APPENDIX D
COMMUNITY-WIDE GHG EMISSIONS INVENTORY AND FORECASTS MEMO

City of San José:

Draft Community-wide Emissions Inventory and Forecasts Memorandum

This memorandum (memo) describes the 2014 San José community-wide greenhouse gas (GHG) inventory update and emissions forecasts. Staff from AECOM, David J. Powers & Associates, and Hexagon Transportation Consultants (collectively referred to as the project team) worked with City of San José staff to develop the inventory information presented herein. This memo first describes the environmental and policy context that provide a purpose for the GHG inventory. The memo then presents a summary of the inventory and forecast results and their comparison to the City's previous 2008 inventory. The technical methodologies applied to develop emissions estimates for each sector are then presented, including data sources and collection and the quantification methodologies. The memo then presents the 2014 inventory in greater detail with figures, tables, and narrative text. Next, the memo presents a comparison of the 2008 and 2014 inventories, with a sector-by-sector description of where technological methodologies varied in the two inventories. Finally, the emissions forecasts for the 2020, 2030, and 2040 planning horizon years are presented. Attachment A provides data tables that support quantification of the emissions estimates presented throughout this memo. Attachment B provides additional calculation explanations related to the solid waste sector emissions.

SCIENTIFIC AND POLICY CONTEXT

Climate Science Overview

Unlike emissions of criteria pollutants (six common air pollutants including nitrogen dioxide, carbon monoxide, ozone, sulfur dioxide, particulate matter, and lead) and toxic air pollutants, which have local or regional impacts, GHG emissions have a broader, global impact. Global warming is a process whereby GHGs accumulating in the atmosphere contribute to an increase in the temperature of the earth's atmosphere. The principal GHGs contributing to global warming are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated compounds.

Greenhouse gases allow visible and ultraviolet light from the sun to pass through the atmosphere, but they prevent heat from escaping back out into space, in a process known as the 'greenhouse effect'. Human-caused emissions of these GHGs in excess of natural ambient concentrations are understood to be responsible for intensifying the greenhouse effect, and have led to an alteration of the energy balance transfers between the atmosphere, space, land, and the oceans and a trend of unnatural warming of the earth's climate. According to the Intergovernmental Panel on Climate Change (IPCC), it is extremely unlikely that global climate change of the past 50 years can be explained without the contribution from human activities.

Greenhouse Gas Reduction Strategy

In 2005, Governor Schwarzenegger signed Executive Order (EO) S-3-05, which recognizes California's vulnerability to a reduced snowpack, exacerbation of air quality problems, and potential sea-level rise due to a changing climate. To address these concerns, the Governor established targets to reduce statewide GHG emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80% below 1990 levels by 2050. In 2006, California became the first state in the country to adopt a statewide GHG reduction target, through the adoption of Assembly Bill 32 (AB 32). This law codifies the EO S-3-05 requirement to reduce statewide emissions to 1990 levels by 2020. Then, in early 2015, Governor Brown signed EO B-30-

15 to establish an interim target between the 2020 and 2050 targets, calling for reductions of 40% below 1990 levels by 2030. Senate Bill 32, California Global Warming Solutions Act of 2006 (SB 32) was signed by the Governor on September 8, 2016.

In November 2011, the City adopted the Envision San José 2040 General Plan and certified an associated Program Environmental Impact Report (EIR). The potential impact of GHG emissions and climate change related to the implementation of the General Plan were analyzed in the EIR. The EIR studied the underlying causes of climate change; included forecasts of the City's potential future GHG emissions; and identified measures the City is taking to limit its contribution to cumulative GHG emissions. As a result of this analysis, the City adopted a Greenhouse Gas Reduction Strategy as a part of the General Plan.

The Greenhouse Gas Reduction Strategy establishes the City of San José's approach to establishing greenhouse gas reduction targets, including reduction measures and actions largely contained in the Envision San José 2040 General Plan.

Envision San José 2040 General Plan 4-Year Review

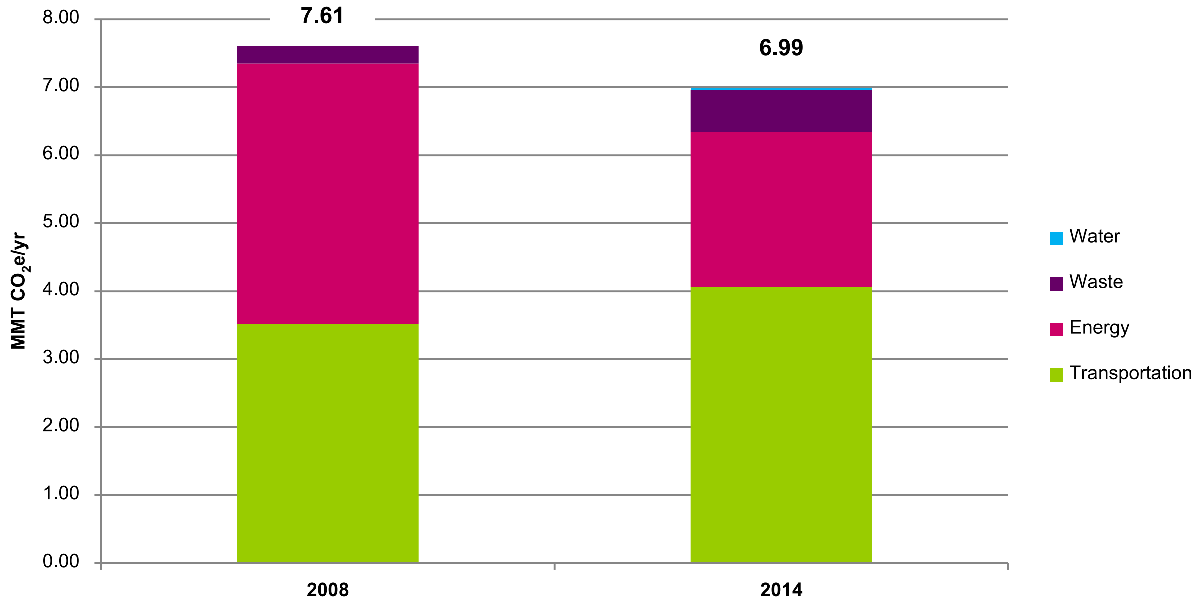
Per Implementation Policy IP-2.4 of the Envision San José 2040 General Plan, the City's achievement of GHG emission reduction goals and targets should be evaluated during the 4-Year Review. As mentioned above, this memo compares San Jose's GHG emissions in 2008, prepared during the Envision San José 2040 General Plan update process, and in 2014, after four years of implementing the Plan.

Additionally, as part of the California Environmental Quality Act (CEQA) analysis for the General Plan 4-Year Review, the project team projected GHG emissions under the adjusted 2040 proposed land use scenario recommended by the 4-Year Review Task Force (e.g., Jobs to Employed Resident Ratio of 1:1). In the event the results of the GHG projections do not meet the City targets for GHG reductions, mitigation measures, in the form of additional high-level GHG reduction strategies, will be identified to help achieve the City's long-term GHG emissions target.

INVENTORY AND FORECASTS SUMMARY

San José's 2014 community inventory totals 6.99 million metric tons of carbon dioxide equivalent (MMT CO_2e). More than half of the emissions come from vehicle use within the community. Another one-third of emissions come from community-wide energy use. Together these two sectors represent 90% of total emissions. Waste emissions (including solid waste disposal and wastewater treatment) contribute approximately 9% of total emissions, while potable water consumption provides the remainder. In 2008, San José's community inventory totaled 7.61 MMT CO_2e/yr. As shown in Figure 1 on the following page, transportation emissions increased 15% from 2008 to 2014, primarily as a result of population and employment growth. Energy emissions decreased by 41% through implementation of energy efficiency programs and use of cleaner electricity sources. Waste emissions also decreased since 2008, although discrepancies in the underlying emissions calculations from 2008 explain much of the difference. Finally, the 2008 inventory did not include water-related emissions, which were added for 2014 to provide a more complete assessment of community-generated emissions. Since 2008, community emissions have decreased 8.1%, while population has increased 2.2% and service population has increased 0.9%.

Figure 1 – 2008 and 2014 Community Inventory Comparison



Note: MMT CO_2e/yr = million metric tons of carbon dioxide equivalent per year

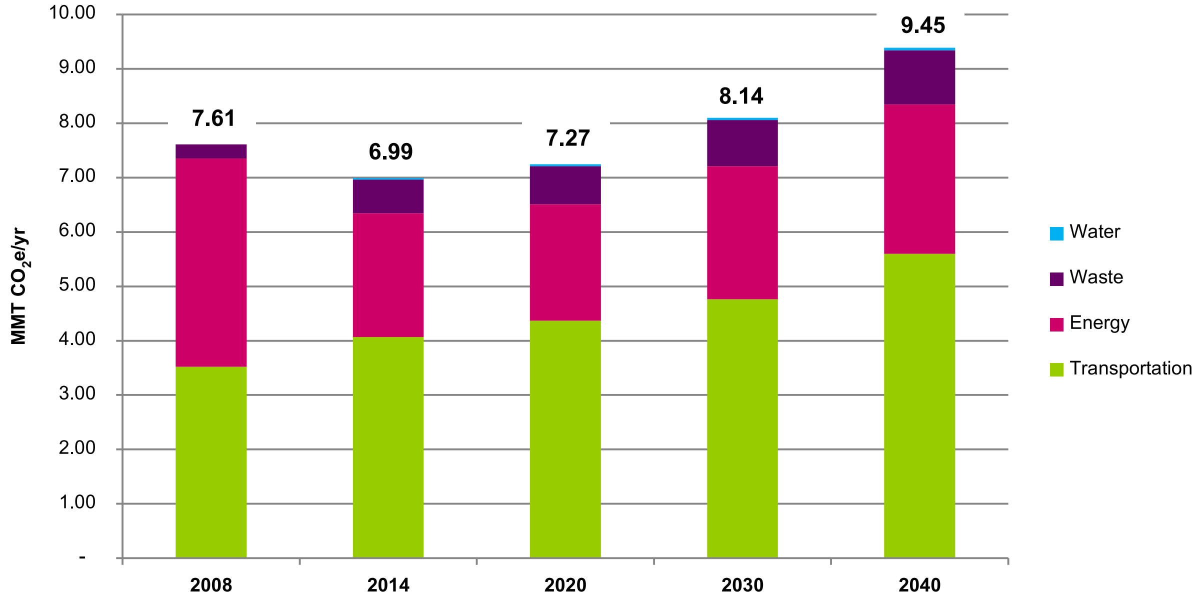
Figure 2 shows the result of the business-as-usual emissions forecasts through the 2040 planning horizon year. This scenario estimates how emissions will grow in the community if resource consumption patterns from the 2014 base year continue into the future (e.g., electricity consumption and tons of solid waste disposed per capita remain constant). This forecast scenario does not assume implementation of statewide policies and programs that will serve to reduce local GHG emissions. As shown, emissions are forecast to increase 91% from the 2014 inventory update year through the year 2040.

Figure 2 – Business-as-Usual Emissions Forecasts

Note: MMT CO_2e/yr = million metric tons of carbon dioxide equivalent per year

This analysis also considered the likely impact of several statewide actions designed to reduce GHG emissions, including programs that target on-road vehicle emissions and electricity emissions. The result of this analysis is the adjusted business-as-usual forecast scenario shown in Figure 3. In this scenario, the community's emissions will continue to grow, but at a slower rate than in the business-as-usual scenario shown in Figure 2. Emissions are forecast to increase 35% from 2014 levels by the year 2040.

Figure 3 – Adjusted Business-as-Usual Emissions Forecasts



Note: MMT CO_2e/yr = million metric tons of carbon dioxide equivalent per year

2014 INVENTORY METHODOLOGY

Data Collection and Analysis

The project team and staff from the City of San José collected data from various City departments, private entities (e.g., PG&E), and other government entities (e.g., Association of Bay Area Governments [ABAG]) that provide services within the community. Data collection efforts were focused on community-wide activities (e.g., electricity consumption within the city) that occurred in 2014. Community-wide activities span all land uses (e.g., residential, commercial, and industrial) located within the legal boundaries of the city.

The project team used emissions factors recommended by California Air Resources Board (ARB), Bay Area Air Quality Management District (BAAQMD), the California Climate Action Registry, US Environmental Protection Agency (EPA), the Intergovernmental Panel on Climate Change (IPCC), and the Pacific Gas and Electric Company (PG&E), to estimate community-wide emissions. It should be noted that emission factors are continually refined and improved to reflect better measurement technology and research; these factors reflect the best available information at the time the inventory was prepared and in some instances differ from those used in the 2008 inventory. As shown in Attachment A, data supporting the community-wide inventory are provided to assist with future inventory update comparisons.

Emission Sectors

This 2014 inventory update was prepared based on guidance provided in the ICLEI *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions Version 1.1* (Community Protocol). The Community Protocol defines five basic emissions generating activities that must be included in all protocol-compliant emissions inventory reports. These required activities include:

- Use of electricity by the community,
- Use of fuel in residential and commercial stationary combustion equipment,
- On-road passenger and freight motor vehicle travel,
- Use of energy in potable water and wastewater treatment and distribution, and
- Generation of solid waste by the community.

In addition to these five required activities, cities may optionally include other emissions activities in their inventory as deemed relevant to their community. To allow closer comparison to the City's previous community inventory, the 2014 inventory update includes several additional emissions activities that were included in the 2008 community inventory, including:

- Off-road vehicles (boats, aircraft support equipment, public transit trains),
- Off-road equipment (e.g., forklifts, lawn mowers), and
- Wastewater treatment process emissions.

The following sections describe the data sources, quantification methods, and data limitations within each emission sector included in the 2014 inventory update.

Energy Consumption – Electricity and Natural Gas

The energy consumption sector includes the use of electricity and natural gas by all land uses within the legal boundaries of the city. Although emissions associated with electricity production are likely to occur in a different jurisdiction, consumers are considered accountable for the generation of those emissions. Therefore, electricity related GHGs are considered indirect emissions. For example, a San José resident may consume electricity within the city that was generated in a different region. Natural gas emissions, however, are considered a direct emission because the combustion activity directly generates the emissions at the point of consumption (e.g., within a home for heating or cooling purposes).

Data Sources

PG&E provides electricity and natural gas to residents and businesses in San José, and provided electricity and natural gas consumption data to the project team for the 2014 calendar year. PG&E provided all electricity and natural gas consumption data in the form of kilowatt-hours per year (kWh/yr) and therms per year (therms/yr). PG&E also provided electricity and natural gas emissions factors specific to the data year (i.e., 2014). See Attachment A for the 2014 PG&E energy consumption data and emissions factors used in this inventory update.

Quantification Methodology

The non-direct access electricity-related GHG emissions were quantified using a PG&E-specific emission factor that accounts for the 2014 PG&E electricity production portfolio. PG&E provided a 2014 emissions factor expressed as pounds of carbon dioxide per kWh (lbs CO_2/kWh). The project team collected additional information to account for electricity-related methane (CH_4) and nitrous oxide (N_2O) emissions. The project team collected

CH_4 and N_2O emissions factors from the eGRID 2012 dataset (the most current dataset available at time of inventory preparation) for the CAMX-WECC California subregion. These factors were expressed as lbs/gigawatt hour (lbs/GWh). The project team used global warming potential (GWP) factors from the UN International Panel on Climate Change (IPCC) Fourth Assessment Report to convert the CH_4 and N_2O emissions factors into carbon dioxide equivalent (CO_2e)[1]; GWP values of 25 and 298 were applied to the CH_4 and N_2O emissions factors, respectively.[2] Finally, the project team added the emissions factors from each of the three chemicals to calculate a 2014 electricity factor expressed in terms of CO_2e/kWh.

The project team developed a second electricity emissions factor using the same process described above with all three inputs (i.e., CO_2, CH_4, N_2O) collected from eGRID 2012 for the CAMX-WECC California subregion. This regional electricity factor was applied to the direct access electricity category because PG&E transmits but does not generate electricity consumed by those customers. While the precise source of electricity used in the direct access segment is unknowable, the CAMX-WECC factor was selected as a proxy for this segment following discussions with PG&E staff.

Natural gas GHG emissions were also quantified using a PG&E-specific natural gas emission factor.

Electricity and natural gas activity data (e.g., kWh/yr and therms/yr) were then multiplied by their corresponding emissions factors to calculate total emissions from each energy source expressed as metric tons of carbon dioxide equivalent (MT CO_2e).

Mobile Sources

The mobile sources sector includes the on-road transportation and off-road vehicle and equipment subsectors. The on-road transportation subsector consists of on-road vehicles that would travel along local roadways and freeways. Off-road vehicles, which are discussed in greater detail below, include boating, public transit trains, and airport ground support equipment (GSE) (excluding aircraft operations). The off-road equipment subsector represents equipment use for lawn and garden, construction, industrial, and light commercial applications.

On-Road Vehicles

The on-road vehicles sub-sector includes exhaust-related GHG emissions associated with on-road vehicles coming to and leaving from the City of San José. Vehicle trips were distinguished by their origin and destination as being internal (i.e., within city limits) or external (i.e., outside of city limits). For the purposes of this GHG inventory and pursuant to the California Air Resources Board (ARB) Regional Targets Advisory Committee (RTAC) prescribed methods, only the internal-internal and external-internal vehicle trips were included in the City's inventory.[3] That is, if a vehicle trip originated and terminated within city limits, it would be considered an internal-internal trip. If a trip originated within city limits and terminated outside of city limits, or vice versa, it would be considered an internal-external trip (or an external-internal trip). If a trip neither originated nor terminated within city limits, but passed through city limits, the vehicle miles traveled (VMT) associated with this external-external trip would be omitted from the inventory because the jurisdiction has no control over the trip, and therefore is not responsible.

One hundred percent of VMT associated with internal-internal trips were included in the inventory. RTAC recommends that a jurisdiction take responsibility for half of the VMT if a trip would originate or terminate in its jurisdiction. Therefore, 50% of

[1] CH_4 and N_2O have significantly stronger greenhouse gas effects than CO_2.

[2] The 2008 inventory used the following GWP values from the IPCC Second Assessment Report: CH_4 = 21; N_2O = 310

[3] Regional Targets Advisory Committee (RTAC). 2009. Recommendations of the Regional Targets Advisory Committee (RTAC) Pursuant to Senate Bill 375: Report to the California Air Resources Board. Available: <http://www.arb.ca.gov/cc/sb375/rtac/report/092909/finalreport.pdf>

the internal-external and external-internal VMT were included in the inventory. All external-external trips and VMT were omitted from San José's inventory.

Data Sources

The project team's transportation planning consultant, Hexagon, developed VMT data for the inventory update based on a city-specific traffic model developed in support of the City's ongoing General Plan 4-Year Review. The travel demand model was developed to determine the VMT from the three previously described vehicle trip types: Internal-Internal (I-I), Internal-External (I-E), and External-Internal (E-I), where "internal" represents an origin or destination within the city and "external" represents any origin or destination outside of the city boundaries. The project team processed the travel demand model outputs to include all I-I VMT and 50% of I-E and E-I VMT pursuant to the previously described RTAC methodology. As discussed above, all External-External VMT (i.e., pass-through trips) were excluded from the inventory in order to avoid counting pass-through trips for which jurisdictions are not responsible and over which they have no control. The project team developed annual VMT by speed bin for year 2015 (corresponding with the base year in the General Plan update traffic demand model) and year 2040 (corresponding to the 2040 General Plan horizon year). The City's on-road transportation annual VMT was estimated using a linear backcast between the 2015 and 2040 VMT data points to estimate a 2014 VMT value to align with the inventory update year. The estimation assumed linear growth from 2015 through 2040 (with the linear trajectory extended to year 2014), and year 2015 speed bin distributions were used to estimate 2014 on-road transportation emissions.

Quantification Methodology

Emission factors for the on-road transportation sector were obtained from ARB's vehicle emissions model, EMFAC2014. EMFAC2014 is a mobile source emission model for California which provides vehicle emission factors by county, vehicle class, operational year, and speed bin. For the emissions inventory, Santa Clara County emission factors for operational year 2014 were used. County-wide fleet emission factors for each speed bin were weighted by VMT for each vehicle class. In other words, emissions factors for vehicle classes that represent a higher percentage of VMT for a particular speed bin would be weighted according to their relative VMT proportion for that speed bin. The result was a weighted emission factor for each speed bin that represents all vehicle classes weighted by VMT within the County. Pursuant to US Environmental Protection Agency guidance, CO_2e emissions were calculated by dividing CO_2 emissions by 0.95, which accounts for other GHGs such as nitrous oxide (N_2O), methane (CH_4), and other high global warming potential gases.[4]

Off-Road Vehicles

The off-road vehicles subsector includes boating activities, airport GSE, and public transit trains.

Data Sources

For boating activities, City staff provided total Santa Clara County boating activities occurring in 2014. Activities included annual attendance records at the various parks for power boats, personal watercrafts, and non-power boats. The parks that are located within city limits include all of Calero Park and half of Anderson Lake.

For airport GSE, City staff provided 2014 annual fuel consumption for GSE at the Norman Y. Mineta San Jose International Airport (SJC).

[4] USEPA. 2005. Emission Facts: Greenhouse Gas Emission from a Typical Passenger Vehicle. Available: <http://www.epa.gov/oms/climate/420f05004.htm>.

For public transit trains (i.e., Caltrain, Alamont Corridor Express [ACE], and Amtrak [Capitol Corridor]), City staff provided 2014 activities and infrastructure for the trains, including pass-by trips and train miles within city limits. The average daily ridership per train for each of the three public transit trains was obtained from the respective operating company websites.[5,6,7] The project team updated the associated emissions factor that was used in the 2008 inventory with a current value (expressed as lb CO_2e/passenger mile).

Quantification Methodology

ARB's off-road equipment emissions model, OFFROAD, was used to estimate total GHG emissions associated with boating in Santa Clara County in year 2014. OFFROAD provides emissions for CO_2, N_2O, and CH_4 by boat type. The total Santa Clara County boating emissions for power boats, personal watercrafts, and non-power boats were allocated to the City using the proportion of recorded attendances at parks located within the city out of the total Santa Clara County.

For airport GSE, emission factors for diesel and gasoline fuel combustion were obtained from the California Climate Action Registry's (CCAR) General Reporting Protocol Version 3.1.[8] Annual fuel consumption was multiplied by the corresponding emission factors for CO_2, N_2O, and CH_4.

Train emissions were developed using the same methods as those described for the City's 2008 Emissions Inventory. 2014 activity and infrastructure parameters, including pass-by trips, average daily ridership, and train miles within city limits, were multiplied by a passenger mile CO_2e emissions factor.

Off-Road Equipment

This sub-sector includes emissions associated with off-road equipment used in construction, light commercial, industrial, and lawn and gardening operations.

Data Sources

Data for construction, light commercial, industrial, and lawn and gardening equipment were obtained from the ARB model OFFROAD2007, which provides county-level emissions factors for off-road equipment.[9] OFFROAD uses a multitude of factors and indicators to estimate and project off-road equipment activity levels. This includes, but is not limited to population, statewide rules and regulations, academic studies, growth forecasts, existing ARB reporting systems (e.g., Diesel Off-Road On-Line Reporting System [DOORS]), and non-compliance estimates.[10] The project team collected demographic data describing city and county population, households, and local jobs.

Quantification Methodology

ARB's OFFROAD2007 model was used to quantify GHG emissions associated with the previously identified off-road equipment sources. Demographic and economic indicators were used to allocate San José's proportional

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[5] Caltrain. 2014. February 2014 Caltrain Annual Passenger Counts Key Findings. Available: <http://www.caltrain.com/Assets/_MarketDevelopment/pdf/2014+Annual+Passenger+Count+Key+Findings.pdf>. Accessed March 2, 2016.

[6] Santa Clara Valley Transportation Authority. 2014. Transit Operations Performance Report: 2014 Annual Report. Available: <http://www.vta.org/sfc/servlet.shepherd/document/download/069A0000001ePEjIAM>. Accessed March 2, 2016.

[7] Capitol Corridor Joint Powers Authority. 2015. Capitol Corridor Performance Report 2015. Available: <http://www.capitolcorridor.org/downloads/performance_reports/CCJPA_Performance2015.pdf>. Accessed March 2, 2016.

[8] California Climate Action Registry (CCAR). General Reporting Protocol, Version 3.1. Available: <http://sfenvironment.org/sites/default/files/fliers/files/ccar_grp_3-1_january2009_sfe-web.pdf>. Accessed March 2, 2016.

[9] CARB. 2006 (December). Off-Road Emissions Inventory. Available: <http://www.arb.ca.gov/msei/offroad/offroad.htm>.

[10] Additional information regarding the assumptions and factors used to estimate OFFROAD activity levels can be found at: <http://www.arb.ca.gov/msei/categories.htm>

share of total county-wide emissions for each of the four off-road equipment sources included in the inventory update. The ratio of San José's households plus jobs compared to county-wide values was used to allocate the city's share of emissions from lawn and garden equipment. The ratio of jobs in the city compared to the entire county was used to allocate emissions from construction, industrial, and light commercial equipment.

Wastewater Treatment

The wastewater sector includes emissions resulting from wastewater treatment processes and discharge of treated wastewater. Wastewater treatment process emissions include methane emissions from treatment of influent biochemical oxygen demand (BOD) in the wastewater treatment lagoons and fugitive methane and nitrous oxide (N_20) emissions during combustion of digester gas. Following treatment, discharged effluent contains nitrogen that can form N_2O emissions. These process emissions are considered indirect, Scope 2 emissions associated with the community-wide inventory. Energy-related emissions for the operation of the San Jose-Santa Clara Regional Wastewater Facility (SJSC-RWF) are included in the PG&E-provided energy data (i.e., electricity and natural gas) and represented in the previously described energy consumption sector.

Data Sources

City staff provided annual influent and effluent volumes, average influent BOD, and average effluent nitrogen content data for the 2014 base year. City staff provided these data for the entire SJSC-RWF, which also serves residents and businesses in the City of Santa Clara and other jurisdictions, in addition to San José's residents and businesses. The population estimate used to calculate digester gas production represents the total population served by the SJSC-RWF and is reported on the SJSC-RWF website.[11]

Quantification Methodology

The Community Protocol equations WW.6 and WW.12 were used to quantify CH_4 and N_2O emissions from influent BOD treatment at lagoons and discharged effluent, respectively. Generation of CH_4 depends on the BOD of influent liquid and the type of treatment system, while generation of N_2O depends on the nitrogen content of effluent discharged from the facility. Generation of both types of emissions also depend on the amount of annual influent and effluent (i.e., volume of wastewater received and discharged, respectively).

Community Protocol equations WW.1.(alt) and WW.2.(alt) were used to calculate fugitive methane and nitrous oxide emissions resulting from incomplete digester gas combustion. The equations include several default inputs to estimate digester gas production based on the service population of the wastewater facility. Digester gas is combusted in engines that primarily generate biogenic CO_2 emissions, which are not included in GHG inventories; however, a small portion of digester gas escapes as fugitive emissions. Default values from the Community Protocol equations were used to estimate digester gas generation and the destruction efficiency of engines combusting the digester gas.

Solid Waste

The solid waste sector includes CO_2 and CH_4 emissions associated with solid waste disposal. During the solid waste decomposition process, CO_2 emissions are generated under aerobic conditions (i.e., in the presence of oxygen) and CH_4 emissions are generated under anaerobic conditions (i.e., in the absence of oxygen). Solid waste disposal activities also generate GHG exhaust emissions associated with waste management vehicles; however, these vehicle-related emissions are represented in the mobile sources sector.

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[11] City of San José. 2016. San José-Santa Clara Regional Wastewater Facility. Available: <https://www.sanjoseca.gov/Index.aspx?NID=1663>. Accessed March 7, 2016.

Data Sources

City staff provided San José's baseline solid waste disposal data in tons per year. The statewide waste characterization study was used to estimate the proportion of different waste types within the City's solid waste stream.

Quantification Methodology

Solid waste emissions were modeled using the methane commitment model outlined in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Attachment B documents the data inputs, equations, and assumptions used to estimate the 2014 solid waste emissions (as well as emissions for the 2020, 2030, and 2040 planning horizon years).

Potable Water

The water emissions sector includes energy-related emissions associated with the pumping, treatment, conveyance, and distribution of potable water for land uses within the city. Three water companies provide potable water service to the city's residents and businesses, including the City-owned Municipal Water System (MWS), the Great Oaks Water Company (GOWC), and the San José Water Company (SJWC).

Data Sources

City staff provided the project team with a water supply assessment memo that was prepared in support of the General Plan 4-year review. The memo (*Summary Review Regarding Water Supply for Envision San José 2040* prepared by Schaaf & Wheeler) includes a table describing total water consumption by water supplier from 2012-2015. The 2014 water supply values were used in this inventory analysis. It should be noted that SJWC does not separate water demand by customer area, so isolating San José customers from their total water supply value was not possible. The project team contacted SJWC staff separately to discuss specific data needs for the inventory update and were told that San José-specific consumption values could not be obtained given the company's database constraints, consistent with Schaaf & Wheeler's finding in the water supply assessment memo. Water supply sources (e.g., groundwater, surface water) were obtained from each water provider's 2010 Urban Water Management Plan. Potable water process energy intensity values were obtained from the report *Embedded Energy in Water Studies – Study 2: Water Agency Function Component Study and Embedded Energy-Water Load Profiles* prepared by GEI Consultants/Navigant Consulting for the California Public Utilities Commission (CPUC). Appendix B of the report provides water agency profiles. The electricity emissions factor applied to the potable water sector comes from the US EPA's eGRID 2012 analysis for the CAMX subregion (WECC California).

Quantification Methodology

This sector uses equation WW.14.1 from the Community Protocol to estimate energy-related emissions from water consumption. Total water consumption in 2014 was multiplied by water supply source ratios to calculate the total water consumption by source by water provider shown in Table 1 on the following page.

Table 1 Water Supply Source by Provider				
Water Provider	**Groundwater (MG)**	**Surface (MG)**	**Recycled (MG)**	**Total (MG)**
Great Oaks Water Company	3,475	-	-	3,475
San José Water Company	15,944	25,595	420	41,959
Municipal Water Service	188	5,145	941	6,274
Total	19,607	30,740	1,361	51,707

Note: MG = million gallons

Source: Total water for each provider from *Summary Review Regarding Water Supply for Envision San Jose 2040*, Table 7, Schaaf & Wheeler, March 2016. Available online: <http://www.sanjoseca.gov/DocumentCenter/View/55130#page=7> Water supply sources by provider calculated by AECOM based on providers' 2010 Urban Water Management Plans.

Per the Community Protocol guidance, water supply energy intensity values were acquired from the CPUC-sponsored water study referenced above. However, of the City's three water providers, only SJWC was profiled in the study. This analysis assumes that the energy intensities provided for SJWC are representative of the other two water providers. Further, the study provides energy information for five segments of the water process, whereas the Community Protocol equation references four segments in its equation. Table 2 below shows how the CPUC study segments were assumed to correlate to the Community Protocol equation terms.

Table 2 Water Process Segments	
CPUC Study Segment	**Community Protocol Equation Term**
Groundwater	Extraction
Booster Pumps	Distribution/Conveyance
Raw Water Treatment	Distribution/Conveyance
Water Treatment	Treatment
Pressure System Pumps	Distribution/Conveyance

The CPUC study did not provide annual averages for energy intensity by water process phase, but instead provided summer and winter information as High Water Demand Day, Low Water Demand Day, and Average Water Demand Day, as well as Summer Peak Energy Demand Day. For purposes of this analysis, the summer and winter Average Water Demand Day information was averaged to create an Annual Average Water Demand Day as shown in Table 3 on the following page.

Table 3 Energy Intensity in Water Supply – San Jose Water Company				
Segment	**ICLEI Equation Term**	**Avg. Summer (kWh/MG)**	**Avg. Winter (kWh/MG)**	**Annual Average (kWh/MG)**
Groundwater	Extraction	1,548	3,421	2,485
Booster Pumps	Distribution/Conveyance	1,340	533	937
Raw Water Pump	Distribution/Conveyance	3	-	2
Water Treatment	Treatment	39	26	33
Pressure System Pumps	Distribution/Conveyance	48	9	29

Note: kWh = kilowatt hour; MG = million gallons

Source: Avg. Summer and Avg. Winter values from *Embedded Energy in Water Studies – Study 2: Water Agency Function Component Study and Embedded Energy-Water Load Profiles, Appendix B,* pg 280-297, GEI Consultants/Navigant Consulting, August 2010. Available online: <ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%202/Appendix%20B%20-%20Agency%20Profiles%20-%20FINAL.pdf> Adapted by AECOM 2016.

Water process segment emissions were calculated separately and summed for the sector total. Per the Community Protocol, extraction emissions only apply to groundwater use and treatment emissions only apply to surface water use. Therefore, extraction segment emissions were calculated by multiplying total groundwater use by the extraction energy factor by the eGRID electricity factor; treatment segment emissions were calculated by multiplying total surface water by the treatment energy factor by the eGRID electricity factor; and, distribution/conveyance emissions were calculated by multiplying total water consumption by the distribution/conveyance energy factor by the eGRID electricity factor.

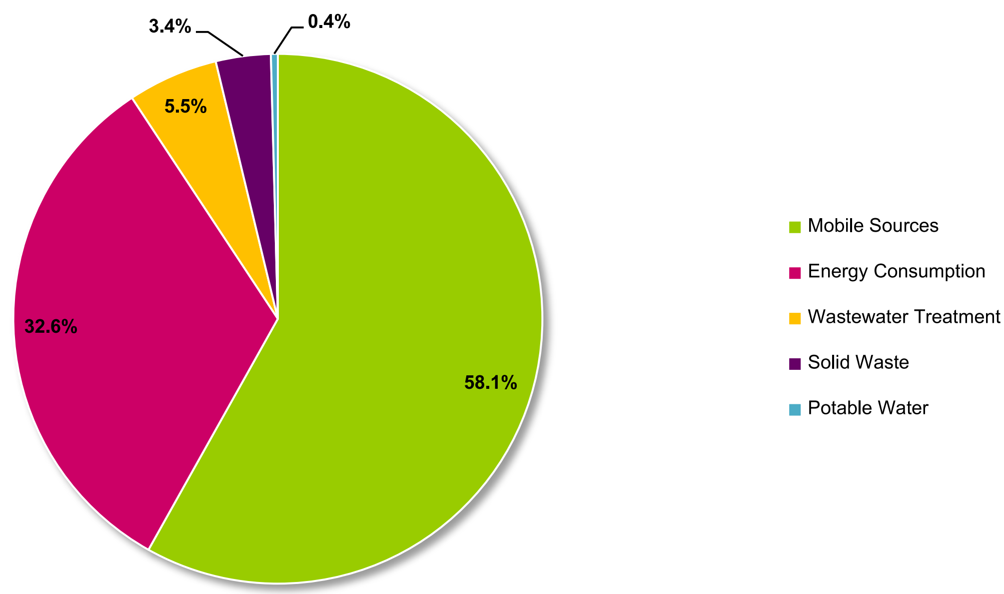
Recycled water contributed approximately 2.5% of total water consumption in 2014. However, the Community Protocol does not provide a methodology for assessing energy use related to recycled water use; it only considers groundwater and surface water. For purposes of this analysis, recycled water was combined with surface water since it does not require energy use associated with groundwater pumping. Further, the Community Protocol equation to calculate emissions from the water treatment segment is intended to address energy use associated with treating surface water to potable water standards; not to consider the energy required to treat wastewater to recycled water standards. In San José, the South Bay Water Recycling (SBWR) main pump station receives tertiary-treated water from the adjacent SJSC-RWF, which is located within the city boundary. Therefore, the project team assumes that the energy required to produce the recycled water distributed by SBWR is included in the total energy consumption of the SJSC-RWF, which is included in the inventory's energy sector.

It should be noted that SJWC was unable to provide information specific to their San José customers for use in this analysis. Therefore, the project team analyzed the energy-related emissions resulting from the total SJWC water supply (i.e., San José and surrounding jurisdictions), resulting in an overestimate of the community's emissions in this sector. However, given the relatively small contribution of potable water emissions to the total inventory, this overestimate does not substantially influence the inventory results. City-specific water consumption information from SJWC may be available for future inventory updates and would help to further refine the community inventory.

GHG Emissions Inventory

The City of San José's 2014 GHG inventory totals 6.99 MMT CO_2e/yr. Mobile sources and energy consumption are the largest emissions sectors, contributing 91% of total emissions; mobile sources are the largest sector, contributing more than half of all emissions (58%), while energy consumption contributes one-third of total emissions (33%). Waste-related emissions are the next largest contributor with wastewater treatment plant operations and the disposal of solid waste contributing 9% of total emissions combined. The consumption of potable water provides the remaining community-wide emissions, totaling less than 1%. Figure 4 below illustrates the community's emissions by sector.

Figure 4 – 2014 Community-wide Emissions by Sector



For informational purposes, per capita and per service population (SP) emission rates for San José were calculated using population and jobs estimates for the community. Table 4 below shows demographic information collected for this analysis.

Table 4
Demographic Data

Year	2008	2014	2015	2040
Population	985,307 [1]	1,007,162 [2]	1,010,805 [3]	-
Jobs	369,450 [1]	359,128 [4]	374,225 [5]	751,650 [5]
Service Population	1,354,757	1,366,290	-	-

Source: AECOM 2016

Note: Service Population = Population + Jobs

[1] General Plan EIR Appendix K - Greenhouse Gas Emissions, Table 3-5 Development of County-to-City Scaling Factors for Off-Road Equipment Emissions

[2] Linear interpolation between 2008 and 2015 values

[3] City of San José, 2016

[4] Linear backcast from 2015 and 2040 values

[5] David J. Powers & Associates, 2016

Table 5 shows the 2014 community emissions in MT CO_2e/yr for each sector and sub-sector. The 2014 population and service population values shown in Table 4 were used to calculate the community emissions efficiency rates provided at the bottom of Table 5. In 2014, San José generated approximately 6.94 MT CO_2e/yr/capita and 5.12 MT CO_2e/yr/SP.

Table 5
San José 2014 Community-wide GHG Emissions Inventory

Emission Sector/Subsector	Emissions (MT CO_2e/yr)	Percent of Total (%)
Mobile Sources	**4,065,263**	**58.1%**
On-Road Vehicles	*3,745,113*	*53.6%*
Off-Road Vehicles (ships, trains, aircraft equipment)	*27,946*	*0.4%*
Off-Road Equipment	*292,204*	*4.2%*
Energy Consumption	**2,277,002**	**32.6%**
Electricity	1,330,968	19.0%
Residential	*362,447*	*5.2%*
Non-residential	*581,639*	*8.3%*
Direct Access	*386,882*	*5.5%*
Natural Gas	946,033	13.5%
Residential	*538,218*	*7.7%*
Non-residential	*407,816*	*5.8%*
Solid Waste	**234,620**	**3.4%**
Wastewater Treatment	**386,213**	**5.5%**
Potable Water	**29,530**	**0.4%**
TOTAL	**6,992,628**	**100.0%**
Emissions Per Capita – 2014 (MT CO_2e/capita/yr)	6.94	
Emissions Per Service Population – 2014 (MT CO_2e/SP/yr)	5.12	

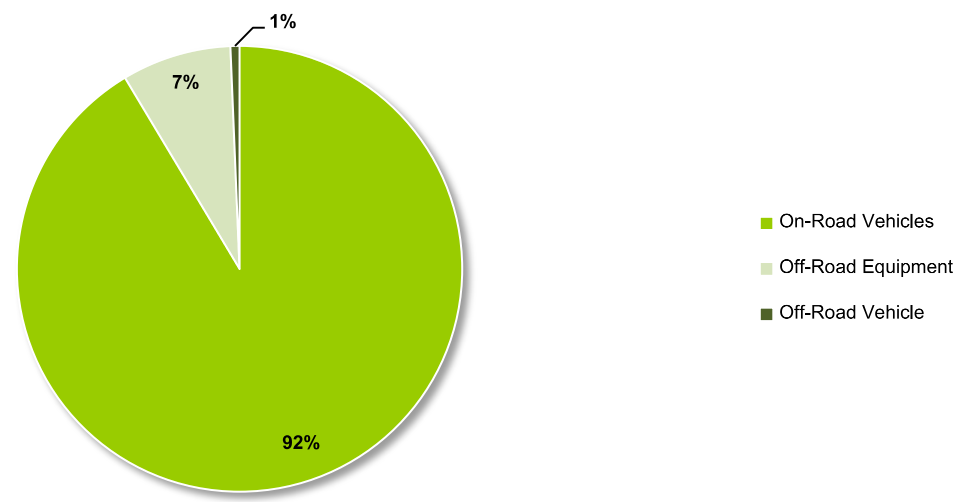
Notes: Totals may not appear to add exactly due to rounding; SP = service population, calculated as population plus jobs, see Table 4
Source: AECOM 2016

Sub-Sector Analysis

Mobile Sources

Mobile source emissions consist of three sub-sectors. On-road vehicles represent the largest emissions source within the sector, accounting for approximately half of the community's total emissions. Off-road equipment provides an additional 4% of total emissions through use of lawn and garden equipment, light commercial and industrial equipment, and construction equipment within the community. Off-road vehicles, consisting of train ridership within the City's boundaries (i.e., Caltrain, ACE, and Capitol Corridor) contribute less than 1% of total emissions. Figure 5 on the following page illustrates the contribution of each sub-sector to the total mobile sources sector.

Figure 5 – Mobile Source Emissions by Sub-Sector



Energy Consumption

Energy sector emissions are split between electricity (58%) and natural gas (42%), as shown in Figure 6 below. Non-residential users are responsible for 43% of total energy emissions. Residential users contribute 40% of energy emissions. Direct access users provide the remaining 17% of emissions. Electricity represents 59% of non-residential energy emissions, and natural gas provides the remaining 41% of emissions. The opposite is true of residential users, with electricity and natural gas providing 40% and 60% of emissions, respectively. Direct access customers receive electricity through PG&E infrastructure, which is generated or procured by a third-party provider. See Figures 7 and 8 on the following page for an illustration of energy emissions by end user and fuel type.

Figure 6 – Energy Consumption by Source

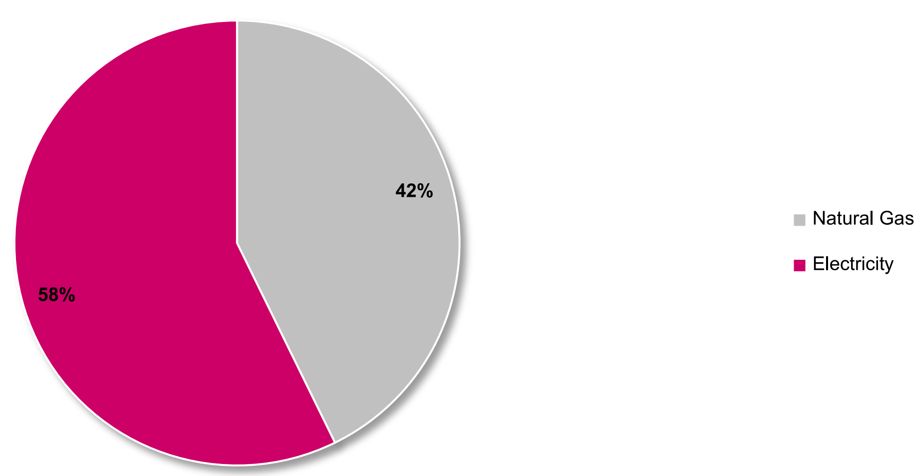
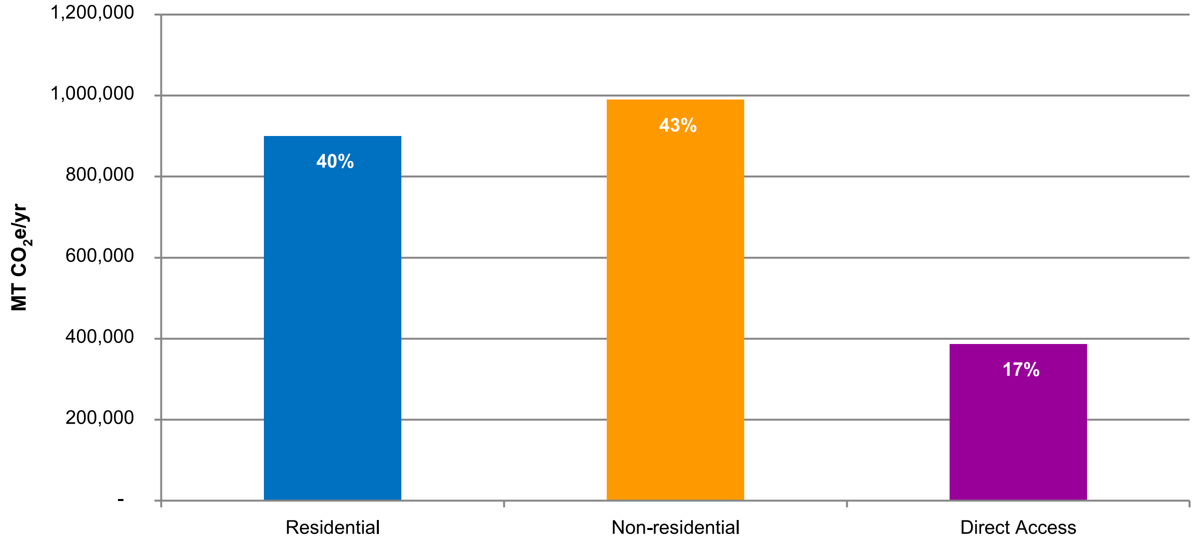
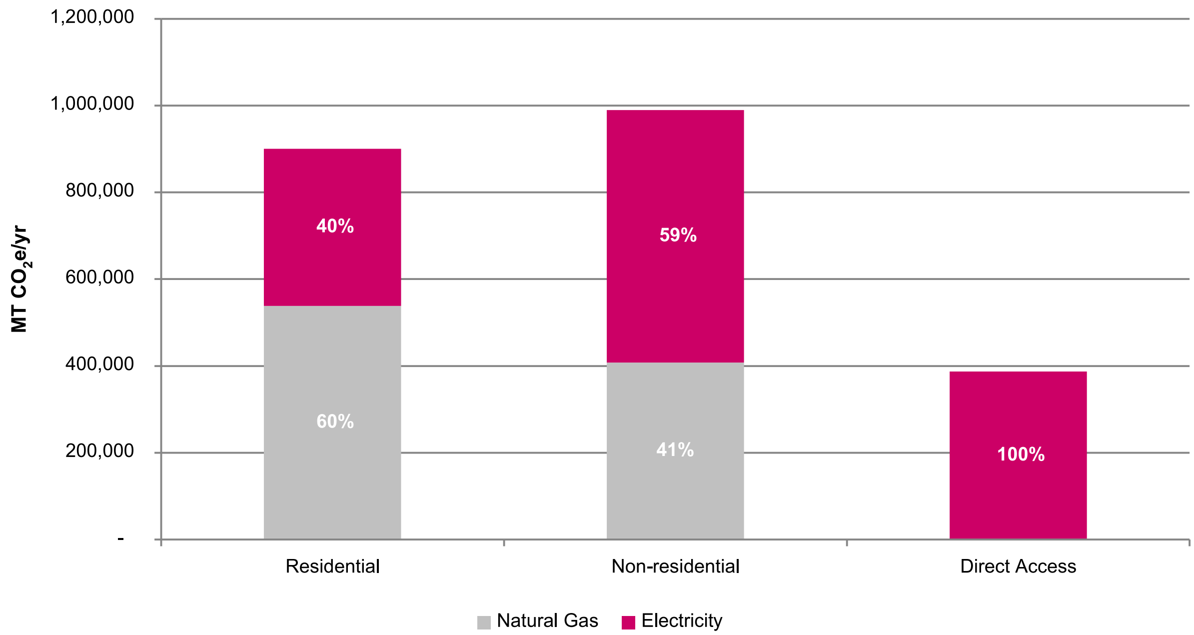


Figure 7 – Energy Consumption by End User



Note: MT CO_2e/yr = metric tons carbon dioxide equivalent per year; percentages represent end user contribution to total energy consumption sector emissions; percentages may not sum to 100% due to rounding

Figure 8 – Energy Consumption by Fuel Type by End User



Note: MT CO_2e/yr = metric tons carbon dioxide equivalent per year; percentages represent energy source contributions to end user total energy consumption

Comparison to 2008 Inventory

The City's previous community-wide inventory prepared for the Envision San José 2040 General Plan update represents emissions levels in calendar year 2008. As part of this inventory update project, the project team reviewed the previous inventory to compare results and identify methodological or data discrepancies that could affect direct comparisons between the two inventories. This section first compares the two inventories to illustrate the community's emissions trends over the past 6 years, and then describes variations in the inventories on a sector-by-sector basis.

Inventory Comparison

As shown in the *Integrated Final Program EIR* for the Envision San José 2040 General Plan (General Plan EIR), the 2008 inventory was organized into the following five sectors:

- Transportation
- Residential
- Commercial
- Industrial
- Waste

Table 6 on the following page shows the 2008 estimated emissions by sector as included in the General Plan EIR. For purposes of comparison with the 2014 inventory update, Table 7 on the following page represents results from the 2008 and 2014 inventories using a common naming convention. The residential, commercial, and industrial sectors from the 2008 inventory were combined in the "energy consumption" sector; within this sector, the commercial and industrial subsectors were combined and renamed non-residential.[12] Further, the transportation sector is shown as "mobile sources" and the 2008 transportation sector is split into two sub-sectors (on-road vehicles and off-road vehicles) based on analysis provided in the General Plan EIR Appendix K – Greenhouse Gas Emissions; the 2008 inventory did not specifically identify off-road equipment as a separate subsector. Finally, the "waste" sector includes the solid waste and wastewater treatment subsectors from the 2014 inventory; the 2008 inventory only identified a waste sector, and sufficient information was unavailable to determine what subsectors it might include, if any. Demographic indicators from Table 4 were used to compare emissions efficiency levels across the two inventories.

[12] Direct access energy users as identified in the 2014 inventory are included in the non-residential sub-sector of Table 8 for comparison purposes only; direct access users can include both residential and non-residential customers.

Table 6 Estimated 2008 Community GHG Emissions for San José		
Sector Category	**Annual Emissions ($MMT\ CO_2e/yr$)**	**Percent**
Transportation	3.52	46.3%
Residential	1.47	19.3%
Commercial	1.33	17.5%
Industrial	1.03	13.5%
Waste	0.26	3.4%
TOTAL	**7.61**	**100.0%**

Notes: Totals may not appear to add exactly due to rounding; MMT CO_2e/yr = million metric tons of carbon dioxide equivalent per year
Source: Envision San José 2040 General Plan, Integrated Final Program EIR. Section 3.0 Environmental Setting, Impacts, and Mitigation, pg. 800. City of San José. September 2011.

Table 7 2008 and 2014 GHG Emissions Inventory Comparison		
Emission Sector/Subsector	**2008 Emissions ($MMT\ CO_2e/yr$)**	**2014 Emissions ($MMT\ CO_2e/yr$)**
Mobile Sources	**3.52**	**4.07**
On-Road Vehicles	3.48	3.75
Off-Road Vehicles (ships, trains, aircraft equipment)	0.04	0.03
Off-Road Equipment	- [1]	0.29
Energy Consumption	**3.83**	**2.28**
Residential	1.47	0.90
Non-residential	2.36	1.38
Waste	**0.26**	**0.62**
Solid Waste	- [1]	0.23
Wastewater Treatment	- [1]	0.39
Potable Water	**- [2]**	**0.03**
TOTAL	**7.61**	**6.99**
Emissions Per Capita (MT CO_2e/capita/yr)	7.72	6.94
Emissions Per Service Population (MT CO_2e/SP/yr)	5.62	5.12

Source: AECOM 2016
Notes: Totals may not appear to add exactly due to rounding; SP = service population, calculated as population plus jobs
[1] Not identified separately in 2008 inventory
[2] Sector not included in 2008 inventory

Based on the City's 2008 inventory shown in Tables 6 and 7, emissions have decreased 8.1% community-wide since 2008. During the same period, the city's population has increased 2.2% and service population increased 0.9%, resulting in a decrease in emissions generated per capita and per service population. This demonstrates that the city has been able to accommodate residential and employment growth more efficiently, with fewer emissions generated per unit of growth. This is the result of decreasing energy emissions through energy efficiency improvements and increased use of renewable energy sources in the electricity grid, as well as a modest decrease in the daily vehicle miles traveled per service population (i.e., residents and jobs) in the city.

Sector Comparisons

The following sections describe differences between the 2008 and 2014 inventories regarding the methodological approaches used or data quality.

Mobile Sources

On-Road Vehicles

Based on the traffic model analysis developed in support of the City's General Plan update project, daily VMT from on-road vehicles operated within the city's boundaries increased 7.6% from 2008 to 2014. The City's service population grew 0.9% during that same period. Both inventories used the RTAC methodology when estimating VMT values associated with the city's land uses. It is worth noting that the VMT estimates from the two inventories were developed from different proprietary travel demand models and used different version of the EMFAC model for vehicle emissions factors, so an exact comparison from one year to the next cannot be made. However, this type of discrepancy is common in most inventory updates and the quantification methodologies used were the same, resulting in a high level of compatibility among the inventories.

Off-Road Vehicles

The project team used the same methodologies (when applicable) as described in the 2008 inventory to estimate community emissions from use of trains, airport equipment, and boats in 2014.

Trains

The 2008 and 2014 inventories applied the same methodology for estimating emissions resulting from train ridership within the city boundaries. The increase in train-related emissions between 2008 and 2014 is due to increased service operation along some lines (i.e., additional trains per day, additional track miles in city) and increased daily average ridership along some lines.

Airport Ground Support Equipment

The decrease in emissions from airport equipment from 2008 to 2014 is explained by methodological differences and City efforts to reduce airport-related emissions. The 2008 inventory represents 100% of Santa Clara County's off-road emissions from airport ground support equipment (GSE) as included in the OFFROAD2007 emissions model. The 2008 inventory methodology states that SJC was the only commercial airport within the county using GSE during the 2008 baseline inventory year; other civilian airports operating within the county at that time would not use GSE. Therefore, all GSE-related emissions that were estimated within the OFFROAD207 model were assumed to be associated with SJC.

The 2014 inventory update relied upon empirical fuel consumption data provided by airport staff as opposed to emissions estimates from the OFFROAD model. Since the 2008 inventory, the City has taken steps to replace its diesel- and gasoline-powered GSE with electric vehicle models. Electricity consumption related to refueling the new GSE is included within the energy consumption sector, and not represented separately in the 2014 inventory update. Airport GSE emissions included in the 2014 inventory are based on total gallons of gasoline and diesel consumed by the remaining non-electric airport equipment.

Boats

The 2008 and 2014 inventories both used ARB's OFFROAD model to determine boat emissions within Santa Clara County. However, the 2008 inventory used the total Santa Clara County boating emissions to represent the city's boating emissions. This method would likely overestimate the city's total boating emissions. For the 2014 inventory update, the project team used a proportional ratio of boat attendances by boat type at facilities within the city compared to total attendances within Santa Clara County. Using this approach, the project team calculated ratios for power boats, non-power boats, and pleasure craft. These ratios were then used to allocate total Santa Clara County emissions for each boat type. As previously described, total annual boat attendances by boat type and park were provided by the Santa Clara County Parks and Recreation Department. Using this method, total Santa Clara County boating emissions are allocated to the city based on boat attendance days within the city.

Off-Road Equipment

As shown in the City's General Plan EIR, off-road equipment is not identified as a separate sub-sector within the emissions inventory. However, Appendix K to the EIR does describe a methodology for how off-road equipment emissions were quantified. The 2014 off-road equipment estimates were prepared using the same methodology to support direct comparison of the inventories, even though the 2008 inventory does not separately identify this sub-sector. As described earlier in this memo, city population, household, and local jobs data were compared to county-wide data to calculate San José's proportional share of emissions from lawn and garden, light commercial, industrial, and construction equipment, based on the OFFROAD2007 model for Santa Clara County.

Potable Water

The 2008 inventory did not estimate emissions from the potable water sector. As previously described, energy consumption related to potable water use is one of the five required emissions sources for a community inventory according to the Community Protocol. The emissions estimate presented in this memo is based on several assumptions to determine total energy use associated with water consumption within the city boundary. Future inventory updates may have the benefit of better empirical data for this sector, which would help to improve the inventory's accuracy.

Energy Consumption

Both inventories collected electricity and natural gas activity data from PG&E for all land uses within the city's boundary. Table 8 on the following page compares energy consumption for 2008 and 2014 according to the end user type, including residential, non-residential, and direct access customers within the City's boundary. These categories are based on PG&E's rate schedule classifications.

As shown, residential electricity and natural gas consumption decreased from 2008 to 2014. According to PG&E staff, reductions in residential energy consumption can be explained, in part, by participation in utility-sponsored energy efficiency programs. Other factors, such as variations in local weather condition, could also contribute to changes in energy use. Non-residential electricity and natural gas use also decreased, but at a more equal rate, 16% and 18%, respectively. The decreases in this category can be explained, in part, by participation in utility-sponsored energy efficiency improvement programs that identify opportunities for both electricity and natural gas conservation. A deeper analysis of economic changes within the community during this time frame might also indicate a transition away from land uses that typically consume relatively more natural gas (e.g., manufacturing) towards less energy-intensive uses (e.g., retail). Purchases of direct access electricity increased nearly 50% since 2008. Direct access electricity is an option that allows customers to purchase their electricity directly from 3rd-party electric service providers. The electricity is transported and delivered through PG&E's transmission infrastructure, but is not generated by PG&E. Direct access customers are typically large electricity consumers that negotiate lower rates with a 3rd party provider. It is worth noting that data centers, which consume large quantities of electricity, could appear in both the non-residential and direct access categories. However, PG&E staff noted that the majority of data centers within San José are represented in the non-residential category. As previously mentioned, this is due to self-selection in which customers can choose the electricity rate schedule that best meets their individual needs.

Table 8 2008 and 2013 Energy Consumption Activity Data						
	ELECTRICITY			NATURAL GAS		
User Type	2008 Consumption (kWh/yr)	2014 Consumption (kWh/yr)	% Change	2008 Consumption (therm/yr)	2014 Consumption (therm/yr)	% Change
Residential	1,917,716,406	1,826,557,048	-4.8%	123,489,652	101,121,013	-18.1%
Non-Residential	3,484,374,792	2,931,175,964	-15.9%	93,670,593	76,620,912	-18.2%
Direct Access	872,382,672	1,306,615,167	49.8%	-	-	-
Total	**6,274,473,870**	**6,064,348,179**	**-3.3%**	**217,160,245**	**177,741,925**	**-18.2%**

Source: Adapted by AECOM 2016; 2014 values provided to AECOM by PG&E in April 2016; 2008 values adapted from Envision San José 2040 General Plan Integrated Final Program EIR, Appendix K – Greenhouse Gas Emissions, pgs. A-3 and A-4.

Notes: kWh/yr = kilowatt hours per year

Solid Waste

Solid waste emissions are not clearly identified in the 2008 inventory; the waste sector emissions identified therein may represent solid waste, wastewater treatment operations, or a combination of both. However, the General Plan EIR Appendix K describes the methodology used to estimate the 2008 solid waste emissions, which differs from the methodology the project team used to calculate the 2014 emissions. The 2008 inventory calculated the city's proportional share of solid waste emissions based on BAAQMD's 2007 Santa Clara County emissions inventory. As previously described, the 2014 inventory estimated solid waste emissions using the methane commitment method described in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. As with on-road vehicle emissions, direct comparisons of solid waste emissions from one inventory year to the next are often difficult to make due to the complexity involved in calculating landfill-generated emissions and the differing methodologies incorporated in the various landfill emissions calculators and equations available for use.

Wastewater Treatment

The 2008 and 2014 inventories both quantified emissions associated with three distinct wastewater processes: lagoon treatment of influent (i.e., CH_4 emissions), discharge of effluent (i.e., N_2O emissions), and fugitive digester gas (i.e., fugitive CH_4 emissions). The 2008 inventory used general influent BOD, effluent nitrogen, and digester gas production factors that are based on population. However, for the 2014 inventory, City staff provided SJSC-RWF-specific influent BOD and effluent nitrogen levels that were used to calculate wastewater emissions. For digester gas, because facility-specific information was not available, the same digester gas production factors used in the 2008 inventory were also used for the 2014 inventory. Consistent with the Community Protocol, the 2014 inventory also calculated fugitive N_2O emissions resulting from incomplete combustion of digester gas. These N_2O emissions represent 4.0% of the total fugitive digester gas emissions in 2014; the 2008 inventory did not include N_2O emissions from digester gas. It should be noted that the SJSC-RWF-specific BOD and nitrogen content information represents activity levels for the entire SJSC-RWF service area (i.e., the total customer base served by the facility, rather than only those customers with a City of San José address). Future inventory updates should attempt to separate the amount of influent and effluent allocated to land uses within the city boundary in order to provide a more accurate assessment of community-wide wastewater treatment emissions. In addition, efforts should be taken to obtain SJSC-RWF-specific data related to processing digester gas in order to create a more city-specific inventory.

Emissions Forecasts

Emissions forecasts were developed for a business-as-usual (BAU) scenario in which no local or statewide actions are taken to reduce GHG emissions (beyond those policies and programs already in place), and an adjusted business-as-usual (ABAU) scenario in which reductions resulting locally from implementation of statewide policies and programs are considered. Both scenarios can be useful in community emissions planning efforts. Forecasts were developed for the 2020, 2030, and 2040 planning horizon years. The 2020 forecasts align with the State's 2020 GHG reduction target codified in Assembly Bill 32 (i.e., return to 1990 emissions levels). The 2030 forecasts align with the State's 2030 GHG reduction target codified in Senate Bill 32 (i.e., achieve emissions reductions of 40% below 1990 levels). The 2040 forecasts align with the City's 2040 General Plan update horizon year and show an emissions trajectory toward the State's 2050 GHG target year (i.e., EO S-3-05 goal to reduce emissions 80% below 1990 emissions levels by 2050).

Business-as-Usual Emissions Forecasts

Table 9 presents the results of the City's emissions forecasts. The methodology used to estimate these forecasts is presented following the forecast analysis discussion.

Table 9
San José Community-wide Business-as-Usual Emissions Forecasts

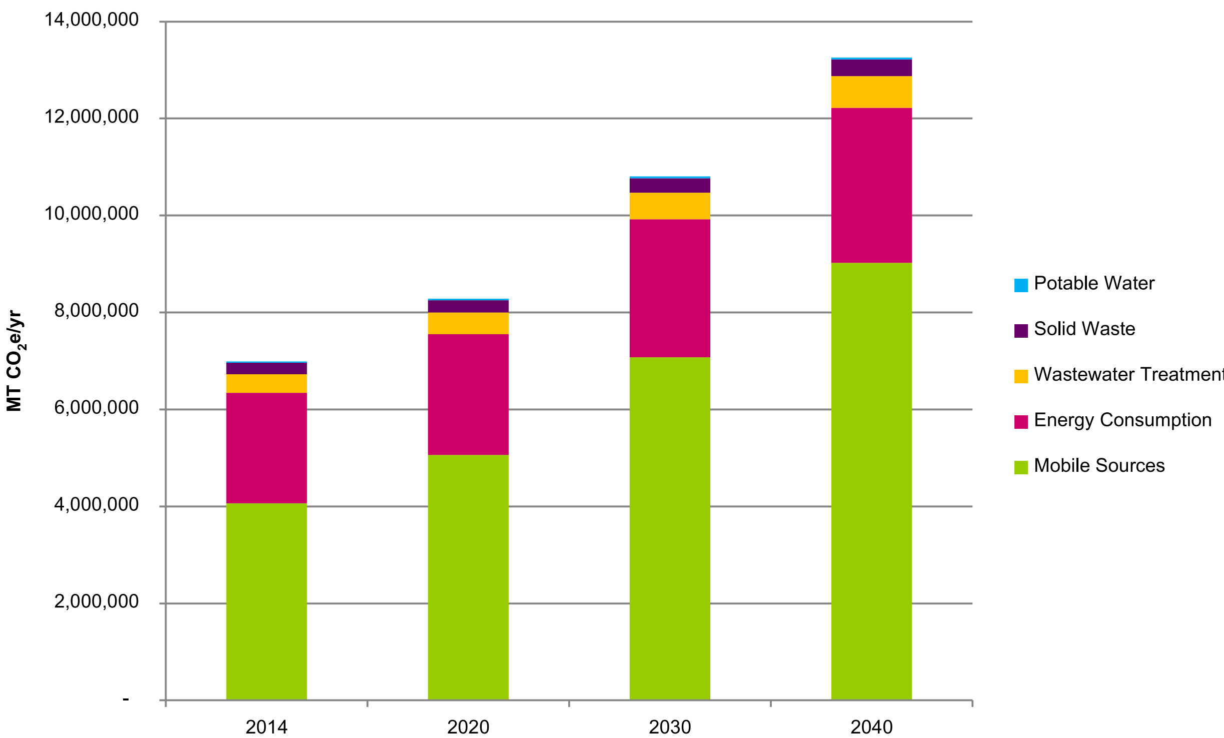
Emission Sector/Subsector	2014 (MT CO_2e/yr)	2020 (MT CO_2e/yr)	2030 (MT CO_2e/yr)	2040 (MT CO_2e/yr)
Mobile Sources	**4,065,263**	**5,063,066**	**7,078,860**	**9,024,771**
On-Road Vehicles	*3,745,113*	*4,657,094*	*6,516,461*	*8,296,965*
Off-Road Vehicles (ships, trains, aircraft equipment)	*27,946*	*35,770*	*51,608*	*67,205*
Off-Road Equipment	*292,204*	*370,202*	*510,791*	*660,602*
Energy Consumption	**2,277,002**	**2,502,817**	**2,879,177**	**3,255,537**
Electricity	1,330,968	1,470,809	1,703,875	1,936,942
Residential	*362,447*	*387,913*	*430,357*	*472,801*
Non-residential	*581,639*	*650,326*	*764,803*	*879,281*
Direct Access	*386,882*	*432,570*	*508,715*	*584,861*
Natural Gas	946,033	1,032,009	1,175,301	1,318,594
Residential	*538,218*	*576,034*	*639,061*	*702,088*
Non-residential	*407,816*	*455,975*	*536,241*	*616,507*
Solid Waste	**234,620**	**262,326**	**308,504**	**354,681**
Wastewater Treatment	**386,213**	**447,821**	**550,502**	**653,182**
Potable Water	**29,530**	**33,017**	**38,830**	**44,642**
TOTAL	**6,992,628**	**8,309,048**	**10,855,873**	**13,332,812**
Change from 2014 Baseline Levels	-	18.8%	55.2%	90.7%
Emissions Per Capita – 2014 (MT CO_2e/capita/yr)	6.94	7.71	9.08	10.15
Emissions Per Service Population – 2014 (MT CO_2e/SP/yr)	5.12	5.44	6.04	6.46

Notes: Totals may not appear to add exactly due to rounding; SP = service population, calculated as population plus jobs, see Table 12
Source: AECOM 2016

The City's emissions are projected to increase nearly 19% by 2020, 55% by 2030, and almost 91% by 2040 from the 2014 baseline levels. The increase is driven primarily by projected increases in community travel (i.e., VMT). The transportation sector is forecast to increase 122% by 2040. A growing service population for the San Jose Regional Wastewater Facility will lead to increased wastewater flows and associated process emissions, with the wastewater treatment sector forecast to increase nearly 70% by 2040. A growing residential and local employment base within the City will lead to increased solid waste generation and energy consumption, with the solid waste and energy sectors forecast to increase 51% and 43% by 2040, respectively. Figure 9 shows the growth in emissions by sector for the horizon years.

As a reminder, these BAU forecasts represent a scenario in which no local or State efforts are taken to curb emissions growth; the scenario represents future emissions if the rate of emissions generation per unit of growth (e.g., population, employment, households) is held constant. Further, forecasts are based on the best information available at the time of preparation. As each horizon year approaches, a City-wide emissions inventory update will be the best method to calculate actual emissions results. Forecasts should also be updated along with the City-wide inventory to incorporate new information related to each sector and sub-sector.

Figure 9 – Business-as-Usual Emissions Forecasts



Business-as-Usual Emissions Forecast Methodology

This section describes the methodological approach taken to develop BAU emissions forecasts for the 2020, 2030, and 2040 horizon years.

Emissions Growth Indicators

Estimating future GHG emissions resulting from community-wide land use activities is an imprecise science. A single formula cannot perfectly capture the number of factors affecting how residents, businesses, and industries will consume resources in the future. Rather, numerous indicators can illustrate the growth of GHG emissions and resource consumption within a community. Emissions projection indicators should (1) represent the factors that influence GHG emissions growth within a community, (2) be based on the local context for greater applicability (as opposed to use of statewide or national trends), and (3) represent a readily-available metric to facilitate future revisions.

The indicators most directly linked to residential, commercial, and industrial resource consumption are community-wide population and local jobs. Increases in residents or jobs are typically associated with growth in household sizes, number of dwelling units, and non-residential square footage, all of which lead to increased energy consumption, transportation, water use, solid waste and wastewater generation, and other GHG-generating activities. Service population (SP) is another commonly used indicator for emissions forecasting purposes, which represents the sum of resident population and local jobs within a community. Use of these demographic growth indicators (i.e., population, jobs, service population) in San José further strengthen the relationship between the emissions forecasts and the 2040 General Plan. Finally, some inventory sectors have specific operational growth estimate analyses that can be used as proxies for how their associated GHG emissions will grow (e.g., train ridership).

Table 10 lists the growth indicators that were applied to each emissions sector and/or subsector to estimate the emissions forecasts in each horizon year.

Table 10
Growth Indicators by Sector

Sector / Subsector	Growth Indicator
Mobile Sources	
On-Road Vehicles	Vehicle Miles Traveled (VMT) from traffic model
Off-Road Vehicles	Boats: OFFROAD2007 emissions model and City and County demographic estimates Aircraft equipment: Aviation demand forecasts Public transit trains: Ridership forecasts
Off-Road Equipment	OFFROAD2007 emissions model and City and County demographic estimates
Energy	
Electricity - Residential	Residential average annual growth
Electricity – Non-residential	Service Population average annual growth
Electricity – Direct Access	Service Population average annual growth
Natural Gas - Residential	Residential average annual growth
Natural Gas - Non-residential	Service Population average annual growth

Table 10 Growth Indicators by Sector	
Sector / Subsector	**Growth Indicator**
Solid Waste	Tons disposed per service population
Wastewater Treatment	
Process Emissions – BOD influent and Nitrogen effluent	Influent average annual growth
Process Emissions – Digester gas	Influent average annual growth
Potable Water	Service Population average annual growth

The following formula demonstrates how the majority of GHG emissions sectors were forecast using average annual growth rates:

$$\mathbf{Emissions_{FUTURE} = Emissions_{BASE} + (Emissions_{BASE} \times AAGR \times Years)}$$

Where:

$Emissions_{FUTURE}$ = GHG emissions during the 2020, 2030, or 2040 planning horizon years

$Emissions_{BASE}$ = GHG emissions during the 2014 baseline year

AAGR = average annual growth rate (as specified per sector or sub-sector)

Years = years of growth between the baseline and planning horizon year

Emissions forecasts for On-Road Vehicles, Boats, Off-Road Equipment, and Solid Waste were quantified using a different methodology than that expressed in the equation above. The following sections provide additional detail on forecasts in these sectors and sub-sectors.

Mobile Sources Sector

On-Road Vehicles

The on-road vehicle emissions forecasts were calculated based on the projected levels of vehicle travel within the community under the preferred 2040 General Plan land use alternative. This estimation approach directly links the emissions forecasts with the land use and circulation strategies described in the City's 2040 General Plan. The City's transportation consultant, Hexagon Transportation Consultants, provided VMT estimates for a 2015 baseline year and the 2040 General Plan buildout scenario pursuant to the ARB RTAC prescribed methods. This forecast method allows more specific estimates for future transportation sector emissions than would be possible using the previously described average annual growth rate approach, as the VMT estimates were based on the mix and geographic distribution of land uses described in the City's 2040 General Plan. The data provided was organized according to speed bin and time-of-day (i.e., morning, midday, afternoon, night, daily). AECOM used the 2015 and 2040 VMT data to interpolate VMT data for the 2020 and 2030 horizon years, assuming linear growth between 2015 and 2040. AECOM also used the 2015 and 2040 data to estimate 2014 VMT levels using a linear backcast (i.e., straight line growth between the 2015 and 2040 values to estimate the 2014 values along that line). Table 11 on the following page presents the estimated daily VMT for each horizon year and the annualization factor used to convert daily VMT to annual values.

Table 11 Transportation Growth Estimates					
	2014	**2015**	**2020**	**2030**	**2040**
Daily Vehicle Miles Traveled	20,165,677 [1]	20,588,249 [2]	22,701,107 [3]	26,926,824 [3]	31,152,540 [2]
Annualization Factor [4]	347	347	347	347	347

Source: Hexagon 2016, AECOM 2016

[1] Year 2014 VMT estimates were estimating using linear backcasting from 2015 and 2040 values

[2] Hexagon Transportation Consultants, 2016

[3] Year 2020 and 2030 VMT estimates were interpolated between year 2015 and year 2040 values

[4] California Air Resources Board recommends using an annualization factor of 347 days/year. ARB. 2008. Climate Change Scoping Plan Appendices (Volume II). Available online: <http://www.arb.ca.gov/cc/scopingplan/document/appendices_volume2.pdf>. Accessed August, 31, 2016.

AECOM used the City-specific VMT data to develop two on-road vehicle emissions scenarios: (1) a business-as-usual (BAU) scenario in which statewide programs designed to reduce transportation emissions *are not* implemented, and (2) an adjusted BAU (ABAU) scenario in which statewide programs *are* implemented. Community-wide VMT estimates can be combined with on-road emissions factors provided in ARB's EMFAC mobile source emission model to estimate community vehicle emissions. EMFAC is an on-road transportation model for California, developed by ARB and approved by the US Environmental Protection Agency, which provides vehicle emission factors and emissions estimates by vehicle class and county or region. To estimate the City's emissions forecasts, Santa Clara County Sub-Area emission factors for operational year 2014, 2020, 2030, and 2040 were used. EMFAC's county-wide fleet emission factors for each speed bin were weighted by VMT for each vehicle class. In other words, emissions factors for vehicle classes that represent a higher percentage of VMT for a particular speed bin are weighted according to their relative VMT proportion for that speed bin. The result was a weighted emission factor for each speed bin that represents all vehicle classes weighted by VMT within the County Sub-Area. These weighted emissions factors were applied to the City-specific VMT data described above. Pursuant to US Environmental Protection Agency guidance, CO_2e emissions were calculated by dividing CO_2 emissions by 0.95, which accounts for other GHGs such as nitrous oxide (N_2O), methane (CH_4), and other high global warming potential gases.[13]

EMFAC2014, (the most current version of the model), includes different options, or modes, for evaluating vehicle emissions. The model's "SB375" mode approximates vehicle emissions in the absence of the statewide programs designed to reduce vehicle emissions. The model's "default" mode outputs include all applicable emissions reductions resulting from implementation of various statewide programs designed to reduce vehicle emissions. Therefore, the SB375 mode outputs represent a BAU emissions scenario, and the default mode outputs represent an ABAU emissions scenario (see Adjusted Business-as-Usual Forecast Methodology section for results from the EMFAC2014 default mode analysis).

After conversations with ARB technical staff, AECOM learned that the SB375 mode does not include emissions from heavy-duty vehicle classes in its output because statewide reductions in the EMFAC2014 default option only pertain to the light and medium-duty vehicle classes. In order to develop a complete BAU emissions scenario, AECOM added the heavy-duty vehicle emissions values generated through the default mode model run to the SB375 values.

[13] USEPA. 2005. Emission Facts: Greenhouse Gas Emission from a Typical Passenger Vehicle. Available: <http://www.epa.gov/oms/climate/420f05004.htm>.

AECOM then ran the default and SB375 modes for the model's Santa Clara County Sub-Area for the years 2014, 2020, 2030, and 2040 to calculate the ratio of ABAU emissions to BAU emissions for each of the planning horizon years. This ratio describes the relationship of ABAU and BAU emissions at the Santa Clara County Sub-Area level, and was assumed to reflect the same ratio that would be experienced at the city level. The resulting ratios were applied to the City's default mode emissions results to estimate the City's BAU emissions in the absence of statewide vehicle emissions programs.

Off-Road Vehicles

Boats

As with the 2014 inventory calculations, ARB's off-road equipment emissions model, OFFROAD2007, was used to estimate total GHG emissions associated with boating in Santa Clara County in the 2020, 2030, and 2040 horizon years. OFFROAD2007 provides emissions for CO_2, N_2O, and CH_4 by boat type. The City's share of total Santa Clara County boating emissions for power boats, personal watercrafts, and non-power boats was allocated using the same proportion of recorded attendances at parks located within the city as is described in the 2014 Inventory Methodology section.

Aircraft

Emissions from GSE at the Norman Y. Mineta International Airport were forecast based on the estimated growth in total aviation activity at the airport between 2014 and 2027. AECOM referred to a summary of demand forecasts provided on the airport's Airport Improvement Program Overview webpage to identify a proxy for GSE fuel consumption growth.[14] The draft report provided a summary of operation forecasts for total airport activity (i.e., domestic and international airlines, all-cargo carriers, general aviation, and military) for 2000-2027. AECOM calculated the average annual growth from 2014-2027 as 2.78%, and applied this growth factor to the 2014 inventory emissions value for the 2020, 2030, and 2040 horizon years. This methodology approximates a BAU forecast scenario. However, the City is currently replacing gasoline- and diesel-powered GSE with electric and compressed natural gas vehicles. Future inventory updates will be able to more accurately reflect actual emissions resulting from these activities. It is worth noting that emissions from this category represent 0.002% of total 2014 community emissions, and a more detailed emissions forecasting methodology would not substantially alter the community-wide emissions totals.

Trains

Emissions forecasts for public transit trains (including Caltrain, Alamont Corridor Express [ACE], and Amtrak [Capitol Corridor]) were estimated based on ridership forecasts from each operator.

Caltrain emissions were estimated based on ridership forecasts developed in support of the Caltrain Peninsula Corridor Electrification Project.[15] AECOM collected 2040 ridership forecasts that reflect implementation of Caltrain's electrification project and completion of the Transbay Transit Center (TTC). The memo provided daily boardings by operator in the project corridor for 2013, 2020, and 2040. AECOM calculated the average annual growth rate from the 2013 observed boardings and the 2040 Project + TTC scenario for the Caltrain operator as 5.03%. AECOM applied this growth factor to the 2014 inventory emissions value for the 2020, 2030, and 2040 horizon years. This assumes that Caltrain ridership growth will occur evenly throughout the system (i.e., San José will experience the same average annual ridership increase as the entire system along the project corridor).

ACE emissions were estimated based on ridership forecasts developed in support of the ACE*forward* project.[16] Ridership forecasts were provided for 2020 and 2025 under project and no project scenarios. AECOM used the 2015 baseline ridership and 2020 project scenario to calculate average annual ridership growth of 13.9% for the 2015-2020 period.

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[14] Available online: http://www.flysanjose.com/fl/about/improve/overview/CR_Dem_Fore.pdf

[15] Available online: http://www.caltrain.com/Assets/Caltrain+Modernization+Program/FEIR/App+I+Ridership.pdf

[16] Available online: http://www.acerail.com/About/Board/Board-Meetings/2016/April-1,-2016/Found-here-link.pdf

AECOM used the 2020 baseline ridership and 2025 project scenario to calculate average annual ridership growth of 19.2% for the 2020-2025 period. AECOM applied the 2015-2020 growth factor to the 2014 inventory emissions value to estimate emissions in the 2020 horizon year, and applied the 2020-2025 growth factor to the 2020 emissions value to estimate emissions in the 2030 horizon year. This estimate assumes that ridership will continue to increase at the same rate through 2030 as is forecast from 2020-2025. Unlike the Caltrain and Amtrak ridership forecasts, ACE forecasts only extend through 2025. Instead of assuming that the high levels of ridership growth forecast through 2025 will continue, AECOM used San José's estimated service population growth rate for the 2014-2040 period to forecast ACE emissions from the 2030-2040 period. This estimate acknowledges that the ACE-specific ridership forecasts are based on discrete system improvements, and assumes that ridership growth will moderate following project completion.

Amtrak emissions forecasts were estimated based on ridership estimates prepared during the Capitol Corridor 2014 Vision Plan Update.[17] The plan provides a 2015 baseline ridership estimate and a 2040 "natural growth" ridership estimate that represents a scenario in which none of the long-term vision plan or short- and medium-term projects were implemented. AECOM calculated the average annual growth rate between the 2015 and 2040 values as 2.5%, and applied this growth factor to the 2014 inventory emissions value for the 2020, 2030, and 2040 horizon years. This assumes that Amtrak ridership growth will occur evenly throughout the Capitol Corridor system (i.e., San José will experience the same average annual ridership increase as the entire corridor). It should be noted the California High Speed Rail (HSR) intends to have a stop in San José by 2029 and is proposed to be constructed as part of the Phase I development. The emissions impact of a high-speed train stop located in San José relative to the community's VMT estimates was not analyzed as part of this project. Further, the construction timing of the HSR is less certain than other rail improvement projects considered in these emissions forecasts (e.g., Transbay Transit Center). Future emissions inventory updates and forecasts should consider the status of the HSR project, and if feasible, include an assessment of its impact relative to the community's on-road vehicle and public transit emissions estimates.

Off-Road Equipment

As with the 2014 off-road equipment calculations, AECOM used ARB's OFFROAD2007 to quantify GHG emissions associated with off-road equipment sources, including equipment associated with lawn and garden, construction, industrial, and light industrial use. The model provides county-level emission estimates, which were scaled to the city level using demographic indicators, including jobs and households. Table 12 on the following page shows the jobs and households forecasts for the City and County, and San José's calculated share of the growth indicators for each horizon year. The ratio of jobs in the City compared to the entire County was used to allocate emissions from construction, industrial, and light commercial equipment. The ratio of San José's households plus jobs compared to County-wide values was used to allocate the City's share of emissions from lawn and garden equipment.

[17] Available online: http://www.capitolcorridor.org/downloads/CCJPAVisionPlanFinal.pdf

Table 12 City and Count Demographic Indicators					
City of San José					
	2014	**2015**	**2020**	**2030**	**2040**
Jobs	359,128 [1]	374,225 [2]	449,710 [3]	600,680 [3]	751,650 [2]
Households	314,259 [1]	318,686 [2]	340,818 [3]	385,084 [3]	429,350 [2]
Santa Clara County					
	2010	**2014**	**2020**	**2030**	**2040**
Jobs	926,270 [4]	966,703 [5]	1,027,353 [5]	1,128,437 [5]	1,229,520 [4]
Households	604,200 [4]	636,296 [6]	678,320 [7]	748,360 [7]	818,390 [4]
		2014	**2020**	**2030**	**2040**
Jobs Ratio (City/County)		37%	44%	53%	61%
Jobs + Households Ratio (City/County)		42%	46%	53%	58%

Source: AECOM 2016

[1] Linear backcast from 2015 and 2040 values

[2] David J. Powers & Associates, 2016

[3] Linear interpolation between 2015 and 2040 values

[4] Association of Bay Area Governments and Metropolitan Transportation Commission. Draft Plan Bay Area, July 2013. Final Forecast of Jobs, Population and Housing. Available at: http://planbayarea.org/pdf/final_supplemental_reports/FINAL_PBA_Forecast_of_Jobs_Population_and_Housing.pdf

[5] Linear interpolation between 2010 and 2040 values

[6] CA Department of Finance. Report E-5, Population and Housing Estimates for Cities, Counties, and the State, January 1, 2011-2015, with 2010 Benchmark

[7] Linear interpolation between 2014 and 2040 values

Energy Consumption Sector

AECOM used population and jobs data from the 2014 base year and 2040 General Plan horizon year to estimate energy emissions growth assuming a linear growth trend. Table 13 on the following page shows the growth indicators used in the forecasts. The table includes population, jobs, and service population metrics, as well as the annual average growth rates for the 2014-2040 forecasting period. Residential electricity and natural gas emissions were forecast based on population growth. Non-residential electricity and natural gas and direct access electricity emissions were forecast based on service population growth.

Table 13 City of San José Demographic Projections							
Indicator	**2008**	**2014**	**2015**	**2020**	**2030**	**2040**	**Average Annual Growth** (2014-2040)
Population	985,307 [1]	1,007,162 [2]	1,010,805 [1]	1,095,536 [3]	1,204,673 [3]	1,313,811 [4]	1.2%
Jobs	-	359,128 [5]	374,225 [4]	449,710 [6]	600,680 [6]	751,650 [4]	4.2%
Service Population	-	1,366,290	-	1,545,246	1,805,353	2,065,461	2.0%

Source: AECOM 2016

Note: Service Population = Population + Jobs

[1] General Plan EIR Appendix K - Greenhouse Gas Emissions, Table 3-5 Development of County-to-City Scaling Factors for Off-Road Equipment Emissions

[2] Linear interpolation between 2008 and 2015 Population values

[3] Linear interpolation between 2014 and 2040 Populations values

[4] David J. Powers & Associates, 2016

[5] Linear backcast from 2015 and 2040 Jobs values

[6] Linear interpolation between 2015 and 2040 Jobs values

Solid Waste Sector

As described in the 2014 Inventory Methodology section of this memo, City staff provided solid waste disposal data for the 2014 baseline year. AECOM divided this value by the 2014 service population (see Table 13) to calculate a disposal rate per service population (i.e., metric tons [MT] / SP), resulting in a rate of 0.44 MT/SP. AECOM then multiplied this disposal rate by the service population forecasts for the 2020, 2030, and 2040 horizon years to estimate total waste disposal in those years. This estimate assumes the rate of solid waste disposal will remain constant from the base year through the horizon years. AECOM then calculated solid waste emissions using the methane commitment methodology described in Attachment B.

Wastewater Treatment Sector

AECOM estimated process emissions at the wastewater treatment plant based on 2040 wastewater flow projections in The Plant Master Plan 2013.[18] AECOM compared the 2014 and 2040 influent flow values to calculate an average annual growth rate of 2.7%. AECOM then applied this growth rate to the BOD influent/nitrogen effluent and digester gas sub-sector baseline emissions. This estimation assumes that the ratio of influent to effluent will remain constant from 2014 through 2040, and that the production of digester gas will grow at the same rate as influent increases.

Potable Water Sector

Potable water emissions were forecast based on the average annual service population growth rate shown in Table 13. AECOM applied this growth rate to the 2014 baseline emissions value to estimate water emissions in the 2020, 2030, and 2040 horizon years.

[18] Available online: http://www.sanjoseculture.org/DocumentCenter/View/38425

Adjusted Business-as-Usual Emissions

In addition to the BAU emissions forecasts, AECOM develop ABAU forecasts that estimate what the community-wide emissions would be if certain statewide policies and programs are fully implemented. Reductions associated with vehicle emissions and electricity emissions were considered in this analysis, specifically on-road vehicle programs included in the EMFAC2014 transportation model and implementation of the Renewables Portfolio Standard. Table 14 presents the results of the ABAU emissions forecast analysis.

Table 14
San José Community-wide Adjusted Business-as-Usual Emissions Forecasts

Emission Sector/Subsector	2014 (MT CO_2e/yr)	2020 (MT CO_2e/yr)	2030 (MT CO_2e/yr)	2040 (MT CO_2e/yr)
Mobile Sources	**4,065,263**	**4,367,832**	**4,762,359**	**5,594,661**
On-Road Vehicles	*3,745,113*	*3,961,860*	*4,199,960*	*4,866,900*
Off-Road Vehicles (ships, trains, aircraft equipment)	*27,946*	*35,770*	*51,608*	*67,159*
Off-Road Equipment	*292,204*	*370,202*	*510,791*	*660,602*
Energy Consumption	**2,277,002**	**2,155,231**	**2,479,056**	**2,802,881**
Electricity	1,330,968	1,123,222	1,303,754	1,484,286
Residential	*362,447*	*258,046*	*286,280*	*314,514*
Non-residential	*581,639*	*432,607*	*508,759*	*584,911*
Direct Access	*386,882*	*432,570*	*508,715*	*584,861*
Natural Gas	946,033	1,032,009	1,175,301	1,318,594
Residential	*538,218*	*576,034*	*639,061*	*702,088*
Non-residential	*407,816*	*455,975*	*536,241*	*616,507*
Solid Waste	**234,620**	**262,326**	**308,504**	**354,681**
Wastewater Treatment	**386,213**	**447,821**	**550,502**	**653,182**
Potable Water	**29,530**	**33,017**	**38,830**	**44,642**
TOTAL	**6,992,628**	**7,266,228**	**8,139,250**	**9,450,092**
Change from 2014 Baseline Levels	-	3.9%	16.4%	35.1%
Emissions Per Capita – 2014 (MT CO_2e/capita/yr)	6.94	6.74	6.81	7.19
Emissions Per Service Population – 2014 (MT CO_2e/SP/yr)	5.12	4.76	4.53	4.58

Notes: Totals may not appear to add exactly due to rounding; SP = service population, calculated as population plus jobs, see Table 12
Source: AECOM 2016

Total emissions are still forecast to increase in the ABAU scenario, but at a slower rate than shown in the BAU forecast analysis. Emissions are estimated to increase 4% by 2020, 16% by 2030, and 35% by 2040 (compared to 91% growth by 2040 in the BAU scenario). The differences between the ABAU and BAU scenarios only occur in the on-road vehicles and electricity sub-sectors. Implementation of statewide programs (described later in this section) will result in slower emissions growth within the on-road vehicles sub-sector, and negative emissions growth in the electricity sub-sector. As a result, wastewater treatment represents the highest growth sector in the ABAU scenario (nearly 70% by 2040), followed by potable water (51% by 2040) and solid waste (51% by 2040). Emissions growth in these sectors is largely a function of service population growth in the City or regionally, and are not subject to reductions associated with the statewide actions considered in this analysis.[19] The mobile source and energy consumption sector emissions are forecast to increase 38% and 23% by 2040, respectively. It should be noted that the natural gas sub-sector of energy consumption emissions will not be affected by the statewide programs considered in this analysis. Therefore, natural gas emissions are the same in the BAU and ABAU scenarios. Figure 10 illustrates the community-wide emissions growth under the ABAU scenario, and Figure 11 compares the BAU and ABAU forecast scenarios.

Figure 10 – Adjusted Business-as-Usual Forecasts

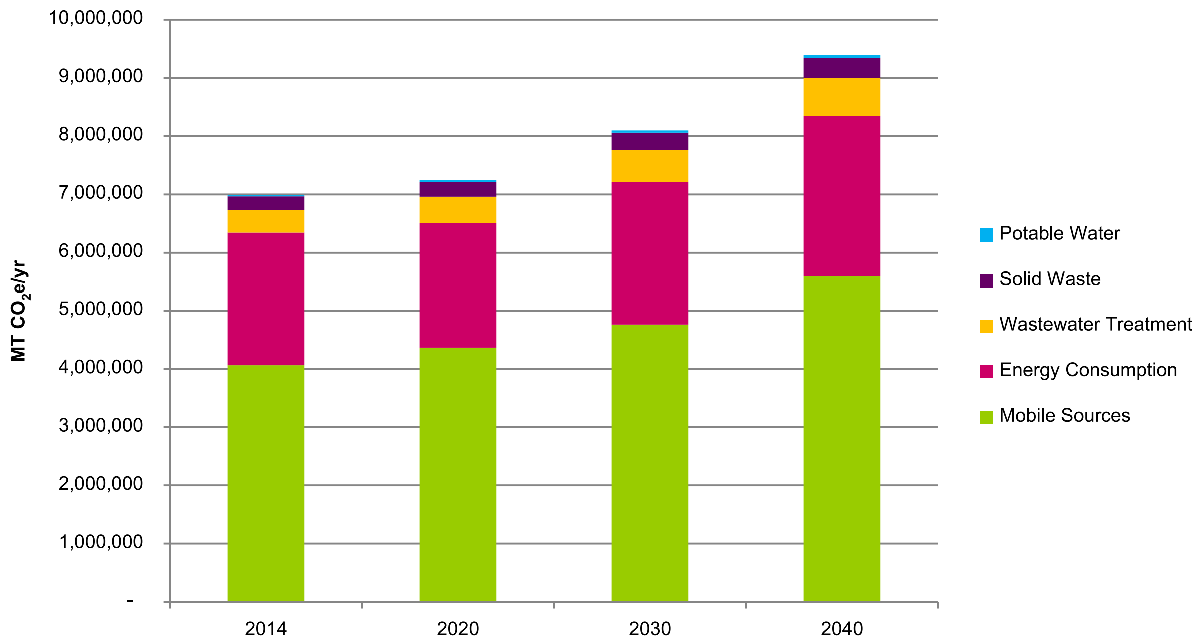
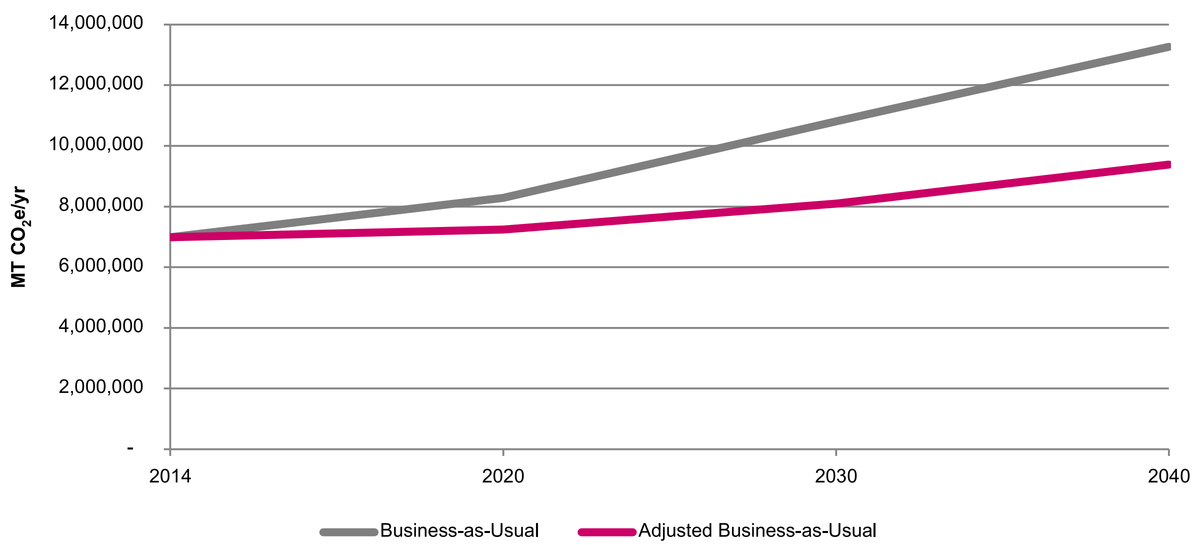


Figure 11 – Forecast Scenario Comparison



[19] Potable water emissions are a result of electricity consumption used to pump, treat, and convey water to the city. Because electricity consumption associated with this sector occurs in and outside of the City's boundary, a regional electricity emissions factor is used to estimate water-related emissions. While the State's Renewables Portfolio Standard (RPS) may result in electricity reductions relative to the regional electricity emissions factor, the precise impact of the RPS on the regional factor is unknown at this time. Therefore, to be conservative, RPS-related reductions were not applied to the potable water sector in this analysis.

Adjusted Business-as-Usual Emissions Forecast Methodology

On-Road Vehicles

As previously described, AECOM used the EMFAC2014 transportation model default mode outputs to estimate ABAU emissions. The default mode estimates light- and medium-duty vehicle emissions in a scenario where benefits from the Pavley, Advanced Clean Cars (ACC), and Low Carbon Fuel Standard (LCFS) programs are considered. These programs are briefly described below.

Pavley

Assembly Bill (AB) 1493, also referred to as Pavley I or California Clean Car Standards, is California's mobile source GHG emissions regulations for passenger vehicles, and was signed into law in 2002. AB 1493 requires ARB to develop and adopt regulations that reduce GHG emissions from passenger vehicles, light-duty trucks, and other non-commercial vehicles for personal transportation. In 2004, ARB approved amendments to the California Code of Regulations adding GHG emissions standards to California's existing standards for motor vehicle emissions for new passenger vehicles from 2009 to 2016.

Advanced Clean Cars

In 2012, ARB adopted the Low-Emissions Vehicle (LEV) III amendments to California's LEV regulations. As part of the Advanced Clean Cars (ACC) Program, these amendments include more stringent emission standards for both criteria pollutants and GHG emissions for new passenger vehicles. The regulation combines new GHG emissions with control of smog-causing pollutants standards. This new approach also includes efforts under the Zero-Emission Vehicle Program to support increased use of plug-in hybrids and zero-emission vehicles (ZEV). The ACC exhaust emission standards will be phased in for new vehicle models from 2017 through 2025 for passenger cars, light-duty trucks, and medium-duty passenger vehicles.

Low Carbon Fuel Standard

Executive Order (EO) S-01-07 was designed to reduce the carbon intensity of California's transportation fuels by at least 10% by 2020. The Low Carbon Fuel Standard (LCFS) is a performance standard with flexible compliance mechanisms that incentivizes the development of a diverse set of clean, low-carbon transportation fuel options to reduce GHG emissions.

Together, these statewide programs reduce total vehicle fuel consumption through vehicle efficiency requirements and reduce fuel-consumption emissions through reductions in fuel carbon intensity.

To calculate the ABAU emissions forecast, AECOM applied the EMFAC2014 default mode weighted emissions factors for the Santa Clara County Sub-Area operational years 2020, 2030, and 2040 to the City's VMT speed bin data, as previously described. The EMFAC2014 default mode output represents a complete estimate of ABAU emissions since it includes all vehicle classes and statewide emissions reductions for light- and medium-duty vehicles.

Electricity

The State has adopted several pieces of legislation to reduce emissions from electricity consumption. Senate Bill (SB) 1078, SB 107, EO S-14-08, SB X1-2, and SB 350 established increasingly stringent Renewables Portfolio Standard (RPS) requirements for California's utilities. The legislation requires the State's electricity providers to incrementally increase the emissions-free electricity sources within their generation portfolios. RPS-eligible energy sources include wind, solar, geothermal, biomass, and small-scale hydro-electrical power facilities. The following legislative actions represent the evolving scope of the RPS program:

- SB 1078 required investor-owned utilities to provide at least 20% of their electricity from renewable resources by 2020.
- SB 107 accelerated the SB 1078 the timeframe to take effect in 2010.
- EO S-14-08 increased the RPS further to 33% by 2020.
- SB X1-2 codified the 33% RPS requirement established by Executive Order S-14-08.
- SB 350 increased the RPS requirement to 50% by 2030.

As described in the 2014 Inventory Methodology section, electricity emissions are estimated by multiplying electricity consumption (i.e., kilowatt hours [kWh]) by an electricity emissions factor (e.g., MT CO_2e/kWh). The BAU emissions were calculated to assume the City's electricity emissions factor in 2014 would remain constant through the horizon years. The City's electricity emissions factor in 2014 describes PG&E's electricity generation portfolio in that year. For this forecast, the BAU scenario assumes that the RPS would not be fully implemented. The ABAU scenario assumes that PG&E will comply with the RPS legislation and future electricity consumption will generate fewer emissions as a result of additional emissions-free electricity sources included in PG&E's generation portfolio.

The BAU scenario assumed an electricity emissions factor of 0.000198 MT CO_2e/kWh. The ABAU scenario assumes an electricity emissions factor of 0.000132 MT CO_2e/kWh, based on a guidance document published by PG&E that describes how the company's electricity emissions factor would change through 2020 as a result of RPS compliance and on-going de-carbonization efforts (i.e., expiration of coal-fired power plant contracts).[20]

It should be noted, the electricity emissions factor used in the ABAU scenario only assumes achievement of the 2020 RPS requirements (i.e., 33% renewable electricity). The 2030 RPS would require 50% renewable electricity is provided to the City's residents and businesses, which will result in additional emissions reductions between the 2020 and 2040 horizon years. However, PG&E has not yet released its estimates for compliance with the 2030 RPS requirement. In order to comply with the 2030 RPS requirements, PG&E will need to increase its share of RPS-compliant electricity purchases. To date, the company's pathway for compliance has not been defined, and it is too speculative to estimate what mix of electricity sources might be selected to achieve this requirement. Therefore, it is too speculative to determine what the resulting electricity emissions factor would be. AECOM conservatively estimated ABAU emissions forecasts related to this statewide action by holding the 2020 electricity emissions factor constant through 2040.

ABAU emissions forecasts for the direct access sub-sector were not adjusted to reflect implementation of the RPS. Direct access electricity is purchased by large energy consumers that may find discounted electricity rates from 3rd party energy providers. The exact source of this electricity cannot be known with certainty, and to the extent that it is generated outside of California, it would not be subject to the RPS requirements. Therefore, AECOM excluded direct access electricity from RPS-related emissions reductions to reflect a conservative estimate of ABAU forecasts.

SB 32 and Scoping Plan Update

AB 32 resulted in the California Air Resources Board (ARB) adoption of a *Climate Change Scoping Plan* (Scoping Plan) in 2008. The Scoping Plan outlines the State's plan to achieve the AB 32 GHG target through emission reductions that consist of a mix of direct regulations; alternative compliance mechanisms; and different types of incentives, voluntary actions, market based mechanisms, and funding. ARB updated the Scoping Plan in 2014 to analyze progress to date towards the statewide reduction goals, and consider new strategies and technologies for future implementation. The adoption of SB 32 now provides ARB with a statutory basis for updating the Scoping Plan to address the State's 2030 GHG reduction target, which will likely include expansion of existing policies and programs and/or development of new GHG-reducing strategies. As the regulatory framework surrounding the State's GHG targets grows, it may be possible to

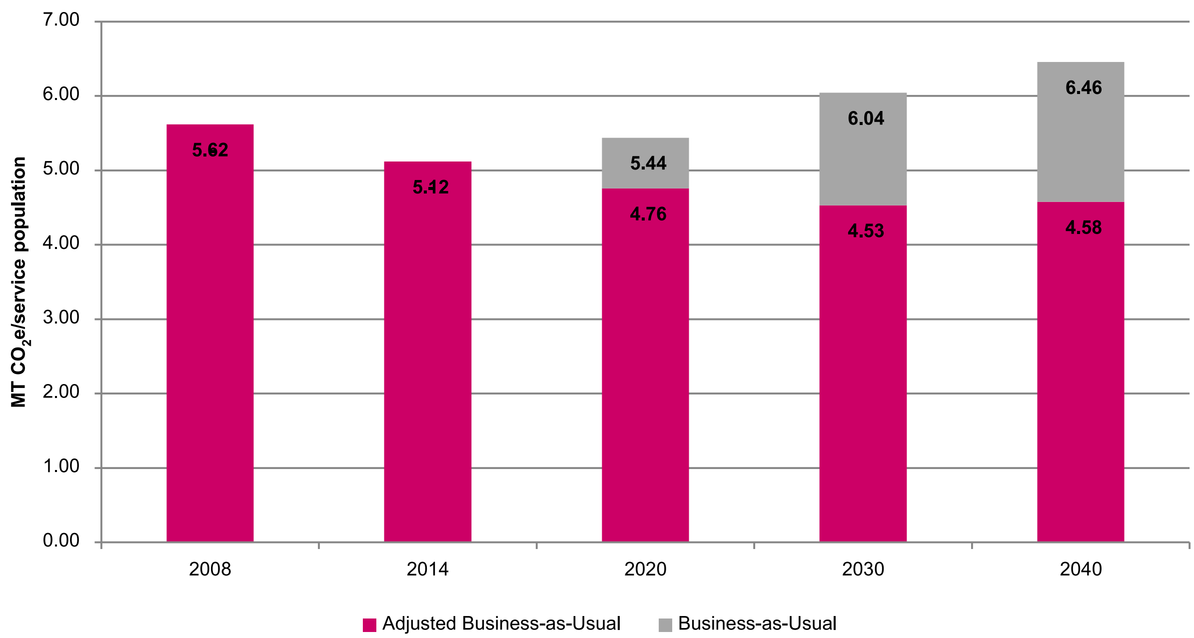
[20] Available online: https://www.pge.com/includes/docs/pdfs/shared/environment/calculator/pge_ghg_emission_factor_info_sheet.pdf

evaluate a wider range of statewide reductions at the local community level. Further, a future Scoping Plan update may provide additional technical analysis to support revisions to the City's ABAU emissions forecasts presented in this memo, possibly showing lower long-term emissions growth and greater emissions efficiency (on a service population basis).

Conclusion

During the previous four years of implementing the Envision San José 2040 General Plan, community-wide emissions have decreased 8.1%. Additionally, the City's ability to accommodate population and employment growth has also improved when analyzing GHG emissions from an efficiency perspective. In 2008, the City generated 5.62 MT CO_2e/service population; that value has improved to 5.12 MT CO_2e/service population in 2014. The long-term population and employment growth in San José forecast within the Envision San José 2040 General Plan will lead to higher levels of GHG emissions community-wide, primarily from the transportation sector. However, consideration of the statewide actions designed to achieve California's GHG emissions targets indicates that local GHG emissions could grow at a considerably slower rate if those statewide actions are fully implemented. The result would be a 35% increase in total GHG emissions by 2040 from 2014 levels, while GHG efficiency levels would improve to 4.58 MT CO_2e/service population in 2040 from the 2014 efficiency levels. Figure 12 illustrates the community's GHG efficiency levels from 2008 through 2040 under the business-as-usual and adjusted business-as-usual emissions forecast scenarios presented in this memo. Additional statewide action resulting from the State's efforts to achieve the 2030 GHG target codified in SB 32 could result in even lower ABAU emissions levels than those currently forecast in this memo.

Figure 12 – GHG Efficiency per Service Population



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Attachment A
Inventory Data Tables

City of San José
Energy Consumption Sector
Activity Data - 2014

ELECTRICITY

User Type	Consumption (kWh/yr)	Emissions (MT CO_2e)
Residential		***362,447.29***
NONGOVENT	1,826,360,991	362,408.39
(3) COUNTY	95,371	18.92
(4) CITY	83,480	16.57
(5) DISTRICT	17,206	3.41
Commercial		***434,651.12***
NONGOVENT	1,989,472,846	394,774.99
(3) COUNTY	34,227,973	6,791.92
(4) CITY	81,902,564	16,252.09
(5) DISTRICT	84,825,609	16,832.11
Industrial		***146,987.87***
NONGOVENT	634,874,149	125,979.32
(3) COUNTY	19,517,879	3,872.97
(4) CITY	57,565,108	11,422.76
(5) DISTRICT	28,789,836	5,712.82
Direct Access		***386,882.11***
NONGOVENT	1,293,227,279	382,918.02
(3) COUNTY	-	-
(4) CITY	-	-
(5) DISTRICT	13,387,888	3,964.09
Total	**6,064,348,179**	**1,330,968**

NATURAL GAS

User Type	Consumption (therm/yr)	Emissions (MT CO_2e)
Residential		***538,217.59***
NONGOVENT	101,079,506	537,996.67
(3) COUNTY	38,170	203.16
(4) CITY	2,299	12.24
(5) DISTRICT	1,038	5.52
Commercial		***374,061.36***
NONGOVENT	64,119,684	341,277.65
(3) COUNTY	2,009,406	10,695.08
(4) CITY	1,925,102	10,246.37
(5) DISTRICT	2,224,937	11,842.25
Industrial		***33,754.20***
NONGOVENT	15/15 Rule Fail	-
(3) COUNTY	246,506	1,312.03
(4) CITY	5,696,515	30,319.76
(5) DISTRICT	398,762	2,122.41
Total	**177,741,925**	**946,033**

Source: PG&E Green Communities program, March 2016

Note: Direct Access electricity used eGRID 2012 emissions factor; all other electricity categories use PG&E-specific factor

City of San José
Energy Consumption Sector
Emissions Factors

Emissions Sector	Subsector	Emission Factor Type	Value	Units	Source
Energy					
	Electricity				
		PG&E 2005	0.4890	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2006	0.4560	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2007	0.6357	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2008	0.6410	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2009	0.5750	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2010	0.445	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2011	0.393	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2012	0.4440	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2013	0.4990	lbs CO2 per kWh	PG&E. 2014. Emission Factors and Other Information
		PG&E 2014	0.4350	lbs CO2 per kWh	PG&E. 2016. Emission Factors and Other Information
		PG&E 2015	0.4290	lbs CO2 per kWh	PG&E. 2016. Emission Factors and Other Information
		2012	650.31	lbs CO2 per MWh	eGRID2012: CAMX, WECC California
		2012	31.12	lbs CH4 per GWh	eGRID2012: CAMX, WECC California <http://www.epa.gov/sites/production/files/2015-10/documents/egrid2012_summarytables_0.pdf>
		2012	5.67	lbs N2O per GWh	
		PG&E 2014	0.4375	lbs CO2e per kWh	PG&E 2016 and eGRID2012
		CA 2012	0.6528	lbs CO2e per kWh	eGRID2012: CAMX, WECC California
		2020	0.000132	MT CO2e/kWh	https://www.pge.com/includes/docs/pdfs/shared/environment/calculator/pge_ghg_emission_factor_info_sheet.pdf
	Natural Gas				
		2005	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2006	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2007	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2008	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2009	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2010	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2011	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2012	11.70	lbs CO2 per therm	PG&E. 2014. Emission Factors and Other Information
		2013	11.70	lbs CO2 per therm	PG&E. 2016. Emission Factors and Other Information
		2014	11.70	lbs CO2 per therm	PG&E. 2016. Emission Factors and Other Information
		2015	11.70	lbs CO2 per therm	PG&E. 2016. Emission Factors and Other Information
		2009	0.00500	kg CH4 per MMBtu	CCAR General Reporting Protocol v3.1
		2009	0.00010	kg N2O per MMBtu	CCAR General Reporting Protocol v3.1
		2014	11.73	lbs CO2e per therm	PG&E 2016 and CCAR GRP
Off-Road Vehicles	Caltrain		0.37	lbs CO_2e/passenger-mile	https://www.carbonfund.org/how-we-calculate
	ACE		0.37	lbs CO_2e/passenger-mile	https://www.carbonfund.org/how-we-calculate
	Capitol Corridor		0.37	lbs CO_2e/passenger-mile	https://www.carbonfund.org/how-we-calculate

City of San José
Unit Conversions and Standards

Emissions Sector	Category	Value	Conversion	Source
All	GWP	1	CO_2	IPCC 4th Assessment Report
	GWP	25	CH_4	IPCC 4th Assessment Report
	GWP	298	N_2O	IPCC 4th Assessment Report
	Weight	2000	lbs/ton	
	Weight	2204.623	lbs/MT	
	Weight	453.59	grams/lb	
	Weight	1000000	grams/MT	
	Annualize	365	days/year	
Energy	Electricity	1000	kWh/MWh	
		1000	MWh/GWh	
	Natural Gas	100,000	Btu/therm	
		0.10	MMBtu/therm	
		2.20462	lbs/kg	
Water/Wastewater				
	volume	0.0283	m^3/ft^3	
	Annualize	365.25	days/year	

City of San José
On-Road Vehicles
VMT by Speed Bin

Citywide 2014 GHG Inventory

Speed Bin	2014 Citywide DVMT (miles/day)	Speed Bin Distribution (%)	Annualization Factor (days/year)	Annual Citywide VMT (miles/year)	Emission Factor (grams/mile)	2014 ABAU Emissions (MT CO_2e/yr)
5	185,947	0.9%	347	64,523,609	1,544.54	104,904.93
10	328,268	1.6%	347	113,909,135	1,688.52	202,461.40
15	619,997	3.1%	347	215,138,903	1,002.15	226,950.97
20	1,072,506	5.3%	347	372,159,610	832.87	326,274.40
25	4,893,222	24.3%	347	1,697,947,909	542.07	968,851.24
30	2,708,565	13.4%	347	939,871,999	413.73	409,317.51
35	1,851,362	9.2%	347	642,422,628	437.91	296,131.71
40	921,764	4.6%	347	319,852,122	401.32	135,120.04
45	1,055,339	5.2%	347	366,202,494	362.41	139,702.34
50	871,766	4.3%	347	302,502,927	439.12	139,826.60
55	1,174,018	5.8%	347	407,384,163	402.06	172,415.48
60	3,313,975	16.4%	347	1,149,949,269	370.96	449,033.54
65	1,168,949	5.8%	347	405,625,275	407.81	174,123.21
Total	**20,165,677**	**100%**		**6,997,490,044**		**3,745,113**

Notes:
Emission factors are obtained from EMFAC2014 for Santa Clara County, Year 2014
Emission factors are weighted by total VMT per vehicle class

City of San José
4-Year Review GHG Analysis (VMT Data)
VMT Interpolation for 2014, 2020, and 2030

Notes:
VMT by Speed Bin calculated with City of San Jose General Plan Model.
VMT are calculated assuming trips that have an origin and destination (I-I) in San Jose are
X-X trips are exluded.

Source:
2015 and 2040 (i.e., 2016 General Plan) VMT by speed bin from Hexagon Transportation Consultants, August 2016
2014, 2020, and 2030 VMT interpolation prepared by AECOM, August 2016

VMT By Speed Bin

Speed Interval	2014 - Interpolated				
	Morning	Midday	Afternoon	Night	Daily
0 - 5	12,880	13,548	157,250	2,269	185,947
5 - 10	16,219	24,923	280,734	6,393	328,268
10 - 15	69,559	86,632	426,404	37,402	619,997
15 - 20	178,425	192,708	612,796	88,577	1,072,506
20 - 25	960,015	1,563,952	1,559,871	809,384	4,893,222
25 - 30	521,051	823,047	937,585	426,882	2,708,565
30 - 35	313,491	791,027	451,082	295,762	1,851,362
35 - 40	251,248	382,490	232,300	55,726	921,764
40 - 45	176,699	557,657	203,820	117,163	1,055,339
45 - 50	198,441	502,917	158,435	11,974	871,766
50 - 55	225,550	752,676	156,989	38,802	1,174,018
55 - 60	420,928	966,313	178,000	1,748,734	3,313,975
60 - 65	138,535	227,711	70,854	731,849	1,168,949
Totals	3,483,039	6,885,601	5,426,120	4,370,917	20,165,677

Source: AECOM 2016
Note: AECOM developed 2014 values through linear backcasting of the 2040 (2016 General Plan) and 2015 values

VMT By Speed Bin

Speed Interval	2020 - Interpolated				
	Morning	Midday	Afternoon	Night	Daily
0 - 5	24,900	23,490	310,442	3,173	362,005
5 - 10	56,279	36,930	524,630	5,932	623,772
10 - 15	119,065	117,389	633,038	44,068	913,560
15 - 20	244,703	244,811	770,031	95,302	1,354,848
20 - 25	1,080,161	1,744,450	1,601,779	869,824	5,296,214
25 - 30	596,113	968,852	908,543	453,740	2,927,248
30 - 35	378,640	933,641	452,072	317,492	2,081,846
35 - 40	269,427	584,256	228,726	72,833	1,155,242
40 - 45	201,019	713,683	190,019	125,557	1,230,277
45 - 50	193,300	604,270	145,764	15,394	958,728
50 - 55	222,602	737,974	145,927	87,154	1,193,657
55 - 60	396,898	836,628	167,022	1,984,726	3,385,274
60 - 65	123,831	205,319	63,976	825,311	1,218,437
Totals	3,906,939	7,751,693	6,141,969	4,900,507	22,701,107

Source: AECOM 2016
Note: AECOM developed 2020 values through linear interpolation of 2015 and 2040 (2016 General Plan) values

VMT By Speed Bin

Speed Interval	2030 - Interpolated				
	Morning	Midday	Afternoon	Night	Daily
0 - 5	44,935	40,059	565,761	4,680	655,435
5 - 10	123,046	56,943	931,123	5,165	1,116,278
10 - 15	201,576	168,650	977,429	55,177	1,402,831
15 - 20	355,168	331,648	1,032,090	106,511	1,825,417
20 - 25	1,280,405	2,045,280	1,671,624	970,558	5,967,867
25 - 30	721,218	1,211,859	860,140	498,503	3,291,719
30 - 35	487,222	1,171,332	453,723	353,709	2,465,985
35 - 40	299,725	920,532	222,769	101,346	1,544,371
40 - 45	241,552	973,726	167,016	139,546	1,521,841
45 - 50	184,731	773,193	124,647	21,095	1,103,665
50 - 55	217,689	713,470	127,490	167,741	1,226,390
55 - 60	356,847	620,487	148,725	2,378,047	3,504,105
60 - 65	99,325	167,998	52,513	981,082	1,300,918
Totals	4,613,438	9,195,178	7,335,051	5,783,156	26,926,824

Source: AECOM 2016
Note: AECOM developed 2030 values through linear interpolation of 2015 and 2040 (2016 General Plan) values

VMT By Speed Bin

Speed Interval	2015				
	Morning	Midday	Afternoon	Night	Daily
0 - 5	14,883	15,205	182,782	2,420	215,290
5 - 10	22,896	26,924	321,383	6,316	377,519
10 - 15	77,810	91,758	460,843	38,513	668,924
15 - 20	189,471	201,392	639,002	89,698	1,119,563
20 - 25	980,039	1,594,035	1,566,856	819,457	4,960,387
25 - 30	533,561	847,348	932,745	431,358	2,745,012
30 - 35	324,349	814,796	451,247	299,384	1,889,776
35 - 40	254,278	416,118	231,704	58,577	960,677
40 - 45	180,752	583,661	201,520	118,562	1,084,495
45 - 50	197,584	519,809	156,323	12,544	886,260
50 - 55	225,059	750,226	155,145	46,861	1,177,291
55 - 60	416,923	944,699	176,170	1,788,066	3,325,858
60 - 65	136,084	223,979	69,708	747,426	1,177,197
Totals	3,553,689	7,029,950	5,545,428	4,459,182	20,588,249

Source: Hexagon 2016
Note: 2015 was General Plan transportation analysis base year; GHG inventory update year is 2014

VMT By Speed Bin

Speed Interval	2016 General Plan				
	Morning	Midday	Afternoon	Night	Daily
0 - 5	64,969	56,629	821,081	6,186	948,865
5 - 10	189,813	76,956	1,337,617	4,398	1,608,784
10 - 15	284,087	219,911	1,321,819	66,286	1,892,103
15 - 20	465,633	418,485	1,294,149	117,719	2,295,986
20 - 25	1,480,649	2,346,110	1,741,470	1,071,292	6,639,521
25 - 30	846,322	1,454,866	811,737	543,266	3,656,191
30 - 35	595,804	1,409,023	455,373	389,925	2,850,125
35 - 40	330,023	1,256,808	216,812	129,858	1,933,501
40 - 45	282,086	1,233,770	144,014	153,535	1,813,405
45 - 50	176,162	942,115	103,529	26,795	1,248,601
50 - 55	212,775	688,966	109,054	248,327	1,259,122
55 - 60	316,796	404,346	130,428	2,771,367	3,622,937
60 - 65	74,819	130,678	41,050	1,136,852	1,383,399
Totals	5,319,938	10,638,663	8,528,133	6,665,806	31,152,540

Source: Hexagon 2016
Note: This table assumes a 2040 horizon year

City of San José
Off-Road Vehicles: Boating

Park Name	Within City	# Power Boats	PB Attendence	# Pleasure Watercraft	PWC Attendence	# Non-Power Boats	NPB Attendence	Special Permit Boats	Special Permit Boat Attendence	Total Attendence	Total Launches
Alviso Marina	0%	6,800	23,800			2,342	3,513			27,313	9,142
Anderson Lake	50%	5,054	17,689	639	959	277	416			19,064	5,970
Calero	100%	2,709	9,482	884	1,326	798	1,197			12,005	4,391
Coyote Lake	0%	689	2,412	151	227	162	243			2,882	1,002
Lexington	0%							4,490	35,920	35,920	4,490
Stevens Creek	0%									-	
Vasona	0%	100	350					3,744	7,488	7,838	3,844
Santa Clara County Total		15,352	53,733	1,674	2,512	3,579	5,369	8,234	43,408	105,022	28,839
City of San Jose Total		5,236	18,327	1,204	1,806	937	1,405	-	-		
City of San Jose Allocation			34%		72%		26%				

Activity Data				2014 OFFROAD Emissions				
Boat Type	Santa Clara County	City of San Jose	Percent	Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
Personal Watercraft (PWC)	2,512	1,806	72%	788.08	1.15	0.17	868.65	624
Non-Power Boat (NPB)	5,369	1,405	26%	6.90	0.01	0.00	7.50	2
Power Boat (PB)	53,733	18,327	34%	20,471.81	7.23	4.36	21,950.73	7,487
Total	61,614	21,537	35%	21,266.79	8.38	4.53	22,826.88	**8,113**

2020
OFFROAD Emissions

Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
1,249.47	1.17	0.26	1,356.95	975
6.37	0.00	0.00	6.91	2
23,654.05	6.53	4.53	25,166.83	8,584
24,909.90	7.71	4.79	26,530.69	**9,561**

2030
OFFROAD Emissions

Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
2,598.80	2.01	0.53	2,807.19	2,018
5.58	0.00	0.00	6.02	2
30,229.69	6.34	4.94	31,861.45	10,867
32,834.07	8.35	5.48	34,674.67	**12,886**

2040
OFFROAD Emissions

Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
5,429.55	4.09	1.11	5,861.33	4,213
4.88	0.00	0.00	5.27	1
38,825.47	7.72	6.19	40,863.61	13,937
44,259.90	11.82	7.30	46,730.20	**18,151**

City of San José
Off-Road Vehicles: Trains

Transit Name	Transit Line	Daily Activity (passby trips) [1]	Average Ridership (riders/train) [2]	Train Miles in City (miles) [1]	Emission Factor (lb CO_2e/ passenger-mile) [3]	2014 CO_2e Emissions (MT/yr)	2020 CO_2e Emissions (MT/yr)	2030 CO_2e Emissions (MT/yr)	2040 CO_2e Emissions (MT/yr)
Caltrain									
	Diridon North	92	616	2.4	0.37	8,440	10,988	15,235	19,483
	Tamien North	40	616	4.13	0.37	6,314	8,221	11,399	14,577
	Tamien South	6	616	15.87	0.37	3,640	4,739	6,570	8,402
ACE									
	Diridon	8	546	3.27	0.37	886	1,623	4,738	5,670
Capitol Corridor									
	Diridon	14	135	3.27	0.37	383	439	534	628
Total						**19,662**	**26,010**	**38,476**	**48,759**

Sources:

[1] Email from David J. Powers & Associates to AECOM, received February 03, 2016; data included in email from City of San José

[2] Caltrain (Uniform Limited Passengers Per Train by Service Type): http://www.caltrain.com/Assets/_MarketDevelopment/pdf/2014+Annual+Passenger+Count+Key+Findings.pdf

[2] ACE (ACE Average Weekday Riders/8 trains/day): http://www.vta.org/sfc/servlet.shepherd/document/download/069A0000001ePEjIAM

[2] Amtrak (Annual Ridership/365 days/30 trains/day): http://www.capitolcorridor.org/downloads/performance_reports/CCJPA_Performance2015.pdf

[3] Carbonfund.org (commuter rail emission factor): https://www.carbonfund.org/how-we-calculate

CALTRAIN FORECAST

Model Estimated Daily Boardings by Train Operator in the Project Corridor 2013, 2020, and 2040

	2013 Observed	2040 Project + TTC	Avg. Annual Growth
Caltrain	47,100	111,100	**5.03%**

Source:
http://www.caltrain.com/Assets/Caltrain+Modernization+Program/FEIR/App+I+Ridership.pdf

ACE FORECAST

	2015	2020 No Build	2020 - 6 ACE	2025 No Build	2025 - 10 ACE	2020-2025 w/ Project
	2015	2020	2020	2025	2025	
South Bay Stations	913	1042	1546	1132	3029	
Avg. Annual Growth		2.8%	**13.9%**	2.4%	23.2%	**19.2%**

Source:
http://www.acerail.com/About/Board/Board-Meetings/2016/April-1,-2016/Found-here-link.pdf

AMTRAK FORECAST

	2015	2040	2040	Avg. Annual Growth
	Baseline	Natural Growth	Plus Projects	
Baseline	1,402,300		2,267,200	**2.5%**

Source:
http://www.capitolcorridor.org/downloads/CCJPAVisionPlanFinal.pdf

City of San José
Off-Road Vehicles: Airport Ground Support Equipment

Airport Ground Support Equipment			Emission Factors (kg/gallon)			2014	2020	2030	2040
Fuel Use in 2014	**gallons/mo**	**gallons/yr**	**CO_2**	**N_2O**	**CH_4**	**MT CO_2e/yr**	**MT CO_2e/yr**	**MT CO_2e/yr**	**MT CO_2e/yr**
Unleaded Gasoline	1,052	12,624	8.81	0.00022	0.00050	112.20			
Diesel	475	5,700	10.15	0.00026	0.00058	58.38			
Total						**171**	**199**	**247**	**294**

Source:
Fuel consumption data from City of San José, February 2016
Emission factors from General Reporting Protocol Version 3.1 (Table C.3 and C.6)

Global Warming Potential (GWP)

CO_2	1
CH_4	25
N_2O	298

Source:
GWP from IPCC Fourth Assessment Report

Enplaned Passenger Forecasts

	2014	2027	Avg. Annual Growth
Passengers	5,067,000	8,150,000	4.7%
Total General Aviation Ops	58,000	73,200	2.0%
Airport Total	193,710	263,790	**2.78%**

Source:
http://www.flysanjose.com/fl/about/improve/overview/CR_Dem_Fore.pdf

City of San José
Off-Road Equipment

Annualization Factor 365

Off-Road Equipment/Vehicle Class	OFFROAD Category	Demographics: Demographic	Santa Clara County	City of San Jose	2014: Ratio (City/County)	Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
Lawn and Garden	Lawn and Garden Equipment	Households + Jobs	1,602,999	673,387	42%	27,775	42	18	34,278	14,399
Construction	Construction and Mining Equipment	Jobs	966,703	359,128	37%	371,673	40	2	373,362	138,703
Industrial	Industrial Equipment	Jobs	966,703	359,128	37%	306,324	103	17	314,036	116,664
Light Commercial	Light Commercial Equipment	Jobs	966,703	359,128	37%	57,153	17	9	60,397	22,438
TOTAL										**292,204**

Off-Road Equipment/Vehicle Class	OFFROAD Category	Demographic	Santa Clara County	City of San Jose	2020: Ratio (City/County)	Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
Lawn and Garden	Lawn and Garden Equipment	Households + Jobs	1,705,673	790,528	46%	29,192	43	19	35,842	16,612
Construction	Construction and Mining Equipment	Jobs	1,027,353	449,710	44%	404,107	29	2	405,560	177,528
Industrial	Industrial Equipment	Jobs	1,027,353	449,710	44%	329,706	95	18	337,495	147,734
Light Commercial	Light Commercial Equipment	Jobs	1,027,353	449,710	44%	61,500	14	10	64,715	28,328
TOTAL										**370,202**

Off-Road Equipment/Vehicle Class	OFFROAD Category	Demographic	Santa Clara County	City of San Jose	2030: Ratio (City/County)	Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
Lawn and Garden	Lawn and Garden Equipment	Households + Jobs	1,876,797	985,764	53%	31,895	46	20	39,108	20,541
Construction	Construction and Mining Equipment	Jobs	1,128,437	600,680	53%	459,145	22	3	460,510	245,135
Industrial	Industrial Equipment	Jobs	1,128,437	600,680	53%	377,664	106	21	386,503	205,740
Light Commercial	Light Commercial Equipment	Jobs	1,128,437	600,680	53%	70,407	14	11	73,971	39,376
TOTAL										**510,791**

Off-Road Equipment/Vehicle Class	OFFROAD Category	Demographic	Santa Clara County	City of San Jose	2040: Ratio (City/County)	Santa Clara County Total (MT CO_2/yr)	Santa Clara County Total (MT CH_4/yr)	Santa Clara County Total (MT N_2O/yr)	Santa Clara County Total (MT CO_2e/yr)	City of San Jose (MT CO_2e/yr)
Lawn and Garden	Lawn and Garden Equipment	Households + Jobs	2,047,920	1,181,000	58%	34,797	50	22	42,664	24,604
Construction	Construction and Mining Equipment	Jobs	1,229,520	751,650	61%	513,719	21	3	515,187	314,952
Industrial	Industrial Equipment	Jobs	1,229,520	751,650	61%	430,750	120	24	440,832	269,497
Light Commercial	Light Commercial Equipment	Jobs	1,229,520	751,650	61%	80,263	16	12	84,322	51,549
TOTAL										**660,602**

DEMOGRAPHIC FORECASTS

	City of San Jose					Santa Clara County				
Indicator	**2014**	**2015**	**2020**	**2030**	**2040**	**2010**	**2014**	**2020**	**2030**	**2040**
Jobs	359,128	374,225	449,710	600,680	751,650	926,270	966,703	1,027,353	1,128,437	1,229,520
Households	314,259	318,686	340,818	385,084	429,350	604,210	636,296	678,320	748,360	818,400

Source: See Table 12 in City of San Jose 2014 Community Inventory and Forecasts Memo

City of San José
Wastewater Sector (Process Emissions)

	2014 Influent Emissions							2014 Effluent Emissions					
Facility/Jurisdiction	**Influent (MGD)**	**Influent (gal/yr)**	**Influent BOD (mg/L)**	**Influent BOD (kg/yr)**	**Adjusted BOD Emission Factor (kg CH_4/kg BOD)**	**CH_4 Emissions (MT/yr)**	**Influent Emissions (MT CO_2e)**	**Effluent (MGD)**	**Effluent (gal/yr)**	**Effluent Nitrogen Content (mg/L)**	**Effluent Nitrogen Content (kg/yr)**	**N_2O Emissions (MT/yr)**	**Effluent Emissions (MT CO_2e)**
San Jose-Santa Clara Regional WW Facility	101.70	37,117,000,000	334	31,672,985	0.48	15,203	380,076	84.00	31,653,000,000	16.1	1,928,886	15.16	4,516

Note: City staff provided influent and effluent values as both average MGD and MG/yr. This analysis uses the annual values instead of applying an annualization factor to the average daily values.

Population Served by SJSC-WF (Year 2014)

City of San Jose	1,016,479
Total Population Served	1,400,000
Percent	

Source: https://www.sanjoseca.gov/DocumentCenter/View/29166

Influent Forecasts

	2014	**2040** [1]	**Avg. Annual Growth**
MGD	101.7	172	**2.7%**

[1] Source: http://www.sanjoseculture.org/DocumentCenter/View/38425

EMISSION FACTORS AND EQUATIONS

Methane Emissions

Emission Factor (kg CH_4/kg BOD)	**Max CH_4 Producing Capacity (kg CH_4/kg BOD)**	**Methane Correction Factor (MCF)**	**Fraction of BOD Removed in Primary Treatment**	**Conversion (L/gal)**
0.48	0.6	0.8	0.325	3.785

Source: ICLEI Community Protocol equation WW.6; Fraction of BOD Removed value is default value from equation WW.6(alt)

Nitrogen Emissions

$EF_{Effluent}$ (kg N2O-N/kg N)	**MW Ratio (N_2O/N_2)**
0.005	1.57

Source: ICLEI Community Protocol equation WW.12

Methane Correction Factors (MCF)

Untreated Systems	**Comments**	**MCF**	**Range**
Sea, river and lake discharge	Rivers with high organic loads, can turn anaerobic	0.1	0 - 0.2
Stagnant sewer	Open and warm	0.5	0.4 - 0.8
Flowing sewer (open or closed)	Fast moving, clean (insign amounts of CH4)	0	0
Treated System	**Comments**	**MCF**	**Range**
Centralized aerobic treatment plant	Well managed. Some CH4 from settling basins	0	0 - 0.1
Centralized aerobic treatment plant	Not well managed. Overloaded	0.3	0.2 - 0.4
Anaerobic digester for sludge	No CH4 recovery	0.8	0.8 - 1.0
Anaerobic reactor	No CH4 recovery	0.8	0.8 - 1.0
Anaerobic shallow lagoon	Less than 2 meter depth	0.2	0 - 0.3
Anaerobic deep lagoon	More than 2 meter depth	0.8	0.8 - 1.0
Septic system	Half BOD settles in anaerobic tank	0.5	0.5
Latrine	Dry climate, ground water table lower than latrine (3-5 persons)	0.1	0.05 - 0.15
Latrine	Dry climate, ground water table lower than latrine (many users)	0.5	0.4 - 0.6
Latrine	Wet climate/flush water use, groundwater table higher than latrine	0.7	0.7 - 1.0
Latrine	Regular sediment removal for fertilizer	0.1	0.1

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Chapter 6, Table 6.3 - Default MCF Values for Domestic Wastewater;
MCF of 0.8 was used in City's 2008 community inventory

City of San José
Wastewater Sector (Digester Gas Emissions)

Fugitive CH_4 Emissions - Modeled

						Captured/Combusted		Digester Gas Emitted	
Population Served	**Digester Gas Production Rate (ft^3/person/day)**	**Methane Fraction of Biogas (%)**	**Methane Density (g/m^3)**	**Destruction Efficiency (%)**	**Annualization (days/year)**	**Biogenic Emissions (MT CH_4/year)**	**Biogenic Emissions (MT CO_2e/year)**	**Fugitive Emissions (MT CH_4/year)**	**Fugitive Emissions (MT CO_2e/year)**
1,400,000	1	65%	662.00	99%	365.25	6,164.69	154,117.25	62.27	**1,557**

Notes:
Population from San Jose-Santa Clara Regional Wastewater Facility website: https://www.sanjoseca.gov/Index.aspx?NID=1663
ICLEI Community Protocol equation WW.1.(alt) references equation source as Local Government Operations Protocol (LGOP) Equation 10.2, but represent equation differently within ICLEI Protocol; For purposes of this analysis, the referenced equation from the LGOP was used because it is the same methodology referenced in Envision San José 2040 General Plan Integrated Final Program EIR, Appendix K – Greenhouse Gas Emissions, pgs. 21-22.

Fugitive N20 Emissions - Modeled

Population Served	**Digester Gas Production Rate (ft^3/person/day)**	**Methane Fraction of Biogas (%)**	**Default BTU Content (BUT/ft^3)**	**Conversion BTU to 1 MMBTU**	**N_2O Emission Factor (kg N_2O/MMBTU)**	**Conversion Factor (day/year)**	**Conversion kg to MT**	**GWP N_2O**	**Fugitive Emissions (MT CO_2e/year)**
1,400,000	1	65%	1,028.00	0.00000	0.00063	365.25	0.00	298.00	**64.1**

Notes:
Population from San Jose-Santa Clara Regional Wastewater Facility website: https://www.sanjoseca.gov/Index.aspx?NID=1663
Methodology from ICLEI Community Protocol equation WW.2.(alt)

	MT CO_2e/year
TOTAL FUGITIVE EMISSIONS - 2014	**1,621**

City of San José
Potable Water Energy Use

WATER SUPPLY SOURCES

Water Supply Sources from City's Water Providers

Collected from each company's 2010 Urban Water Management Plan

	Groundwater	Surface	Recycled
Great Oaks Water Company	100%	0%	0%
San Jose Water Company	38%	61%	1%
MWS	3%	82%	15%

	Groundwater	Surface
Great Oaks Water Company	100%	0%
San Jose Water Company	38%	62%
MWS	3%	97%

Note:

ICLEI Community Protocol Appendix F equation WW.14.1 does not specify how to treat recycled water. For purposes of this energy analysis, recycled water is combined with surface water since it does not require energy use associated with groundwater pumping. Further, it is assumed that the energy use associated with treating the recycled water to standards for reuse are represented within the Energy sector, which includes energy use at the San Jose-Santa Clara Regional Water Facility (SJSC RWF). [The South Bay Water Recycling main pump station is adjacent to SJSC RWF, within the City of San Jose boundary.] Thereore, the estimation of water treatment included in this analysis only pertains to the treatment of surface water prior to distribution.

WATER USAGE - 2014

Actual Water Usage - 2014

Collected from Schaaf & Wheeler memo prepared for City of San Jose: *Summary Review Water Supply for Envision San Jose 2040 memo*

Table 7: UWMP Demand Predictions vs. Actual Drought (AFY)

	2014 - AFY	2014 - MG
Great Oaks Water Company	10,663	3,475
San Jose Water Company	128,767	41,959
MWS	19,254	6,274

Conversions

Gallons per Acre Foot (AF)	
325,851	
Gallons per Million Gallons (MG)	
1,000,000	

WATER USE BY SUPPLY SOURCE - 2014

	Groundwater (MG)	Surface (MG)	
Great Oaks Water Company	3,475	-	3,475
San Jose Water Company	15,944	26,014	41,959
MWS	188	6,086	6,274
Total	19,607	32,100	51,707

City of San José
Potable Water Energy Use

ENERGY INTENSITIES BY PROCESS

San Jose Water Company

Source: *Embedded Energy in Water Studies, Study 2: Water Agency and Function Component Study and Embedded Energy-Water Load Profiles, Appendix B*

ftp://ftp.cpuc.ca.gov/gopher-data/energy%20efficiency/Water%20Studies%202/Appendix%20B%20-%20Agency%20Profiles%20-%20FINAL.pdf

Segment	ICLEI Equation Term	Avg Summer (kWh/MG)	Avg Winter (kWh/MG)	Annual Average (kWh/MG)	
Groundwater	Extraction	1,548	3,421	2,485	Only groundwater is extracted.
Booster Pumps	Distribution/Conveyance	1,340	533	937	
Raw Water Pump	Distribution/Conveyance	3	-	2	
Water Treatment	Treatment	39	26	33	Only surface water is treated.
Pressure System Pumps	Distribution/Conveyance	48	9	29	
TOTAL		2,978	3,989	3,484	

Note:

Per ICLEI Community Protocol guidance, the above energy intensity information was collected from a study of California water providers. Of the City's three water providers, only the San Jose Water Company (SJWC) was profiled in the study. This analysis assumes that the energy intensities provided for SJWC are representative of the other two water providers. Further, the study provides information on five segments of the water process (shown in the above table in the Segment column). The ICLEI equation references four segments: extraction, conveyance, treatment, and distribution. For purposes of this analysis, the "Groundwater" segment was applied to the extraction phase; the "Water Treatment" segment was applied to the treatment phase; and the "Booster Pump", "Raw Water Pump", and "Pressure System Pumps" were applied to the distribution/conveyance phase. Also, the study did not provide annual averages for energy intensity by water process phase, but rather provided summer and winter information as High Water Demand Day, Low Water Demand Day, and Average Water Demand Day, as well as Summer Peak Energy Demand Day. For purposes of this analysis, the summer and winter Average Water Demand Day information was averaged to create an annual Average Water Demand Day.

ELECTRICITY EMISSIONS FACTOR

eGRID 2012

	CO2 (lb/MWh)	CH4 (lb/GWh)	N20 (lb/GWh)	
CAMX - WECC California	650.31	31.12	5.67	
	CO2	**CH4**	**N2O**	**Total**
lb/kWh	0.65031	0.00003112	0.00000567	
metric ton	0.0002949756	0.0000000141	0.0000000026	
GWP	1	25	298	
MT CO2e/kWh	0.0002949756	0.0000003529	0.0000007664	0.000296095

Conversions

lbs per metric ton	MW per kW	GW to kW
2204.623	0.001	0.000001

Note:

This analysis uses a California regional electricity emissions factor from eGRID 2012 instead of the city-specific factor used in the Energy sector. The water system serving the city is part of a regional network that extends beyond the City's boundaries, and likely extends beyond the boundaries of the City's electricity provider (i.e., PG&E).

Attachment B
Solid Waste Emissions Estimates

AECOM prepared solid waste emissions estimates for the 2014 base year, and the 2020, 2030, and 2040 forecast years using the methane commitment model outlined in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The equations and inputs associated with that model are presented below, followed by additional data items used to estimate San José's solid waste emissions. AECOM applied equations 8.1, 8.3, and 8.4 from the GPC, as follows.

Equation 8.1: Degradable organic carbon (DOC)

DOC = (0.15 x A) + (0.2 x B) + (0.4 x C) + (0.43 x D) + (0.24 x E) + (0.15 x F) + (0.39 x G) + (0.0 x H) + (0.0 x I) + (0.0 x J) + (0.0 x K)	
A	= Fraction of solid waste that is food
B	= Fraction of solid waste that is garden waste and other plant debris
C	= Fraction of solid waste that is paper
D	= Fraction of solid waste that is wood
E	= Fraction of solid waste that is textiles
F	= Fraction of solid waste that is industrial waste
G	= Fraction of solid waste that is rubber and leather
H	= Fraction of solid waste that is plastics
I	= Fraction of solid waste that is metal
J	= Fraction of solid waste that is glass
K	= Fraction of solid waste that is other, inert waste

Source: Default carbon content values sourced from IPCC Waste Model spreadsheet, available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf

Note: GPC Equation 8.1 includes factors A-F; AECOM added factors G-K using the default DOC content in % of wet waste from the same IPCC Waste Model spreadsheet referenced in the source above

Equation 8.3: Methane commitment estimate for solid waste sent to landfill

CH_4 emissions = $MSW_x \times L_0 \times (1-f_{rec}) \times (1-OX)$		
Description		**Value**
CH_4 emissions	= Total CH_4 emissions in metric tons	Computed
MSW_x	= Mass of solid waste sent to landfill in inventory year, measured in metric tons	User input
L_0	= Methane generation potential	Equation 8.4 Methane generation potential
f_{rec}	= Fraction of methane recovered at the landfill (flared or energy recovery)	User input
OX	= Oxidation factor	0.1 for well-managed landfills; 0 for unmanaged landfills

Source: Adapted from *Revised 1996 IPCC Guidelines for National Greenhous Gas Inventories*

AECOM used the following values in Equation 8.3:

- MSW_x = see Table B.4
- f_{rec} = 75%
- OX = 0.1

Equation 8.4: Methane generation potential, L_0

L_0 = $MCF \times DOC \times DOC_F \times F \times 16/12$		
Description		**Value**
L_0	= Methane generation potential	Computed
MCF	= Methane correction factor based on type of landfill site for the year of deposition (managed, unmanaged, etc., fraction)	Managed = 1.0 Unmanaged (≥ 5 m deep) = 0.8 Unmanaged (<5 m deep) = 0.4 Uncategorized = 0.6
DOC	= Degradable organic carbon in year of deposition, fraction (tons C/tons waste)	Equation 8.1
DOC_F	= Fraction of DOC that is ultimately degraded (reflects the fact that some organic carbon does not degrade)	Assumed equal to 0.6
F	= Fraction of methane in landfill gas	Default range 0.4-0.6 (usually taken to be 0.5)
16/12	= Stoichiometric ratio between methane and carbon	

Source: *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)*

AECOM used the following values in Equation 8.4:

- MCF = 1.0
- DOC_f = 0.5; GPC equation 8.4 notes that the DOC_f value is assumed to be 0.6, as shown in the preceding table. However, the IPCC guidance upon which GPC developed its solid waste reporting protocol suggests a default DOC_f value of 0.5, which AECOM applied in its calculations for San José.[1]
- F = 0.5

3.6.1 San José Waste Characterization

AECOM collected waste disposal data from the City of San José and statewide waste characterization data from CalRecycle to estimate value MSW_x in Equation 8.3.

Waste Disposal Data

City staff provided solid waste disposal data for the baseline year of 2014, as shown in Table B.1. City data was provided in short tons, which AECOM converted into metric tons (1 short ton = 0.9072 metric tons) for use in Equation 8.3.

Table B.1
Annual Solid Waste Disposal

Year	Waste Disposed (short tons)	Waste Disposed (metric tons)
2014	661,857	600,427

AECOM forecast future disposal values for the 2020, 2030, and 2040 horizon years using a metric tons/service population (MT/SP) ratio based on City data. AECOM used 2014 service population data to calculate a MT/SP ratio to be applied to the 2020, 2030, and 2040 horizon years. See Table B.2 for the waste disposal forecasts and inputs.

Table B.2
Waste Disposal Forecasts

Year	Metric Tons (MT)	Service Population (SP) [1]	MT/SP [2]
2014	600,427 [3]	1,366,290	0.44
2020	646,246 [4]	1,527,637	0.44
2030	761,878 [4]	1,796,549	0.44
2040	877,511 [4]	2,065,461	0.44

Source: AECOM 2016

Notes: Service population (SP) = population from jobs

[1] David J. Powers & Associates, 2016

[2] 2014 value calculated from MT and SP data shown in table above; 2020, 2030, and 2040 years assume 2014 MT/SP rate remains constant

[3] See Table B.1

[4] Calculated as SP * (MT/SP)

[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste. Available online at: <http://www.ipcc-nggip.iges.or.jp/public/2006gl/>

Waste Characterization

AECOM estimated landfill waste composition based on CalRecycle's *2014 Disposal-Facility-Based Characterization of Solid Waste in California* report. Per the report, CalReycle's side-by-side analysis of the 2008 Statewide Waste Characterization Study and the 2014 study results identified an unexpected anomaly in the distribution of waste per sector (i.e., residential, commercial, and self-hauled). CalRecycle is obtaining additional data to verify the 2014 report results. In the interim, the 2014 report presents two sets of data: one reflecting the 2014 calculated sector percentages, and the other based on the 2008 report sector percentages. AECOM selected to use the set of data based on the 2008 report.

The CalRecycle report estimates the percentage of different materials in California's waste stream. AECOM referred to *Table 7: Composition of California's Overall Disposed Waste Stream* to determine the distribution of waste by the material types included in Equation 8.1. Table B.3 shows the results of this data sorting.

Table B.3

Waste Characterization – Selected Material Categories

Material	Estimated % of Total Disposed Waste Stream	Material Categories/Sub-types from CalRecycle 2014 Report [1]
Paper	18.1%	Paper category plus Gypsum Board sub-type from Inerts and Other category
Textiles	3.6%	Textiles sub-type from Other Organic category
Food	30.8%	Other Organic category minus Textiles sub-type
Wood	13.7%	Lumber sub-type from Inerts and Other category
Rubber and Leather	0.1%	Tires sub-type from Special Waste category
Plastics	10.4%	Plastic category
Metal	3.1%	Metal category
Glass	2.5%	Glass category
Other	17.7%	Electronics category, Household Hazardous Waste (HHW) category, Mixed Residue category, Inerts and Other category (minus Lumber and Gypsum Board sub-types), and Special Waste category (minus Tires sub-type)
Total	100.0%	

Source: AECOM 2016

[1] *2014 Disposal-Facility-Based Characterization of Solid Waste in California,* CalRecycle 2015. Available online at: <http://www.calrecycle.ca.gov/Publications/Documents/1546/20151546.pdf>

San José Waste Disposal by Characterization Type

AECOM multiplied the solid waste disposal values (in metric tons) from Table B.2 by the waste characterization values presented in Table B.3 to estimate disposal values by waste type for the 2014, 2020, 2030, and 2040 planning horizon years. Table B.4 on the following page presents the results, which were applied to Equations 8.1 and 8.3 to calculate San José's solid waste emissions.

Table B.4 Waste Disposed by Waste Type				
Waste Type	**2014 (MT)**	**2020 (MT)**	**2030 (MT)**	**2040 (MT)**
Paper	108,677	121,511	142,901	164,291
Textiles	21,615	24,168	28,422	32,677
Food	184,931	206,770	243,168	279,566
Wood	82,258	91,972	108,163	124,353
Rubber and Leather	600	671	790	908
Plastics	62,444	69,819	82,109	94,399
Metal	18,613	20,811	24,475	28,138
Glass	15,011	16,783	19,738	22,692
Other	106,276	118,826	139,743	160,660
Total	**600,427**	**671,332**	**789,507**	**907,683**

Source: AECOM 2016

Notes: MT = metric tons

Table B.5 presents the emissions results by waste type and year.

Table B.5 Solid Waste Emissions by Waste Type				
Waste Type	**2014 (MT CO_2e)**	**2020 (MT CO_2e)**	**2030 (MT CO_2e)**	**2040 (MT CO_2e)**
Paper	91,061	101,814	119,737	137,659
Textiles	10,867	12,150	14,289	16,428
Food	58,108	64,970	76,407	87,843
Wood	74,094	82,844	97,427	112,010
Rubber and Leather	491	548	645	742
Plastics	0	0	0	0
Metal	0	0	0	0
Glass	0	0	0	0
Other	0	0	0	0
Total	**234,620**	**262,326**	**308,504**	**354,681**

Source: AECOM 2016

Notes: MT CO_2e = metric tons of carbon dioxide equivalent