hr)

Emission (lb/yr) = Emissions (lb/hr) x Run time (hr/yr)

Waste Gas Burner (enclosed type) Capacities:

From the vendor quote, 2 flares, 1125 scfm each

1125 scfm = 67500 scf/hr = 0.0675 MMscf/hr

Table A-5. Emissions of Toxic Air Contaminants from the Backup Steam Boilers Fired on Digester Gas									
Toxic Air Contaminant	Emission Factor (lb/MMscf)	Run time (hr/yr)	Fuel Use			Single Boiler Emissions		Two Boilers Emissions	
			(btu/scf)	(MMBtu/hr)	(MMscf/hr)	(lb/hr)	(lb/yr)	(lb/hr)	(lb/yr)
2-Methylnaphthalene	2.40E-05	8,760	647	21.0	0.032	7.79E-07	6.82E-03	1.56E-06	1.36E-02
3-Methylchloranthrene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
7,12-Dimethylbenz(a)anthracene	1.60E-05	8,760	647	21.0	0.032	5.19E-07	4.55E-03	1.04E-06	9.10E-03
Acenaphthene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
Acenaphthylene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
Anthracene	2.40E-06	8,760	647	21.0	0.032	7.79E-08	6.82E-04	1.56E-07	1.36E-03
Benz(a)anthracene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
Benzene	2.10E-03	8,760	647	21.0	0.032	6.82E-05	5.97E-01	1.36E-04	1.19E+00
Benzo(a)pyrene	1.20E-06	8,760	647	21.0	0.032	3.89E-08	3.41E-04	7.79E-08	6.82E-04
Benzo(b)fluoranthene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
Benzo(g,h,i)perylene	1.20E-06	8,760	647	21.0	0.032	3.89E-08	3.41E-04	7.79E-08	6.82E-04
Benzo(k)fluoranthene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
Butane	2.10E+00	8,760	647	21.0	0.032	6.82E-02	5.97E+02	1.36E-01	1.19E+03
Chrysene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
Dibenzo(a,h)anthracene	1.20E-06	8,760	647	21.0	0.032	3.89E-08	3.41E-04	7.79E-08	6.82E-04
Dichlorobenzene	1.20E-03	8,760	647	21.0	0.032	3.89E-05	3.41E-01	7.79E-05	6.82E-01
Ethane	3.10E+00	8,760	647	21.0	0.032	1.01E-01	8.81E+02	2.01E-01	1.76E+03
Fluoranthene	3.00E-06	8,760	647	21.0	0.032	9.74E-08	8.53E-04	1.95E-07	1.71E-03
Fluorene	2.80E-06	8,760	647	21.0	0.032	9.09E-08	7.96E-04	1.82E-07	1.59E-03
Formaldehyde	7.50E-02	8,760	647	21.0	0.032	2.43E-03	2.13E+01	4.87E-03	4.26E+01
Hexane	1.80E+00	8,760	647	21.0	0.032	5.84E-02	5.12E+02	1.17E-01	1.02E+03
Indeno(1,2,3-cd)pyrene	1.80E-06	8,760	647	21.0	0.032	5.84E-08	5.12E-04	1.17E-07	1.02E-03
Naphthalene	6.10E-04	8,760	647	21.0	0.032	1.98E-05	1.73E-01	3.96E-05	3.47E-01
Pentane	2.60E+00	8,760	647	21.0	0.032	8.44E-02	7.39E+02	1.69E-01	1.48E+03
Phenanathrene	1.70E-05	8,760	647	21.0	0.032	5.52E-07	4.83E-03	1.10E-06	9.67E-03
Propane	1.60E+00	8,760	647	21.0	0.032	5.19E-02	4.55E+02	1.04E-01	9.10E+02
Pyrene	5.00E-06	8,760	647	21.0	0.032	1.62E-07	1.42E-03	3.25E-07	2.84E-03
Toluene	3.40E-03	8,760	647	21.0	0.032	1.10E-04	9.67E-01	2.21E-04	1.93E+00

Note:

Steam boilers are provided as backup to produce steam in case the gas turbines are out of service.

The boilers operate in duty/duty configuration to each supply 50 percent of the steam demand. An ultra-low NOx burner was selected to met the low emission requirement of 20 ppmv NOx for digester gas.

Primary fuel is biogas (routine operations). Secondary fuel is natural gas (startup and emergency). Maximum fuel input (LHV) per unit is 21 MMBtu/hr based on current design documents.

Sources of Emission Factors:

AP-42, Table 1.4-3, when an emission factor was below the detec tion limit - the detection limit was used (values used for both natural gas and digester gas)

Equations:

Gas Use (MMscf/hr) = Gas use (MMBtu/hr) / btu/scf

Emission (lb/hr) = Emission Factor (lb/MMscf) x Fuel Use (MMscf/hr)

Emission (lb/yr) = Emissions (lb/hr) x Run time (hr/yr)

Heat Content (647 btu/scf) from CER dated December 2015

Table A-6. Emissions of Toxic Air Contaminants from the Backup Steam Boilers Fired on Natural Gas									
Toxic Air Contaminant	Emission Factor (lb/MMscf)	Run time (hr/yr)	Fuel Use			Single Boiler Emissions		Two Boilers Emissions	
			(btu/scf)	(MMBtu/hr)	(MMscf/hr)	(lb/hr)	(lb/yr)	(lb/hr)	(lb/yr)
2-Methylnaphthalene	2.40E-05	8,760	1,050	21.0	0.020	4.80E-07	4.20E-03	9.60E-07	8.41E-03
3-Methylchloranthrene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
7,12-Dimethylbenz(a)anthracene	1.60E-05	8,760	1,050	21.0	0.020	3.20E-07	2.80E-03	6.40E-07	5.61E-03
Acenaphthene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
Acenaphthylene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
Anthracene	2.40E-06	8,760	1,050	21.0	0.020	4.80E-08	4.20E-04	9.60E-08	8.41E-04
Benz(a)anthracene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
Benzene	2.10E-03	8,760	1,050	21.0	0.020	4.20E-05	3.68E-01	8.40E-05	7.36E-01
Benzo(a)pyrene	1.20E-06	8,760	1,050	21.0	0.020	2.40E-08	2.10E-04	4.80E-08	4.20E-04
Benzo(b)fluoranthene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
Benzo(g,h,i)perylene	1.20E-06	8,760	1,050	21.0	0.020	2.40E-08	2.10E-04	4.80E-08	4.20E-04
Benzo(k)fluoranthene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
Butane	2.10E+00	8,760	1,050	21.0	0.020	4.20E-02	3.68E+02	8.40E-02	7.36E+02
Chrysene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
Dibenzo(a,h)anthracene	1.20E-06	8,760	1,050	21.0	0.020	2.40E-08	2.10E-04	4.80E-08	4.20E-04
Dichlorobenzene	1.20E-03	8,760	1,050	21.0	0.020	2.40E-05	2.10E-01	4.80E-05	4.20E-01
Ethane	3.10E+00	8,760	1,050	21.0	0.020	6.20E-02	5.43E+02	1.24E-01	1.09E+03
Fluoranthene	3.00E-06	8,760	1,050	21.0	0.020	6.00E-08	5.26E-04	1.20E-07	1.05E-03
Fluorene	2.80E-06	8,760	1,050	21.0	0.020	5.60E-08	4.91E-04	1.12E-07	9.81E-04
Formaldehyde	7.50E-02	8,760	1,050	21.0	0.020	1.50E-03	1.31E+01	3.00E-03	2.63E+01
Hexane	1.80E+00	8,760	1,050	21.0	0.020	3.60E-02	3.15E+02	7.20E-02	6.31E+02
Indeno(1,2,3-cd)pyrene	1.80E-06	8,760	1,050	21.0	0.020	3.60E-08	3.15E-04	7.20E-08	6.31E-04
Naphthalene	6.10E-04	8,760	1,050	21.0	0.020	1.22E-05	1.07E-01	2.44E-05	2.14E-01
Pentane	2.60E+00	8,760	1,050	21.0	0.020	5.20E-02	4.56E+02	1.04E-01	9.11E+02
Phenanathrene	1.70E-05	8,760	1,050	21.0	0.020	3.40E-07	2.98E-03	6.80E-07	5.96E-03
Propane	1.60E+00	8,760	1,050	21.0	0.020	3.20E-02	2.80E+02	6.40E-02	5.61E+02
Pyrene	5.00E-06	8,760	1,050	21.0	0.020	1.00E-07	8.76E-04	2.00E-07	1.75E-03
Toluene	3.40E-03	8,760	1,050	21.0	0.020	6.80E-05	5.96E-01	1.36E-04	1.19E+00

Note:

Steam boilers are provided as backup to produce steam in case the gas turbines are out of service.

The boilers operate in duty/duty configuration to each supply 50 percent of the steam demand. An ultra-low NOx burner was selected to met the low emission requirement of 20 ppmv NOx for digester gas.

Primary fuel is biogas (routine operations). Secondary fuel is natural gas (startup and emergency). Maximum fuel input (LHV) per unit is 21 MMBtu/hr based on current design documents.

Sources of Emission Factors:

AP-42, Table 1.4-3, when an emission factor was below the detec tion limit - the detection limit was used (values used for both natural gas and digester gas)

Equations:

Gas Use (MMscf/hr) = Gas use (MMBtu/hr) / btu/scf

Emission (lb/hr) = Emission Factor (lb/MMscf) x Fuel Use (MMscf/hr)

Emission (lb/yr) = Emissions (lb/hr) x Run time (hr/yr)

Heat content of natural gas is 1,050 btu/scf.

Table A-7. Emissions of Toxic Air Contaminants from Odor Control Unit 1					
Toxic Air Contaminant	**Emission Factor**		**Run time**	**Odor Control Unit 1 Emissions**	
	(ppm)	**(lb/hr)**	**(hr/yr)**	**(lb/hr)**	**(lb/yr)**
Hydrogen Sulfide	0.10	0.024	8760	0.024	211

Table A-8. Emissions of Toxic Air Contaminants from Odor Control Unit 2					
Toxic Air Contaminant	**Emission Factor**		**Run time**	**Odor Control Unit 2 Emissions**	
	(ppm)	**(lb/hr)**	**(hr/yr)**	**(lb/hr)**	**(lb/yr)**
Hydrogen Sulfide	0.10	0.029	8760	0.029	251

Sources of Hydrogen Sulfide Concentrations:

H_2S concentration from CER dated December 2015

Equations:

Emission Factor/Emissions (lb/hr) = see Table D-6

Emissions (lb/yr) = Emissions (lb/hr) x Run time (hr/yr)

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Attachment B: GHG Operational Emissions Calculations Tables B-1 through B-8

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GHG	Emission Factor (kg/MMBtu)	Run time (hr/yr)	Fuel Use (MMBtu/hr)	GWP	Single Turbine CO2e Emissions (tons/yr)	Three Turbines CO2e Emissions (tons/yr)
CO2	52.07	8760	2.1	1	1,056	3,168
N2O	0.00063	8760	2.1	310	3.96	11.88
Methane	0.0032	8760	2.1	21	1.36	4.09

Table B-2. Emissions of GHG from Microturbines Fired on Digester Gas

Note:

Microturbines will be installed in the future (starting in 2032). Only three turbines can operate at a time.

Sources of Emission Factors:

The Climate Registry 2015, Tables 12.1 (wastewater treatment biogas) and 12.9.1 (biogas, industrial)

Equations:

Emissions (tons/yr) = Emission Factor (kg/MMBtu) x Fuel Use (MMBtu/hr) x Run Time (hr/year) x GWP x 0.00110231 ton/kg

Heat Input (2.3 MMbtu/hr) from manufacturer specifications adjusted to 2.1 MMBtu/hr at design conditions

Fuel consumption per unit at 100% load (LHV) at 59 deg F air temperature and 60 percent relative humidity is 2.1 MMBtu/hr

Table B-3. Emissions of GHG During Non-Emergency Use of the Emergency Diesel Engine					
GHG	**Emission Factor (kg/MMBtu)**	**Run Time (hr/year)**	**Fuel Use (gal/hr)**	**GWP**	**Single Engine CO2e Emissions (ton/yr)**
CO2	73.96	500	105	1	556
N2O	NA	500	105	310	NA
Methane	0.00401	500	105	21	0.63

Sources of Emission Factors:

The Climate Registry 2015, Tables 12.1 (Distillate Fuel Oil No. 2) and 12.7 (Large Stationary Diesel Oil Engines >600hp (447 kW))

Equations:

Emissions (tons/yr) = (Emission Factor (kg/MMBtu) x Fuel Use (gal/hr) x 0.13 MMBtu/gal x Run Time (hr/year) x GWP x 0.00110231 ton/kg

Fuel use (105 gal/hr) per manufacturer specifications at 100% load

Mechanical input (1500 kWm) per manufacturer specifications

Vendor quote states fuel density 7 lb/gal (18,390 BTU/lb) = 0.13 MMBtu/gal

Assume runtime up to 500 hr/year for emergency use

GHG	Emission Factor (kg/MMBtu)	Run time (hr/yr)	Fuel Use (scf/hr)	btu/scf	GWP	Single Burner CO2e Emissions (tons/yr)	Two Burners CO2e Emissions (tons/yr)
CO2	52.07	500	67,500	647	1	1,253	2,507
N2O	0.00063	500	67,500	647	310	4.70	9.40
Methane	0.0032	500	67,500	647	21	1.62	3.24

Table B-4. Emissions of GHG from the Waste Gas Burners

Note:

The waste gas burners are expected to be used only druing startup and emergency situations.

Each waste gas burner is sized to accommodate 50 percent of the maximum gas production rate.

Sources of Emission Factors:

The Climate Registry 2015, Tables 12.1 (wastewater treatment biogas) and 12.9.1 (biogas)

Equations:

Emissions (tons/yr) = Emission Factor (kg/MMBtu) x MMBtu/1E+6 btu x Fuel Use(scf/hr) x btu/scf x Run Time(hr/year) x GWP x 0.00110231 ton/kg

Waste Gas Burner (enclosed type) Capacities:

From the vendor quote, 2 flares, 1125 scfm each

1125 scfm = 67500 scf/hr = 0.0675 MMscf/hr

Heat Content (647 btu/scf) from CER dated December 2015

Table B-5. Emissions of GHG from the Backup Steam Boilers Fired on Digester Gas						
GHG	**Emission Factor (kg/MMBtu)**	**Run time (hr/yr)**	**Fuel Use (MMBtu/hr)**	**GWP**	**Single Boiler CO2e Emissions (tons/yr)**	**Two Boilers CO2e Emissions (tons/yr)**
CO2	52.07	8,760	21.0	1	10,559	21,118
N2O	0.00063	8,760	21.0	310	39.60	79.21
Methane	0.0032	8,760	21.0	21	13.63	27.25

Table B-6. Emissions of GHG from Backup Steam Boilers while Fired on Natural Gas						
GHG	**Emission Factor (kg/MMBtu)**	**Run time (hr/yr)**	**Fuel Use (MMBtu/hr)**	**GWP**	**Single Boiler CO2e Emissions (tons/yr)**	**Two Boilers CO2e Emissions (tons/yr)**
CO2	53.06	8,760	21.0	1	10,760	21,519
N2O	0.0001	8,760	21.0	310	6.29	12.57
Methane	0.001	8,760	21.0	21	4.26	8.52

Note:

Steam boilers are provided as backup to produce steam in case the gas turbines are out of service.

The boilers operate in duty/duty configuration to each supply 50 percent of the steam demand. An ultra-low NOx burner was selected to met the low emission requirement of 20 ppmv NOx for digester gas.

Primary fuel is biogas (routine operations). Secondary fuel is natural gas (startup and emergency). Maximum fuel input (LHV) per unit is 21 MMBtu/hr based on current design documents.

Sources of Emission Factors:

The Climate Registry 2015, Tables 12.1 (wastewater treatment biogas/natural gas 1025 to 1050 btu) and 12.9.1 (biogas/natural gas)

Equations:

Emissions (tons/yr) = Emission Factor (kg/MMBtu) x Fuel Use (MMBtu/hr) x Run Time (hr/year) x GWP x 0.00110231 ton/kg

Table B-7. Emissions of GHG from Truck Hauling (Diesel)								
GHG	**CO2 Emission Factor**	**Units**	**GWP**	**Trucks/yr**	**Roundtrip Miles per truck**	**Roundtrip Miles per year**	**Average MPG**	**CO2e Emissions (ton/year)**
CO2								
Biosolids	10.21	kg/gal	1	3,700	100	370,000	6.53	638
Screening	10.21	kg/gal	1	100	100	10,000	6.53	17.24
Polymer	10.21	kg/gal	1	34	800	27,200	6.53	46.88
Ferric	10.21	kg/gal	1	200	100	20,000	6.53	34
N2O								
Biosolids	0.0048	g/mile	310	3,700	100	370,000	6.53	0.61
Screening	0.0048	g/mile	310	100	100	10,000	6.53	0.016
Polymer	0.0048	g/mile	310	34	800	27,200	6.53	0.045
Ferric	0.0048	g/mile	310	200	100	20,000	6.53	0.03
Methane								
Biosolids	0.0051	g/mile	21	3,700	100	370,000	6.53	0.044
Screening	0.0051	g/mile	21	100	100	10,000	6.53	0.0012
Polymer	0.0051	g/mile	21	34	800	27,200	6.53	0.0032
Ferric	0.0051	g/mile	21	200	100	20,000	6.53	0.002

Sources of Emission Factors:

The Climate Registry 2015, Tables 13.1 (diesel fuel) and 13.4 (Diesel Medium and Heavy-Duty Vehicles, uncontrolled)

Equations:

Emissions (ton/year) = Emission Factor (kg/gallon) x Roundtrip Miles per Year x 0.00110231ton/kg x GWP / MPG

Emissions (ton/year) = Emission Factor (g/mile) x Roundtrip Miles per Year x 0.00000110231ton/g x GWP

Average MPG:

Huai et al., 2006. Analysis of heavy-duty diesel truck activity and emissions data. Atmospheric Envrionment 40 (2006) 2333-2340

Table 4: Average fuel economy (mpg) for Detroit Diesel (6.4 mpg, CAT (6.0 mpg, and Cummins Trucks (7.2 mpg)

Trucks per year based on: CER Operational Truck Trip Estimate (2045AA)

Roundtrip Miles per Truck based on: Professional Judgement and "Comparison of Biosolids Processing Alternatives using Greenhouse Gas Emission Estimates" technical memorandum. June 2014

Table B-8. Emissions of GHG from Employee Vehicles (Gasoline)								
GHG	**Emission Factor**	**units**	**cars/day**	**Roundtrip Miles per Car**	**Roundtrip Miles per year**	**MPG**	**GWP**	**CO2e Emissions (ton/year)**
CO2	8.7775	kg/gal	35	50	437,500	30	1	141
N2O	0.0197	g/mile	35	50	437,500	30	310	2.95
Methane	0.178	g/mile	35	50	437,500	30	21	1.80

Sources of Emission Factors:

The Climate Registry 2015, Tables 13.1 (gasoline) and 13.4 (Gasoline Passenger Cars, uncontrolled)

Equations:

Roundtrip Miles per Year = cars/day x Roundtrip Miles per Car x 250 day/yr

Emissions (ton/year) = Emission Factor (kg/gallon) x Roundtrip Miles per Year x 0.00110231ton/kg x GWP / MPG

Emissions (ton/year) = Emission Factor (g/mile) x Roundtrip Miles per Year x 0.00000110231ton/g x GWP

Cars per Day, Roundtrip Miles per Car and MPG based on: Professional Judgement

Attachment C: CAP Operational Emissions Calculations Tables C-1 through C-8

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Table C-1. Emissions of Criteria Air Pollutants from Turbine Fired on Digester Gas							
Criteria Air Pollutant	**Emission Factor**				**Run Time (hr/year)**	**Fuel Use (MMBtu/hr)**	**Single Turbine Emissions (tons/yr)**
	(mg/m³)	**(lb/MMBtu)**	**(ppm)**	**(lb/hr)**			
NOx			25	5.16	8760	61.0	22.59
NMHC	18	0.0016			8760	61.0	0.43
CO			50	6.28	8760	61.0	27.51
PM10		0.03			8760	61.0	8.02
SOx			50	0.78	8760	61.0	3.43

Note:

Only one turbine can operate at a time; therefore the emissions shown here are for one turbine. The second turbine will be installed in the future.

Sources of Emission Factors:

Consistent with standard practice for air quality emissions as specified in BAAQMD Regulation 9, calculations are done at 15% O2

NOx, CO and PM10 from manufacturer specification

NMHC from vendor (25ppm = 18mg/m³)

SOx based on sulfur content of treated Digester Gas (<50ppm as H2S)

Equations:

Emission Factor (lb/hr) = see Table D-1

Emission Factor (lb/MMBtu) = Emission Factor (mg/m³) x 2.02462E-06lb/mg x m³/35.3147scf x 1E+6scf/MMscf x scf/647btu

Emissions (tons/yr) = Emission Factor (lb/hr) x Run Time (hr/year) x ton/2000lb

Emissions (tons/yr) = Emission Factor (lb/MMBtu) x Fuel Use (MMBtu/hr) x Run Time (hr/year) x ton/2000lb

Heat Input (61.0 MMBtu/hr) = 41.67 MMBtu/hr (turbine) + 19.3 MMBtu/hr (duct burner)

Turbine heat input from vendor specifications (8,865 Btu/kW-hr x 4,600 kWe = 40.8 MMBtu/hr) adjusted for design conditions

https://mysolar.cat.com/en_US/products/power-generation/gas-turbine-packages/mercury-50.html

Heat input: 41.67 MMBtu/hr at design conditions (59 deg F and 60 percent RH) for digester gas and 40.12 MMBtu/hr for natural gas at 100 percent load.

Maximum duct burner fuel input (LHV) is 19.3 MMBtu/hr from CER dated December 2015

Table C-2. Emissions of Criteria Air Pollutants from Microturbines Fired on Digester Gas									
Criteria Air Pollutant	Emission Factor				Power Output	Run Time	Fuel Use	Single Turbine Emissions	Three Turbines Emissions
	(lb/MMBtu)	(lb/MWh)	(ppm)	(lb/hr)	(MW)	(hr/year)	(MMBtu/hr)	(tons/yr)	(tons/yr)
NOx		0.4			0.2	8760	2.1	0.35	1.05
NMHC		0.1			0.2	8760	2.1	0.088	0.26
CO		3.6			0.2	8760	2.1	3.15	9.46
PM10	0.0129				0.2	8760	2.1	0.12	0.36
SOx			50	0.027	0.2	8760	2.1	0.12	0.35

Note:

Microturbines will be installed in the future (starting in 2032). Only three turbines can operate at a time.

Sources of Emission Factors:

NOx, NMHC, CO, and PM10 from manufacturer specifications

SOx based on sulfur content of treated Digester Gas (<50ppm as H2S)

Equations:

Emission Factor (lb/hr) = see Table D-2

Emissions (tons/yr) = Emission Factor (lb/hr) x Run Time (hr/year) x ton/2000lb

Emissions (tons/yr) = Emission Factor (lb/MMBtu) x Fuel Use (MMBtu/hr) x Run Time (hr/year) x ton/2000lb

Emissions (tons/yr) = Emission Factor (lb/MWh) x Power Output (MWh) x Run Time (hr/year) x ton/2000lb

Heat Input (2.3 MMbtu/hr) from manufacturer specifications adjusted to 2.1 MMBtu/hr at design conditions

Fuel consumption per unit at 100% load (LHV) at 59 deg F air temperature and 60 percent relative humidity is 2.1 MMBtu/hr

Table C-3. Emissions of Criteria Air Pollutants During Non-Emergency Use of the Emergency Diesel Engine

Criteria Air Pollutant	100% Standby Emission Factor (g/kWh)	Mechanical Output (kWm)	Run Time (hr/year)	Single Engine Emissions (tons/yr)
NOx + NMHC	6.40	1500	500	5.29
CO	3.50	1500	500	2.89
PM10	0.20	1500	500	0.17

Criteria Air Pollutant	Emission Factor (lb/MMBtu)	Fuel Use (gal/hr)	Run Time (hr/year)	Single Engine Emissions (tons/yr)
SOx	0.001515	105	500	0.005

Sources of Emission Factors:

NOx, CO, NMHC, and PM10 were compiled from BAAQMD BACT

SOx per CARB diesel (15 ppm as S = 0.001515 lb/MMBtu per BAAQMD Permit Handbook, Section 2.3.1)

Equations:

Emissions (tons/yr) = Emission Rate (g/kWh) x Mechanical Output (kWm) x Run Time (hr/year) x 0.00000110231ton/g

Emissions (tons/yr) = (Emission Factor (lb/MMBtu) x Fuel Use (gal/hr) x 0.13 MMBtu/gal x Run Time (hr/year) x ton/2000 lb

Fuel use (105 gal/hr) per manufacturer specifications at 100% load

Mechanical input (1500 kWm) per manufacturer specifications

Vendor quote states fuel density 7 lb/gal (18,390 BTU/lb) = 0.13 MMBtu/gal

Assume runtime up to 500 hr/year for emergency use

Table C-4. Emissions of Criteria Air Pollutants from the Waste Gas Burners									
Criteria Air Pollutant	Emission Factor				Run Time (hr/year)	Fuel Use (scf/hr)	Heat Content (Btu/scf)	Single Burner Emissions (tons/yr)	Two Burners Emissions (tons/yr)
	(lb/MMBtu)	(lb/MMscf)	(ppm)	(lb/hr)					
NOx	0.025				500	67,500	647	0.27	0.55
NMHC	0.14				500	67,500	647	1.53	3.06
CO	0.06				500	67,500	647	0.66	1.31
PM10		17			500	67,500	647	0.29	0.57
SOx			50	0.56	500	67,500	647	0.14	0.28

Note:

The waste gas burners are expected to be used only druing startup and emergency situations.

Each waste gas burner is sized to accommodate 50 percent of the maximum gas production rate.

Sources of Emission Factors:

Vendor Specification for NOx and CO

AP-42 Tables 13.5-1 and 13.5-2 for NMHC

AP-42 Table 2.4-5 for PM10

SOx based on sulfur content of treated Digester Gas (<50ppm as H2S)

Equations:

Emission Factor (lb/hr) = see Table D-3

Emissions (tons/year) = Emission Factor (lb/MMBtu) x Fuel Use (Mscf/hr) x Heat Content (Btu/scf) x CF (1MMBtu/1,000,000Btu) x Run Time (hr/year) x ton/2000lb

Emissions (tons/year) = Emission Factor (lb/hr) x Run Time (hr/year) x ton/2000lb

Emissions (tons/year) = Emission Factor (lb/MMscf) x Fuel Use (scf/hr) x CF (1MMBtu/1,000,000Btu) x Run Time (hr/year) x ton/2000lb

Waste Gas Burner (enclosed type) Capacities:

From the vendor quote, 2 flares, 1125 scfm each

1125 scfm = 67500 scf/hr = 0.0675 MMscf/hr

Heat Content (647 btu/scf) from CER dated December 2015

Table C-5. Emissions of Criteria Air Pollutants from the Backup Steam Boilers Fired on Digester Gas									
Criteria Air Pollutant	Emission Factor (ppm)	Emission Factor (lb/hr)	Emission Factor (lb/MMscf)	Run time (hr/yr)	Fuel Use (btu/scf)	Fuel Use (MMBtu/hr)	Fuel Use (MMscf/hr)	Single Boiler Emissions (tons/yr)	Two Boilers Emissions (tons/yr)
NOx	20	0.66		8,760	647	21.0	0.032	2.89	5.79
NMHC			5.5	8,760	647	21.0	0.032	0.78	1.56
CO	100	2.01		8,760	647	21.0	0.032	8.81	17.61
PM10			7.6	8,760	647	21.0	0.032	1.08	2.16
SOx	50	0.27		8,760	647	21.0	0.032	1.18	2.36

Table C-6. Emissions of Criteria Air Pollutants from the Backup Steam Boilers Fired on Natural Gas									
Criteria Air Pollutant	Emission Factor (ppm)	Emission Factor (lb/hr)	Emission Factor (lb/MMscf)	Run time (hr/yr)	Fuel Use (btu/scf)	Fuel Use (MMBtu/hr)	Fuel Use (MMscf/hr)	Single Boiler Emissions (tons/yr)	Two Boilers Emissions (tons/yr)
NOx	15	0.50		8,760	1,050	21.0	0.020	2.17	4.34
NMHC			5.5	8,760	1,050	21.0	0.020	0.48	0.96
CO	50	1.01		8,760	1,050	21.0	0.020	4.40	8.81
PM10			7.6	8,760	1,050	21.0	0.020	0.67	1.33
SOx			0.6	8,760	1,050	21.0	0.020	0.053	0.11

Note:

Steam boilers are provided as backup to produce steam in case the gas turbines are out of service.

The boilers operate in duty/duty configuration to each supply 50 percent of the steam demand. An ultra-low NOx burner was selected to met the low emission requirement of 20 ppmv NOx for digester gas.

Primary fuel is biogas (routine operations). Secondary fuel is natural gas (startup and emergency). Maximum fuel input (LHV) per unit is 21 MMBtu/hr based on current design documents.

Sources of Emission Factors for Digester Gas:

BACT for CO, 100 ppm

BACT for NOx, 20 ppm

POC, PM10 from AP-42, Table 1.4-2 (Natural Gas)

SOx based on sulfur content of treated Digester Gas (<50ppm as H2S)

Sources of Emission Factors for Natural Gas:

BACT for CO, 50 ppm

Reg 9 Rule 7 for NOx, 15 ppm (9-7-307)

POC, SO2, PM10 from AP-42, Table 1.4-2

AP-42

PM(total) = PM(filterable) + PM(condensable)

Equations:

Emission Factor (lb/MMBtu) = see Tables D-4 and D-5

Gas Use (MMscf/hr) = Gas use (MMBtu/hr) / BTU/scf

Emission (ton/yr) = Emission Factor (lb/hr) x Run time (hr/yr) x ton/2000lb

Emission (ton/yr) = Emission Factor (lb/MMscf) x Gas Use (MMscf/hr) x Run time (hr/yr) x ton/2000lb

Heat Content (647 btu/scf) from CER dated December 2015

Table C-7. Emissions of Criteria Air Pollutants from Truck Hauling (Diesel)

Criteria Air Pollutant	Emission Factor (g/mile)	Trucks/yr	Roundtrip Miles per truck	Roundtrip Miles per year	Emissions (ton/year)
Biosolids					
NOx	1.10E+00	3,700	100	370,000	0.45
NHMC	6.65E-02	3,700	100	370,000	0.027
CO	3.93E-01	3,700	100	370,000	0.16
PM10	4.39E-03	3,700	100	370,000	0.0018
PM2.5	4.20E-03	3,700	100	370,000	0.0017
SOx	1.40E-02	3,700	100	370,000	0.0057
Screening					
NOx	1.10E+00	100	100	10,000	0.012
NHMC	6.65E-02	100	100	10,000	0.00073
CO	3.93E-01	100	100	10,000	0.0043
PM10	4.39E-03	100	100	10,000	0.000048
PM2.5	4.20E-03	100	100	10,000	0.000046
SOx	1.40E-02	100	100	10,000	0.00015
Polymer					
NOx	1.39E+00	34	800	27,200	0.042
NHMC	7.97E-02	34	800	27,200	0.0024
CO	4.70E-01	34	800	27,200	0.014
PM10	5.59E-03	34	800	27,200	0.00017
PM2.5	5.35E-03	34	800	27,200	0.00016
SOx	1.37E-02	34	800	27,200	0.00041
Ferric					
NOx	1.39E+00	200	100	20,000	0.03
NHMC	7.97E-02	200	100	20,000	0.002
CO	4.70E-01	200	100	20,000	0.010
PM10	5.59E-03	200	100	20,000	0.0001
PM2.5	5.35E-03	200	100	20,000	0.0001
SOx	1.37E-02	200	100	20,000	0.0003

Sources of Emission Factors:

CARB EMFAC2014 (v1.0.7), BAAQMD, year 2045, annual

T7 Single for biosolids and screenings

T7 Tractor for polymer and ferric

Equations:

Emissions (ton/year) = Emission Factor (g/mile) x Roundtrip Miles per Year x 0.00000110231 ton/g

Trucks per year based on: CER Operational Truck Trip Estimate (2045AA)

Roundtrip Miles per Truck based on: Professional Judgement and "Comparison of Biosolids Processing Alternatives using Greenhouse Gas Emission Estimates" technical memorandum. June 2014

Average MPG:

Huai et al., 2006. Analysis of heavy-duty diesel truck activity and emissions data. Atmospheric Envrionemtn 40 (2006) 2333-2340

Table 4: Average fuel economy (mpg) for Detroit Diesel (6.4 mpg, CAT (6.0 mpg, and Cummins Trucks (7.2 mpg)

Table C-8. Emissions of Criteria Air Pollutants from Employee Vehicles (Gasoline)					
Criteria Air Pollutant	**Emission Factor (g/mile)**	**cars/day**	**Roundtrip Miles per Car**	**Roundtrip Miles per year**	**Emissions (ton/year)**
NOx	2.10E-02	35	50	437,500	0.010
NMHC	3.45E-03	35	50	437,500	0.0017
CO	2.70E-01	35	50	437,500	0.13
PM10	6.78E-04	35	50	437,500	0.00033
PM2.5	6.24E-04	35	50	437,500	0.00030
SOx	1.89E-03	35	50	437,500	0.00091

Sources of Emission Factors:

Consistent with standard practice for air quality emissions as specified in BAAQMD Regulation 9, calculations are done at 15% O2

CARB EMFAC2014 (v1.0.7), BAAQMD, year 2045, annual

LDA (passenger cars)

Equations:

Roundtrip Miles per Year = cars/day x Roundtrip Miles per Car x 250 days/yr

Emissions (ton/year) = Emission Factor (g/mile) x Roundtrip Miles per Year x 0.00000110231 ton/g

Cars per Day and Roundtrip Miles per Car based on: Professional Judgement

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Attachment D: Conversion Factors
Tables D-1 through D-6

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Table D-1. Convert ppm to lb/hr for Turbine Fired on Digester Gas			
Parameter	**NOx**	**SO2 sulfur as H2S**	**CO**
Cgas (ppm)	25	50	50
MW (NO2)	46.0055		
MW (H2S)		34.0809	
MW (SO2)		64.066	
MW (CO)			28.01
dscfm	28,804	1,571	28,804
Constant	1.557E-07	1.557E-07	1.557E-07
lb/hr	5.16		6.28
lb/hr (H2S)		0.42	
lb/hr (SO2)		0.78	

Pound per hour (lb/hr) calculation based on EPA Method 2 flowrate

lb/hr = Cgas x MW x dscfm x constant

dscfm for SO2 = 61 MMBtu/hr x hr/60min x scf/647btu x 1E+6 btu/MMBtu (heat input)

dscfm for NOx and CO = 28,803.54 (exhaust) from manufacturer for the combined turbine/duct burner (digester gas as fu

Where:

lb/hr = emissions expressed as pounds per hour

Cgas = effluent gas concentration, dry basis, ppm

MW = molecular weight

dscfm = gas flowrate, dry standard cubic feet per minute

constant = 1.557E-7, derived below

Constant:

$$1.557\mathrm{E}-7 = \frac{1\ \text{mole}}{24.06\ \text{L}} \times \frac{1\ \text{lb}}{453.6\ \text{g}} \times \frac{0.02832\ \text{m}^3}{\text{ft}^3} \times \frac{60\ \text{min}}{\text{hr}} \times \frac{1\ \text{L}}{1{,}000\ \text{ml}}$$

Heat Content (647 btu/scf) from CER dated December 2015

Heat Input (61.0 MMBtu/hr) = 41.67 MMBtu/hr (turbine) + 19.3 MMBtu/hr (duct burner) adjusted for design conditions

Turbine heat input from vendor specifications (8,865 Btu/kW-hr x 4,600 kWe = 40.8 MMBtu/hr)

https://mysolar.cat.com/en_US/products/power-generation/gas-turbine-packages/mercury-50.html

Heat input: 41.67 MMBtu/hr at design conditions (59 deg F and 60 percent RH) for digester gas and 40.12 MMBtu/hr for natural gas at 100 percent load.

Maximum duct burner fuel input (LHV) is 19.3 MMBtu/hr from CER dated December 2015

Table D-2. Convert ppm to lb/hr for Microturbines Fired on Digester Gas	
Parameter	SO2 sulfur as H2S
Cgas (ppm)	50
MW (NO2)	
MW (H2S)	34.0809
MW (SO2)	64.066
MW (CO)	
dscfm	54.1
Constant	1.557E-07
lb/hr	
lb/hr (H2S)	0.014
lb/hr (SO2)	0.027

NOx and CO emission factor information from manufacturer specifications

Pound per hour (lb/hr) calculation based on EPA Method 2 flowrate

lb/hr = Cgas x MW x dscfm x constant

dscfm = 2.1 MMBtu/hr x hr/60min x scf/647btu x 1E+6 btu/MMBtu

Where:

lb/hr = emissions expressed as pounds per hour

Cgas = effluent gas concentration, dry basis, ppm

MW = molecular weight

dscfm = gas flowrate, dry standard cubic feet per minute

constant = 1.557E-7, derived below

Constant:

$$1.557\text{E} - 7 = \frac{1 \text{ mole}}{24.06 \text{ L}} \times \frac{1 \text{ lb}}{453.6 \text{ g}} \times \frac{0.02832 \text{ m}^3}{\text{ft}^3} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{1 \text{ L}}{1{,}000 \text{ ml}}$$

Heat Content (647 btu/scf) from CER dated December 2015

Heat Input (2.3 MMbtu/hr) from manufacturer specifications adjusted to 2.1 MMBtu,

Fuel consumption per unit at 100% load (LHV) at 59 deg F air temperature and 60 per

Table D-3. Convert ppm to lb/hr for the Waste Gas Burners	
Parameter	**Enclosed**
Cgas (ppm)	50
MW (H2S)	34.0809
MW (SO2)	64.066
dscfm	1,125
Constant	1.557E-07
lb/hr sulfur	0.30
lb/hr sulfur dioxide	0.56

Pound per hour (lb/hr) calculation based on EPA Method 2 flowrate

lb/hr = Cgas x MW x dscfm x constant

Where:

lb/hr = emissions expressed as pounds per hour

Cgas = effluent gas concentration, dry basis, ppm

MW = molecular weight

dscfm = gas flowrate, dry standard cubic feet per minute

constant = 1.557E-7, derived below

Constant:

$$1.557\text{E}-7 = \frac{1\text{ mole}}{24.06\text{ L}} \times \frac{1\text{ lb}}{453.6\text{ g}} \times \frac{0.02832\text{ m}^3}{\text{ft}^3} \times \frac{60\text{ min}}{\text{hr}} \times \frac{1\text{ L}}{1{,}000\text{ ml}}$$

Table D-4. Convert ppm to lb/hr for the Backup Steam Boilers Fired on Digester Gas			
Parameter	**NOx**	**SO2 sulfur as H2S**	**CO**
Cgas (ppm)	20	50	100
MW (NO2)	46.0055		
MW (H2S)		34.0809	
MW (SO2)		64.066	
MW (CO)			28.01
dscfm	4,610	541	4,610
Constant	1.557E-07	1.557E-07	1.557E-07
lb/hr	0.66		2.01
lb/hr (H2S)		0.14	
lb/hr (SO2)		0.27	

Pound per hour (lb/hr) calculation based on EPA Method 2 flowrate

lb/hr = Cgas x MW x dscfm x constant

dscfm for SO2 = 21 MMBtu/hr x hr/60min x scf/647btu x 1E+6 btu/MMBtu (heat input)

dscfm for NOx and CO = 4610 (exhaust) from manufacturer (not on a dry basis, conservative)

Where:

lb/hr = emissions expressed as pounds per hour

Cgas = effluent gas concentration, dry basis, ppm

ppmv from BAAQMD BACT

Fd for natural gas assumed for digester gas

MW = molecular weight

dscfm = gas flowrate, dry standard cubic feet per minute

constant = 1.557E-7, derived below

Constant:

$$1.557\text{E}-7 = \frac{1\ \text{mole}}{24.06\ \text{L}} \times \frac{1\ \text{lb}}{453.6\ \text{g}} \times \frac{0.02832\ \text{m}^3}{\text{ft}^3} \times \frac{60\ \text{min}}{\text{hr}} \times \frac{1\ \text{L}}{1{,}000\ \text{ml}}$$

Heat Content (647 btu/scf) from CER dated December 2015

Table D-5. Convert ppm to lb/hr for the Backup Steam Boilers Fired on Natural Gas		
Parameter	**NOx**	**CO**
Cgas (ppm)	15	50
MW (NO2)	46.0055	
MW (CO)		28.01
dscfm	4,610	4,610
Constant	1.557E-07	1.557E-07
lb/hr	0.50	1.01

Pound per hour (lb/hr) calculation based on EPA Method 2 flowrate

lb/hr = Cgas x MW x dscfm x constant

dscfm for NOx and CO = 4610 (exhaust) from manufacturer (not on a dry basis)

Where:

lb/hr = emissions expressed as pounds per hour

Cgas = effluent gas concentration, dry basis, ppm

NOx ppmv from BAAQMD Reg 9, Rule 7

CO ppmv from BAAQMD BACT

MW = molecular weight

dscfm = gas flowrate, dry standard cubic feet per minute

constant = 1.557E-7, derived below

Constant:

$$1.557\text{E}-7 = \frac{1\ \text{mole}}{24.06\ \text{L}} \times \frac{1\ \text{lb}}{453.6\ \text{g}} \times \frac{0.02832\ \text{m}^3}{\text{ft}^3} \times \frac{60\ \text{min}}{\text{hr}} \times \frac{1\ \text{L}}{1{,}000\ \text{ml}}$$

Table D-6. Convert ppm to lb/hr for the Odor Control Units

Parameter	Odor Control Unit 1 Bypass Stack	Odor Control Unit 2 Bypass Stack
Cgas (ppm)	0.1	0.1
MW (H2S)	34.0809	34.0809
dscfm	45,300	54,100
Constant	1.557E-07	1.557E-07
lb/hr H2S	0.0240	0.029

Removal efficiencies depend on inlet concentrations. At 10 ppm H2S, assume 99 percent removal through biofilter.

Polishing stage may be bypassed. Assume biofilter bypass concentrations (0.1 ppm H2S).

Note that dispersion from stack to fenceline can easily be 100:1 resulting in less than 1 ppbV H2S at fenceline or 2 D/T which meets 5 D/T maximum goal.

Pound per hour (lb/hr) calculation based on EPA Method 2 flowrate

lb/hr = Cgas x MW x dscfm x constant

Cgas

Odor Contol Unit 1 = 10 ppm x 99% control efficiency = 0.1

Odor Contol Unit 2 = 10 ppm x 99% control efficiency = 0.1

Where:

lb/hr = emissions expressed as pounds per hour

Cgas = effluent gas concentration, dry basis, ppm

MW = molecular weight

dscfm = gas flowrate, dry standard cubic feet per minute

constant = 1.557E-7, derived below

Constant:

$$1.557\text{E}-7 = \frac{1\ \text{mole}}{24.06\ \text{L}} \times \frac{1\ \text{lb}}{453.6\ \text{g}} \times \frac{0.02832\ \text{m}^3}{\text{ft}^3} \times \frac{60\ \text{min}}{\text{hr}} \times \frac{1\ \text{L}}{1{,}000\ \text{ml}}$$

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

Consultant
Transmittal

Brown AND Caldwell with ch2m BLACK & VEATCH and associated firms

CS-235 Planning and Engineering Services
SEP Biosolids Digester Facilities Project

Date:	2/7/17
Transmittal No.:	
Subject:	Solar Turbine Warranty Letter for PM2.5
To:	Carolyn Chiu, SFPUC
From:	Tracy Stigers, BDFP Team

cc: See page 2 for distribution

Transmittal Items			
No.	**Item**	**Action Requested**	**Due Date**
1	Solar Turbine Warranty Letter for PM2.5	For your information	NA
2			
3			
4			
5			

Remarks

Attached is the project specific warranty letter from Solar Turbines, dated February 6, 2017.

Some history: The original particulate matter emissions factor communicated to Black & Veatch by Solar of 0.03 lb/MMBtu represents Solar's generic landfill/digester gas emissions factor across their turbine product line. The 0.02 lb/MMBtu emission factor provided more recently in Product Information Letter (PIL) 205 is Solar's standard emission factor for the Mercury 50 on landfill/digester gas applications.

Recent communications between Solar and Black & Veatch were useful in highlighting the specific project characteristics for BDFP such as proposed treatment prior to the turbine to identify the site fuel characteristics more completely. Solar's Product Policy Board then evaluated this information and recent data from other facilities and has written a project specific warranty that is based on these factors. The project specific warranty letter from Solar Turbines, dated February 6, 2017, is attached and commits Solar to a PM2.5 warranty of 0.016 lb/MMBtu(HHV) for the Mercury 50 combustion turbine for the BDFP project.

The February 6, 2017 letter also defines the requirements for source testing to be completed by an experienced source testing firm and laboratory and in accordance with the EPA methods described in the letter.

Black & Veatch endorses the use of the warranty value of 0.016 lb/MMBtu for BDFP air emissions modeling and Black & Veatch is confident that Solar Turbine has completed the formal internal review process to vet this number and is comfortable with reliance on this value for design purposes.

Distribution			
Name	**Organization**	**Via email with SP link**	**Hard Copy**
Rosanna Tse	SFPUC	☑	☐
Karen Frye	SFPUC	☑	☐
Sue Chau	SFPUC	☑	☐
		☐	☐
		☐	☐

Solar Turbines
A Caterpillar Company

Solar Turbines Incorporated

9330 Sky Park Court
San Diego, CA 92123
Tel: (858) 694-1616

Submitted Electronically

February 6, 2017

Steven Scott
Black & Veatch
ScottSC@BV.com

RE: PM10/2.5 Emissions Warranty for the Digester Gas Fired *Mercury*™ 50

Dear Mr. Scott:

Solar Turbines Incorporated (Solar) will offer a $PM_{10/2.5}$ warranty of 0.016 lb/MMBtu (HHV) on the *Mercury* 50 combustion turbines planned for the San Francisco Public Utility Commission (SFPUC) project.

Particulate matter, specifically $PM_{10/2.5}$ can be very difficult to measure from a gas fuel fired turbine. Nearly all particulate matter from gas turbine exhaust is less than one micrometer (micron) in diameter. Thus the emission rates of TSP, PM_{10}, and $PM_{2.5}$ from gas turbines are theoretically equivalent although source testing will show variation due to test method detection levels and processes.

To achieve good test results, Solar's recommends that EPA Methods 201/201A be used to measure the "front half". EPA Method 202 (with nitrogen purge and field blanks) should be used to measure the "back half". EPA Method 5, which measures the front and back halves may be substituted (e.g. where exhaust temperatures do not allow the use of Method 202). The turbine should have a minimum of 300 operating hours prior to conducting particulate matter source testing. The turbine should be running for 3-4 hours prior to conducting a particulate matter source test so that the turbine and auxiliary equipment is in a sustained "typical" operating mode prior to gathering samples. Testing should include three 4-hour test runs.

Please feel free to contact me at 858.694.6609 if you have any questions or need any additional information.

Sincerely,

Leslie Witherspoon
Solar Turbines Incorporated
Manager Environmental Programs
witherspoon_leslie_h@solarturbines.com

cc: Lisa Conley, Solar

Duct burner emission factor reference

From: Robert Clark [mailto:RClark@cleaverbrooks.com]
Sent: Wednesday, January 25, 2017 10:06 AM
To: Overhaug, Lori
Cc: ProjectWise-Water-Americas
Subject: RE: SFPUC HRSG Emergency Cases CS-235

Good morning Lori,

I got a response from the burner guys. Their response to the questions are below.

We used the following, based on HHV and at 100% MCR

NOx lb/MMBtu 0.08
CO lb/MMBtu 0.1
PM lb/MMBtu 0.01, Estimate particle size to be < 10ɥm, excludes particles emitted from the CGT and notwithstanding the quality of the BG fuel (i.e. it could come in very dirty and full of particles)

Let me know if you have any other questions!

Best regards,

Robert (BJ) Clark
Sales Engineer
Engineered Boiler Systems

APPENDIX E
ADDITIONAL TABLES

Table E-1
Modeling Parameters for Construction Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Source Type[1]	Source ID	Description	Source Area	Release Height[1]	Initial Vertical Dimension[1]
				m^2	m	m
Construction Equipment	Area	S01	Asphalt Plant	7,573	5.0	1.4
		S02	Central Shops	22,106	5.0	1.4
		S03	North of Central Shops	5,518	5.0	1.4
		S04	East of Central Shops	6,943	5.0	1.4
		S06	Potential Staging Area - 1550 Evans	19,379	5.0	1.4
		1550_A	Demolition of 330 Warehouse	3,610	5.0	1.4
		1550_B	Demolition of 1550 Office	3,645	5.0	1.4

Source	Source Type[2]	Source Group	Release Height[3]	Initial Lateral Dimension[4]	Initial Vertical Dimension[3]
			m	m	m
Onroad Vehicles	Volume	See Figure 2	2.5	Varies[4]	2.32

Notes:

1. Onsite construction equipment was modeled as area sources with initial vertical dimensions of 1.4 meters, consistent with the San Francisco Community Risk Reduction Plan (CRRP-HRA) (BAAQMD 2012). Release height was not specified in the CRRP-HRA, so the default value from South Coast Air Quality Management District (SCAQMD) Local Significance Threshold Methodology was used (SCAQMD 2008).
2. Onroad vehicles, including haul trucks, worker vehicles, and shuttle busses, were modeled as a series of adjacent volume sources, consistent with the CRRP-HRA.
3. Volume source parameters were taken from the CRRP-HRA modeling files (BAAQMD 2012).
4. Initial lateral dimension is determined by road width. For a complete list of source locations and parameters, see Appendix F - AERMOD modeling files.

Abbreviations:

AERMOD - United States Environmental Protection Agency Regulatory Air dispersion Model
BAAQMD - Bay Area Air Quality Management District
CRRP - Community Risk Reduction Plan
HRA - health risk assessment
m - meter
m^2 - square meter
SCAQMD - South Coast Air Quality Management District
SFPUC - San Francisco Public Utilities Commission

References:

BAAQMD. 2012. The San Francisco Community Risk Reduction Plan: Technical Support Documentation. December. Available at: http://www.gsweventcenter.com/Draft_SEIR_References%5C2012_12_BAAQMD_SF_CRRP_Methods_and_Findings_v9.pdf

SCAQMD. 2008. Final Localized Significance Threshold Methodology. July. Available at: http://www.aqmd.gov/docs/default-source/ceqa/handbook/localized-significance-thresholds/final-lst-methodology-document.pdf?sfvrsn=2.

RAMBOLL ENVIRON

Table E-2
Modeling Parameters for Existing Operational Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source[1]	**Source No.**	**Source Type**	**Stack Height Above Grade**	**Stack Temperature**	**Stack Velocity**	**Stack Diameter (nominal)**
			m	K	m/s	m
Industrial Boilers[2]	S8201	Point	9.85	367.0	11.31	0.29
	S8202	Point	9.85	367.0	11.31	0.29
Waste Gas Burners[3]	A7003	Point	19.81	1,088.7	0.28	1.83
	A7004	Point	19.81	1,088.7	0.28	1.83
Cogeneration Engine[4]	S10	Point	7.32	367.0	15.47	0.51

Notes:

1. Sources listed represent sources that would be removed for the Project, as provided by SFPUC.
2. The modeling parameters for the existing industrial boilers are from the CRRP-HRA Modeling Files, as provided by BAAQMD.
3. For the existing waste gas burners, the modeling parameters used were provided by ESA for the Project waste gas burners.
4. For the existing cogeneration engine, the modeling parameters for the existing stationary engine modeled in the CRRP-HRA were used.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District
CRRP - Community Risk Reduction Plan
HRA - health risk assessment
K - Kelvin
m - meter
m/s - meters per second
SFPUC - San Francisco Public Utilities Commission

References:

ESA. 2015. RFI 7-6. AERMOD Stationary Source Modeling Parameters. August 17.
SFPUC. 2015. Organized RFI List Revised 7.2.2015. July 2.

Table E-3
Modeling Parameters for Project Operational Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source[1]	Source Type	Number of Sources	Stack Height Above Grade	Stack Temperature	Stack Velocity	Stack Diameter (nominal)
			m	K	m/s	m
Turbine	Point	1	22.86	445.9	17.78	1.22
Microturbines[2]	Point	3	15.85	552.6	24.89	0.36
Boilers	Point	2	18.29	533.7	13.72	0.61
Emergency Engine	Point	1	18.29	677.0	91.44	0.41
Waste Gas Burners	Point	2	12.19	1,144.3	7.11	2.44
Solids Odor Control	Point	4	11.58	Ambient	10.67	2.01

Notes:

1. The BDFP Consultant Design Team provided the source list, number of sources, source locations, stack height, stack temperature, stack velocity, and stack diameter to be used for air dispersion modeling in AERMOD.
2. A single stack was used to model the microturbines based on the data provided.

Abbreviations:

AERMOD - United States Environmental Protection Agency Regulatory Air dispersion Model
BDFP - Biosolids Digester Facilities Project
K - Kelvin
m - meter
m/s - meters per second
SFPUC - San Francisco Public Utilities Commission

References:

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell with CH2M and Black & Veatch. 2015. Conceptual Engineering Report (Draft Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. December.

ESA. 2015. RFI 7-6. AERMOD Stationary Source Modeling Parameters. August 17.

ESA. 2015. RFI 7-6. Stationary Emissions Sources Layout. August 17.

Table E-4
Modeling Parameters for Cumulative Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Source	Source Type[1]	Source Group	Source Area	Release Height[1]	Initial Vertical Dimension[1]
			m^2	m	m
Construction Equipment	Area	AreaA	16,961	5.0	1.4
		AreaB	64,207	5.0	1.4
		AreaC	23,196	5.0	1.4
		OFF001	10,875	5.0	1.4
		OFF002	37,981	5.0	1.4
		OFF003	7,717	5.0	1.4
		OFF004	12,718	5.0	1.4
		OFF006	4,623	5.0	1.4
		OFF009	3,663	5.0	1.4
		OFF010	5,345	5.0	1.4
		OFF011	101,813	5.0	1.4
		OFF012	11,630	5.0	1.4
		OFF020	19,274	5.0	1.4

Source	Source Type[2]	Source Group	Release Height[3]	Initial Lateral Dimension[4]	Initial Vertical Dimension[3]
			m	m	m
Onroad Vehicles (Headworks only)	Volume	AreaA	2.5	Varies[4]	2.32

Notes:

1. Onsite construction equipment was modeled as area sources with initial vertical dimensions of 1.4 meters, consistent with the San Francisco Community Risk Reduction Plan (CRRP-HRA) (BAAQMD 2012). Release height was not specified in the CRRP-HRA, so the default value from South Coast Air Quality Management District (SCAQMD) Local Significance Threshold Methodology was used (SCAQMD 2008).
2. Onroad vehicles, including haul trucks, worker vehicles, and shuttle busses, were modeled as a series of adjacent volume sources, consistent with the CRRP-HRA (BAAQMD 2012).
3. Volume source parameters were taken from the CRRP-HRA modeling files (BAAQMD 2012).
4. Initial lateral dimension is determined by road width. For a complete list of source locations and parameters, see Appendix F - AERMOD Modeling Files.

Abbreviations:

AERMOD - United States Environmental Protection Agency Regulatory Air dispersion Model
BAAQMD - Bay Area Air Quality Management District
CRRP - Community Risk Reduction Plan
HRA - health risk assessment
m - meter
m^2 - square meter
SCAQMD - South Coast Air Quality Management District
SFPUC - San Francisco Public Utilities Commission

References:

Bay Area Air Quality Management District (BAAQMD). 2012. The San Francisco Community Risk Reduction Plan: Technical Support Documentation. December. Available at: http://www.gsweventcenter.com/Draft_SEIR_References%5C2012_12_BAAQMD_SF_CRRP_Methods_and_Findings_v9.pdf

South Coast Air Quality Management District (SCAQMD). 2008. Final Localized Significance Threshold Methodology. July. Available at: http://www.aqmd.gov/docs/default-source/ceqa/handbook/localized-significance-thresholds/final-lst-methodology-document.pdf?sfvrsn=2. Accessed October 13, 2016.

Table E-5a
Modeled Offroad Construction Emission Rates (Uncontrolled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Fuel	Days of Construction Per Year	Total Emissions[2]			Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			PM_{10} Emissions	$PM_{2.5}$ Emissions	TOG Emissions	TOG Emissions	PM_{10} Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			lbs	lbs	lbs	g/s	g/s	g/s	g/s
Year 1	**Diesel**	260	212	212	191	0.004	0.0031	0.0031	--
Year 2		260	199	199	179	0.004	0.0029	0.0029	--
Year 3		260	180	180	161	0.003	0.0026	0.0026	--
Year 4		260	136	136	122	0.002	0.0020	0.0020	--
Year 5		260	97	97	86	0.0017	0.00140	0.00140	--
Demolition		20	2.8	2.8	5.2	0.0014	0.000040	0.000040	--
Paving		49	3.5	3.5	3.1	0.00033	0.000051	0.000051	--
Year 1	**Gasoline**	260	39	39	841	0.017	0.00056	0.00056	0.012
Year 2		260	55	55	1191	0.024	0.00079	0.00079	0.017
Year 3		260	51	51	1099	0.022	0.00073	0.00073	0.016
Year 4		260	44	44	948	0.019	0.00063	0.00063	0.014
Year 5		260	22	22	477	0.010	0.00032	0.00032	0.007

Notes:

1. "Uncontrolled" emissions shown here represent emissions using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance.
2. Total DPM and $PM_{2.5}$ emissions are the total Project off-road emissions shown in Table 4a.
3. Acute HRA emissions are calculated assuming each piece of equipment in each phase will operate at the same time during the maximum hour.
4. Chonic HRA emission rates were averaged over 365 days per year, 24 hours per day. Operating hours of 7AM - 3PM and 7AM - 8PM were accounted for in the AERMOD model (see Appendix F).

Abbreviation:

AERMOD - United States Environmental Protection Agency Regulatory Air dispersion Model
DPM - diesel particulate matter
DPF - diesel particulate filter
g/s - grams per second
HRA - health risk assessment
lbs - pounds
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

Table E-5b
Modeled Offroad Construction Emission Rates (Controlled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Fuel	Days of Construction Per Year	Total Emissions[2]			Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			PM_{10} Emissions	$PM_{2.5}$ Emissions	TOG Emissions	TOG Emissions	PM_{10} Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			lbs	lbs	lbs	g/s	g/s	g/s	g/s
Year 1	**Diesel**	260	104	104	856	0.017	0.0015	0.0015	--
Year 2		260	99	99	778	0.016	0.0014	0.0014	--
Year 3		260	89	89	707	0.014	0.0013	0.0013	--
Year 4		260	69	69	515	0.010	0.0010	0.0010	--
Year 5		260	51	51	347	0.0070	0.00074	0.00074	--
Demolition		20	1.3	1.3	8.6	0.0023	0.000018	0.000018	--
Paving		49	2.3	2.3	5.7	0.00062	0.000034	0.000034	--
Year 1	**Gasoline**	260	39	39	841	0.017	0.00056	0.00056	0.012
Year 2		260	55	55	1191	0.024	0.00079	0.00079	0.017
Year 3		260	51	51	1099	0.022	0.00073	0.00073	0.016
Year 4		260	44	44	948	0.019	0.00063	0.00063	0.014
Year 5		260	22	22	477	0.010	0.00032	0.00032	0.007

Notes:

1. "Controlled" emissions shown here represent emissions using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.
2. Total DPM and $PM_{2.5}$ emissions are the total Project off-road emissions shown in Table 4c.
3. Acute HRA emissions are calculated assuming each piece of equipment in each phase will operate at the same time during the maximum hour.
4. Chonic HRA emission rates were averaged over 365 days per year, 24 hours per day. Operating hours of 7AM - 3PM and 7AM - 8PM were accounted for in the AERMOD model (see Appendix F).

Abbreviation:

AERMOD - United States Environmental Protection Agency Regulatory Air dispersion Model
DPM - diesel particulate matter
DPF - diesel particulate filter
g/s - grams per second
HRA - health risk assessment
lbs - pounds
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

Table E-6a
Modeled Onroad Construction Emission Rates (Uncontrolled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 1	SURF13	Diesel	2.23E-03	1.24E-06	1.76E-06	--
	SURF8		1.02E-02	5.39E-06	6.85E-06	--
	SURF7		9.95E-03	4.32E-06	4.70E-06	--
	SURF12		6.74E-03	3.12E-06	3.44E-06	--
	SURF4		1.00E-02	4.64E-06	5.35E-06	--
	SURF3		8.49E-03	5.82E-06	8.31E-06	--
	SURF2		1.04E-02	6.70E-06	9.50E-06	--
	SURF1		9.97E-03	4.40E-06	4.86E-06	--
	SURF10		1.87E-03	6.37E-07	6.96E-07	--
	280SON		6.94E-03	7.50E-06	1.28E-05	--
	SURF11		1.53E-02	1.68E-05	2.83E-05	--
	SURF14		1.91E-03	8.11E-07	1.05E-06	--
	280NOFF		6.84E-03	6.99E-06	1.18E-05	--
	WSUR7		9.87E-04	6.49E-07	8.09E-07	--
	SURF9		5.26E-04	3.37E-07	3.75E-07	--
	WSUR5		1.12E-03	2.57E-06	4.07E-06	--
	WSUR4		1.99E-03	1.56E-06	2.06E-06	--
	WSUR3		2.11E-03	1.56E-06	2.06E-06	--
	PHELPST		--	4.09E-06	5.71E-06	--
	WSUR3	Gas	2.12E-02	--	5.06E-06	1.00E-04
	WSUR2		2.11E-02	--	1.82E-05	8.58E-04
	WSUR1		2.59E-02	--	4.68E-06	5.25E-04
	WSUR10		2.58E-02	--	4.50E-06	5.24E-04
	W28SON		1.54E-02	--	1.56E-05	3.13E-04
	W28SOF		1.29E-02	--	2.34E-06	2.62E-04
	W28NON		--	--	--	--
	W28NOF		8.43E-03	--	7.92E-06	1.71E-04
	PHELPSW		--	--	3.71E-05	1.70E-03
Year 2	SURF13	Diesel	2.46E-04	3.47E-07	5.07E-07	--
	SURF8		4.28E-03	5.57E-06	7.24E-06	--
	SURF7		4.17E-03	4.46E-06	4.91E-06	--
	SURF12		3.26E-04	2.49E-07	2.78E-07	--
	SURF4		4.20E-03	4.79E-06	5.61E-06	--
	SURF3		4.41E-03	7.05E-06	1.04E-05	--
	SURF2		4.40E-03	6.93E-06	1.01E-05	--
	SURF1		4.18E-03	4.54E-06	5.09E-06	--
	SURF10		--	--	--	--
	280SON		2.51E-03	6.77E-06	1.20E-05	--
	SURF11		4.93E-04	7.50E-07	1.31E-06	--

Table E-6a
Modeled Onroad Construction Emission Rates (Uncontrolled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 2 (cont'd)	SURF14	Diesel	--	--	--	--
	280NOFF		2.46E-03	6.30E-06	1.10E-05	--
	WSUR7		1.22E-03	8.07E-07	1.04E-06	--
	SURF9		4.67E-04	4.59E-07	5.17E-07	--
	WSUR5		1.37E-03	3.07E-06	5.24E-06	--
	WSUR4		2.47E-03	1.92E-06	2.65E-06	--
	WSUR3		2.60E-03	4.00E-06	6.50E-06	--
	PHELPST		--	4.49E-06	6.46E-06	--
	WSUR3	Gas	2.71E-02	--	3.16E-05	1.30E-03
	WSUR2		2.70E-02	--	3.06E-05	1.30E-03
	WSUR1		3.30E-02	--	7.83E-06	7.95E-04
	WSUR10		3.30E-02	--	7.51E-06	7.94E-04
	W28SON		1.98E-02	--	2.63E-05	4.76E-04
	W28SOF		1.65E-02	--	3.90E-06	3.97E-04
	W28NON		--	--	--	--
	W28NOF		1.08E-02	--	1.33E-05	2.60E-04
	PHELPSW		--	--	4.44E-05	1.83E-03
Year 3	SURF13	Diesel	2.68E-04	4.32E-07	6.95E-07	--
	SURF8		3.57E-03	3.83E-06	5.35E-06	--
	SURF7		3.46E-03	3.13E-06	3.57E-06	--
	SURF12		1.70E-03	1.39E-06	1.61E-06	--
	SURF4		3.49E-03	3.34E-06	4.10E-06	--
	SURF3		3.71E-03	4.76E-06	7.74E-06	--
	SURF2		3.70E-03	4.68E-06	7.54E-06	--
	SURF1		3.47E-03	3.19E-06	3.70E-06	--
	SURF10		--	--	--	--
	280SON		2.17E-03	4.41E-06	9.09E-06	--
	SURF11		3.85E-03	6.43E-06	1.30E-05	--
	SURF14		--	--	--	--
	280NOFF		2.13E-03	4.12E-06	8.34E-06	--
	WSUR7		1.43E-03	7.82E-07	1.12E-06	--
	SURF9		5.03E-04	5.91E-07	6.93E-07	--
	WSUR5		1.55E-03	2.72E-06	5.76E-06	--
	WSUR4		2.88E-03	1.83E-06	2.87E-06	--
	WSUR3		2.99E-03	3.60E-06	7.13E-06	--
	PHELPST		--	3.46E-06	5.48E-06	--
	WSUR3	Gas	2.97E-02	--	4.17E-05	1.57E-03
	WSUR2		2.97E-02	--	4.05E-05	1.56E-03
	WSUR1		3.62E-02	--	1.03E-05	9.54E-04
	WSUR10		3.62E-02	--	9.89E-06	9.53E-04
	W28SON		2.17E-02	--	3.48E-05	5.72E-04
	W28SOF		1.81E-02	--	5.14E-06	4.77E-04
	W28NON		--	--	--	--
	W28NOF		1.19E-02	--	1.76E-05	3.12E-04
	PHELPSW		--	--	4.42E-05	1.66E-03

Table E-6a
Modeled Onroad Construction Emission Rates (Uncontrolled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 4	SURF13	Diesel	3.02E-04	4.82E-07	8.07E-07	--
	SURF8		2.20E-03	1.16E-06	1.67E-06	--
	SURF7		2.12E-03	9.56E-07	1.10E-06	--
	SURF12		1.19E-03	6.11E-07	7.19E-07	--
	SURF4		2.15E-03	1.02E-06	1.28E-06	--
	SURF3		2.30E-03	1.44E-06	2.44E-06	--
	SURF2		2.29E-03	1.42E-06	2.38E-06	--
	SURF1		2.13E-03	9.72E-07	1.15E-06	--
	SURF10		--	--	--	--
	280SON		1.37E-03	1.33E-06	2.89E-06	--
	SURF11		2.65E-03	2.29E-06	4.86E-06	--
	SURF14		--	--	--	--
	280NOFF		1.34E-03	1.24E-06	2.65E-06	--
	WSUR7		1.84E-03	4.44E-07	9.18E-07	--
	SURF9		5.61E-04	6.64E-07	7.92E-07	--
	WSUR5		1.93E-03	8.98E-07	5.08E-06	--
	WSUR4		3.69E-03	9.50E-07	2.40E-06	--
	WSUR3		3.78E-03	1.37E-06	6.22E-06	--
	PHELPST		--	3.17E-06	5.21E-06	--
	WSUR3	Gas	3.60E-02	--	5.34E-05	1.84E-03
	WSUR2		3.59E-02	--	5.18E-05	1.84E-03
	WSUR1		4.38E-02	--	1.31E-05	1.12E-03
	WSUR10		4.37E-02	--	1.26E-05	1.12E-03
	W28SON		2.63E-02	--	4.46E-05	6.75E-04
	W28SOF		2.19E-02	--	6.55E-06	5.61E-04
	W28NON		--	--	--	--
	W28NOF		1.44E-02	--	2.26E-05	3.68E-04
	PHELPSW		--	--	4.41E-05	1.52E-03
Year 5	SURF13	Diesel	3.11E-04	3.79E-07	6.54E-07	--
	SURF8		9.71E-04	8.92E-07	1.31E-06	--
	SURF7		9.34E-04	7.44E-07	8.67E-07	--
	SURF12		8.72E-04	6.24E-07	7.41E-07	--
	SURF4		9.45E-04	7.89E-07	1.00E-06	--

Table E-6a
Modeled Onroad Construction Emission Rates (Uncontrolled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 5 (cont'd)	SURF3	Diesel	1.02E-03	1.09E-06	1.90E-06	--
	SURF2		1.02E-03	1.07E-06	1.85E-06	--
	SURF1		9.37E-04	7.56E-07	9.01E-07	--
	SURF10		--	--	--	--
	280SON		6.17E-04	9.78E-07	2.25E-06	--
	SURF11		1.87E-03	2.38E-06	5.34E-06	--
	SURF14		--	--	--	--
	280NOFF		6.01E-04	9.16E-07	2.06E-06	--
	WSUR7		1.70E-03	3.43E-07	7.27E-07	--
	SURF9		5.74E-04	5.36E-07	6.46E-07	--
	WSUR5		1.79E-03	6.72E-07	4.06E-06	--
	WSUR4		3.41E-03	7.31E-07	1.91E-06	--
	WSUR3		3.49E-03	1.03E-06	4.96E-06	--
	PHELPST		--	2.96E-06	5.01E-06	--
	WSUR3	Gas	3.36E-02	--	4.51E-05	1.44E-03
	WSUR2		3.35E-02	--	4.37E-05	1.43E-03
	WSUR1		4.09E-02	--	1.11E-05	8.75E-04
	WSUR10		4.08E-02	--	1.06E-05	8.74E-04
	W28SON		2.46E-02	--	3.77E-05	5.27E-04
	W28SOF		2.04E-02	--	5.52E-06	4.37E-04
	W28NON		--	--	--	--
	W28NOF		1.34E-02	--	1.91E-05	2.87E-04
	PHELPSW		--	--	4.39E-05	1.40E-03

Notes:

1. "Uncontrolled" emissions shown here represent emissions using Tier 2 equipment with Diesel Particulate Filters (DPF), as required by the San Francisco Clean Construction Ordinance.
2. See Figure 2 for modeled roadways, and Appendix F for AERMOD model parameters.
3. Maximum hour TOG emissions are calculated assuming all vehicles associated with each road segment travel during the maximum hour.
4. Annualized TOG, DPM, and $PM_{2.5}$ emission rates were normalized over 365 days per year, 24 hours per day. The AERMOD model was adjusted to account for these emissions occuring between 7AM and 3PM (or 7AM to 8PM, depending on the year as discussed further in the report) every day.

Abbreviations:

AERMOD - United States Environmental Protection Agency Regulatory Air dispersion Model
DPF - diesel particulate filter
DPM - Diesel Particulate Matter
g/s - grams per second
HRA - health risk assessment
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

Table E-6b
Modeled Onroad Construction Emission Rates (Controlled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 1	SURF13	Diesel	1.10E-03	1.44E-06	2.01E-06	--
	SURF8		4.93E-03	7.75E-06	9.48E-06	--
	SURF7		4.73E-03	7.17E-06	7.79E-06	--
	SURF12		3.20E-03	4.51E-06	5.01E-06	--
	SURF4		4.79E-03	7.34E-06	8.30E-06	--
	SURF3		4.23E-03	7.44E-06	1.02E-05	--
	SURF2		5.18E-03	8.46E-06	1.15E-05	--
	SURF1		4.75E-03	7.21E-06	7.92E-06	--
	SURF10		8.85E-04	9.11E-07	1.01E-06	--
	280SON		3.77E-03	6.71E-06	1.23E-05	--
	SURF11		8.16E-03	1.38E-05	2.59E-05	--
	SURF14		9.26E-04	9.93E-07	1.27E-06	--
	280NOFF		3.67E-03	6.43E-06	1.15E-05	--
	WSUR7		9.87E-04	6.49E-07	8.09E-07	--
	SURF9		2.52E-04	6.29E-07	6.85E-07	--
	WSUR5		1.12E-03	2.57E-06	4.07E-06	--
	WSUR4		1.99E-03	1.56E-06	2.06E-06	--
	WSUR3		2.11E-03	1.56E-06	2.06E-06	--
	PHELPST		--	6.01E-06	7.81E-06	--
	WSUR3	Gas	2.12E-02	--	5.06E-06	1.00E-04
	WSUR2		2.11E-02	--	1.82E-05	8.58E-04
	WSUR1		2.59E-02	--	4.68E-06	5.25E-04
	WSUR10		2.58E-02	--	4.50E-06	5.24E-04
	W28SON		1.54E-02	--	1.56E-05	3.13E-04
	W28SOF		1.29E-02	--	2.34E-06	2.62E-04
	W28NON		--	--	--	--
	W28NOF		8.43E-03	--	7.92E-06	1.71E-04
	PHELPSW		--	--	3.71E-05	1.70E-03
Year 2	SURF13	Diesel	1.36E-04	5.35E-07	7.09E-07	--
	SURF8		2.32E-03	9.75E-06	1.17E-05	--
	SURF7		2.22E-03	9.01E-06	9.71E-06	--
	SURF12		1.74E-04	4.87E-07	5.30E-07	--
	SURF4		2.25E-03	9.23E-06	1.03E-05	--
	SURF3		2.45E-03	1.07E-05	1.44E-05	--
	SURF2		2.44E-03	1.07E-05	1.41E-05	--
	SURF1		2.23E-03	9.07E-06	9.86E-06	--
	SURF10		--	--	--	--
	280SON		1.51E-03	7.54E-06	1.30E-05	--
	SURF11		2.93E-04	8.28E-07	1.41E-06	--

Table E-6b

Modeled Onroad Construction Emission Rates (Controlled Scenario)[1]

SFPUC Biosolids Digester Facilities Project

San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 2 (cont'd)	SURF14	Diesel	--	--	--	--
	280NOFF		1.47E-03	7.23E-06	1.22E-05	--
	WSUR7		1.22E-03	8.07E-07	1.04E-06	--
	SURF9		2.49E-04	9.11E-07	9.95E-07	--
	WSUR5		1.37E-03	3.07E-06	5.24E-06	--
	WSUR4		2.47E-03	1.92E-06	2.65E-06	--
	WSUR3		2.60E-03	4.00E-06	6.50E-06	--
	PHELPST		--	7.04E-06	9.20E-06	--
	WSUR3	Gas	2.71E-02	--	3.16E-05	1.30E-03
	WSUR2		2.70E-02	--	3.06E-05	1.30E-03
	WSUR1		3.30E-02	--	7.83E-06	7.95E-04
	WSUR10		3.30E-02	--	7.51E-06	7.94E-04
	W28SON		1.98E-02	--	2.63E-05	4.76E-04
	W28SOF		1.65E-02	--	3.90E-06	3.97E-04
	W28NON		--	--	--	--
	W28NOF		1.08E-02	--	1.33E-05	2.60E-04
	PHELPSW		--	--	4.44E-05	1.83E-03
Year 3	SURF13	Diesel	1.72E-04	7.56E-07	1.04E-06	--
	SURF8		2.23E-03	7.15E-06	8.88E-06	--
	SURF7		2.13E-03	6.65E-06	7.28E-06	--
	SURF12		1.04E-03	2.49E-06	2.80E-06	--
	SURF4		2.16E-03	6.80E-06	7.76E-06	--
	SURF3		2.37E-03	7.82E-06	1.10E-05	--
	SURF2		2.36E-03	7.77E-06	1.08E-05	--
	SURF1		2.13E-03	6.69E-06	7.40E-06	--
	SURF10		--	--	--	--
	280SON		1.49E-03	5.38E-06	1.02E-05	--
	SURF11		2.61E-03	6.68E-06	1.35E-05	--
	SURF14		--	--	--	--
	280NOFF		1.45E-03	5.17E-06	9.52E-06	--
	WSUR7		1.43E-03	7.82E-07	1.12E-06	--
	SURF9		3.11E-04	1.30E-06	1.44E-06	--
	WSUR5		1.55E-03	2.72E-06	5.76E-06	--
	WSUR4		2.88E-03	1.83E-06	2.87E-06	--
	WSUR3		2.99E-03	3.60E-06	7.13E-06	--
	PHELPST		--	6.17E-06	8.35E-06	--
	WSUR3	Gas	2.97E-02	--	4.17E-05	1.57E-03
	WSUR2		2.97E-02	--	4.05E-05	1.56E-03
	WSUR1		3.62E-02	--	1.03E-05	9.54E-04
	WSUR10		3.62E-02	--	9.89E-06	9.53E-04
	W28SON		2.17E-02	--	3.48E-05	5.72E-04
	W28SOF		1.81E-02	--	5.14E-06	4.77E-04
	W28NON		--	--	--	--
	W28NOF		1.19E-02	--	1.76E-05	3.12E-04
	PHELPSW		--	--	4.42E-05	1.66E-03

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Table E-6b
Modeled Onroad Construction Emission Rates (Controlled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 4	SURF13	Diesel	2.09E-04	8.99E-07	1.24E-06	--
	SURF8		1.49E-03	2.33E-06	2.90E-06	--
	SURF7		1.41E-03	2.16E-06	2.37E-06	--
	SURF12		7.92E-04	1.27E-06	1.42E-06	--
	SURF4		1.44E-03	2.21E-06	2.53E-06	--
	SURF3		1.59E-03	2.55E-06	3.61E-06	--
	SURF2		1.58E-03	2.53E-06	3.55E-06	--
	SURF1		1.42E-03	2.18E-06	2.41E-06	--
	SURF10		--	--	--	--
	280SON		1.01E-03	1.76E-06	3.35E-06	--
	SURF11		1.93E-03	2.75E-06	5.40E-06	--
	SURF14		--	--	--	--
	280NOFF		9.81E-04	1.69E-06	3.13E-06	--
	WSUR7		1.84E-03	4.44E-07	9.18E-07	--
	SURF9		3.75E-04	1.55E-06	1.72E-06	--
	WSUR5		1.93E-03	8.98E-07	5.08E-06	--
	WSUR4		3.69E-03	9.50E-07	2.40E-06	--
	WSUR3		3.78E-03	1.37E-06	6.22E-06	--
	PHELPST		--	6.02E-06	8.19E-06	--
	WSUR3	Gas	3.60E-02	--	5.34E-05	1.84E-03
	WSUR2		3.59E-02	--	5.18E-05	1.84E-03
	WSUR1		4.38E-02	--	1.31E-05	1.12E-03
	WSUR10		4.37E-02	--	1.26E-05	1.12E-03
	W28SON		2.63E-02	--	4.46E-05	6.75E-04
	W28SOF		2.19E-02	--	6.55E-06	5.61E-04
	W28NON		--	--	--	--
	W28NOF		1.44E-02	--	2.26E-05	3.68E-04
	PHELPSW		--	--	4.41E-05	1.52E-03
Year 5	SURF13	Diesel	2.25E-04	7.51E-07	1.04E-06	--
	SURF8		6.90E-04	1.82E-06	2.28E-06	--
	SURF7		6.54E-04	1.69E-06	1.86E-06	--
	SURF12		6.09E-04	1.30E-06	1.46E-06	--
	SURF4		6.65E-04	1.73E-06	1.99E-06	--

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Table E-6b
Modeled Onroad Construction Emission Rates (Controlled Scenario)[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Source Group[2]	Fuel	Modeled Emission Rates for Acute HRA[3]	Modeled Emission Rates for Cancer Risk and Chronic HRA[4]		
			TOG Emissions	DPM Emissions	$PM_{2.5}$ Emissions	TOG Emissions
			g/s	g/s	g/s	g/s
Year 5 (cont'd)	SURF3	Diesel	7.38E-04	1.99E-06	2.85E-06	--
	SURF2		7.34E-04	1.97E-06	2.80E-06	--
	SURF1		6.57E-04	1.70E-06	1.89E-06	--
	SURF10		--	--	--	--
	280SON		4.74E-04	1.36E-06	2.66E-06	--
	SURF11		1.42E-03	3.02E-06	6.06E-06	--
	SURF14		--	--	--	--
	280NOFF		4.59E-04	1.31E-06	2.48E-06	--
	WSUR7		1.70E-03	3.43E-07	7.27E-07	--
	SURF9		4.04E-04	1.30E-06	1.44E-06	--
	WSUR5		1.79E-03	6.72E-07	4.06E-06	--
	WSUR4		3.41E-03	7.31E-07	1.91E-06	--
	WSUR3		3.49E-03	1.03E-06	4.96E-06	--
	PHELPST		--	5.95E-06	8.13E-06	--
	WSUR3	Gas	3.36E-02	--	4.51E-05	1.44E-03
	WSUR2		3.35E-02	--	4.37E-05	1.43E-03
	WSUR1		4.09E-02	--	1.11E-05	8.75E-04
	WSUR10		4.08E-02	--	1.06E-05	8.74E-04
	W28SON		2.46E-02	--	3.77E-05	5.27E-04
	W28SOF		2.04E-02	--	5.52E-06	4.37E-04
	W28NON		--	--	--	--
	W28NOF		1.34E-02	--	1.91E-05	2.87E-04
	PHELPSW		--	--	4.39E-05	1.40E-03

Notes:

1. "Controlled" emissions shown here represent emissions using Tier 4 Final equipment for all equipment greater than or equal to 140 horsepower. Equipment with horsepower less than 140 horsepower were assumed to be Tier 2 equipment with a Diesel Particulate Filter (DPF). "Controlled" emissions also include renewable diesel for all diesel offroad equipment and on-road haul trucks.
2. See Figure 2 for modeled roadways, and Appendix F for AERMOD model parameters.
3. Maximum hour TOG emissions are calculated assuming all vehicles associated with each road segment travel during the maximum hour.
4. Annualized TOG, DPM, and $PM_{2.5}$ emission rates were normalized over 365 days per year, 24 hours per day. The AERMOD model was adjusted to account for these emissions occuring between 7AM and 3PM (or 7AM to 8PM, depending on the year as discussed further in the report) every day.

Abbreviations:

AERMOD - United States Environmental Protection Agency Regulatory Air dispersion Model
DPF - diesel particulate filter
DPM - Diesel Particulate Matter
g/s - grams per second
HRA - health risk assessment
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

Table E-7a
Existing Operational TAC Emissons
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Source No.	Chemical	CAS Number	Throughput Data (mmscf/yr)	Emission Factor (lb/mmscf)	Emissions (lb/yr)	Modeled Emission Rates for Cancer Risk and Chronic HRA[1] (g/s)
Emergency Waste Gas Burners[2]	A7003 and A7004	Benzene	71432	113.8	0.159	18	2.60E-04
		Formaldehyde	50000		1.169	133	1.91E-03
		PAHs	1150		0.014	1.6	2.29E-05
		Naphthalene	91203		0.011	1.3	1.80E-05
		Acetaldehyde	75070		0.043	4.9	7.04E-05
		Acrolein	107028		0.01	1.1	1.64E-05
		Propylene	115071		2.44	278	3.99E-03
		Toluene	108883		0.058	6.6	9.49E-05
		Xylenes	1330207		0.029	3.3	4.75E-05
		Ethylbenzene	100414		1.444	164	2.36E-03
		Hexane	110543		0.029	3.3	4.75E-05
		$PM_{2.5}$	--		17	1,934	2.78E-02
Cogeneration Engine[3]	S10	Formaldehyde	50000	184.3	--	76	1.09E-03
		Acetaldehyde	75070		--	3	4.03E-05
		Benzene	71432		--	10	1.48E-04
		Ethylbenzene	100414		--	1	1.34E-05
		$PM_{2.5}$	--		--	1,099	1.58E-02
Hot Water Boilers[4]	8201 and 8202	Benzene	71432	128.3	0.0021	0.27	3.87E-06
		PAH's	1150		0.001037	0.1331	1.91E-06
		1,4-Dichlorobenzene	106467		0.0012	0.15	2.21E-06
		Formaldehyde	50000		0.075	9.62	1.38E-04
		Hexane	110543		1.8	231	3.32E-03
		Naphthalene	91203		0.00061	0.078	1.13E-06
		Toluene	108883		0.0034	0.44	6.27E-06
		$PM_{2.5}$	--		0.98	125.69	1.81E-03

Notes:

1. Modeled emission rates for cancer risk and chronic HI were calculated by converting the pounds per year emissions to grams per second assuming continous operation for 8760 hours per year.

2. The existing waste gas burners were not modeled for the CRRP-HRA. The toxic air contaminant (TAC) emissions for the existing waste gas burners were calculated using the emission factors used by the BDFP Consultant Design Team to calculate the TAC emissions for the Project waste gas burners. The $PM_{2.5}$ emissions from the existing waste gas burners were calculated using the PM_{10} emission factor from AP-42, Table 2.4-5, and total 2014 digester gas throughput to the waste gas burners, as provided by SFPUC and shown in Table 9. These emissions were used to calculate the cancer risk from the existing waste gas burners.

3. The cogeneration engine was not modeled for the CRRP-HRA. The organics emissions from the cogeneration engine are from the 2015 BAAQMD Source Emissions for the Plant (No. 568). The organics emissions were speciated based on the ARB 2015 organics speciation profile for reciprocating internal combustion engines that run on natural gas (Organic Profile 719). These emissions were used to calculate the cancer risk from the existing cogeneration engine.

4. The hot water boilers were modeled for the CRRP-HRA; however, the modeling was refined to account for more exact source locations and building downwash. The organics emissions from the boilers are from the 2016 CER, and PAHs were combined using BAAQMD Toxic Air Contaminant Trigger Levels Table 2-5-1. These emissions were used to calculate the adjusted existing cancer risk from the existing boilers.

Abbreviations:

ARB - California Air Resources Board
BAAQMD - Bay Area Air Quality Management District
BDFP - Biosolids Digester Facilities Project
CAS - chemical abstracts service
CER - Conceptual Engineering Report
CRRP - Community Risk Reduction Plan
g/s - grams per second
HI - hazard index
HRA - health risk assessment
mmscf - million standard cubic feet
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TAC - toxic air contaminant
yr - year

References:

BAAQMD. 2010. Table 2-5-1 Toxic Air Contaminant Trigger Levels. January 6. Available online at: http://www.baaqmd.gov/~/media/files/engineering/air-toxics-programs/table_2-5-1.pdf?la=en

Biosolids Digester Facilities Project Consultant Team, Brown and Caldwell and CH2M and Black & Veatch (BDFP Consultant Design Team). 2016. Conceptual Engineering Report (Final), Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. March.

Table E-7b
Modeled Project Operational Emission Rates for the Transition Period in 2023
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source[1]	Chemical	CAS Number	Modeled Emission Rates for Acute HRA[2] (g/s)	Modeled Emission Rates for Cancer Risk and Chronic HRA[2] (g/s)
Two Turbines (1 duty/ 1 future standby)[3]	1,3-Butadiene	106990	0	0
	1,4-Dichlorobenzene	106467	0	0
	Acetaldehyde	75070	0	0
	Carbon tetrachloride	56235	0	0
	Chlorobenzene	108907	0	0
	Chloroform	67663	0	0
	Ethylene Dichloride	107062	0	0
	Formaldehyde	50000	0	0
	Methylene chloride	75092	0	0
	Tetrachloroethylene	127184	0	0
	Trichloroethylene	79016	0	0
	Vinyl chloride	75014	0	0
	Vinylidene chloride	75354	0	0
	$PM_{2.5}$	25	0	0
Microturbines (3)[4]	1,3-Butadiene	106990	0	0
	1,4-Dichlorobenzene	106467	0	0
	Acetaldehyde	75070	0	0
	Carbon tetrachloride	56235	0	0
	Chlorobenzene	108907	0	0
	Chloroform	67663	0	0
	Ethylene Dichloride	107062	0	0
	Formaldehyde	50000	0	0
	Methylene chloride	75092	0	0
	Tetrachloroethylene	127184	0	0
	Trichloroethylene	79016	0	0
	Vinyl chloride	75014	0	0
	Vinylidene chloride	75354	0	0
	$PM_{2.5}$	25	0	0
Emergency Engine[5]	Diesel PM	9901	8.3E-02	4.8E-04
	TOG	TOG	1.4E-01	8.3E-04
	$PM_{2.5}$	25	0.0E+00	4.9E-04

Table E-7b
Modeled Project Operational Emission Rates for the Transition Period in 2023
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source[1]	Chemical	CAS Number	Modeled Emission Rates for Acute HRA[2] (g/s)	Modeled Emission Rates for Cancer Risk and Chronic HRA[2] (g/s)
Two Waste Gas Burners (2 standby)[6]	Benzene	71432	1.4E-03	2.4E-04
	Formaldehyde	50000	0.0099	1.8E-03
	PAH's	1150	1.2E-04	4.6E-06
	Naphthalene	91203	9.4E-05	1.7E-05
	Acetaldehyde	75070	3.7E-04	6.5E-05
	Acrolein	107028	8.5E-05	1.5E-05
	Propylene	115071	0.021	3.7E-03
	Toluene	108883	4.9E-04	8.8E-05
	Xylenes	1330207	2.5E-04	4.4E-05
	Ethylbenzene	100414	0.0123	2.2E-03
	Hexane	110543	2.5E-04	4.4E-05
	$PM_{2.5}$	25	0.000	2.6E-02
Existing Waste Gas Burners[6]	Benzene	71432	1.4E-03	2.4E-04
	Formaldehyde	50000	0.0099	1.8E-03
	PAH's	1150	1.2E-04	4.6E-06
	Naphthalene	91203	9.4E-05	1.7E-05
	Acetaldehyde	75070	3.7E-04	6.5E-05
	Acrolein	107028	8.5E-05	1.5E-05
	Propylene	115071	0.021	3.7E-03
	Toluene	108883	4.9E-04	8.8E-05
	Xylenes	1330207	2.5E-04	4.4E-05
	Ethylbenzene	100414	0.0123	2.2E-03
	Hexane	110543	2.5E-04	4.4E-05
	$PM_{2.5}$	25	0.000	2.6E-02
Backup Boilers[7]	Benzene	71432	3.4E-06	1.5E-08
	PAH's	1150	1.7E-06	7.6E-09
	1,4-Dichlorobenzene	106467	1.9E-06	8.7E-09
	Formaldehyde	50000	1.2E-04	5.5E-07
	Hexane	110543	0.0029	1.3E-05
	Naphthalene	91203	9.7E-07	4.4E-09
	Toluene	108883	5.4E-06	2.5E-08
	$PM_{2.5}$	25	0.0E+00	8.7E-05
Solids Odor Control (4 stacks)	Hydrogen Sulfide	7783064	4.8E-04	4.8E-04

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Table E-7b
Modeled Project Operational Emission Rates for the Transition Period in 2023
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Notes:

1. The 2023 Transition Period reflects the emissions generated during the 6 to 12 month period of bringing the equipment online for the Project. During the first 6 months, it is assumed that neither the cogeneration engine nor turbine are operating, but that 50% of the existing biogas production will be burned using the existing waste gas burners, and 50% will be burned through the new waste gas burners. Additionally, for start-up, the back-up boiler will operate on natural gas instead of digester gas. (Assumptions based on the Start-Up Narrative provided in an email from Sue Chau on November 12, 2015.)
2. Chronic emission rates calculated from the total emissions presented in Table 16a, averaged over continuous operation. Acute emission rates were scaled by the actual hours of operation in Table 16a.
3. The turbines were assumed to not yet be operating during the transition period. Therefore, emissions are zero.
4. The first, second, and third microturbines will start operating in 2031, 2037, and 2042, respectively. Therefore, for 2023, no microturbine emissions were calculated.
5. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel-fueled CI engines to a maximum of 50 hours per year.
6. During the transition period, 50% of the existing facility biogas production will be burned in the existing waste gas burners, and 50% will be burned in the new waste gas burners. The existing facility biogas production is the sum of the 2014 biogas throughput from the existing waste gas burners, the existing boilers, and the existing the cogeneration engine.
7. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. During the start up of the facility, the backup steam boilers will be fired on natural gas. However, during full operation, the primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies.

Abbreviations:

ATCM - California Air Toxics Control Measure
BAAQMD - Bay Area Air Quality Management District
CAS - chemical abstract services
CI - Compression Ignition
g/s - grams per second
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

Reference:

Biosolids Digester Facilties Project Consulting Team, Brown and Caldwell with CH2M and Black & Veatch. 2015. Preliminary CER Operational Air Emissions prepared for the SFPUC Biosolids Digester Facilities Project. July.

BAAQMD. 2012. Recommended Methods for Screening and Modeling Local Risks and Hazards, Version 3.0. May.

Table E-7c
Modeled Project Operational Emission Rates for 2023 and 2045
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Source	Chemical	CAS Number	Modeled Emission Rates for Acute HRA (g/s)[1]			Modeled Emission Rates for Cancer Risk and Chronic HRA (g/s)[1]		
	-		2023[2]	2023 and 2045 Average[3]	2045[4]	2023[2]	2023 and 2045 Average[3]	2045[4]
Two Turbines[5] (1 duty/ 1 future standby)	1,3-Butadiene	106990	7.5E-05	7.5E-05	7.5E-05	7.5E-05	7.5E-05	7.5E-05
	1,4 Dichlorobenzene	106467	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04
	Acetaldehyde	75070	4.1E-04	4.1E-04	4.1E-04	4.1E-04	4.1E-04	4.1E-04
	Carbon tetrachloride	56235	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04
	Chlorobenzene	108907	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04
	Chloroform	67663	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04
	Ethylene Dichloride	107062	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04
	Formaldehyde	50000	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03	1.5E-03
	Methylene chloride	75092	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-04
	Tetrachloroethylene	127184	1.6E-04	1.6E-04	1.6E-04	1.6E-04	1.6E-04	1.6E-04
	Trichloroethylene	79016	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04	1.4E-04
	Vinyl chloride	75014	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04	2.8E-04
	Vinylidene chloride	75354	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04	1.2E-04
	$PM_{2.5}$	25	1.2E-01	1.2E-01	1.2E-01	1.2E-01	1.2E-01	1.2E-01
Four (4) 200 kW microturbines (future: 3 duty/ 1 standby)[6]	1,3-Butadiene	106990	0.0E+00	3.9E-06	7.8E-06	0.0E+00	3.9E-06	7.8E-06
	1,4 Dichlorobenzene	106467	0.0E+00	7.9E-06	1.6E-05	0.0E+00	7.9E-06	1.6E-05
	Acetaldehyde	75070	0.0E+00	2.1E-05	4.2E-05	0.0E+00	2.1E-05	4.2E-05
	Carbon tetrachloride	56235	0.0E+00	7.9E-06	1.6E-05	0.0E+00	7.9E-06	1.6E-05
	Chlorobenzene	108907	0.0E+00	6.4E-06	1.3E-05	0.0E+00	6.4E-06	1.3E-05
	Chloroform	67663	0.0E+00	6.7E-06	1.3E-05	0.0E+00	6.7E-06	1.3E-05
	Ethylene Dichloride	107062	0.0E+00	6.0E-06	1.2E-05	0.0E+00	6.0E-06	1.2E-05
	Formaldehyde	50000	0.0E+00	7.6E-05	1.5E-04	0.0E+00	7.6E-05	1.5E-04
	Methylene chloride	75092	0.0E+00	5.2E-06	1.0E-05	0.0E+00	5.2E-06	1.0E-05
	Tetrachloroethylene	127184	0.0E+00	8.3E-06	1.7E-05	0.0E+00	8.3E-06	1.7E-05
	Trichloroethylene	79016	0.0E+00	7.1E-06	1.4E-05	0.0E+00	7.1E-06	1.4E-05
	Vinyl chloride	75014	0.0E+00	1.4E-05	2.9E-05	0.0E+00	1.4E-05	2.9E-05
	Vinylidene chloride	75354	0.0E+00	6.0E-06	1.2E-05	0.0E+00	6.0E-06	1.2E-05
	$PM_{2.5}$	25	0.0E+00	5.2E-03	1.0E-02	0.0E+00	5.2E-03	1.0E-02
One Emergency Diesel Engine[7]	Diesel PM	9901	8.3E-02	8.3E-02	8.3E-02	4.8E-04	4.8E-04	4.8E-04
	TOG	TOG	1.4E-01	1.4E-01	1.4E-01	8.3E-04	8.3E-04	8.3E-04
	$PM_{2.5}$	25	8.6E-02	8.6E-02	8.6E-02	4.9E-04	4.9E-04	4.9E-04
Waste Gas Burners[8]	Benzene	71432	1.3E-03	1.3E-03	1.3E-03	4.6E-05	2.7E-05	7.7E-06
	Formaldehyde	50000	9.9E-03	9.9E-03	9.9E-03	3.4E-04	2.0E-04	5.7E-05
	PAH's	1150	2.5E-05	2.5E-05	2.5E-05	8.7E-07	5.1E-07	1.5E-07
	Naphthalene	91203	9.4E-05	9.4E-05	9.4E-05	3.2E-06	1.9E-06	5.3E-07
	Acetaldehyde	75070	3.7E-04	3.7E-04	3.7E-04	1.3E-05	7.3E-06	2.1E-06
	Acrolein	107028	8.5E-05	8.5E-05	8.5E-05	2.9E-06	1.7E-06	4.9E-07
	Propylene	115071	2.1E-02	2.1E-02	2.1E-02	7.1E-04	4.2E-04	1.2E-04
	Toluene	108883	4.9E-04	4.9E-04	4.9E-04	1.7E-05	9.9E-06	2.8E-06
	Xylenes	1330207	2.5E-04	2.5E-04	2.5E-04	8.5E-06	4.9E-06	1.4E-06
	Ethylbenzene	100414	1.2E-02	1.2E-02	1.2E-02	4.2E-04	2.5E-04	7.0E-05
	Hexane	110543	2.5E-04	2.5E-04	2.5E-04	8.5E-06	4.9E-06	1.4E-06
	$PM_{2.5}$	25	1.4E-01	1.4E-01	1.4E-01	4.9E-03	2.9E-03	8.2E-04
Two Backup Steam Boilers (2 standby)[9]	Benzene	71432	8.6E-06	8.6E-06	8.6E-06	3.9E-08	4.4E-08	4.9E-08
	PAH's	1150	4.2E-06	4.2E-06	4.2E-06	1.9E-08	2.2E-08	2.4E-08
	1,4 Dichlorobenzene	106467	4.9E-06	4.9E-06	4.9E-06	2.2E-08	2.5E-08	2.8E-08
	Formaldehyde	50000	3.1E-04	3.1E-04	3.1E-04	1.4E-06	1.6E-06	1.7E-06
	Hexane	110543	7.3E-03	7.3E-03	7.3E-03	3.3E-05	3.8E-05	4.2E-05
	Naphthalene	91203	2.5E-06	2.5E-06	2.5E-06	1.1E-08	1.3E-08	1.4E-08
	Toluene	108883	1.4E-05	1.4E-05	1.4E-05	6.3E-08	7.1E-08	7.9E-08
	$PM_{2.5}$	25	3.1E-02	3.1E-02	3.1E-02	1.4E-04	1.6E-04	1.8E-04
Solids Odor Control (4 stacks)	Hydrogen Sulfide	7783064	4.8E-04	4.8E-04	4.8E-04	4.8E-04	4.8E-04	4.8E-04

Table E-7c
Modeled Project Operational Emission Rates for 2023 and 2045
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Notes:

1. Modeled emission rates are calculated from the emissions shown in Tables 16b and 16c.
2. The Full Operation 2023 scenario assumes all project emission sources are fully operational, with the exception of the future equipment and the microturbines, which are not expected to operate until future years.
3. 2023 and 2045 emission rates were averaged and used to represent emissions between 2023 and 2045 in the health risk assessment calculations.
4. The 2045 scenario shows increased emissions because the hours of operation of some of the stationary sources are expected to increase as the biogas production increases at the plant. The hours of operation of the waste gas burners decreases because the addition of a future standby turbine and the microturbines are expected to handle all the biogas generated at the facility. By 2045, the waste gas burners are expected to only operate in emergency situations.
5. Emissions were calculated for one turbine because only one turbine can operate at a time.
6. The first, second, and third microturbines will start operating in 2031, 2037, and 2042, respectively. Therefore, for the 2022 scenario, no microturbine emissions were calculated.
7. The California Air Toxics Control Measure (ATCM) for Stationary Compression Ignition (CI) Engines (17 CCR 93115.6(3)(1)(C)) and BAAQMD Rule 9-8-330.3 restrict non-emergency use of emergency standby diesel- fueled CI engines to a maximum of 50 hours per year.
8. In 2023, emissions were calculated for two waste gas burners that are expected to operate 3% of the time (300 hours/year). In 2045, emissions were calculated for two waste gas burners that are expected to operate only if the biogas production exceeds the volume that can be used to fuel the turbines and microturbines. By 2045, a standby turbine will be installed and the waste gas burners will operate only during emergency situations.
9. Emissions were calculated for two backup steam boilers that will only be operated when the turbines are down (e.g., electrical failure) or during testing. The primary fuel for the backup steam boilers is digester gas and the secondary fuel is natural gas, which will only be used during emergencies or for start-up.

Abbreviations:

ATCM - California Air Toxics Control Measure
BAAQMD - Bay Area Air Quality Management District
CAS - chemical abstract services
CI - Compression Ignition
g/s - grams per second
PAH - polycyclic aromatic hydrocarbon
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas

Reference:

BAAQMD. 2012. Recommended Methods for Screening and Modeling Local Risks and Hazards, Version 3.0. May.

Table E-8a
Year by Year Modeled DPM Emission Rates for Cumulative Chronic HI Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	AreaB	Onsite	Offroad	3.9E-03
2019	AreaB	Onsite	Offroad	2.7E-03
2020	AreaB	Onsite	Offroad	8.7E-05
2021	AreaB	Onsite	Offroad	0.0E+00
2022	AreaB	Onsite	Offroad	0.0E+00
2023	AreaB	Onsite	Offroad	0.0E+00
2024	AreaB	Onsite	Offroad	0.0E+00
2025	AreaB	Onsite	Offroad	0.0E+00
2045	AreaB	Onsite	Offroad	0.0E+00
2018	AreaC	Onsite	Offroad	2.9E-03
2019	AreaC	Onsite	Offroad	1.6E-03
2020	AreaC	Onsite	Offroad	0.0E+00
2021	AreaC	Onsite	Offroad	0.0E+00
2022	AreaC	Onsite	Offroad	0.0E+00
2023	AreaC	Onsite	Offroad	0.0E+00
2024	AreaC	Onsite	Offroad	0.0E+00
2025	AreaC	Onsite	Offroad	5.4E-04
2045	AreaC	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	4.2E-04
2019	AreaA	Onsite	Offroad	5.3E-04
2020	AreaA	Onsite	Offroad	7.1E-04
2021	AreaA	Onsite	Offroad	6.0E-04
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	0.0E+00
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	2.0E-04
2019	AreaA	Onsite	Offroad	0.0E+00
2020	AreaA	Onsite	Offroad	0.0E+00
2021	AreaA	Onsite	Offroad	0.0E+00
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	0.0E+00
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	0.0E+00
2019	AreaA	Onsite	Offroad	0.0E+00
2020	AreaA	Onsite	Offroad	0.0E+00
2021	AreaA	Onsite	Offroad	0.0E+00
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	0.0E+00
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	0.0E+00
2019	AreaA	Onsite	Offroad	0.0E+00
2020	AreaA	Onsite	Offroad	0.0E+00
2021	AreaA	Onsite	Offroad	0.0E+00
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	1.7E-04
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00

Table E-8a
Year by Year Modeled DPM Emission Rates for Cumulative Chronic HI Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	HW_G02	Onsite	Operational	0.0E+00
2019	HW_G02	Onsite	Operational	0.0E+00
2020	HW_G02	Onsite	Operational	0.0E+00
2021	HW_G02	Onsite	Operational	0.0E+00
2022	HW_G02	Onsite	Operational	2.4E-04
2023	HW_G02	Onsite	Operational	2.4E-04
2024	HW_G02	Onsite	Operational	2.4E-04
2025	HW_G02	Onsite	Operational	2.4E-04
2045	HW_G02	Onsite	Operational	2.4E-04
2018	ON_G01	Onsite	Operational	4.8E-05
2019	ON_G01	Onsite	Operational	4.8E-05
2020	ON_G01	Onsite	Operational	4.8E-05
2021	ON_G01	Onsite	Operational	4.8E-05
2022	ON_G01	Onsite	Operational	4.8E-05
2023	ON_G01	Onsite	Operational	4.8E-05
2024	ON_G01	Onsite	Operational	4.8E-05
2025	ON_G01	Onsite	Operational	4.8E-05
2045	ON_G01	Onsite	Operational	4.8E-05
2018	ON_G02	Onsite	Operational	2.5E-05
2019	ON_G02	Onsite	Operational	2.5E-05
2020	ON_G02	Onsite	Operational	2.5E-05
2021	ON_G02	Onsite	Operational	2.5E-05
2022	ON_G02	Onsite	Operational	2.5E-05
2023	ON_G02	Onsite	Operational	2.5E-05
2024	ON_G02	Onsite	Operational	2.5E-05
2025	ON_G02	Onsite	Operational	2.5E-05
2045	ON_G02	Onsite	Operational	2.5E-05
2018	280NOFF	Offsite	Onroad	5.6E-06
2019	280NOFF	Offsite	Onroad	3.1E-06
2020	280NOFF	Offsite	Onroad	2.3E-06
2021	280NOFF	Offsite	Onroad	2.0E-06
2022	280NOFF	Offsite	Onroad	0.0E+00
2023	280NOFF	Offsite	Onroad	1.4E-06
2024	280NOFF	Offsite	Onroad	0.0E+00
2025	280NOFF	Offsite	Onroad	0.0E+00
2045	280NOFF	Offsite	Onroad	0.0E+00
2018	SURF11	Offsite	Onroad	0.0E+00
2019	SURF11	Offsite	Onroad	0.0E+00
2020	SURF11	Offsite	Onroad	0.0E+00
2021	SURF11	Offsite	Onroad	0.0E+00
2022	SURF11	Offsite	Onroad	0.0E+00
2023	SURF11	Offsite	Onroad	0.0E+00
2024	SURF11	Offsite	Onroad	0.0E+00
2025	SURF11	Offsite	Onroad	0.0E+00
2045	SURF11	Offsite	Onroad	0.0E+00
2018	SURF12	Offsite	Onroad	0.0E+00
2019	SURF12	Offsite	Onroad	0.0E+00
2020	SURF12	Offsite	Onroad	0.0E+00
2021	SURF12	Offsite	Onroad	0.0E+00
2022	SURF12	Offsite	Onroad	0.0E+00
2023	SURF12	Offsite	Onroad	0.0E+00
2024	SURF12	Offsite	Onroad	0.0E+00
2025	SURF12	Offsite	Onroad	0.0E+00
2045	SURF12	Offsite	Onroad	0.0E+00

Table E-8a
Year by Year Modeled DPM Emission Rates for Cumulative Chronic HI Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	SURF13	Offsite	Onroad	3.1E-06
2019	SURF13	Offsite	Onroad	1.7E-06
2020	SURF13	Offsite	Onroad	1.3E-06
2021	SURF13	Offsite	Onroad	1.2E-06
2022	SURF13	Offsite	Onroad	0.0E+00
2023	SURF13	Offsite	Onroad	9.5E-07
2024	SURF13	Offsite	Onroad	0.0E+00
2025	SURF13	Offsite	Onroad	0.0E+00
2045	SURF13	Offsite	Onroad	0.0E+00
2018	SURF2	Offsite	Onroad	3.1E-06
2019	SURF2	Offsite	Onroad	1.7E-06
2020	SURF2	Offsite	Onroad	1.3E-06
2021	SURF2	Offsite	Onroad	1.2E-06
2022	SURF2	Offsite	Onroad	0.0E+00
2023	SURF2	Offsite	Onroad	9.5E-07
2024	SURF2	Offsite	Onroad	0.0E+00
2025	SURF2	Offsite	Onroad	0.0E+00
2045	SURF2	Offsite	Onroad	0.0E+00
2018	SURF3	Offsite	Onroad	1.5E-05
2019	SURF3	Offsite	Onroad	2.0E-05
2020	SURF3	Offsite	Onroad	4.5E-06
2021	SURF3	Offsite	Onroad	1.4E-05
2022	SURF3	Offsite	Onroad	0.0E+00
2023	SURF3	Offsite	Onroad	4.5E-07
2024	SURF3	Offsite	Onroad	0.0E+00
2025	SURF3	Offsite	Onroad	0.0E+00
2045	SURF3	Offsite	Onroad	0.0E+00
2018	SURF4	Offsite	Onroad	1.3E-05
2019	SURF4	Offsite	Onroad	1.5E-05
2020	SURF4	Offsite	Onroad	4.1E-06
2021	SURF4	Offsite	Onroad	1.1E-05
2022	SURF4	Offsite	Onroad	0.0E+00
2023	SURF4	Offsite	Onroad	1.1E-06
2024	SURF4	Offsite	Onroad	0.0E+00
2025	SURF4	Offsite	Onroad	0.0E+00
2045	SURF4	Offsite	Onroad	0.0E+00
2018	SURF7	Offsite	Onroad	1.2E-05
2019	SURF7	Offsite	Onroad	1.4E-05
2020	SURF7	Offsite	Onroad	3.9E-06
2021	SURF7	Offsite	Onroad	1.0E-05
2022	SURF7	Offsite	Onroad	0.0E+00
2023	SURF7	Offsite	Onroad	1.1E-06
2024	SURF7	Offsite	Onroad	0.0E+00
2025	SURF7	Offsite	Onroad	0.0E+00
2045	SURF7	Offsite	Onroad	0.0E+00
2018	SURF8	Offsite	Onroad	1.5E-05
2019	SURF8	Offsite	Onroad	1.7E-05
2020	SURF8	Offsite	Onroad	4.7E-06
2021	SURF8	Offsite	Onroad	1.2E-05
2022	SURF8	Offsite	Onroad	0.0E+00
2023	SURF8	Offsite	Onroad	1.2E-06
2024	SURF8	Offsite	Onroad	0.0E+00
2025	SURF8	Offsite	Onroad	0.0E+00
2045	SURF8	Offsite	Onroad	0.0E+00

Table E-8a
Year by Year Modeled DPM Emission Rates for Cumulative Chronic HI Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	SURF1	Offsite	Onroad	2.0E-06
2019	SURF1	Offsite	Onroad	1.1E-06
2020	SURF1	Offsite	Onroad	9.0E-07
2021	SURF1	Offsite	Onroad	7.9E-07
2022	SURF1	Offsite	Onroad	0.0E+00
2023	SURF1	Offsite	Onroad	7.6E-07
2024	SURF1	Offsite	Onroad	0.0E+00
2025	SURF1	Offsite	Onroad	0.0E+00
2045	SURF1	Offsite	Onroad	0.0E+00
2018	SURF10	Offsite	Onroad	2.0E-06
2019	SURF10	Offsite	Onroad	1.1E-06
2020	SURF10	Offsite	Onroad	8.9E-07
2021	SURF10	Offsite	Onroad	7.9E-07
2022	SURF10	Offsite	Onroad	0.0E+00
2023	SURF10	Offsite	Onroad	7.5E-07
2024	SURF10	Offsite	Onroad	0.0E+00
2025	SURF10	Offsite	Onroad	0.0E+00
2045	SURF10	Offsite	Onroad	0.0E+00
2018	SURF14	Offsite	Onroad	2.5E-06
2019	SURF14	Offsite	Onroad	1.4E-06
2020	SURF14	Offsite	Onroad	1.1E-06
2021	SURF14	Offsite	Onroad	9.7E-07
2022	SURF14	Offsite	Onroad	0.0E+00
2023	SURF14	Offsite	Onroad	8.5E-07
2024	SURF14	Offsite	Onroad	0.0E+00
2025	SURF14	Offsite	Onroad	0.0E+00
2045	SURF14	Offsite	Onroad	0.0E+00
2018	SURF9	Offsite	Onroad	2.5E-06
2019	SURF9	Offsite	Onroad	3.3E-06
2020	SURF9	Offsite	Onroad	7.6E-07
2021	SURF9	Offsite	Onroad	2.4E-06
2022	SURF9	Offsite	Onroad	0.0E+00
2023	SURF9	Offsite	Onroad	9.0E-08
2024	SURF9	Offsite	Onroad	0.0E+00
2025	SURF9	Offsite	Onroad	0.0E+00
2045	SURF9	Offsite	Onroad	0.0E+00
2018	280SON	Offsite	Onroad	6.0E-06
2019	280SON	Offsite	Onroad	3.3E-06
2020	280SON	Offsite	Onroad	2.5E-06
2021	280SON	Offsite	Onroad	2.2E-06
2022	280SON	Offsite	Onroad	0.0E+00
2023	280SON	Offsite	Onroad	1.5E-06
2024	280SON	Offsite	Onroad	0.0E+00
2025	280SON	Offsite	Onroad	0.0E+00
2045	280SON	Offsite	Onroad	0.0E+00
2018	OFF001	Offsite	Offroad	7.1E-03
2019	OFF001	Offsite	Offroad	7.1E-03
2020	OFF001	Offsite	Offroad	7.1E-03
2021	OFF001	Offsite	Offroad	7.1E-03
2022	OFF001	Offsite	Offroad	5.9E-03
2023	OFF001	Offsite	Offroad	0.0E+00
2024	OFF001	Offsite	Offroad	0.0E+00
2025	OFF001	Offsite	Offroad	0.0E+00
2045	OFF001	Offsite	Offroad	0.0E+00

Table E-8a
Year by Year Modeled DPM Emission Rates for Cumulative Chronic HI Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	OFF002	Offsite	Offroad	6.9E-04
2019	OFF002	Offsite	Offroad	6.9E-04
2020	OFF002	Offsite	Offroad	0.0E+00
2021	OFF002	Offsite	Offroad	0.0E+00
2022	OFF002	Offsite	Offroad	0.0E+00
2023	OFF002	Offsite	Offroad	0.0E+00
2024	OFF002	Offsite	Offroad	0.0E+00
2025	OFF002	Offsite	Offroad	0.0E+00
2045	OFF002	Offsite	Offroad	0.0E+00
2018	OFF003	Offsite	Offroad	1.3E-03
2019	OFF003	Offsite	Offroad	1.3E-03
2020	OFF003	Offsite	Offroad	0.0E+00
2021	OFF003	Offsite	Offroad	0.0E+00
2022	OFF003	Offsite	Offroad	0.0E+00
2023	OFF003	Offsite	Offroad	0.0E+00
2024	OFF003	Offsite	Offroad	0.0E+00
2025	OFF003	Offsite	Offroad	0.0E+00
2045	OFF003	Offsite	Offroad	0.0E+00
2018	OFF004	Offsite	Offroad	1.1E-04
2019	OFF004	Offsite	Offroad	1.1E-04
2020	OFF004	Offsite	Offroad	0.0E+00
2021	OFF004	Offsite	Offroad	0.0E+00
2022	OFF004	Offsite	Offroad	0.0E+00
2023	OFF004	Offsite	Offroad	0.0E+00
2024	OFF004	Offsite	Offroad	0.0E+00
2025	OFF004	Offsite	Offroad	0.0E+00
2045	OFF004	Offsite	Offroad	0.0E+00
2018	OFF006	Offsite	Offroad	5.9E-04
2019	OFF006	Offsite	Offroad	5.9E-04
2020	OFF006	Offsite	Offroad	0.0E+00
2021	OFF006	Offsite	Offroad	0.0E+00
2022	OFF006	Offsite	Offroad	0.0E+00
2023	OFF006	Offsite	Offroad	0.0E+00
2024	OFF006	Offsite	Offroad	0.0E+00
2025	OFF006	Offsite	Offroad	0.0E+00
2045	OFF006	Offsite	Offroad	0.0E+00
2018	OFF009	Offsite	Offroad	8.6E-03
2019	OFF009	Offsite	Offroad	8.6E-03
2020	OFF009	Offsite	Offroad	0.0E+00
2021	OFF009	Offsite	Offroad	0.0E+00
2022	OFF009	Offsite	Offroad	0.0E+00
2023	OFF009	Offsite	Offroad	0.0E+00
2024	OFF009	Offsite	Offroad	0.0E+00
2025	OFF009	Offsite	Offroad	0.0E+00
2045	OFF009	Offsite	Offroad	0.0E+00
2018	OFF010	Offsite	Offroad	5.6E-04
2019	OFF010	Offsite	Offroad	5.6E-04
2020	OFF010	Offsite	Offroad	0.0E+00
2021	OFF010	Offsite	Offroad	0.0E+00
2022	OFF010	Offsite	Offroad	0.0E+00
2023	OFF010	Offsite	Offroad	0.0E+00
2024	OFF010	Offsite	Offroad	0.0E+00
2025	OFF010	Offsite	Offroad	0.0E+00
2045	OFF010	Offsite	Offroad	0.0E+00

Table E-8a
Year by Year Modeled DPM Emission Rates for Cumulative Chronic HI Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, California

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	OFF011	Offsite	Offroad	2.6E-02
2019	OFF011	Offsite	Offroad	2.6E-02
2020	OFF011	Offsite	Offroad	2.6E-02
2021	OFF011	Offsite	Offroad	2.6E-02
2022	OFF011	Offsite	Offroad	2.6E-02
2023	OFF011	Offsite	Offroad	1.3E-02
2024	OFF011	Offsite	Offroad	0.0E+00
2025	OFF011	Offsite	Offroad	0.0E+00
2045	OFF011	Offsite	Offroad	0.0E+00
2018	OFF012	Offsite	Offroad	6.8E-03
2019	OFF012	Offsite	Offroad	6.8E-03
2020	OFF012	Offsite	Offroad	0.0E+00
2021	OFF012	Offsite	Offroad	0.0E+00
2022	OFF012	Offsite	Offroad	0.0E+00
2023	OFF012	Offsite	Offroad	0.0E+00
2024	OFF012	Offsite	Offroad	0.0E+00
2025	OFF012	Offsite	Offroad	0.0E+00
2045	OFF012	Offsite	Offroad	0.0E+00
2018	OFF020	Offsite	Offroad	0.0E+00
2019	OFF020	Offsite	Offroad	0.0E+00
2020	OFF020	Offsite	Offroad	0.0E+00
2021	OFF020	Offsite	Offroad	0.0E+00
2022	OFF020	Offsite	Offroad	0.0E+00
2023	OFF020	Offsite	Offroad	0.0E+00
2024	OFF020	Offsite	Offroad	0.0E+00
2025	OFF020	Offsite	Offroad	0.0E+00
2045	OFF020	Offsite	Offroad	0.0E+00

Notes:

1. Cumulative Project descriptions can be found in Table 17, and total DPM emissions can be found in Table 18a.
2. Emission rates were calculated by averaging total annual emissions over continuous operation. Hour of day restrictions were accounted for in the AERMOD model (See Appendix F).

Abbreviations:

DPM - diesel particulate matter
g/s - gram per second
HI - hazard index
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission

Table E-8b
Year by Year Modeled $PM_{2.5}$ Emission Rates for Cumulative $PM_{2.5}$ Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	AreaB	Onsite	Offroad	3.6E-03
2019	AreaB	Onsite	Offroad	2.5E-03
2020	AreaB	Onsite	Offroad	8.0E-05
2021	AreaB	Onsite	Offroad	0.0E+00
2022	AreaB	Onsite	Offroad	0.0E+00
2023	AreaB	Onsite	Offroad	0.0E+00
2024	AreaB	Onsite	Offroad	0.0E+00
2025	AreaB	Onsite	Offroad	0.0E+00
2045	AreaB	Onsite	Offroad	0.0E+00
2018	AreaC	Onsite	Offroad	2.7E-03
2019	AreaC	Onsite	Offroad	1.5E-03
2020	AreaC	Onsite	Offroad	0.0E+00
2021	AreaC	Onsite	Offroad	0.0E+00
2022	AreaC	Onsite	Offroad	0.0E+00
2023	AreaC	Onsite	Offroad	0.0E+00
2024	AreaC	Onsite	Offroad	0.0E+00
2025	AreaC	Onsite	Offroad	5.0E-04
2045	AreaC	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	4.2E-04
2019	AreaA	Onsite	Offroad	5.3E-04
2020	AreaA	Onsite	Offroad	7.1E-04
2021	AreaA	Onsite	Offroad	6.0E-04
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	0.0E+00
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	2.0E-04
2019	AreaA	Onsite	Offroad	0.0E+00
2020	AreaA	Onsite	Offroad	0.0E+00
2021	AreaA	Onsite	Offroad	0.0E+00
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	0.0E+00
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	0.0E+00
2019	AreaA	Onsite	Offroad	0.0E+00
2020	AreaA	Onsite	Offroad	0.0E+00
2021	AreaA	Onsite	Offroad	0.0E+00
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	0.0E+00
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00
2018	AreaA	Onsite	Offroad	0.0E+00
2019	AreaA	Onsite	Offroad	0.0E+00
2020	AreaA	Onsite	Offroad	0.0E+00
2021	AreaA	Onsite	Offroad	0.0E+00
2022	AreaA	Onsite	Offroad	0.0E+00
2023	AreaA	Onsite	Offroad	1.7E-04
2024	AreaA	Onsite	Offroad	0.0E+00
2025	AreaA	Onsite	Offroad	0.0E+00
2045	AreaA	Onsite	Offroad	0.0E+00

Table E-8b
Year by Year Modeled $PM_{2.5}$ Emission Rates for Cumulative $PM_{2.5}$ Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	HW_G02	Onsite	Operational	0.0E+00
2019	HW_G02	Onsite	Operational	0.0E+00
2020	HW_G02	Onsite	Operational	0.0E+00
2021	HW_G02	Onsite	Operational	0.0E+00
2022	HW_G02	Onsite	Operational	2.4E-04
2023	HW_G02	Onsite	Operational	2.4E-04
2024	HW_G02	Onsite	Operational	2.4E-04
2025	HW_G02	Onsite	Operational	2.4E-04
2045	HW_G02	Onsite	Operational	2.4E-04
2018	ON_G01	Onsite	Operational	4.8E-05
2019	ON_G01	Onsite	Operational	4.8E-05
2020	ON_G01	Onsite	Operational	4.8E-05
2021	ON_G01	Onsite	Operational	4.8E-05
2022	ON_G01	Onsite	Operational	4.8E-05
2023	ON_G01	Onsite	Operational	4.8E-05
2024	ON_G01	Onsite	Operational	4.8E-05
2025	ON_G01	Onsite	Operational	4.8E-05
2045	ON_G01	Onsite	Operational	4.8E-05
2018	ON_G02	Onsite	Operational	2.5E-05
2019	ON_G02	Onsite	Operational	2.5E-05
2020	ON_G02	Onsite	Operational	2.5E-05
2021	ON_G02	Onsite	Operational	2.5E-05
2022	ON_G02	Onsite	Operational	2.5E-05
2023	ON_G02	Onsite	Operational	2.5E-05
2024	ON_G02	Onsite	Operational	2.5E-05
2025	ON_G02	Onsite	Operational	2.5E-05
2045	ON_G02	Onsite	Operational	2.5E-05
2018	280NOFF	Offsite	Onroad	9.4E-06
2019	280NOFF	Offsite	Onroad	5.4E-06
2020	280NOFF	Offsite	Onroad	4.7E-06
2021	280NOFF	Offsite	Onroad	4.3E-06
2022	280NOFF	Offsite	Onroad	0.0E+00
2023	280NOFF	Offsite	Onroad	4.0E-06
2024	280NOFF	Offsite	Onroad	0.0E+00
2025	280NOFF	Offsite	Onroad	0.0E+00
2045	280NOFF	Offsite	Onroad	0.0E+00
2018	SURF9	Offsite	Onroad	2.8E-06
2019	SURF9	Offsite	Onroad	3.7E-06
2020	SURF9	Offsite	Onroad	8.9E-07
2021	SURF9	Offsite	Onroad	2.9E-06
2022	SURF9	Offsite	Onroad	0.0E+00
2023	SURF9	Offsite	Onroad	1.1E-07
2024	SURF9	Offsite	Onroad	0.0E+00
2025	SURF9	Offsite	Onroad	0.0E+00
2045	SURF9	Offsite	Onroad	0.0E+00
2018	SURF11	Offsite	Onroad	0.0E+00
2019	SURF11	Offsite	Onroad	0.0E+00
2020	SURF11	Offsite	Onroad	0.0E+00
2021	SURF11	Offsite	Onroad	0.0E+00
2022	SURF11	Offsite	Onroad	0.0E+00
2023	SURF11	Offsite	Onroad	0.0E+00
2024	SURF11	Offsite	Onroad	0.0E+00
2025	SURF11	Offsite	Onroad	0.0E+00
2045	SURF11	Offsite	Onroad	0.0E+00

Table E-8b
Year by Year Modeled $PM_{2.5}$ Emission Rates for Cumulative $PM_{2.5}$ Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	SURF12	Offsite	Onroad	0.0E+00
2019	SURF12	Offsite	Onroad	0.0E+00
2020	SURF12	Offsite	Onroad	0.0E+00
2021	SURF12	Offsite	Onroad	0.0E+00
2022	SURF12	Offsite	Onroad	0.0E+00
2023	SURF12	Offsite	Onroad	0.0E+00
2024	SURF12	Offsite	Onroad	0.0E+00
2025	SURF12	Offsite	Onroad	0.0E+00
2045	SURF12	Offsite	Onroad	0.0E+00
2018	SURF13	Offsite	Onroad	4.3E-06
2019	SURF13	Offsite	Onroad	2.5E-06
2020	SURF13	Offsite	Onroad	2.1E-06
2021	SURF13	Offsite	Onroad	1.9E-06
2022	SURF13	Offsite	Onroad	0.0E+00
2023	SURF13	Offsite	Onroad	1.8E-06
2024	SURF13	Offsite	Onroad	0.0E+00
2025	SURF13	Offsite	Onroad	0.0E+00
2045	SURF13	Offsite	Onroad	0.0E+00
2018	SURF2	Offsite	Onroad	4.3E-06
2019	SURF2	Offsite	Onroad	2.5E-06
2020	SURF2	Offsite	Onroad	2.1E-06
2021	SURF2	Offsite	Onroad	1.9E-06
2022	SURF2	Offsite	Onroad	0.0E+00
2023	SURF2	Offsite	Onroad	1.8E-06
2024	SURF2	Offsite	Onroad	0.0E+00
2025	SURF2	Offsite	Onroad	0.0E+00
2045	SURF2	Offsite	Onroad	0.0E+00
2018	SURF3	Offsite	Onroad	2.2E-05
2019	SURF3	Offsite	Onroad	3.0E-05
2020	SURF3	Offsite	Onroad	7.4E-06
2021	SURF3	Offsite	Onroad	2.4E-05
2022	SURF3	Offsite	Onroad	0.0E+00
2023	SURF3	Offsite	Onroad	9.0E-07
2024	SURF3	Offsite	Onroad	0.0E+00
2025	SURF3	Offsite	Onroad	0.0E+00
2045	SURF3	Offsite	Onroad	0.0E+00
2018	SURF4	Offsite	Onroad	1.5E-05
2019	SURF4	Offsite	Onroad	1.7E-05
2020	SURF4	Offsite	Onroad	5.1E-06
2021	SURF4	Offsite	Onroad	1.4E-05
2022	SURF4	Offsite	Onroad	0.0E+00
2023	SURF4	Offsite	Onroad	1.5E-06
2024	SURF4	Offsite	Onroad	0.0E+00
2025	SURF4	Offsite	Onroad	0.0E+00
2045	SURF4	Offsite	Onroad	0.0E+00
2018	SURF7	Offsite	Onroad	1.3E-05
2019	SURF7	Offsite	Onroad	1.5E-05
2020	SURF7	Offsite	Onroad	4.4E-06
2021	SURF7	Offsite	Onroad	1.2E-05
2022	SURF7	Offsite	Onroad	0.0E+00
2023	SURF7	Offsite	Onroad	1.3E-06
2024	SURF7	Offsite	Onroad	0.0E+00
2025	SURF7	Offsite	Onroad	0.0E+00
2045	SURF7	Offsite	Onroad	0.0E+00

Table E-8b
Year by Year Modeled $PM_{2.5}$ Emission Rates for Cumulative $PM_{2.5}$ Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	SURF8	Offsite	Onroad	1.9E-05
2019	SURF8	Offsite	Onroad	2.2E-05
2020	SURF8	Offsite	Onroad	6.6E-06
2021	SURF8	Offsite	Onroad	1.8E-05
2022	SURF8	Offsite	Onroad	0.0E+00
2023	SURF8	Offsite	Onroad	1.9E-06
2024	SURF8	Offsite	Onroad	0.0E+00
2025	SURF8	Offsite	Onroad	0.0E+00
2045	SURF8	Offsite	Onroad	0.0E+00
2018	SURF1	Offsite	Onroad	2.2E-06
2019	SURF1	Offsite	Onroad	1.2E-06
2020	SURF1	Offsite	Onroad	1.0E-06
2021	SURF1	Offsite	Onroad	9.4E-07
2022	SURF1	Offsite	Onroad	0.0E+00
2023	SURF1	Offsite	Onroad	9.3E-07
2024	SURF1	Offsite	Onroad	0.0E+00
2025	SURF1	Offsite	Onroad	0.0E+00
2045	SURF1	Offsite	Onroad	0.0E+00
2018	SURF10	Offsite	Onroad	2.2E-06
2019	SURF10	Offsite	Onroad	1.2E-06
2020	SURF10	Offsite	Onroad	1.0E-06
2021	SURF10	Offsite	Onroad	9.1E-07
2022	SURF10	Offsite	Onroad	0.0E+00
2023	SURF10	Offsite	Onroad	9.0E-07
2024	SURF10	Offsite	Onroad	0.0E+00
2025	SURF10	Offsite	Onroad	0.0E+00
2045	SURF10	Offsite	Onroad	0.0E+00
2018	SURF14	Offsite	Onroad	3.3E-06
2019	SURF14	Offsite	Onroad	1.8E-06
2020	SURF14	Offsite	Onroad	1.6E-06
2021	SURF14	Offsite	Onroad	1.4E-06
2022	SURF14	Offsite	Onroad	0.0E+00
2023	SURF14	Offsite	Onroad	1.4E-06
2024	SURF14	Offsite	Onroad	0.0E+00
2025	SURF14	Offsite	Onroad	0.0E+00
2045	SURF14	Offsite	Onroad	0.0E+00
2018	280SON	Offsite	Onroad	1.0E-05
2019	280SON	Offsite	Onroad	5.8E-06
2020	280SON	Offsite	Onroad	5.1E-06
2021	280SON	Offsite	Onroad	4.7E-06
2022	280SON	Offsite	Onroad	0.0E+00
2023	280SON	Offsite	Onroad	4.4E-06
2024	280SON	Offsite	Onroad	0.0E+00
2025	280SON	Offsite	Onroad	0.0E+00
2045	280SON	Offsite	Onroad	0.0E+00
2018	OFF001	Offsite	Offroad	6.5E-03
2019	OFF001	Offsite	Offroad	6.5E-03
2020	OFF001	Offsite	Offroad	6.5E-03
2021	OFF001	Offsite	Offroad	6.5E-03
2022	OFF001	Offsite	Offroad	5.4E-03
2023	OFF001	Offsite	Offroad	0.0E+00
2024	OFF001	Offsite	Offroad	0.0E+00
2025	OFF001	Offsite	Offroad	0.0E+00
2045	OFF001	Offsite	Offroad	0.0E+00

Table E-8b
Year by Year Modeled $PM_{2.5}$ Emission Rates for Cumulative $PM_{2.5}$ Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	OFF002	Offsite	Offroad	6.4E-04
2019	OFF002	Offsite	Offroad	6.4E-04
2020	OFF002	Offsite	Offroad	0.0E+00
2021	OFF002	Offsite	Offroad	0.0E+00
2022	OFF002	Offsite	Offroad	0.0E+00
2023	OFF002	Offsite	Offroad	0.0E+00
2024	OFF002	Offsite	Offroad	0.0E+00
2025	OFF002	Offsite	Offroad	0.0E+00
2045	OFF002	Offsite	Offroad	0.0E+00
2018	OFF003	Offsite	Offroad	1.2E-03
2019	OFF003	Offsite	Offroad	1.2E-03
2020	OFF003	Offsite	Offroad	0.0E+00
2021	OFF003	Offsite	Offroad	0.0E+00
2022	OFF003	Offsite	Offroad	0.0E+00
2023	OFF003	Offsite	Offroad	0.0E+00
2024	OFF003	Offsite	Offroad	0.0E+00
2025	OFF003	Offsite	Offroad	0.0E+00
2045	OFF003	Offsite	Offroad	0.0E+00
2018	OFF004	Offsite	Offroad	1.0E-04
2019	OFF004	Offsite	Offroad	1.0E-04
2020	OFF004	Offsite	Offroad	0.0E+00
2021	OFF004	Offsite	Offroad	0.0E+00
2022	OFF004	Offsite	Offroad	0.0E+00
2023	OFF004	Offsite	Offroad	0.0E+00
2024	OFF004	Offsite	Offroad	0.0E+00
2025	OFF004	Offsite	Offroad	0.0E+00
2045	OFF004	Offsite	Offroad	0.0E+00
2018	OFF006	Offsite	Offroad	5.4E-04
2019	OFF006	Offsite	Offroad	5.4E-04
2020	OFF006	Offsite	Offroad	0.0E+00
2021	OFF006	Offsite	Offroad	0.0E+00
2022	OFF006	Offsite	Offroad	0.0E+00
2023	OFF006	Offsite	Offroad	0.0E+00
2024	OFF006	Offsite	Offroad	0.0E+00
2025	OFF006	Offsite	Offroad	0.0E+00
2045	OFF006	Offsite	Offroad	0.0E+00
2018	OFF009	Offsite	Offroad	7.2E-03
2019	OFF009	Offsite	Offroad	7.2E-03
2020	OFF009	Offsite	Offroad	0.0E+00
2021	OFF009	Offsite	Offroad	0.0E+00
2022	OFF009	Offsite	Offroad	0.0E+00
2023	OFF009	Offsite	Offroad	0.0E+00
2024	OFF009	Offsite	Offroad	0.0E+00
2025	OFF009	Offsite	Offroad	0.0E+00
2045	OFF009	Offsite	Offroad	0.0E+00
2018	OFF010	Offsite	Offroad	5.6E-04
2019	OFF010	Offsite	Offroad	5.6E-04
2020	OFF010	Offsite	Offroad	0.0E+00
2021	OFF010	Offsite	Offroad	0.0E+00
2022	OFF010	Offsite	Offroad	0.0E+00
2023	OFF010	Offsite	Offroad	0.0E+00
2024	OFF010	Offsite	Offroad	0.0E+00
2025	OFF010	Offsite	Offroad	0.0E+00
2045	OFF010	Offsite	Offroad	0.0E+00

Table E-8b
Year by Year Modeled $PM_{2.5}$ Emission Rates for Cumulative $PM_{2.5}$ Analysis
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Year	Modeled Groups[1]	Location	Emission Type	Emission Rate[2] (g/s)
2018	OFF011	Offsite	Offroad	8.3E-03
2019	OFF011	Offsite	Offroad	8.3E-03
2020	OFF011	Offsite	Offroad	8.3E-03
2021	OFF011	Offsite	Offroad	8.3E-03
2022	OFF011	Offsite	Offroad	8.3E-03
2023	OFF011	Offsite	Offroad	4.1E-03
2024	OFF011	Offsite	Offroad	0.0E+00
2025	OFF011	Offsite	Offroad	0.0E+00
2045	OFF011	Offsite	Offroad	0.0E+00
2018	OFF012	Offsite	Offroad	6.5E-03
2019	OFF012	Offsite	Offroad	6.5E-03
2020	OFF012	Offsite	Offroad	0.0E+00
2021	OFF012	Offsite	Offroad	0.0E+00
2022	OFF012	Offsite	Offroad	0.0E+00
2023	OFF012	Offsite	Offroad	0.0E+00
2024	OFF012	Offsite	Offroad	0.0E+00
2025	OFF012	Offsite	Offroad	0.0E+00
2045	OFF012	Offsite	Offroad	0.0E+00
2018	OFF020	Offsite	Offroad	0.0E+00
2019	OFF020	Offsite	Offroad	0.0E+00
2020	OFF020	Offsite	Offroad	0.0E+00
2021	OFF020	Offsite	Offroad	0.0E+00
2022	OFF020	Offsite	Offroad	0.0E+00
2023	OFF020	Offsite	Offroad	0.0E+00
2024	OFF020	Offsite	Offroad	0.0E+00
2025	OFF020	Offsite	Offroad	0.0E+00
2045	OFF020	Offsite	Offroad	0.0E+00

Notes:

1. Cumulative Project descriptions can be found in Table 17, and total DPM emissions can be found in Table 18b.
2. Emission rates were calculated by averaging total annual emissions over continuous operation. Hour of day restrictions were accounted for in the AERMOD model (See Appendix F).

Abbreviations:

DPM - diesel particulate matter
g/s - gram per second
PM- particulate matter
SFPUC - San Francisco Public Utilities Commission

Table E-8c
Modeled DPM Emission Rates for Cumulative Cancer Risk Analysis (Scenario 1)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Exposure Duration[1]	Modeled Groups	Location	Emission Type	Emission Rate (g/s)[2]
ER_3T	AreaB	Onsite	Offroad	4.1E-03
ER_0-2	AreaB	Onsite	Offroad	2.8E-03
ER_2-16	AreaB	Onsite	Offroad	0.0E+00
ER_16-30	AreaB	Onsite	Offroad	0.0E+00
ER_3T	AreaC	Onsite	Offroad	3.2E-03
ER_0-2	AreaC	Onsite	Offroad	1.9E-03
ER_2-16	AreaC	Onsite	Offroad	3.9E-05
ER_16-30	AreaC	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	4.2E-04
ER_0-2	AreaA	Onsite	Offroad	5.1E-04
ER_2-16	AreaA	Onsite	Offroad	8.0E-05
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	2.0E-04
ER_0-2	AreaA	Onsite	Offroad	7.5E-05
ER_2-16	AreaA	Onsite	Offroad	0.0E+00
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	0.0E+00
ER_0-2	AreaA	Onsite	Offroad	0.0E+00
ER_2-16	AreaA	Onsite	Offroad	0.0E+00
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	0.0E+00
ER_0-2	AreaA	Onsite	Offroad	0.0E+00
ER_2-16	AreaA	Onsite	Offroad	1.2E-05
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	HW_G02	Onsite	Operational	0.0E+00
ER_0-2	HW_G02	Onsite	Operational	0.0E+00
ER_2-16	HW_G02	Onsite	Operational	2.1E-04
ER_16-30	HW_G02	Onsite	Operational	2.4E-04
ER_3T	ON_G01	Onsite	Operational	4.8E-05
ER_0-2	ON_G01	Onsite	Operational	4.8E-05
ER_2-16	ON_G01	Onsite	Operational	4.8E-05
ER_16-30	ON_G01	Onsite	Operational	4.8E-05
ER_3T	ON_G02	Onsite	Operational	2.5E-05
ER_0-2	ON_G02	Onsite	Operational	2.5E-05
ER_2-16	ON_G02	Onsite	Operational	2.5E-05
ER_16-30	ON_G02	Onsite	Operational	2.5E-05
ER_3T	280NOFF	Offsite	Onroad	5.6E-06
ER_0-2	280NOFF	Offsite	Onroad	3.9E-06
ER_2-16	280NOFF	Offsite	Onroad	3.7E-07
ER_16-30	280NOFF	Offsite	Onroad	0.0E+00
ER_3T	SURF11	Offsite	Onroad	0.0E+00
ER_0-2	SURF11	Offsite	Onroad	0.0E+00
ER_2-16	SURF11	Offsite	Onroad	0.0E+00
ER_16-30	SURF11	Offsite	Onroad	0.0E+00
ER_3T	SURF12	Offsite	Onroad	0.0E+00
ER_0-2	SURF12	Offsite	Onroad	0.0E+00
ER_2-16	SURF12	Offsite	Onroad	0.0E+00
ER_16-30	SURF12	Offsite	Onroad	0.0E+00
ER_3T	SURF13	Offsite	Onroad	3.1E-06
ER_0-2	SURF13	Offsite	Onroad	2.2E-06
ER_2-16	SURF13	Offsite	Onroad	2.2E-07
ER_16-30	SURF13	Offsite	Onroad	0.0E+00

Table E-8c
Modeled DPM Emission Rates for Cumulative Cancer Risk Analysis (Scenario 1)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Exposure Duration[1]	Modeled Groups	Location	Emission Type	Emission Rate (g/s)[2]
ER_3T	SURF2	Offsite	Onroad	3.1E-06
ER_0-2	SURF2	Offsite	Onroad	2.2E-06
ER_2-16	SURF2	Offsite	Onroad	2.2E-07
ER_16-30	SURF2	Offsite	Onroad	0.0E+00
ER_3T	SURF3	Offsite	Onroad	1.5E-05
ER_0-2	SURF3	Offsite	Onroad	1.6E-05
ER_2-16	SURF3	Offsite	Onroad	1.3E-06
ER_16-30	SURF3	Offsite	Onroad	0.0E+00
ER_3T	SURF4	Offsite	Onroad	1.3E-05
ER_0-2	SURF4	Offsite	Onroad	1.3E-05
ER_2-16	SURF4	Offsite	Onroad	1.1E-06
ER_16-30	SURF4	Offsite	Onroad	0.0E+00
ER_3T	SURF7	Offsite	Onroad	1.2E-05
ER_0-2	SURF7	Offsite	Onroad	1.2E-05
ER_2-16	SURF7	Offsite	Onroad	1.0E-06
ER_16-30	SURF7	Offsite	Onroad	0.0E+00
ER_3T	SURF8	Offsite	Onroad	1.5E-05
ER_0-2	SURF8	Offsite	Onroad	1.5E-05
ER_2-16	SURF8	Offsite	Onroad	1.2E-06
ER_16-30	SURF8	Offsite	Onroad	0.0E+00
ER_3T	SURF1	Offsite	Onroad	2.0E-06
ER_0-2	SURF1	Offsite	Onroad	1.4E-06
ER_2-16	SURF1	Offsite	Onroad	1.6E-07
ER_16-30	SURF1	Offsite	Onroad	0.0E+00
ER_3T	SURF10	Offsite	Onroad	2.0E-06
ER_0-2	SURF10	Offsite	Onroad	1.4E-06
ER_2-16	SURF10	Offsite	Onroad	1.6E-07
ER_16-30	SURF10	Offsite	Onroad	0.0E+00
ER_3T	SURF14	Offsite	Onroad	2.5E-06
ER_0-2	SURF14	Offsite	Onroad	1.8E-06
ER_2-16	SURF14	Offsite	Onroad	1.9E-07
ER_16-30	SURF14	Offsite	Onroad	0.0E+00
ER_3T	SURF9	Offsite	Onroad	2.5E-06
ER_0-2	SURF9	Offsite	Onroad	2.7E-06
ER_2-16	SURF9	Offsite	Onroad	2.2E-07
ER_16-30	SURF9	Offsite	Onroad	0.0E+00
ER_3T	280SON	Offsite	Onroad	6.0E-06
ER_0-2	280SON	Offsite	Onroad	4.2E-06
ER_2-16	280SON	Offsite	Onroad	3.9E-07
ER_16-30	280SON	Offsite	Onroad	0.0E+00
ER_3T	OFF001	Offsite	Offroad	7.1E-03
ER_0-2	OFF001	Offsite	Offroad	7.1E-03
ER_2-16	OFF001	Offsite	Offroad	1.3E-03
ER_16-30	OFF001	Offsite	Offroad	0.0E+00
ER_3T	OFF002	Offsite	Offroad	6.9E-04
ER_0-2	OFF002	Offsite	Offroad	6.0E-04
ER_2-16	OFF002	Offsite	Offroad	0.0E+00
ER_16-30	OFF002	Offsite	Offroad	0.0E+00
ER_3T	OFF003	Offsite	Offroad	1.3E-03
ER_0-2	OFF003	Offsite	Offroad	1.1E-03
ER_2-16	OFF003	Offsite	Offroad	0.0E+00
ER_16-30	OFF003	Offsite	Offroad	0.0E+00
ER_3T	OFF004	Offsite	Offroad	1.1E-04
ER_0-2	OFF004	Offsite	Offroad	9.9E-05
ER_2-16	OFF004	Offsite	Offroad	0.0E+00
ER_16-30	OFF004	Offsite	Offroad	0.0E+00

Table E-8c
Modeled DPM Emission Rates for Cumulative Cancer Risk Analysis (Scenario 1)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Exposure Duration[1]	Modeled Groups	Location	Emission Type	Emission Rate (g/s)[2]
ER_3T	OFF006	Offsite	Offroad	5.9E-04
ER_0-2	OFF006	Offsite	Offroad	5.1E-04
ER_2-16	OFF006	Offsite	Offroad	0.0E+00
ER_16-30	OFF006	Offsite	Offroad	0.0E+00
ER_3T	OFF009	Offsite	Offroad	8.6E-03
ER_0-2	OFF009	Offsite	Offroad	7.6E-03
ER_2-16	OFF009	Offsite	Offroad	0.0E+00
ER_16-30	OFF009	Offsite	Offroad	0.0E+00
ER_3T	OFF010	Offsite	Offroad	5.6E-04
ER_0-2	OFF010	Offsite	Offroad	4.9E-04
ER_2-16	OFF010	Offsite	Offroad	0.0E+00
ER_16-30	OFF010	Offsite	Offroad	0.0E+00
ER_3T	OFF011	Offsite	Offroad	2.6E-02
ER_0-2	OFF011	Offsite	Offroad	2.6E-02
ER_2-16	OFF011	Offsite	Offroad	6.0E-03
ER_16-30	OFF011	Offsite	Offroad	0.0E+00
ER_3T	OFF012	Offsite	Offroad	6.8E-03
ER_0-2	OFF012	Offsite	Offroad	6.0E-03
ER_2-16	OFF012	Offsite	Offroad	0.0E+00
ER_16-30	OFF012	Offsite	Offroad	0.0E+00
ER_3T	OFF020	Offsite	Offroad	0.0E+00
ER_0-2	OFF020	Offsite	Offroad	0.0E+00
ER_2-16	OFF020	Offsite	Offroad	0.0E+00
ER_16-30	OFF020	Offsite	Offroad	0.0E+00

Notes:

1. Exposure durations represent time periods during the 3rd trimester *in utero*, from birth until age 2, ages 2 - 16, and ages 16 - 30.

2. Emission rates were calculated as the sum of emissions during the exposure time divided by the exposure duration, assuming continuous operation. Operating hours per day were accounted for in the AERMOD model (see Appendix F).

Abbreviations:

DPM - diesel particulate matter
g/s - gram per second
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission

Table E-8d
Modeled DPM Emission Rates for Cumulative Cancer Risk Analysis (Scenario 2)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Exposure Duration[1]	Modeled Groups	Location	Emission Type	Emission Rate[2] (g/s)
ER_3T	AreaB	Onsite	Offroad	0.0E+00
ER_0-2	AreaB	Onsite	Offroad	0.0E+00
ER_2-16	AreaB	Onsite	Offroad	0.0E+00
ER_16-30	AreaB	Onsite	Offroad	0.0E+00
ER_3T	AreaC	Onsite	Offroad	0.0E+00
ER_0-2	AreaC	Onsite	Offroad	1.0E-04
ER_2-16	AreaC	Onsite	Offroad	2.4E-05
ER_16-30	AreaC	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	0.0E+00
ER_0-2	AreaA	Onsite	Offroad	0.0E+00
ER_2-16	AreaA	Onsite	Offroad	0.0E+00
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	0.0E+00
ER_0-2	AreaA	Onsite	Offroad	0.0E+00
ER_2-16	AreaA	Onsite	Offroad	0.0E+00
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	0.0E+00
ER_0-2	AreaA	Onsite	Offroad	0.0E+00
ER_2-16	AreaA	Onsite	Offroad	0.0E+00
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	AreaA	Onsite	Offroad	1.7E-04
ER_0-2	AreaA	Onsite	Offroad	6.4E-05
ER_2-16	AreaA	Onsite	Offroad	0.0E+00
ER_16-30	AreaA	Onsite	Offroad	0.0E+00
ER_3T	HW_G02	Onsite	Operational	2.4E-04
ER_0-2	HW_G02	Onsite	Operational	2.4E-04
ER_2-16	HW_G02	Onsite	Operational	2.4E-04
ER_16-30	HW_G02	Onsite	Operational	2.4E-04
ER_3T	ON_G01	Onsite	Operational	4.8E-05
ER_0-2	ON_G01	Onsite	Operational	4.8E-05
ER_2-16	ON_G01	Onsite	Operational	4.8E-05
ER_16-30	ON_G01	Onsite	Operational	4.8E-05
ER_3T	ON_G02	Onsite	Operational	2.5E-05
ER_0-2	ON_G02	Onsite	Operational	2.5E-05
ER_2-16	ON_G02	Onsite	Operational	2.5E-05
ER_16-30	ON_G02	Onsite	Operational	2.5E-05
ER_3T	280NOFF	Offsite	Onroad	1.4E-06
ER_0-2	280NOFF	Offsite	Onroad	5.2E-07
ER_2-16	280NOFF	Offsite	Onroad	0.0E+00
ER_16-30	280NOFF	Offsite	Onroad	0.0E+00
ER_3T	SURF11	Offsite	Onroad	0.0E+00
ER_0-2	SURF11	Offsite	Onroad	0.0E+00
ER_2-16	SURF11	Offsite	Onroad	0.0E+00
ER_16-30	SURF11	Offsite	Onroad	0.0E+00
ER_3T	SURF12	Offsite	Onroad	0.0E+00
ER_0-2	SURF12	Offsite	Onroad	0.0E+00
ER_2-16	SURF12	Offsite	Onroad	0.0E+00
ER_16-30	SURF12	Offsite	Onroad	0.0E+00
ER_3T	SURF13	Offsite	Onroad	9.5E-07
ER_0-2	SURF13	Offsite	Onroad	3.6E-07
ER_2-16	SURF13	Offsite	Onroad	0.0E+00
ER_16-30	SURF13	Offsite	Onroad	0.0E+00

Table E-8d
Modeled DPM Emission Rates for Cumulative Cancer Risk Analysis (Scenario 2)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Exposure Duration[1]	Modeled Groups	Location	Emission Type	Emission Rate[2] (g/s)
ER_3T	SURF2	Offsite	Onroad	9.5E-07
ER_0-2	SURF2	Offsite	Onroad	3.5E-07
ER_2-16	SURF2	Offsite	Onroad	0.0E+00
ER_16-30	SURF2	Offsite	Onroad	0.0E+00
ER_3T	SURF3	Offsite	Onroad	4.5E-07
ER_0-2	SURF3	Offsite	Onroad	1.7E-07
ER_2-16	SURF3	Offsite	Onroad	0.0E+00
ER_16-30	SURF3	Offsite	Onroad	0.0E+00
ER_3T	SURF4	Offsite	Onroad	1.1E-06
ER_0-2	SURF4	Offsite	Onroad	4.3E-07
ER_2-16	SURF4	Offsite	Onroad	0.0E+00
ER_16-30	SURF4	Offsite	Onroad	0.0E+00
ER_3T	SURF7	Offsite	Onroad	1.1E-06
ER_0-2	SURF7	Offsite	Onroad	4.2E-07
ER_2-16	SURF7	Offsite	Onroad	0.0E+00
ER_16-30	SURF7	Offsite	Onroad	0.0E+00
ER_3T	SURF8	Offsite	Onroad	1.2E-06
ER_0-2	SURF8	Offsite	Onroad	4.6E-07
ER_2-16	SURF8	Offsite	Onroad	0.0E+00
ER_16-30	SURF8	Offsite	Onroad	0.0E+00
ER_3T	SURF1	Offsite	Onroad	7.6E-07
ER_0-2	SURF1	Offsite	Onroad	2.8E-07
ER_2-16	SURF1	Offsite	Onroad	0.0E+00
ER_16-30	SURF1	Offsite	Onroad	0.0E+00
ER_3T	SURF10	Offsite	Onroad	7.5E-07
ER_0-2	SURF10	Offsite	Onroad	2.8E-07
ER_2-16	SURF10	Offsite	Onroad	0.0E+00
ER_16-30	SURF10	Offsite	Onroad	0.0E+00
ER_3T	SURF14	Offsite	Onroad	8.5E-07
ER_0-2	SURF14	Offsite	Onroad	3.2E-07
ER_2-16	SURF14	Offsite	Onroad	0.0E+00
ER_16-30	SURF14	Offsite	Onroad	0.0E+00
ER_3T	SURF9	Offsite	Onroad	9.0E-08
ER_0-2	SURF9	Offsite	Onroad	3.4E-08
ER_2-16	SURF9	Offsite	Onroad	0.0E+00
ER_16-30	SURF9	Offsite	Onroad	0.0E+00
ER_3T	280SON	Offsite	Onroad	1.5E-06
ER_0-2	280SON	Offsite	Onroad	5.5E-07
ER_2-16	280SON	Offsite	Onroad	0.0E+00
ER_16-30	280SON	Offsite	Onroad	0.0E+00
ER_3T	OFF001	Offsite	Offroad	0.0E+00
ER_0-2	OFF001	Offsite	Offroad	0.0E+00
ER_2-16	OFF001	Offsite	Offroad	0.0E+00
ER_16-30	OFF001	Offsite	Offroad	0.0E+00
ER_3T	OFF002	Offsite	Offroad	0.0E+00
ER_0-2	OFF002	Offsite	Offroad	0.0E+00
ER_2-16	OFF002	Offsite	Offroad	0.0E+00
ER_16-30	OFF002	Offsite	Offroad	0.0E+00
ER_3T	OFF003	Offsite	Offroad	0.0E+00
ER_0-2	OFF003	Offsite	Offroad	0.0E+00
ER_2-16	OFF003	Offsite	Offroad	0.0E+00
ER_16-30	OFF003	Offsite	Offroad	0.0E+00
ER_3T	OFF004	Offsite	Offroad	0.0E+00
ER_0-2	OFF004	Offsite	Offroad	0.0E+00
ER_2-16	OFF004	Offsite	Offroad	0.0E+00

Table E-8d
Modeled DPM Emission Rates for Cumulative Cancer Risk Analysis (Scenario 2)
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Exposure Duration[1]	Modeled Groups	Location	Emission Type	Emission Rate[2] (g/s)
ER_16-30	OFF004	Offsite	Offroad	0.0E+00
ER_3T	OFF006	Offsite	Offroad	0.0E+00
ER_0-2	OFF006	Offsite	Offroad	0.0E+00
ER_2-16	OFF006	Offsite	Offroad	0.0E+00
ER_16-30	OFF006	Offsite	Offroad	0.0E+00
ER_3T	OFF009	Offsite	Offroad	0.0E+00
ER_0-2	OFF009	Offsite	Offroad	0.0E+00
ER_2-16	OFF009	Offsite	Offroad	0.0E+00
ER_16-30	OFF009	Offsite	Offroad	0.0E+00
ER_3T	OFF010	Offsite	Offroad	0.0E+00
ER_0-2	OFF010	Offsite	Offroad	0.0E+00
ER_2-16	OFF010	Offsite	Offroad	0.0E+00
ER_16-30	OFF010	Offsite	Offroad	0.0E+00
ER_3T	OFF011	Offsite	Offroad	2.6E-02
ER_0-2	OFF011	Offsite	Offroad	3.2E-03
ER_2-16	OFF011	Offsite	Offroad	0.0E+00
ER_16-30	OFF011	Offsite	Offroad	0.0E+00
ER_3T	OFF012	Offsite	Offroad	0.0E+00
ER_0-2	OFF012	Offsite	Offroad	0.0E+00
ER_2-16	OFF012	Offsite	Offroad	0.0E+00
ER_16-30	OFF012	Offsite	Offroad	0.0E+00
ER_3T	OFF020	Offsite	Offroad	0.0E+00
ER_0-2	OFF020	Offsite	Offroad	0.0E+00
ER_2-16	OFF020	Offsite	Offroad	0.0E+00
ER_16-30	OFF020	Offsite	Offroad	0.0E+00

Notes:

1. Exposure durations represent time periods during the 3rd trimester *in utero*, from birth until age 2, ages 2 - 16, and ages 16 - 30.
2. Emission rates were calculated as the sum of emissions during the exposure time divided by the exposure duration, assuming continuous operation. Operating hours per day were accounted for in the AERMOD model (see Appendix F).

Abbreviations:

DPM - diesel particulate matter
g/s - gram per second
PM - particulate matter
SFPUC - San Francisco Public Utilities Commission

Table E-9
Speciation Profiles for Off-Road Construction Sources
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Diesel TOG[1]

Chemical	CAS Number	Fraction of TOG[2]
1,3-butadiene	106990	0.0019
acetaldehyde	75070	0.074
benzene	71432	0.020
ethylbenzene	100414	0.0031
formaldehyde	50000	0.15
methanol	67561	3.0E-04
methyl ethyl ketone (mek) (2-butanone)	78933	0.015
m-xylene	108383	0.0061
naphthalene	91203	9.0E-04
n-hexane	110543	0.0016
o-xylene	95476	0.0034
propene	115071	0.026
p-xylene	106423	0.0010
styrene	100425	6.0E-04
toluene	108883	0.015

Gasoline Exhaust[3]

Chemical	CAS Number	Fraction of TOG[4]
1,3-Butadiene	106990	0.0055
Acetaldehyde	75070	0.0028
Benzene	71432	0.025
Ethylbenzene	100414	0.011
Formaldehyde	50000	0.016
Hexane	110543	0.016
Methanol	67561	0.0012
Methyl Ethyl Ketone	78933	0.00020
Naphthalene	91203	0.00050
Propylene	115071	0.031
Styrene	100425	0.0012
Toluene	108883	0.058
Xylenes	10605	0.048

Gasoline Evaporative[3]

Chemical	CAS Number	Fraction of TOG
Ethylbenzene	100414	0.0012
Xylenes	10605	0.0058
Toluene	108883	0.017
Hexane	110543	0.015
Benzene	71432	0.0036

Notes:
1. This speciation profile is used for acute impacts only.
2. Fractions are from USEPA Speciation Profile 3161.
3. This speciation profile is used for chronic and acute impacts.
4. Fractions are from BAAQMD 2011, Table 14, Toxic Speciation of TOG due to Tailpipe Emissions, and Table 15, Toxic Speciation of TOG due to Evaporative Losses.

Abbreviations:

BAAQMD - Bay Area Air Quality Management District

CAS - Chemical Abstract Service

SFPUC - San Francisco Public Utilities Commission

TOG - total organic gas

USEPA - United States Environmental Protection Agency

References:

United States Environmental Protection Agency (USEPA). 2014. Speciate Database, Version 4.4. February. Available at: http://www.epa.gov/ttnchie1/software/speciate/. Accessed 17 August 2015.

Table E-10
Speciation Profile for Diesel TOG for On-Road Construction Sources[1]
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Chemical	CAS Number	Fraction of TOG[2]
Acetaldehyde	75070	0.16
Benzene	71432	0.010
Formaldehyde	50000	0.085
Methyl ethyl ketone (mek) (2-butanone)	78933	0.029
Toluene	108883	0.015
Xylene, m- & p-	108383	0.0089
o-Xylene	95476	0.0032

Notes:

1. This speciation profile is used for acute impacts only.
2. All fractions are from USEPA Speciation Profile 4674.

Abbreviations:

CAS - Chemical Abstract Service
SFPUC - San Francisco Public Utilities Commission
TOG - total organic gas
USEPA - United States Environmental Protection Agency

References:

United States Environmental Protection Agency (USEPA). 2014. Speciate Database, Version 4.4. February. Available at: http://www.epa.gov/ttnchie1/software/speciate/. Accessed 17 August 2015.

Table E-11
Speciation Profile for Natural Gas for Existing Cogeneration Engine
SFPUC Biosolids Digester Facilities Project
San Francisco, CA

Chemical	CAS Number	Fraction of Organics[1]
Formaldehyde	50000	0.0081
Acetaldehyde	75070	0.0003
Benzene	71432	0.0011
Ethylbenzene	100414	0.0001

Notes:

1. All fractions are from the 2015 version of the ARB Organic Profile 719, which is the organic profile for Reciprocating Internal Combustion Engines that run on natural gas.

Abbreviations:

ARB - California Air Resources Board
CAS - Chemical Abstract Service
SFPUC - San Francisco Public Utilities Commission

References:

California Air Resources Board (CARB). 2015. Organic Chemical Profiles for Source Categories. February 11. Available at: http://arb.ca.gov/ei/speciate/speciate.htm. Accessed September 2015.

RAMBOLL ENVIRON

APPENDIX F
AERMOD MODELING FILES

(Provided on Zip Drive)

APPENDIX G
RISK CALCULATION DATABASES

(Provided on Zip Drive)