



## Memorandum

<b>Date:</b>	March 26, 2015
<b>To:</b>	Cal Broomhead, Pansy Gee, Donnie Oliveira, Sachiko Tanikawa San Francisco Department of the Environment
<b>From:</b>	Brian Schuster, Rich Walter, Rahul Young ICF International
<b>Subject:</b>	<b>Technical Review of the Fiscal Year 2011-2012 Municipal GHG Inventory for the City and County of San Francisco</b>

This memo provides a summary of key findings from ICF International’s review of the municipal greenhouse gas (GHG) inventory for the City and County of San Francisco for fiscal year 2011-2012 (hereafter referred to as the “FY 2011-2012 municipal GHG inventory”) prepared by the San Francisco Department of the Environment (SFE).

This memo is organized into the following sections:

Section 1 — Background

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Section 4 — Inventory Limitations and Suggestions for Future Improvement

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### 1. Background

ICF International (hereafter referred to as “ICF”), a publicly-traded technical, management and strategy consulting firm with expertise in climate change, energy, transportation, waste, and other issues,<sup>1</sup> was hired by the San Francisco Department of the Environment (SFE) in September 2014 to undertake an independent, third-party review of the FY 2011-2012 municipal GHG inventory. ICF has prepared numerous GHG inventories for companies, cities, counties, states, and countries including preparation of the U.S. national GHG inventory since the late 1980s. This current effort represents the second time that ICF has provided technical review of San Francisco’s municipal inventory, having conducted such an exercise in 2012 for the municipal GHG emissions for San

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<sup>1</sup> Please refer to ICF’s website ([www.icfi.com](http://www.icfi.com)) for further info. ICF’s NASDAQ symbol is “ICFI”

Francisco for the fiscal year 2009-2010. Since then, SFE has produced a FY 2011-2012 municipal GHG inventory.

## 2. Methodology

ICF's technical review of SFE's FY 2011-2012 municipal GHG inventory consisted primarily of a desk review of (a) the GHG Inventory; (b) inventory guidance documents and; (c) approximately 40 supporting documents (back-up records, raw data, PDF files of relevant reports, and email correspondence). Other than a visit to the SFE, our review did not include site visits to specific municipal emissions producing entities. The focus of our review has been primarily on the activity data, emissions factors, overall approaches and methods as well as documentation for the FY 2011-2012 municipal GHG inventory.

ICF's review consisted of the following key components:

- **Kick-off meeting:** A kick-off meeting between ICF and SFE was held in person in October 2014. Subsequent discussions took place via telephone and in person.
- **Review of GHG Inventory and supporting calculations:** ICF's review consisted of checking the methods and accuracy of quantification approaches, with a focus on transparency and completeness of calculations, as well as clear and verifiable references and assumptions for key parameters, with a focus on activity data, emissions factors and calculation approaches applied for the 2012 inventory. Numerical checks of the inventory numbers, both in terms of activity data as well as tons CO<sub>2</sub> equivalent (tons CO<sub>2</sub>e) by sector and in aggregate, were performed by ICF.
- **Check of requested activity data and emissions factors calculations against inventory:** ICF requested original activity data from relevant agencies to double-check the accuracy of such numbers used by SFE in its municipal GHG inventory. Given that electricity and natural gas usage (primarily for buildings, as well as for some transportation) and fuel use in aggregate accounted for approximately 92% of total municipal GHG emissions in 2012 (please see Figure 1), ICF focused on these sectors by obtaining and reviewing electricity and natural gas consumption totals for the City and County of San Francisco from Pacific Gas & Electric (PG&E), electricity breakouts from the San Francisco Public Utilities Commission (SFPUC), and fuel usage figures from various city departments. In addition, ICF reviewed individual emissions factors for electricity (pounds of CO<sub>2</sub> per megawatt-hour, or lbs CO<sub>2</sub>/MWh) for 2012 from PG&E (third-party verified), SFPUC, and the Western Area Power Administration (WAPA), as well as a number of fuel emission factors for city fleet vehicles for gasoline, diesel, compressed natural gas (CNG), biodiesel, and propane from the Climate Registry<sup>2</sup>.

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<sup>2</sup> Climate Registry. 2014. *The Climate Registry's 2014 Default Emission Factors*. Available: <<http://theclimaterregistry.org/wp-content/uploads/2015/01/2014-Climate-Registry-Default-Emissions-Factors.pdf>>.

- **Consistency with the California Air Resources Board's (ARB) Local Government Operations Protocol for Greenhouse Gas Assessments (LGOP) (May 2010, Version 1.1)<sup>3</sup> and the ICLEI - Local Governments for Sustainability (ICLEI) U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (October 2012, Version 1.0)<sup>4</sup>.** The LGOP is the current and latest protocol for generating municipal GHG emissions inventories. In addition, the ICLEI 2012 U.S. Community Protocol (hereafter referred to as the "ICLEI 2012 Protocol"), is the current and latest protocol for generating community GHG emissions inventories, and has a number of updated methods, equations, and emission factors that should be used in place of some of the guidance in the LGOP that is now outdated. As such, the FY 2011-2012 municipal GHG inventory was reviewed to confirm that all sectors, methods, and emissions sources were consistent with the LGOP and the ICLEI 2012 Protocol where appropriate. ICF has noted instances where certain sectors, methods, and emissions sources were not consistent with the LGOP and the ICLEI 2012 Protocol and provided reasons for these inconsistencies as well as recommendations for future inventory updates.
- **Interim findings by ICF:** Following the above steps, ICF produced interim findings and submitted them to SFE in November 2014. Periodic updates were also communicated to SFE from November 2014 up to completion of the review.
- **Revisions by SFE and Final Review by ICF:** Based on ICF's findings, SFE revised the FY 2011-2012 municipal GHG inventory. ICF reviewed the revised 2012 inventory by conducting a final check on methods, calculations and overall conclusions.

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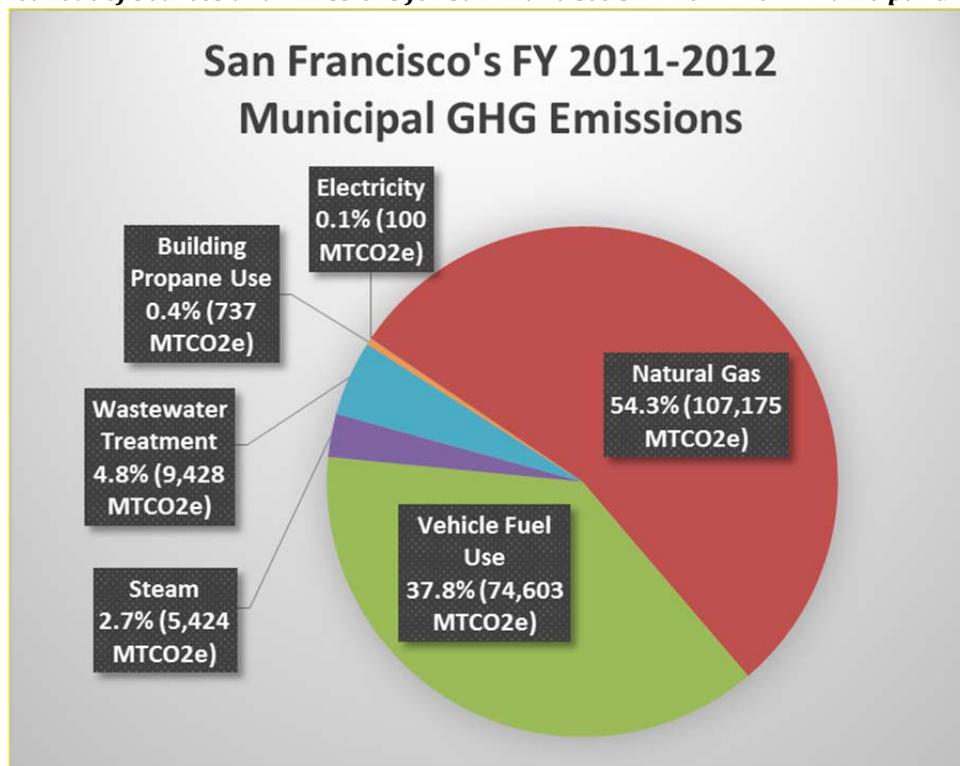
<sup>3</sup> California Air Resources Board. 2010. *Local Government Operations Protocol for Greenhouse Gas Assessments*. Version 1.0. Available: <<http://www.arb.ca.gov/cc/protocols/localgov/localgov.htm>>.

<sup>4</sup> ICLEI – Local Governments for Sustainability USA. 2012. *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*. September. Available: <<http://www.icleiusa.org/tools/ghg-protocol/community-protocol>>.

### 3. Key Findings

San Francisco's 2012 municipal GHG emissions inventory comprises six key components, as described below. The amount of GHG emissions and the percentage of the total 2012 inventory they comprise are shown in Figure 1.

*Figure 1: Breakout of Sources and Emissions for San Francisco's FY 2011-2012 Municipal GHG Inventory*



- **Natural Gas:** Consumption for city departments in buildings. PG&E supplied natural gas usage data and the emissions factor for CO<sub>2</sub>. Additional emission factors for methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) were obtained from the Climate Registry.
- **Steam:** Steam consumption at municipal facilities. Steam use and emission factors were obtained from SFPUC and NRG Energy, Inc. (NRG).
- **Building Propane Use:** This includes all propane fuel use by city departments in buildings. SFE relied on emission factors and methods from the LGOP, the ICLEI 2012 Protocol, and the Climate Registry 2014 emission factors for GHG emissions estimates.
- **Vehicle Fuel Use:** This includes all fuel used by city vehicles and other equipment. SFE relied on emission factors and methods from PG&E (for CNG), the LGOP, the ICLEI 2012 Protocol, and the Climate Registry 2014 emission factors for GHG emissions estimates. Emissions were estimated for the following categories of vehicles:

- Central Shops (fleet vehicles): Central Shops provides motor vehicle maintenance and repair services for all City departments except the SFPUC, the San Francisco Municipal Transportation Agency (SFMTA) (with the exception of the non-revenue vehicles), the San Francisco International Airport (SFO), and the Port of San Francisco (Port). Fuels dispensed by Central Shops include diesel, gasoline, liquefied petroleum gas (LPG)/propane, CNG and biodiesel (various blends).
- SFPUC fleet: The SFPUC has a fleet of close to 1,000 vehicles that are used in the maintenance of the City and County of San Francisco's Power, Water, and Wastewater enterprises. The SFPUC fleet includes vehicles operating in locations outside of City/County borders. Fuels used include gasoline, diesel, CNG and LPG/propane.
- SFO vehicles and parking shuttles: Airport fleet vehicles and parking shuttles use ultra-low sulfur diesel, California reformulated gasoline, CNG and B20 biodiesel.
- SFMTA: Includes SFMTA's revenue fleet which currently runs on biodiesel fuel. The SFMTA is the largest consumers of biodiesel in the City and County of San Francisco and operate 512 buses and 75 non-revenue vehicles. Fuels used include gasoline, diesel, LPG/propane, and biodiesel.
- Additional vehicles: Includes additional vehicle fuel usage data from the following departments: Juvenile Probation (diesel, gasoline, and LPG/propane), SF Recreation and Park, Human Service Agency (gasoline), and the Fire Department (biodiesel, diesel and gasoline).
- **Wastewater Treatment**: This sector includes emissions from the wastewater treatment plants (WWTP) owned and operated by SFPUC, including emissions from digester gas combustion along with process and fugitive emissions of N<sub>2</sub>O from the wastewater treatment process. Electricity used at the WWTPs was included in the building energy sector. SFE relied on emission factors and methods from the LGOP and the ICLEI 2012 Protocol for process and fugitive GHG emissions estimates.
- **Electricity**: Consumption in both buildings as well as for transportation uses (MUNI). In 2012, this comprises electricity from PG&E (general grid electricity), SFPUC, and WAPA. Emission factors were obtained from PG&E, SFPUC, WAPA, and the U.S. Environmental Protection Agency's (U.S. EPA) Emissions & Generation Resource Integrated Database (eGRID). This sector also includes emissions from electric transmission and distribution (T&D) loss, which were estimated using values from eGRID. As described below, the bulk of electricity consumed is from the SFPUC, which has a zero emissions factor and thus this is the smallest emissions sector.<sup>5</sup>

Here are the key findings from ICF's review of San Francisco's FY 2011-2012 municipal GHG emissions inventory:

1. **Clear accounting of boundaries, emissions sectors and key sources of emissions**: The documentation and quantification of activity levels from all major sources of emissions

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<sup>5</sup> By way of comparison, building electricity consumption in the 2010 Municipal GHG Inventory was approximately 8 percent of overall emissions.

associated with municipal operations is essential to developing a credible and rigorous inventory. San Francisco's FY 2011-2012 municipal GHG inventory represents an appropriate attempt at capturing major emission sources and calculating resulting activity levels. It appears that all of the major stationary and mobile categories have been accounted for and appropriately quantified.

2. **Original source documents for key sectors match activity levels:** ICF requested original source documents documenting FY 2011-2012 activity levels for electricity and natural gas consumption (with a focus on PG&E and SFPUC), steam usage, and vehicle fuel use. The activity data were available and matched SFE's FY 2011-2012 municipal GHG inventory data.
3. **Key emission factors (EFs) have been reviewed and validated in consultation with relevant agencies and organizations:**
  - a. Revised PG&E and SFPUC 2011 and 2012 electricity EFs: The 2011 PG&E electricity EF completed third-party verification in January 2013; the 2012 PG&E electricity EF completed third-party verification in January 2014. In addition, the SFPUC has achieved a net zero EF for both 2011 and 2012, which has been verified by a third party. SFE has reflected both of these revised numbers in its FY 2011-2012 municipal GHG inventory. ICF also recommended that for direct estimating CH<sub>4</sub> and N<sub>2</sub>O emissions from electricity, SFE use the latest (year 2010) emission factor from the U.S. EPA's eGRID system for the CAMX sub-region. SFE subsequently made this revision.
  - b. Natural gas EF: The natural gas EF that SFE applied matched the value recommended by PG&E. This factor was consistently applied in the municipal GHG inventory.
  - c. Steam EF: The steam EF that SFE applied matched the value reported by NRG in their AB 32 GHG Verification Report.
4. **Updated emission factors using the latest protocol.** Upon recommendation from ICF, SFE updated their emission calculations to use the latest emission factors from the Climate Registry for 2014. These emission factors are updated by the Climate Registry on a regular basis and were last updated in April 2014.
5. **Inclusion of CH<sub>4</sub> and N<sub>2</sub>O emissions.** SFE has included emissions of CH<sub>4</sub> and N<sub>2</sub>O in the FY 2011-2012 municipal GHG inventory. These emissions were not included in prior inventories. The emission factors for CH<sub>4</sub> and N<sub>2</sub>O used by SFE are the latest available from the Climate Registry, the ICLEI 2012 Protocol, and the U.S. EPA.
6. **Update to Global Warming Potential (GWP) factors.** SFE was previously using GWPs from IPCC's Second Assessment Report (21 for CH<sub>4</sub> and 310 for N<sub>2</sub>O), but has subsequently updated their GWPs to use the latest values from IPCC's Fifth Assessment Report (AR5)<sup>6</sup>: 28 for CH<sub>4</sub> and 265 for N<sub>2</sub>O. These GWPs reflect the latest science on radiative forcing for GHGs.

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<sup>6</sup> Intergovernmental Panel on Climate Change. 2013. *Anthropogenic and Natural Radiative Forcing*. In: *Climate Change 2013: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available: <[http://www.climatechange2013.org/images/report/WG1AR5\\_Chapter08\\_FINAL.pdf](http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf)>.

7. **Inclusion of fugitive and process wastewater treatment emissions.** SFE did not include fugitive and process wastewater treatment emissions from wastewater treatment plants (WWTPs) owned and operated by the city in its FY 2011-2012 municipal GHG inventory, but these emissions are required for municipal inventories by the ICLEI 2012 Protocol. Based on ICF's recommendations, SFE has included these emissions using the best available data and methods in the FY 2011-2012 municipal GHG inventory.
8. **Inclusion of transmission and distribution loss electricity and emissions.** SFE did not include emissions from transmission and distribution (T&D) loss electricity in prior inventories. ICLEI recommends that these emissions are included, since the electricity transmission system is not 100% efficient. SFE subsequently updated the FY 2011-2012 municipal GHG inventory to account for T&D losses using factors from the U.S. EPA (eGRID) as recommended by ICLEI.
9. **Reporting of biogenic emissions of CO<sub>2</sub> from biodiesel combustion as an informational item.** The ICLEI 2012 Protocol does not require community inventories to include biogenic GHG emissions, but it recommends that communities include these emissions as informational items when the data are available. SFE has biodiesel fuel consumption data along with biogenic CO<sub>2</sub> emission factors, and included an estimate of biogenic CO<sub>2</sub> emissions as an informational line-item in the inventory. These biogenic emissions amount to 6,678 MTCO<sub>2</sub>e and are presented separate from in the inventory total for FY 2011-2012, as recommended in the ICLEI Protocol.
10. **Clear links to data sources:** SFE prepared a single Excel file and Access database file that clearly contains all information for key inventory segments in a referenced and linked manner. The organization of the FY 2011-2012 municipal GHG inventory represents an improvement over the FY 2010-2011 municipal GHG inventory that ICF reviewed in 2012. Clearly laid-out components and sub-components of the inventory which are linked to each other, as SFE has done, helps ensure full transparency and credibility, improves the ability to track emissions in the future, and makes it easier for third-party verifiers to corroborate calculations.

## 4. Inventory Limitations and Suggestions for Future Improvement

The following are limitations of the FY 2011-2012 municipal GHG inventory and suggested areas for future improvement for SFE's consideration in relation to the development of SFE municipal GHG inventories:

1. **Use of CH<sub>4</sub> and N<sub>2</sub>O EFs for vehicles.** SFE used a scaling factor, provided by BAAQMD, to estimate CH<sub>4</sub> and N<sub>2</sub>O emissions from on-road fleet vehicles (aside from San Francisco Municipal Railway [MUNI] buses) consuming gasoline, diesel, CNG, and propane. The scaling factor was applied to CO<sub>2</sub> emissions. While this is a reasonably accurate method of estimating approximate emissions of CH<sub>4</sub> and N<sub>2</sub>O for vehicles, the inventory could be improved by using actual disaggregated CH<sub>4</sub> and N<sub>2</sub>O emission factors by vehicle and fuel type. In addition, the scaling factor (1.022) was provided by BAAQMD for the City's community GHG inventory and therefore only represents gasoline and diesel vehicles and is based on the community-wide vehicle fleet, not the municipal vehicle fleet. As such, the use of this scaling factor introduces additional error

when applied to the municipal vehicle fleet (which is composed of a different mix of vehicles than the community-wide fleet, and includes CNG and propane vehicles). Emission factors for gasoline and diesel vehicles can be generated by using the California Air Resources Board's (CARB) EMFAC2014 emissions model<sup>7</sup>, and emission factors for CNG and propane vehicles can be obtained from the Climate Registry; these emission factors are on a per-mile basis. Using these methods would improve the accuracy of the vehicle fuel use sector of the inventory. However, SFE has indicated that obtaining vehicle mileage and/or fuel efficiency data (to back-calculate vehicle mileage) for the city's vehicle fleet is not feasible, and has therefore not used the per-mile emission factors to calculate emissions of CH<sub>4</sub> and N<sub>2</sub>O for vehicles. While SFE's current scaling approach is a reasonable method for estimating CH<sub>4</sub> and N<sub>2</sub>O emissions when mileage data are unavailable, using actual mileage data for fleet vehicles would improve the accuracy of the CH<sub>4</sub> and N<sub>2</sub>O emissions for this sector.

2. **Calculate CH<sub>4</sub> and N<sub>2</sub>O emissions from MUNI buses using actual mileage data.** CH<sub>4</sub> and N<sub>2</sub>O emission factors for on-road vehicles are typically in units of emissions per mile, as opposed to emissions per gallon fuel. In order to estimate CH<sub>4</sub> and N<sub>2</sub>O emissions from MUNI buses, SFE used a fleet average fuel efficiency value (3 miles per gallon) to derive an estimated VMT amount, and then applied the CH<sub>4</sub> and N<sub>2</sub>O emission factors. SFE conducted this analysis because actual VMT data for MUNI buses were not available. While this is a reasonable method for estimating CH<sub>4</sub> and N<sub>2</sub>O emissions when mileage data are unavailable, using actual mileage data for MUNI buses would improve the accuracy of the CH<sub>4</sub> and N<sub>2</sub>O emissions for MUNI buses.
3. **Tenant fuel usage:** Fuel usage by tenants at the Port and SFO besides natural gas was not included in the inventory. This includes fuel such as gasoline and diesel used for equipment such as forklifts and generators. Since the city does not have influence or control over this fuel usage, these emissions are not included in the inventory. This is consistent with the LGOP.
4. **Employee commute emissions:** Emissions from municipal employee commutes were not included in the FY 2011-2012 municipal GHG inventory. Employee commute emissions can represent a meaningful portion of a municipality's total emissions. The LGOP recommends including employee commute emissions as indirect scope 3 emissions in municipal GHG inventories. SFE conducts employee commute surveys every 2 to 3 years in an effort to assess the status of City employee transportation behavior, and to inform program outreach and internal marketing decisions. However, SFE has indicated that the survey results do not provide adequate data to calculate greenhouse gas emissions associated with employee commute.

SFE consulted with ICLEI concerning protocol requirements on employee commute. According to the ICLEI representative (Steinhoff, pers. comm.), the intent of requiring employee commute as part of an inventory is to have a basis for monitoring performance and taking action to reduce related emissions. By conducting routine commute surveys, evaluating the data and taking steps to expand commute use of alternatives to single-occupancy vehicles (transit, bike, etc.), the City is meeting the intent of the requirement by tracking and taking action to reduce the emissions associated with employee commute. The ICLEI representative confirmed this

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<sup>7</sup> See: <http://www.arb.ca.gov/msei/categories.htm>

interpretation. The information collected through the 2010 and 2012 surveys identified the following positive trends:

- a. since 2010, “commuting by driving alone” rates among City employees has dropped one-third, from 51% to 36%;
- b. since 2010, the use of all sustainable transportation modes, except for ride-sharing, has increased; and
- c. CityCycle, the at-work bike-share program for City employees, is estimated to have cut 1,360 gasoline gallon equivalents annually, reducing costs by \$4,366 and CO<sub>2</sub> emissions by approximately 35,467 lbs.

Based on consultation with ICLEI, SFE is meeting the requirements and the intent of the LGOP with their programs and policies promoting sustainable commute options<sup>8</sup> and with their commute surveys that show a positive impact of these programs and policies.

For future inventories, if the survey data can be improved to address adequacy and accuracy issues, ICF recommends that SFE consider calculating GHG emissions from employee commute and including them as scope 3 emissions.

5. **Include waste generation emissions:** Emissions from municipal waste generation were not included in the FY 2011-2012 municipal GHG inventory. SFE has worked with the City’s waste haulers in the past to collect waste generation data for city departments; however, the data that was available from the waste haulers was not an accurate measure of waste generated by municipal facilities and departments. SFE determined that this effort was not useful and is unlikely to repeat this data collection effort until accurate and meaningful data is available from the waste haulers. The LGOP recommends including waste generation emissions for municipal waste as a scope 3 item in municipal GHG inventories. As such, ICF recommends that SFE works with the City’s waste haulers to track (or at least estimate) municipal waste generation data with sufficient accuracy and detail to support emission calculations for future municipal inventories.
6. **Improve the fugitive and process wastewater emissions using actual activity data from the WWTPs.** Per recommendation from ICF, SFE updated the FY 2011-2012 municipal GHG inventory to include fugitive and process emissions from wastewater treatment. However, these emissions were estimated using service population, not actual activity data at the WWTPs (which include the North Point Wet-Weather Facility, the Oceanside Treatment Plant, and the Southeast Treatment Plant). Although the service population method is supported by the LGOP as an alternative to using actual activity data, the inventory could be improved by using actual data from these plants, such as measured average total nitrogen discharge values (kilograms N/day). The ICLEI 2012 Protocol recommends that wastewater treatment emissions are estimated using actual activity data if available.

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<sup>8</sup> The City is committed to policies that promote the use of sustainable transportation. Specifically, three initiatives explicitly promote the use of sustainable modes of transportation: the Transit First Policy, the Healthy Air and Clean Transportation Ordinance (HACTO), and the Greenhouse Gas Emissions Targets and Departmental Climate Action Plan (DepCAP) Program.

7. **Include fugitive emissions from refrigerants & fire suppression equipment:** The LGOP recommends that municipal inventories include fugitive emissions from refrigerants & fire suppression equipment as direct emissions (scope 1). Such emissions include hydrofluorocarbons (HFCs) (e.g., from building chillers and refrigerators and vehicle air conditioners). Fugitive emissions from refrigerant leakage and other substitutes for ozone-depleting substances (ODS) could be added to future municipal inventories if the data are available. These GHGs are often called “high-GWP GHGs” because they typically have high GWP values, ranging anywhere from 100 to 20,000. These emissions were not included in the FY 2011-2012 municipal GHG inventor due to a lack of information and precision identified by SFE. Because many of these refrigerants have high GWP values, GHG emissions can be non-negligible. SFE building maintenance staff may be able to generate the data necessary to support the calculation of these emissions, such as records of refrigerant purchases and recharge quantities, along with an inventory of refrigeration & fire suppression equipment in City facilities. ICF recommends that SFE include these emissions, following LGOP protocol, section 6.6, using data for refrigerants & fire suppression equipment owned and operated by the city for future inventory updates.

## 5. Conclusion and Summary Statement

Based on its review of SFE's FY 2011-2012 municipal GHG inventory, ICF International has verified the information submitted by SFE as being consistent with existing emissions methodologies. The emission estimates were calculated in a consistent and transparent manner and were found to be a fair and appropriate representation of SFE's municipal GHG emissions and were free from material misstatement. ICF identified several minor, immaterial discrepancies in the greenhouse gas inventory which were corrected by SFE during the course of the verification. ICF has verified a total of **197,467 metric tons of CO<sub>2</sub> equivalent (CO<sub>2</sub>e) emissions for the FY 2011-2012 municipal GHG inventory**. ICF has made several suggestions that could further enhance the scope, rigor and transparency for future inventory efforts.



March 26, 2015

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Rich Walter, ICF International

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Date