Appendix C: Community and Municipal Greenhouse Gas Inventory

Appendices

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SAN BERNARDINO COUNTY COMMUNITY AND MUNICIPAL GREENHOUSE GAS INVENTORY

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Acronyms and Abbreviations

AB	Assembly Bill
ARB	California Air Resources Board
CEQA	California Environmental Quality Act
CFCs	chlorofluorocarbons
CH_4	methane
CO_2	carbon dioxide
County	San Bernardino County
EMFAC	emission factor database program
EPA	U.S. Environmental Protection Agency
FY	fiscal year
GHG	greenhouse gas
GWP	global warming potential
HCFCs	hydrochlorofluorocarbons
HFCs	hydrofluorocarbons
ICLEI	Local Governments for Sustainability
kWh	kilowatt hours
LPG	liquid petroleum
$MMTCO_2e$	million MTCO2e
$MTCO_2$	metric tons of carbon dioxide
N_2O	nitrous oxide
O_3	ozone
PFCs	perfluorocarbons
SANBAG	San Bernardino Associated Governments
SB	Senate Bill
SBCTA	San Bernardino County Transportation Authority
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SF_6	sulfur hexafluoride
SP	Service Population
VMT	vehicle miles traveled

Chapter 1
Introduction and Background

1.1 Objectives of this Report

In September 2011, San Bernardino County (County) completed an inventory of greenhouse gas (GHG) emissions for community and municipal operations. In the 2011 GHG inventory report, the County identified a goal of reducing GHG emissions for both community and municipal operations by 15% below current levels at the time, by 2020 (San Bernardino County 2011). To assess the progress toward reaching the 2020 GHG reduction goal since the 2011 analysis, a re-inventory of emissions is critical in determining the County's emissions trajectory. This analysis serves as a mid-course assessment of the County's progress toward the reduction goal and can help inform the County's decision-making processes for GHG reduction strategies.

The primary purpose of this report is to present an updated community and municipal emissions inventory. This report is intended to demonstrate how the County's GHG emissions have changed from the previous inventory analysis (2007 and fiscal year 2006) to the current analysis (2014 and fiscal year [FY] 2015), as well as to provide insight on the drivers of these changes so as to inform current and future policy aimed at reducing GHG emissions.

1.2 Greenhouse Gas Inventory Definitions

Definitions of relevant terms used in this report are included below.

AB 32. The California Global Warming Solutions Act of 2006, widely known as Assembly Bill (AB) 32, requires the California Air Resources Board (ARB) to develop and enforce regulations for the reporting and verification of statewide GHG emissions. The heart of the bill is the requirement that statewide GHG emissions must be reduced to 1990 levels by the year 2020 of the AB 32 Scoping Plan.

AB 32 Scoping Plan. The Scoping Plan for AB 32 was developed by ARB and approved in December 2008. The Scoping Plan has a range of GHG reduction actions, which include direct regulations, compliance mechanisms, monetary and non-monetary incentives, voluntary actions, and market-based mechanisms such as a cap-and-trade system. ARB has already adopted numerous regulations and is currently conducting additional rulemaking for reducing GHG emissions to achieve the emissions cap by 2020. On May 15, 2014, ARB posted the first update to the Scoping Plan. This update builds on the initial Scoping Plan with new strategies and recommendations, identifies opportunities to leverage existing and new funds, defines the climate change priorities of ARB for the next 5 years, and builds a foundation to support the long-term goals identified in Executive Orders S-3-05 and B-16-2012. The update also presents the state's progress toward meeting the 2020 GHG emission reduction goals defined in the initial scoping plan. The AB 32 Scoping Plan provides a roadmap for achieving these reductions and recommends a complementary reduction goal for local governments of 15% below current emissions levels (2008), which is roughly equivalent to 1990 emission levels. ARB is currently working on the 2030 Second Update to the AB 32 Scoping Plan, which will outline policies and actions for the state's 2030 GHG emission target, as

outlined under SB 32 (discussed below). The Second Update to the AB 32 Scoping Plan, the 2030 Draft Scoping Plan, was released on January 20, 2017, for public comment. The Draft 2017 Scoping Plan Update builds on the programs set in place as part of the previous Scoping Plan that was drafted to meet the 2020 reduction targets per AB 32.

AB 1383, Short-Lived Climate Pollutants. Methane Emissions: Dairy and Livestock: Organic Waste: Landfills. AB 1383 requires ARB to approve and implement a plan to reduce methane by 40%, fluorinated gases (F-gases) by 40%, and anthropogenic black carbon by 50% below 2013 levels by 2030. AB 1383 establishes specific targets for reducing organic waste in landfills (50% by 2020 and 75% by 2025 compared to 2014). The legislation also adopted regulations to reduce methane emissions from livestock manure management operations and dairy management operations that would take effect in 2024.

Baseline year. The baseline year for any entity is the year for which emissions are inventoried and reported. For the community and municipal inventories, the baseline years for this report are 2014 and FY 2015, respectively.

Boundary. A GHG inventory represents emissions due to activities associated with a certain boundary, which can be organizational, operational, or geographic. These boundaries determine which emissions are accounted for and reported by the entity.

CAP/Greenhouse Gas Reduction Plan. *Climate Action Plan* (CAP) is a term commonly used in California for a planning document designed to reduce an entity's GHG emissions over a period of time. Some communities use different terms such as a *Greenhouse Gas Reduction Plan*. The specific components of a GHG reduction plan are not required by law or articulated in California GHG legislation. However, air districts and other agencies such as Local Governments for Sustainability (ICLEI) have produced guidance for what should be included in a GHG reduction plan. In addition, California Environmental Quality Act (CEQA) guidelines adopted in 2010 describe elements required in GHG reduction plans if a jurisdiction intends to tier CEQA project compliance off a jurisdictional reduction plan. GHG reduction plans typically include a baseline GHG inventory, a projection of GHG emissions to 2020 (or other future years), a GHG reduction target for 2020 (or other future years), GHG reduction strategies that together achieve the target, implementation actions, monitoring requirements, and adaptive steps to be taken to ensure the jurisdiction meets its identified target.

Community GHG inventory. A community inventory includes GHG emissions associated with the activities of the community as a whole, including residents, businesses, and the municipal government operations.[1] For example, a community GHG inventory includes emissions due to energy used to power and heat homes and businesses; fuel used by vehicles that have either an origin or destination within the jurisdiction; waste that is generated by residents and businesses in the jurisdiction and sent to landfills; fuel use at large stationary sources such as factories or industrial facilities; livestock and fertilizer use; fuel use by off-road equipment; and others. In 2011, a GHG emissions inventory was prepared for the County's community operations as part of the GHG reduction plan. This inventory was referred to as an external inventory, which is another term for a community inventory.

[1] Municipal government emissions are included in the regional community inventory when the emissions occur within the county boundary overall. Sometimes municipal government emissions do not occur within the community boundary.

Direct emissions. Direct emissions include direct releases of GHGs that physically occur within the boundary and are related to fuel combustion, process emissions or fugitive emissions. Examples include the combustion of fuel by vehicles driving within the boundary, the combustion of natural gas or other fuel by industries or facilities within the boundary, or the release of methane from livestock physically located within a jurisdiction.

Emission factor. An emission factor is a unique value equating the amount of GHGs emitted per unit of a given activity, for example metric tons of carbon dioxide ($MTCO_2$) per gallon of gasoline burned.

Emission sector. An emissions sector is a category of GHG emissions reflecting the nature of the activity producing the GHG emissions, for example building energy or on-road transportation. GHG emission sectors included in this inventory are: agriculture, building energy, off-road transportation, on-road transportation, high global warming potential gases (refrigerants), waste landfills, waste generation, wastewater treatment, water consumption and stationary sources.

Greenhouse gas. A GHG is any gas that absorbs infrared radiation in the atmosphere. GHGs include, but are not limited to, water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Of these, all but water vapor and O_3 are regulated under AB 32 and SB 32 and accounted for in the state's GHG inventory.

Indirect emissions. Indirect emissions are indirect releases of GHGs. Indirect releases are GHG emissions that result from activity that occurs within the boundary but the physical release of the GHG emission occurs outside of the boundary. For example, residents and businesses in the county use electricity by turning on lights or other electronic equipment, but the power plant where the electricity is generated, and where fuel is burned to generate the electricity, may be located far away from the county. Electricity use is considered an indirect emission activity.

Municipal GHG inventory. A municipal inventory includes GHG emissions associated with a city or county's services and municipal operations. For example, a municipal GHG inventory includes emissions due to the following: energy used by city or county buildings such as the courthouse, city hall or the jail; fuel used by the city or county vehicle fleet; waste generated by the city and county employees; process emissions associated with treating wastewater if the city or county operates a plant; fugitive emissions of methane from landfills if the city or county operates a landfill; and fuel use by city and county employees commuting to and from work. GHG emissions associated with a city or county's municipal operations are typically 1 to 5% of the community's emissions as a whole. In 2011, a GHG emissions inventory was prepared for the County's municipal operations as part of the GHG reduction plan. This inventory was referred to as an internal inventory, which is another term for a municipal inventory.

SB 32 and AB 197. Senate Bill (SB) 32 (Pavley) bill requires ARB to ensure that statewide GHG emissions are reduced to at least 40% below the 1990 level by 2030, consistent with the target set forth in EO B-30-15. AB 197 creates requirements to form the Joint Legislative Committee on Climate Change Policies; requires ARB to prioritize direct emission reductions from stationary sources, mobile sources, and other sources and consider social costs when adopting regulations to reduce GHG emissions beyond the 2020 statewide limit; requires ARB to prepare reports on sources of GHGs, criteria air pollutants, and toxic air contaminants; establishes 6-year terms for voting members of ARB; and adds two legislators as non-voting members of ARB. Both bills were signed by Governor Brown in September 2016.

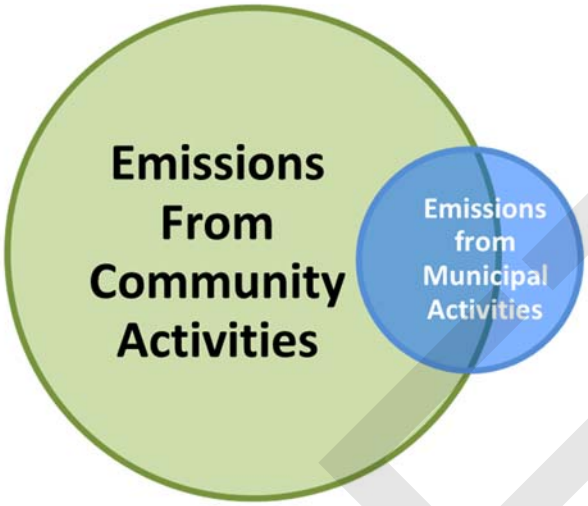
Unit of measure. The unit of measure used throughout the CAP Update is metric tons of carbon dioxide equivalent ($MTCO_2e$). Presenting inventories in carbon dioxide equivalence allows characterization of the complex mixture of GHG as a single unit taking into account that each gas has a different global warming potential (GWP). For this analysis, the GWP values from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report were used. The previous inventory analysis used GWP values from the IPCC's Second Assessment Report. One million $MTCO_2e$ is abbreviated $MMTCO_2e$.

1.3 Community and Municipal—Overlap and Differences

This analysis comprises two separate GHG inventories: one for community operations and one for municipal operations. The community inventory focuses on GHG emissions that result from activities within the unincorporated areas of the County. Some of these emissions may be due to municipal activities and some may not. The municipal inventory focuses on GHG emissions that result from the County's municipal operations and does not include GHG emissions generated by the community (i.e., these emissions are included in the community inventory).

However, there may be some minor overlap in the emissions that are accounted for in both inventories where County facilities and actions occur in the unincorporated County areas. The emissions in these sectors may be counted as both municipal and community emissions, as illustrated in Figure 1-1. For example, employee commute emissions are counted as municipal emissions, but they may also occur in the unincorporated areas and would, therefore, be included in vehicle miles traveled data for the unincorporated areas. Because some of the County's operations take place within the jurisdiction of cities and pertain only to municipal operations, the County's municipal emissions do not entirely overlap with community emissions in the unincorporated areas (Figure 1-1).

Figure 1-1. Overlap between Community Emissions and Municipal Emissions[2]



1.4 Contents of the GHG Inventory Report

This GHG inventory report consists of the following chapters.

- **Chapter 1, Introduction and Background Information**, describes the purpose of this report and provides relevant background information on greenhouse gas inventories.
- **Chapter 2, Greenhouse Gas Inventories**, summarizes the results of the updated community and municipal inventories. A brief overview of the methods used for the inventories is also presented.
- **Chapter 3, Key GHG Inventory Trends**, includes a summary and discussion of the County's emissions between the previous inventory report and this analysis.
- **Chapter 4, References**, includes citations for the documents used to prepare the inventory report.

1.5 Overview of San Bernardino County

San Bernardino County is located in the Southern California region and is the largest county in the United States. It is bordered by the counties of Inyo, Kern, Los Angeles, Orange, and Riverside, and the states of Nevada and Arizona. The County has a diverse variety of landscapes, including forests, mountains, lakes, and deserts. There are 24 incorporated within the County, as well as many other census-designated places and unincorporated communities. The largest employers in the County are in the industries of railroads, schools/universities, hospitals, and state and county government. Over 2 million people live in the entire County[3] of which 325,000 live in the unincorporated County area.

[2] The sizes of the circles are not to scale but attempt to illustrate the difference between community and municipal emissions.

[3] United States Census: https://www.census.gov/quickfacts/table/AFN120212/06071.

For the analysis of the County's GHG emissions, only the unincorporated areas of the County are included in the inventory. The unincorporated areas of the County are divided into four distinct regions: east desert, mountains, north desert, and valley. The socioeconomic data for these regions (i.e., population, employment and household data), which are relevant to the GHG inventory analysis, are shown in Table 1-1.

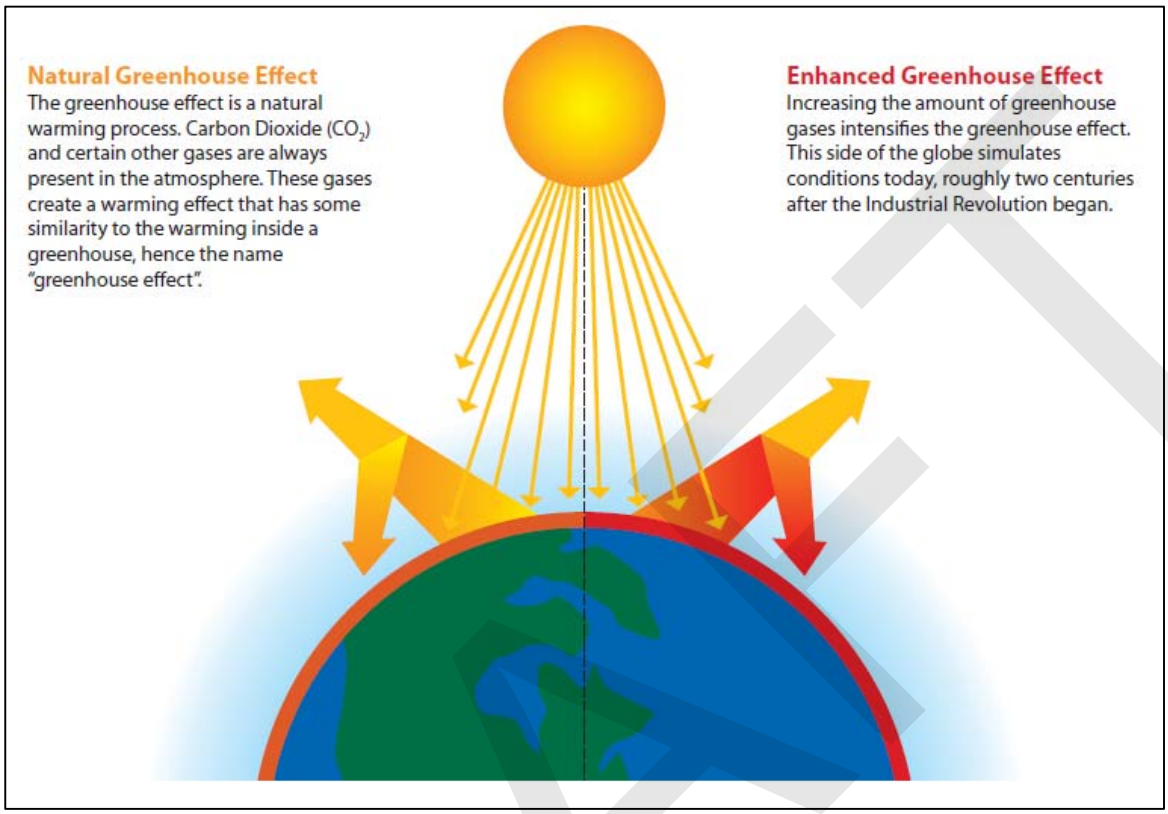
Table 1-1. Socioeconomic Data for Unincorporated San Bernardino County by Region in 2014

Region	Population	Households	Employment
East Desert	25,453	10,435	2,443
Mountains	60,110	22,126	7,715
North Desert	95,580	30,886	9,587
Valley	143,920	34,432	37,680
Total Unincorporated County	**325,064**	**97,879**	**57,425**
Source: pers. comm. Hicks 2016			

1.6 Background on Climate Change and GHG Emissions

The phenomenon known as the greenhouse effect keeps the atmosphere near the Earth's surface warm enough for the successful habitation of humans and other life forms. The greenhouse effect is created by sunlight that passes through the atmosphere (Figure 1-2). Some of the sunlight striking the Earth is absorbed and converted to heat, which warms the surface. The surface emits a portion of this heat as infrared radiation, some of which is absorbed by GHGs in the atmosphere and re-emitted in all directions, including back toward the Earth's surface. Human activities that generate GHGs increase the amount of infrared radiation absorbed by the atmosphere, thus enhancing the greenhouse effect and amplifying the warming of the Earth (Center for Climate and Energy Solutions 2011).

Figure 1-2. The Greenhouse Effect



Increases in fossil fuel combustion and deforestation have exponentially increased concentrations of GHGs in the atmosphere since the Industrial Revolution. Rising atmospheric concentrations of GHGs in excess of natural levels result in increasing global surface temperatures—a phenomenon commonly referred to as *global warming*. Higher global surface temperatures, in turn, result in changes to Earth's climate system, including increased ocean temperature and acidity, reduced sea ice, variable precipitation, and increased frequency and intensity of extreme weather events (Intergovernmental Panel on Climate Change 2013). Large-scale changes to Earth's climate system are collectively referred to as *climate change*.

Climate Change and Global Warming

The terms *global warming* and *climate change* are often used synonymously, but they refer to two different processes. Increasing global surface temperatures as a result of rising atmospheric concentrations of GHGs, in excess of natural levels, is known as *global warming*. Large-scale changes to the Earth's system induced by higher global surface temperatures are collectively referred to as *climate change*.

While changes in global climate have been recorded throughout history, there is strong consensus among the scientific community that recent changes are the result of human-made GHG emissions. A recent study published in Environmental Research Letters indicates that 97% of climate scientists agree that human activity is "very likely" causing current global warming trends (Cook et al. 2013). Every national academy of science in the world likewise concurs that human-made GHG emissions

are accelerating the magnitude and pace of climate change. As stated previously, AB 32 identifies the following six compounds as the major GHGs: CO_2, CH_4, N_2O, PFCs, SF_6, and HFCs. Generally, these emissions are quantified in terms of $MTCO_2e$ emitted per year, which accounts for the relative warming capacity, or GWP of each gas. Water vapor is not identified by AB 32 as a key GHG because natural concentrations and fluctuations far outweigh anthropogenic influence. Table 1-2 describes the key characteristics and sources of the six major GHGs identified by AB 32.

Sources, Sinks, and Global Warming Potentials for Greenhouse Gases

Natural and human activities that generate GHGs are commonly referred to as emissions *sources*. The burning of fossil fuels to power buildings and vehicles is the primary source of CO_2 and a key contributor of CH_4 and N_2O emissions. A GHG *sink* removes and stores GHGs. For example, vegetation is a sink because it removes atmospheric CO_2 during photosynthesis.

GHGs are not created equally. The Global Warming Potential, or GWP, is used to compare GHGs based on their potential to trap heat and remain in the atmosphere. Some gases can absorb more heat than others, and thus have a greater impact on global warming. For example, CO_2 is considered to have a GWP of 1, whereas N_2O has a GWP of 265. This means that N_2O is 265 times more powerful than CO_2.

Table 1-2. Principal Greenhouse Gas Emissions

Greenhouse Gas	Chemical Formula(s)	Primary Emissions Sources	Global Warming Potential[a]	Atmospheric Lifetime (years)
Carbon dioxide	CO_2	Burning of fossil fuels Gas flaring Cement production Land use changes Deforestation	1	50–200
Methane	CH_4	Agricultural practices Natural gas combustion Landfill outgassing	28	12.4
Nitrous oxide	N_2O	Agricultural practices Nylon production Gas-fired power plants Nitric acid production Vehicle emissions	265	121
Perfluorinated carbons	CF_4 C_2F_6	Aluminum production Semiconductor manufacturing	6,630–11,100	10,000–50,000
Sulfur hexafluoride	SF_6	Power distribution Semiconductor manufacturing Magnesium processing	23,500	3,200
Hydrofluorocarbons	HFC-23 HFC-134a HFC-152a	Consumer products Automobile air conditioners Refrigerants	138–12,400	1.5–222

Source: Intergovernmental Panel on Climate Change 2013.
[a] The GWPs listed here are 100-year values without carbon-climate feedbacks, based on the IPCC's Fifth Assessment Report.

The majority of GHG emissions generated in the United States and California are in the form of CO_2. In 2015, for example, CO_2accounted for 82% of the federal GHG inventory, with most of these

emissions generated through the combustion of fossil fuels (U.S. Environmental Protection Agency 2017). Fossil fuels are burned to create electricity and heat to power homes, commercial buildings, and vehicles. In the United States, energy used to power buildings is the primary source of GHG emissions, representing 29% of the 2015 federal GHG inventory. The transportation sector is the next largest source GHG emissions (27%) (U.S. Environmental Protection Agency 2017). In California, the emissions profile is slightly different, with the transportation sector representing the largest source of emissions (39%), followed by industrial emissions (23%) and electricity generation (19%) for a total of 81% of the state's emissions (California Air Resources Board 2017). Other sources of GHG emissions generated in the United States and California include industrial processes, commercial and residential buildings, and agricultural activities.

Chapter 2
Updated Greenhouse Gas Inventories

2.1 Community Inventory

Overview

San Bernardino County's 2014 Community Inventory includes GHG emissions generated by activities within the unincorporated areas of the County only. The inventory also includes emissions that occur outside the unincorporated areas, but only to the extent that such emissions are the result of community activities. For example, GHG emissions generated by regional power plants to provide electricity to local homes and businesses in the unincorporated areas are included in the inventory even though the power plants themselves may not be located within the unincorporated areas of the County. The analysis of community GHG emissions is based on the ICLEI U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions, which is a comprehensive protocol for quantifying GHG emissions (Local Governments for Sustainability 2013).

Total GHG emissions produced by community activities in the unincorporated areas of the County in 2014 were 2,952,859 $MTCO_2e$, which is approximately 0.7% of California's GHG emissions in the same year.[4]

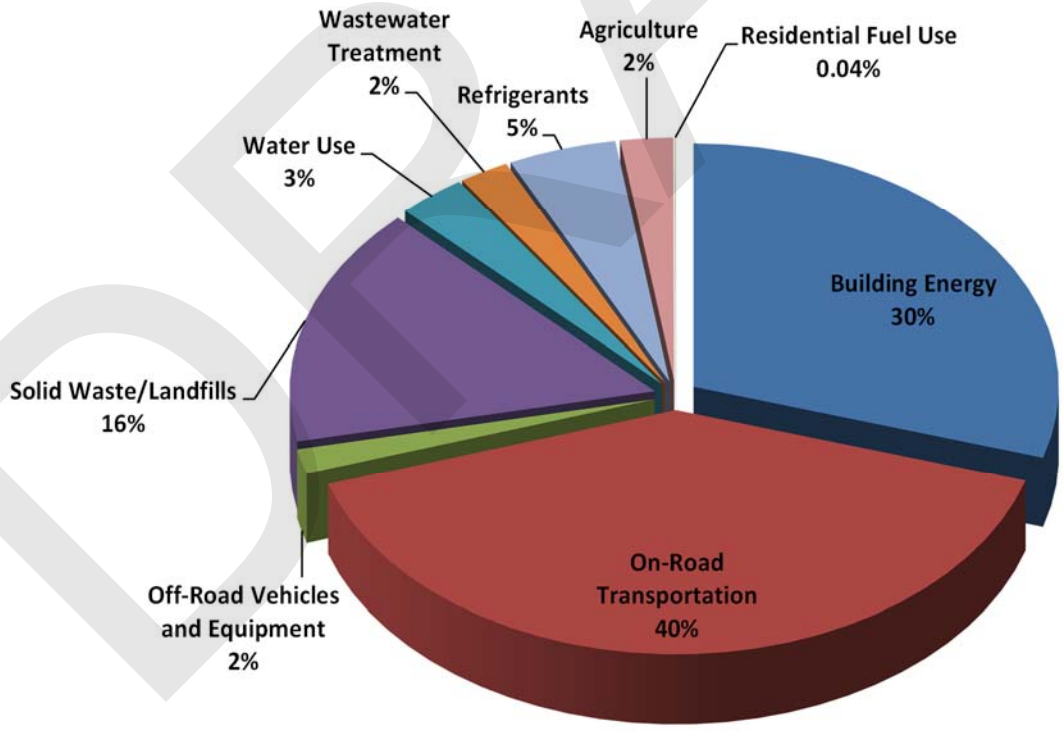
As shown in Table 2-1 and Figure 2-1, on-road transportation and building energy emissions represent the largest sources of community emissions (approximately 40% and 30% of the 2014 Community Inventory). On-road transportation is typically a considerable component of a community's total GHG emissions, ranging from 30 to 70% depending on other sources and local conditions. The majority of on-road emissions in the County come from personal and light-duty vehicles. Building energy is also often one of the largest sources of GHG emissions in community inventories and includes energy consumed for heating, cooling, lighting, and cooking in the residential, commercial, industrial, and other sectors. The third-largest source is landfill emissions, with a contribution of 16% of the total 2014 Community Inventory. The next largest sources in the inventory are refrigerants (5%), water use (3%), off-road vehicles and equipment, wastewater treatment, and agriculture (2% each), and residential fuel use (less than 1%). Stationary source emissions from emissions producing facilities (including cement production facilities) in the County represent a large source of emissions (4.5 $MMTCO_2e$); however, as discussed above, these emissions are provided for informational purposes and are not included in the inventory total, because of the lack of jurisdictional control that the County has over these sources. The methods used to quantify community GHG emissions are discussed in Appendix A.

[4] California statewide GHG emissions in 2014 were 441.9 million metric tons of CO_2e (California Air Resources Board 2017).

Table 2-1. San Bernardino County 2014 Community Greenhouse Gas Inventory

	2014 Inventory	
Emission Sector	**Emissions ($MTCO_2e$)**	**Percent(%) of Inventory**
Building Energy	875,681	29.7
On-Road Transportation	1,188,893	40.3
Off-Road Vehicles and Equipment	48,442	1.6
Solid Waste/Landfills	468,140	15.9
Water Use	89,694	3.0
Wastewater Treatment	65,335	2.2
Refrigerants	146,823	5.0
Agriculture	68,752	2.3
Residential Fuel Use	1,099	0.04
County Total	**2,952,859**	**100.0**
Emissions for Informational Purposes		
Stationary Sources	2,208,124	N/A
Cement Production	2,308,909	N/A
N/A = not applicable		

Figure 2-1. San Bernardino County 2014 Community Inventory by Sector



As shown in Table 2-1, the 2014 community inventory is divided into nine primary sectors. Each sector represents a subset of community emissions, and some comprise multiple emissions-generating activities. For example, natural gas and electricity consumption are both included in the building energy sector. The nine sectors analyzed represent the major emissions categories within the county and are defined as follows.

- **Building energy.** The building energy sector consists of emissions from electricity generation and natural gas combustion by residential, commercial, industrial, and other buildings located in the County. This sector is primarily composed of two main sources of emissions: electricity consumption (approximately 73% of emissions) and natural gas consumption (approximately 27% of emissions). In 2014, the top three consumers of electricity were the industrial (55%), residential (31%), and commercial (14%) sectors. For natural gas, the three largest consumers are residential (70%), commercial (22%), and industrial (6%). Building energy is typically one of the largest sectors in a jurisdiction. In the County, building energy emissions are approximately 30% of total emissions, which is the second-largest sector.
- **On-road transportation.** The on-road transportation sector consists of fuel consumption emissions from vehicle trips related to land uses within the County. Vehicle trips related to land uses in the County traveled an estimated 2.4 billion miles in 2014, resulting in approximately 1.2 $MMTCO_2e$. Approximately 93% of the annual miles traveled are estimated to be light duty vehicles (i.e., passenger vehicles), while 7% are estimated to be heavy-duty vehicles (i.e., trucks). On-road transportation is the largest emission sector for the County's community inventory (40% of community emissions), which is consistent with GHG inventories for other municipal jurisdictions.
- **Off-road vehicles and equipment.** The off-road vehicles and equipment sector consists of fuel consumption emissions from use of off-road equipment (e.g., cranes, bulldozers, lawnmowers, water craft). Off-road vehicles and equipment in the County consumed an estimated 4.9 million gallons of fuel in 2014, resulting in 48,442 $MTCO_2e$. The types of fuel consumed include gasoline, diesel, and liquefied petroleum gas. This sector is typically a small portion of a jurisdiction's GHG inventory, as the activity involved (i.e., operating lawnmowers, bulldozers) is minor when compared to on-road vehicle travel or building energy. In 2014, this sector represents less than 2% of GHG emissions.
- **Waste/landfills.** The waste/landfills sector includes CH_4 emissions from waste generated within the County, and CH_4 emissions released directly from County-owned landfills. Waste generated in the County in 2014 includes approximately 102,000 tons of residential waste and nearly 141,000 tons of non-residential waste. The waste generated in the County was sent to 23 landfills operated by the County and two landfills not operated by the County. Solid waste emissions are the third-largest sector of the Community inventory, representing nearly 16% of the County's total emissions. Emissions from waste generated by the community are included as a separate item only for the portion of waste that is sent to landfills not operated by the County. For all other waste generated by the community and sent to landfills operated by the County, the decomposition emissions are included in the landfill component of the waste sector.
- **Water use.** The water use sector consists of emissions from electricity and natural gas consumption associated with water use, including groundwater pumping, local water distribution, and surface water diversion. It is estimated that water consumption in the County in 2014 is over 32 billion gallons, resulting in over 345 million kilowatt hours (kWh) of

electricity consumed to treat, convey, and distribute water. The indirect electricity emissions resulting from the water-related electricity consumption are nearly 90,000 $MTCO_2e$.

- **Wastewater treatment.** The wastewater treatment sector consists of Fugitive emissions from community wastewater treatment, and emissions from electricity consumed at wastewater treatment plants due to County wastewater generation. Emissions in this sector represent about 2% of the County's total emissions, which is one of the smallest sectors in the Community inventory. Electricity consumption associated with water treatment plants and wastewater conveyance is estimated to be over 194 million kWh in 2014. Electricity consumption accounts for approximately 78% of wastewater treatment emissions. Approximately 6% of the wastewater treatment sector is the result of fugitive emissions directly emitted from wastewater at treatment plants, while 16% of this sector is the result of direct emissions from septic tank systems in the County (i.e., residences not connected to a central sewer system).
- **Refrigerants.** The refrigerants sector consists of high-GWP gases are emitted from residential and commercial/industrial stationary refrigeration and air-conditioning equipment. High-GWP refrigerants include chlorofluorocarbons (CFCs), HCFCs, and HFCs. This sector is the fourth largest sector in the County, resulting in approximately 5% of the Community inventory emissions.
- **Agriculture.** The agriculture sector consists of N_2O emissions from fertilizer application and CH_4 emissions from manure management and enteric fermentation from livestock in the unincorporated areas. Emissions emitted directly from livestock and their manure is the predominant emissions source for this sector (approximately 96% of agriculture emissions). These emissions include CH_4 and N_2O emitted directly from cows, chickens and turkeys and their manure. Emissions resulting from the use of fertilizer on crops in the County represent a smaller portion of agriculture emissions (approximately 4%). There are a wide variety of fruit, vegetable, and grain crops in the County that would require an estimated 1.3 million pounds of fertilizer in 2014. The agriculture sector is one of the smaller sectors in the County, representing approximately 2% of total emissions.
- **Residential fuel use.** The residential fuel use sector consists of stationary fuel combustion at residences of propane/liquid petroleum (LPG), kerosene, and wood. This sector includes sources of energy resulting from heating or other purposes at residences from energy sources other than electricity and natural gas, which are included in the Building Energy sector. The majority of energy consumed among these sources is from wood (81%), while LPG and kerosene represent smaller portions (19% and less than 1%, respectively). Because the CO_2 emissions released when wood is burned are considered to be biogenic,[5] wood burning emissions only include CH_4 and N_2O. Non-building energy sources of energy are a small portion of the energy consumed in the County, and thus emissions for this sector are less 0.5% of the total Community emissions.

Additional emissions were estimated for informational purposes but were not included in the inventory for the following reasons.

- **Stationary sources and cement production.** Stationary fuel combustion and process emissions for industrial and commercial facilities (does not include natural gas combustion; this is included in the building energy sector), and cement production facilities were not included in the County's total community GHG emissions. These emissions were not included because the

[5] Emissions that biogenic are from natural sources and are not included in GHG accounting protocols.

County has limited jurisdictional control over stationary sources, and large stationary point source emissions are regulated by the State of California (under AB 32 through cap-and-trade) and through the U.S. Environmental Protection Agency (EPA) and South Coast Air Quality Management District (under the Clean Air Act) for GHG emissions. Thus, in particular for the larger stationary point sources, local regulation of such sources can be duplicative of state and federal authority.

2.2 Municipal Inventory

Overview

The County's FY 2015 Municipal Inventory includes GHG emissions generated by the County's local government operations as it provides services to the public. The inventory includes emissions that occur either inside or outside the unincorporated areas, but only to the extent that such emissions are the result of municipal activities. For example, GHG emissions generated by a County employee who lives in Riverside County and commutes to work are included in the inventory even though most of the emissions may not be emitted within the unincorporated areas of the County. The analysis of municipal GHG emissions is based on the Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, which is a methodology intended for local governments to quantify their GHG emissions associated with municipal operations (California Air Resources Board et. al. 2010).

The 2015 Municipal Inventory is divided into 10 major sectors. Each sector represents a subset of municipal emissions, and some comprise multiple emissions-generating activities. Total GHG emissions produced by municipal activities in the unincorporated areas of the County in FY 2015 were 635,829 $MTCO_2e$, which is approximately 0.1% of California's GHG emissions in the same year.[6]

As shown in Table 2-2 and Figure 2-2, solid waste/landfills is the largest source of emissions by a substantial margin. While the County owns and operates a number of landfills, non-County waste is sent to these landfills. Building energy and employee commute emissions represent the next largest sources of community emissions (approximately 9% of the Municipal inventory each). The County owns and leases many buildings for its municipal operations and has over 19,000 employees, so energy consumption and vehicle commute emissions represent sizable portions of the municipal inventory. The next largest sources in the inventory are the County vehicle fleet. The rest of the sectors in the inventory represent less than 1% of the total emissions. The methods used to quantify municipal GHG emissions are discussed in Appendix A.

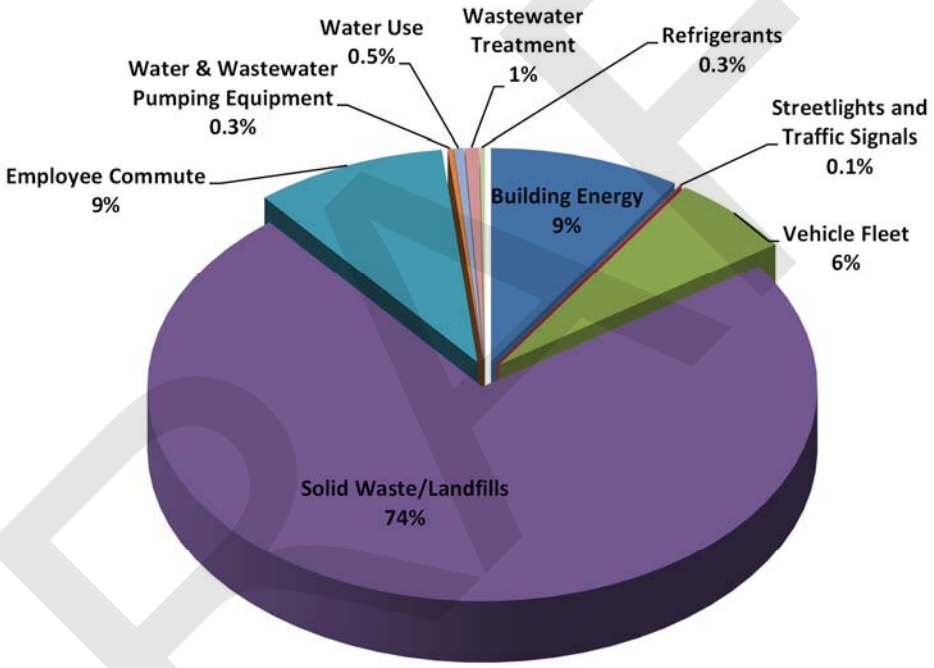
Table 2-2. San Bernardino County Fiscal Year 2015 Municipal Greenhouse Gas Inventory

	2014 Inventory	
Emission Sector[a]	**Emissions ($MTCO_2e$)**	**Percent(%) of Inventory**
Building Energy	58,742	9.2
Streetlights and Traffic Signals	670	0.1

[6] California statewide GHG emissions in 2015 were 440.4 million metric tons of CO_2e (California Air Resources Board 2017).

Emission Sector[a]	2014 Inventory	
	Emissions ($MTCO_2e$)	Percent(%) of Inventory
Vehicle Fleet	38,656	6.1
Solid Waste/Landfills	468,024	73.6
Employee Commute	58,961	9.3
Water & Wastewater Pumping Equipment	1,713	0.3
Water Use	3,083	0.5
Wastewater Treatment	4,349	0.7
Refrigerants	1,631	0.3
Municipal Total	**635,829**	**100.0**

Figure 2-2. San Bernardino County 2014 Municipal Inventory by Sector



As shown in Table 2-2, the municipal inventory is divided into nine primary sectors. Each sector represents a subset of community emissions, and some comprise multiple emissions-generating activities. For example, natural gas and electricity consumption are both included in the building energy sector. The nine sectors analyzed represent the major emissions categories within the County and are defined as follows.

- **Building energy.** The building energy sector consists of emissions from electricity generation and natural gas combustion by County-owned and leased buildings. The energy consumed to power County-owned buildings results in 9% of the County's total municipal emissions, which makes this sector the third largest. The County owns and leases many buildings across different regions and service areas to house its municipal employees. Based on the available data, it is

estimated that buildings associated with County operations (including owned and leased buildings) consumed more than 161 million kWh of electricity and 3 million therms of natural gas in FY 2015. The majority of the municipal building energy emissions are from electricity consumption (71%), while natural gas consumption contributes a smaller portion (28%). Propane use in municipal buildings contributes less than 1% to building energy emissions.

- **Streetlights and traffic signals.** The streetlights and traffic signals sector consists of emissions from electricity generation to operate County-owned streetlights and traffic signals. Emissions from this sector are a small component of the County's municipal inventory, resulting in about 0.1% of emissions. Electricity consumption for streetlights and traffic signals owned by the County is estimated to be 2.7 million kWh.
- **Vehicle fleet.** The vehicle fleet sector consists of fuel consumption emissions from County vehicles (e.g., police cars, fire trucks). Emissions generated by County-owned vehicles resulted in over 38,000 $MTCO_2e$ in FY 2015, which makes this sector the fourth largest. Estimated fuel consumption in County on-road vehicles is over 4 million gallons, the majority of which is gasoline (82%) and diesel (18%). Off-road vehicles owned by the County consumed nearly 142,000 gallons of fuel in FY 2015, the majority of which is diesel (98%). The vehicle fleet sector also includes County-owned equipment that is powered by fuel but is not necessarily a vehicle, such as emergency generators and other stationary equipment.
- **Employee commute.** The employee commute sector consists of fuel consumption emissions from County employees commuting to and from their worksites. Employee commute emissions are typically one of the largest sectors in a jurisdiction's municipal inventory. For the County, municipal employees commuting to and from work generates over 9% of the total municipal emissions. In FY 2015, municipal employees associated with the County traveled almost 143 million miles. It is estimated that 86% of County employees commute to work alone by car, while nearly 12% commute in a carpool with more than one person. Less than 2% of County employees are estimated to commute to work via other means, such as by bus, bicycle, walking, etc.
- **Waste/landfills.** The waste/landfills sector consists of CH_4 emissions from waste generated in municipal buildings, and CH_4 emissions released directly by County-owned landfills. The solid waste and landfills sector is the largest source of GHG emissions for the County's municipal operations by far. In FY 2015, the County had jurisdictional control over 23 landfills. Waste sent to these landfills, however, came from many jurisdictions not associated with the County, its population, or employees. All of the waste emissions from landfills are attributed to the County, consistent with GHG accounting protocols, because the County maintains jurisdictional control over the landfills. The County's control over the landfills is relevant to potential future GHG reduction planning efforts, such as installing CH_4 capture and/or CH_4 flaring at landfills.
- **Water and wastewater pumping Equipment.** The water and wastewater pumping sector consists of emissions from energy used to convey and pump water and wastewater by County-owned pumping equipment. County-owned equipment that pumps water or wastewater may serve municipal or non-municipal buildings, but the County has jurisdictional control over the equipment. This sector represents a small portion of the County's municipal inventory (less than 0.3% of total emissions). Electricity consumed for County-owned pumping equipment is estimated to be 6.5 million kWh.
- **Water use.** The water use sector consists of emissions from electricity and natural gas consumption associated with water consumption in County-owned buildings. Emissions in this

sector would contribute approximately 3,083 $MTCO_2e$ of GHG emission, which is less than 0.5% of the County's total municipal emissions. Estimated water consumption in County buildings and for County operations is over 1 billion gallons for FY 2015, resulting in 11.9 million kWh of electricity to treat and distribute that water.

- **Wastewater treatment.** The wastewater treatment sector consists of fugitive emissions from wastewater treatment that is produced in County-owned buildings. Emissions in this sector, generated as wastewater from County buildings and operations are treated in wastewater treatment plants, would contribute less than 1% of total emissions. Electricity consumption resulting from County wastewater would be nearly 16 million kWh in FY 2015.
- **Refrigerants.** The refrigerants sector consists of fugitive emissions (leaks) from equipment that require the use of refrigerants in County facilities (e.g., vending machines, refrigerators, air conditioners). This sector is one of the smallest sources of emissions in the municipal inventory (eighth largest). The refrigerant quantity used in County-owned equipment and vehicles in FY 2015 is estimated to be 1.2 metric tons.

Chapter 3
Key Greenhouse Gas Inventory Trends

3.1 Introduction

This chapter discusses trends in emissions between the County's previous inventories and current inventories, including emissions trends by sector for both the community and municipal inventories. This chapter also describes the underlying factors that may have contributed to these emissions trends, including changes in demographics, economic forces, and other external changes, and attempts to distinguish these changes from methodological differences between the current and prior inventory methods. For some sectors, as discussed below, emissions methodologies differ between the different inventory years such that identification of clear emissions trends for these sectors is not possible.

3.2 Community GHG Inventory Trends: 2007–2014

Based on a strict comparison of the prior 2007 inventory and the current 2014 inventory, community GHG emissions have overall decreased by 13%. As discussed below, the two inventories differ substantially in methodology due to changes in inventory guidance and practice over time, and as such, a strict comparison of the two inventories is not an appropriate reflection of the change in emissions between 2007 and 2014. The reasons for the changes between inventories is discussed in Section 3.4, *Sector Trends*. .

As shown in Table 3-1, a comparison of the two inventories indicates decreased emissions for some sectors and increased emissions in other sectors. Sectors with substantial inventoried increases over the previous inventory include landfills, water conveyance, wastewater, and residential fuel use. Inventoried emissions in other sectors have decreased by moderate amounts (building energy, on-road transportation, off-road vehicles and equipment), while the agriculture sector has experienced a minor increase. The refrigerants sector was not included in the previous inventory.

Table 3-1. Community Greenhouse Gas Inventory Comparison Table (2007–2014)

Emission Sector	2007 Inventory Emissions ($MTCO_2e$)	2014 Inventory Emissions ($MTCO_2e$)	Change in Inventoried Emissions 2007–2014 (%)
Building Energy	1,280,931	875,681	-32
On-Road Transportation	1,631,666	1,188,893	-27
Off-Road Vehicles and Equipment	157,185	48,442	-69
Solid Waste/Landfills	213,191	468,140	120
Water Conveyance/Water Use	10,696	89,694	739
Wastewater Treatment	27,994	65,335	133
Refrigerants	Not included	146,823	N/A
Agriculture	64,619	68,752	6
Residential Fuel Use[a]	346	1,099	218
County Total	3,386,628	2,952,859	-13
County Total w/o Solid Waste/Landfills[b]	*3,173,437*	*2,484,719*	*-21*
Emissions for Informational Purposes			
Stationary Sources	137,174	2,208,124	1,510
Cement Production	2,729,261	2,308,909	-15

Notes:

[a] The name of this sector in the previous inventory is *Miscellaneous: Residential fires & cooking*

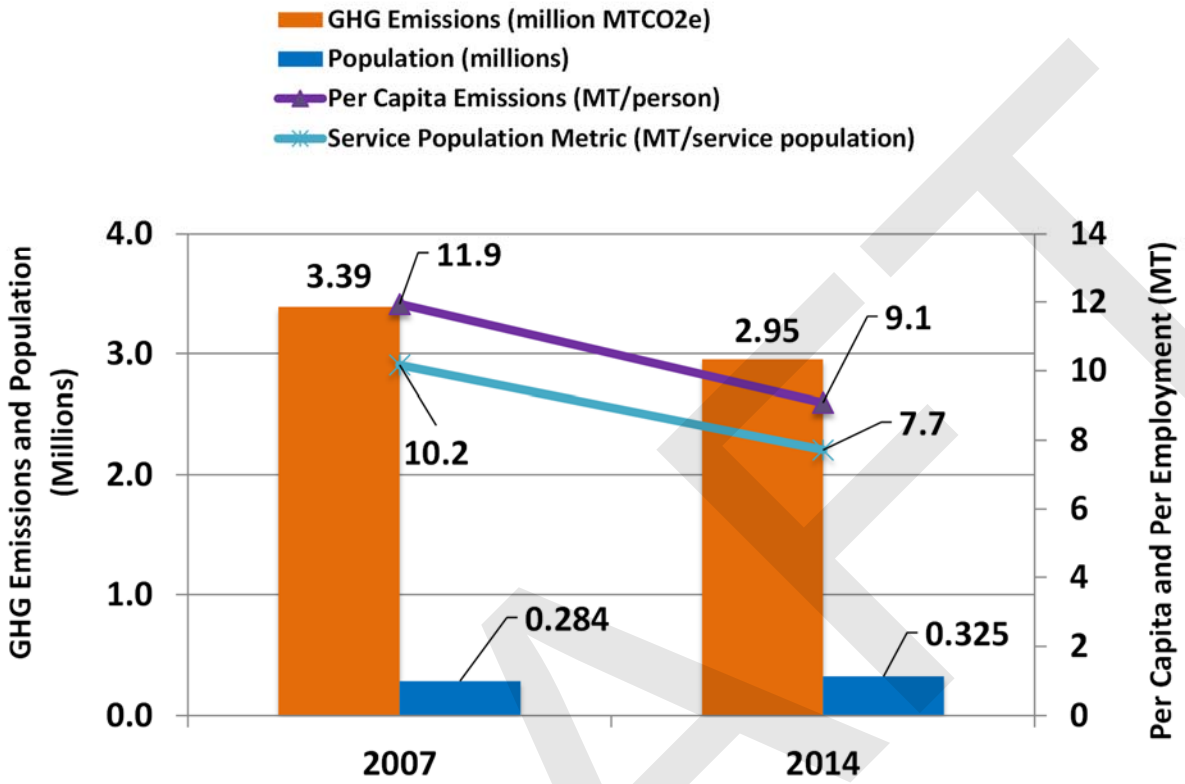
[b] Total provided as the majority of solid waste in County landfills is not derived from the unincorporated County itself.

N/A = not applicable

Figure 3.1 illustrates GHG emissions, the County population, and the per capita rate of emissions for both the previous and current inventory year. Although the population has increased between 2007 and 2014, as shown in Figure 3.1, total and per capita emissions have both decreased. Another useful metric to evaluate emissions is the Service Population (SP) metric, which is the sum of population and employment. Figure 3.1 also includes the SP metric and shows that the 2014 GHG emissions were 7.7 $MTCO_2e$/SP compared to 2007 GHG emissions of 10.2 $MTCO_2e$/SP, which is a decline of 32% in emissions intensity.

Because the total inventory emissions are simply the sum of each of the sectors, the reasons for the changes illustrated in Figure 3.1 are discussed in detail by sector in Section 3.4, *Sector Trends*. Some of the changes reflect differences in inventory methodology as opposed to real-world changes in emissions.

Figure 3-1. County Community Emissions Trend, 2007–2014



3.3 Municipal GHG Inventory Trends: Fiscal Years 2006–2015

Municipal GHG emissions between the previous inventory and the current inventory have increased by a substantial margin (approximately 87%). As shown in Table 3-1, emissions for some sectors have decreased moderately (water and wastewater pumping equipment), while emissions for other sectors have increased substantially (streetlights and traffic signals, solid waste/landfills, and employee commute). The building energy sector experienced a minor decrease of 7% between the previous and current inventories, while the vehicle fleet sector experienced an increase of 11%. A number of sectors have been included in the current inventory that were not included in the previous inventory (water consumption, wastewater treatment, and refrigerants). On a per-employee base, GHG emissions have changed from 20 $MTCO_2e$/employee in FY 2006 to 32.7 $MTCO_2e$/employee in FY 2015.

The reasons for the changes between inventories is best explained in the discussion of individual sector trends, in Section 3.4, *Sector Trends*.

Table 3-2. Municipal Greenhouse Gas Inventory Comparison Table: Fiscal Years 2006–2015

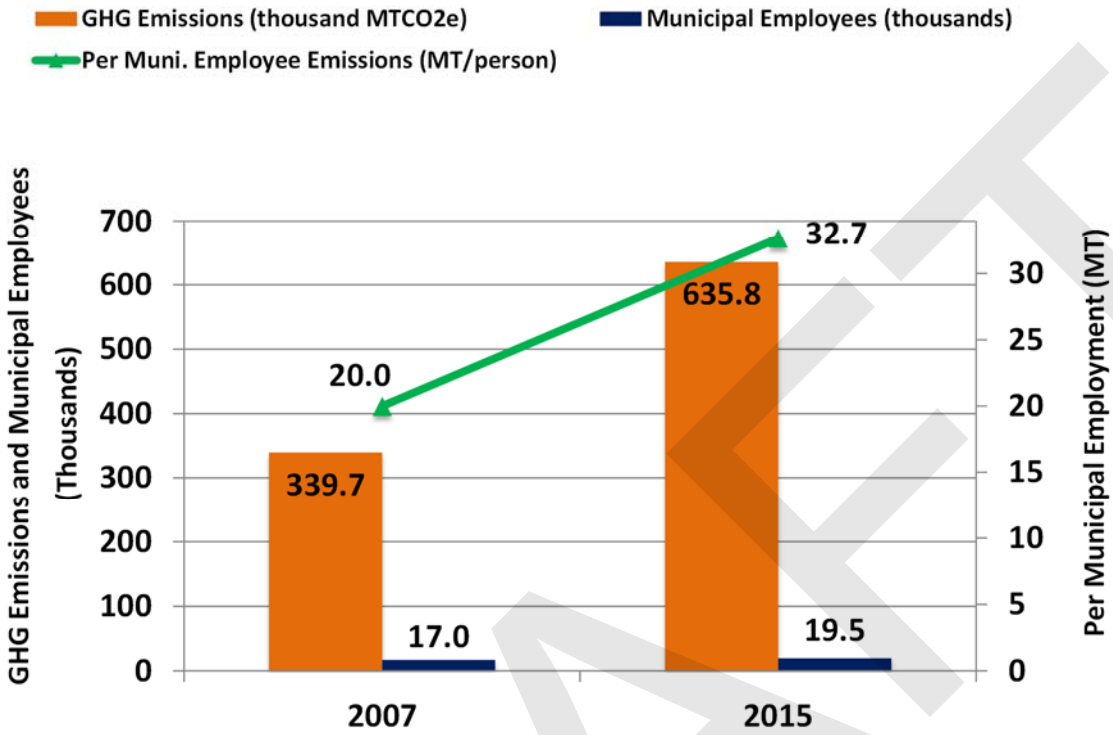
Emission Sector	2006 Emissions ($MTCO_2e$)	2015 Emissions ($MTCO_2e$)	Change in Emissions 2006–2015 (%)
Building Energy	62,981	58,742	-7
Streetlights and Traffic Signals	276	670	143
Vehicle Fleet	34,958	38,656	11
Solid Waste/Landfills	206,817	468,024	126
Employee Commute	32,490	58,961	81
Water & Wastewater Pumping Equipment	2,192	1,713	-22
Water Consumption	Not included	3,083	N/A
Wastewater Treatment	Not included	4,349	N/A
Refrigerants	Not included	1,631	N/A
Municipal Totals	339,714	635,829	87
Excluding Solid Waste/Landfills	*132,987*	*167,805*	*26*

N/A = not applicable

Figure 3.2 illustrates municipal GHG emissions, County employees, and the per municipal employment rate of emissions for both the previous and current inventory year. The number of County employees has increased between FYs 2006 and 2015, as shown in Figure 3.2, and total and per municipal employment emissions have all increased by approximately 87%. As discussed above, the solid waste/landfill sector emissions in the current inventory are substantially greater than the previous inventory, which is the primary reason for the 87% increase. If one excludes the solid waste/landfill sector, then municipal emissions have increased by 26% from FY 2006 to 2015. On a per employee basis, municipal emissions have increased 64% since 2006. However, when excluding the solid waste/landfill sector, then per employee emissions are similar between FYs 2006 and 2015 (7.8 and 8.6 $MTCO_2e$/employee, respectively).

The reasons for the changes in solid waste/landfill sector emissions between inventories, and for all other municipal sectors, are discussed in Section 3.4, *Sector Trends*.

Figure 3-2. County Municipal Emissions Trend, Fiscal Years 2006–2015



3.4 Sector Trends

The subsections below discuss the trends observed between the previous and the current inventories. Looking at the individual sector trends provides a more revealing assessment of how emissions have changed compared to a community- or municipal-wide comparison.

Building Energy

Community

Community-wide building energy emissions have decreased by approximately 32% between the previous inventory and current inventory, despite an increase in population and employment. A portion of the increase can be explained by a decrease in the emissions intensity of electricity produced in the Southern California region. Southern California Edison (SCE), which supplies the majority of electricity to the County, is continually increasing its renewable energy portfolio. In 2014, 36% of SCE's electricity sources were from non-GHG-emitting sources (e.g., geothermal, solar, wind, nuclear) resulting in a GHG emissions factor for 2014 (260 kilograms per mega-watthour of electricity) that is approximately 10% less than the GHG emissions factor used in the 2007 inventory (291 kilograms per mega watthour of electricity) (Southern California Edison 2014, 2015). Electricity emissions factors for other utilities that provide the County with electricity (Bear Valley Electric Services, City of Colton Electric Utility, and City of Needles Electric Utility) were not included in the previous inventory but are included in the current inventory; thus, the downward trend is

primarily the result of SCE's increased renewable portfolio. Energy efficiency improvements in residences and businesses are also likely a contributor to the decrease in emissions.

Another reason for the difference in emissions is a difference in emissions reporting across sectors. In the previous inventory, some water and wastewater related energy emissions were included in this sector. For instance, in the previous inventory, only water-related energy emissions to import water from outside of the County are included in the water sector, while all other water-related energy (conveyance and distribution within the County) are included in the building energy sector. Additionally, the previous inventory only includes fugitive emissions released from wastewater in the wastewater sector but includes energy consumption at wastewater treatment plants in the building energy sector.

The current inventory reports all water- and wastewater-related energy emissions in their respective sectors to the extent possible. From a GHG reduction planning perspective, it is most practical to include all water and wastewater emissions in their own sectors, even if the emissions are from energy consumption, because this allows a straightforward assessment of which sectors will be most affected by GHG-reduction efforts. For example, if water-related emissions are included in the building energy sector and appear to inflate the total emissions in that sector, investing in water-specific GHG-reduction efforts, such as installing more efficient water pumping equipment, may not be an obvious choice. Thus, the current inventory is reporting emissions for the building energy sector and overlapping/related sectors differently than the previous inventory.

Municipal—County Facilities

Building energy emissions generated by energy consumed in County facilities decreased between the previous inventory and current inventory by approximately 7%. A decrease in emissions is expected, however, as discussed in the Community trends discussion, the emissions intensity of electricity produced in the Southern California region has decreased. Because the emission intensity of the electricity consumed in County facilities has decreased, it is reasonable that the overall building energy emissions have experienced a downward trend. Because climate change is causing global temperatures to increase, it is possible the decrease in emissions is not as large as it would otherwise be, because increased energy demand from building cooling could be partially offsetting the increased renewable energy portfolios of the utility providers.

Emissions resulting from natural gas or propane consumption in County facilities are not affected by the increased renewable energy sources, because natural gas and propane are combusted directly at the point of use (in stoves, furnaces, etc.). The emissions intensity of natural gas consumption is, thus, approximately the same between the two inventories and is not responsible for any trends in emissions.

Municipal—Streetlights and Traffic Signals

Outdoor lights, streetlights, and traffic signals represent a small portion of the County' municipal inventory. Emissions in this sector increased by 143%, however, between the previous and current inventories. While it is likely that outdoor lighting has increased in the years between the inventories, an increase of 143% is not likely a real trend. The differences in emissions between the inventories is likely partially caused by differences in dataset completeness and methodology. Given the thorough efforts taken for the current inventory to collect a comprehensive set of data, it is possible that the dataset used for the previous inventory was incomplete, and that the current

inventory dataset includes outdoor lighting data not previously accounted for. Thus, an upward trend in outdoor lighting emissions is expected, but the 143% increase between the previous and current inventories is likely artificially high. It is probable that the actual increase is smaller, but this is not reflected in the 2006 to 2015 comparison due to incomplete data in the FY 2006 inventory.

On-Road Transportation

Community

GHG emissions from on-road vehicles have decreased by approximately 27% between 2007 and 2014. Although the County has experienced growth in population, jobs, and housing units during this time period, the decrease in emissions is partially due to a shift in the vehicle population of the County. The emission factors used in the previous and current inventories to determine how much GHGs are emitted per mile of vehicle travel are from the ARB's emission factor database program (EMFAC) (California Air Resources Board n.d.). The emission factors in EMFAC generally decrease with time (i.e., EMFAC assumes that vehicles get cleaner with time). The reason for this decrease is because older vehicles are retired and replaced by newer, cleaner vehicles with improved fuel economy. A comparison of the EMFAC emission factors between 2007 and 2014 shows that, everything else being equal, emissions would decrease by approximately 3% between these years, which is substantially less than the 27% decrease in emissions between the inventories.

A direct comparison of vehicle miles traveled (VMT) between the inventories cannot be made, because the 2007 inventory used the County-wide South Coast Air Quality Management District (SCAQMD) GHG emissions for on-road sources and apportioned emissions to the unincorporated County using population. The current inventory uses modeled VMT data specific to the unincorporated County provided by Fehr and Peers rather than an entire County estimate applied to the unincorporated County using population. The current VMT analysis is based on the origin-destination approach,[7] which is the recommended approach of California's Regional Targets Advisory Committee. The previous inventory used total County emissions from the EMFAC program, which does not constitute an origin-destination analysis. As such, the previous analysis includes through-trips, which are trips that neither begin nor end in the County. Because the current analysis does not include through-trips, consistent with the state's recommended approach, VMT and emissions are likely overestimated in the previous inventory relative to the current inventory. Despite these differences in methodology, the downward trend in on-road emissions is reasonable considering the effect of old to new vehicle turnover.

Municipal—Employee Commute

Employee commute emissions have increased by approximately 81% between the previous inventory and new inventory. One of the reasons for this increase is because of growth in the number of municipal employees. The previous inventory quantified emissions for approximately 17,000 employees, while the current inventory assumes approximately 19,500 employees (an increase of 15%). However, the substantial increase in commute emissions is likely caused by differences in methodologies. After a review of the previous inventory methodology, it is unclear

[7] An origin-destination analysis accounts for trips in the following manner: 100% of trips that start and end in the County, 50% of the trips that start in the County but end outside of the County, and 50% of the trips that start outside of the County but end in the County. Trips that neither begin nor end in the County are considered through-trips are not included in the County's emissions total.

why the employee commute emissions are in the 32,500 MT CO_2e range given the number of County employees (17,000), and length of the average one-way commute trip (17 miles). Given these numbers, using the methods used for the FY 2015 inventory emissions should be in the 55,000 MT CO_2e range, which is consistent with the current inventory emissions (~59,000 MT CO_2e) after accounting for employee growth and slightly different trip length assumptions. Thus, the substantial increase in employee commute emissions is likely an artificial trend due to methodology differences in the previous inventory.

Municipal—Vehicle Fleet

Emissions produced by vehicles in the County's vehicle fleet have increased by approximately 11% between the previous inventory and the current inventory, due to growth at the County between these years. Although the County has experienced growth in this timeframe, the effect of improved vehicle fuel economy causes a decreasing effect on emissions of approximately 3%. As described above, vehicles become cleaner with time; thus, as the County retired older vehicles and purchased new vehicles, the overall emissions of the fleet trends downward. The increase in County vehicle fuel consumption between the 2 inventory years is primary cause of the upward trend, however.

Off-Road Transportation

Community

Emissions resulting from off-road equipment in the County decreased by almost 70% between the 2007 and current inventories. The previous inventory reported the findings of the SCAQMD GHG inventory, which, in turn, used the ARB's OFFROAD model to quantify emissions (California Air Resources Board 2016). However, after review of the analysis conducted previously, it is likely that off-road emissions were overestimated due to prior methodologies, which apportioned County-wide emissions using population only. The current inventory also uses ARB's OFFROAD model to quantify emissions, and apportions emissions from each equipment type (i.e., construction, industrial, lawn) by the relevant socioeconomic metric for the County (i.e., population, employment, households) which is a more accurate method. For instance, lawn equipment emissions are modeled for the entire County (incorporated plus unincorporated) and are apportioned to the unincorporated County using the percentage of households in the unincorporated areas relative to the whole County. Agricultural equipment emissions were apportioned to the unincorporated County using agricultural crop data rather than socioeconomic data.

If comparing two inventories conducted using identical methodologies, off-road equipment activity would likely increase between 2007 and 2014 as the County grows, but emissions would also experience a moderate downward effect as vehicle efficiency improves and fuels become cleaner. The resulting trend in emissions between inventories could either be upward or downward depending on the rate of growth. For the County's inventories, because of the discrepancy in modeling results in the previous inventory, the substantial decrease of 70% between inventories is an artificial trend and should not be considered to be reflective of decreased growth or substantial improvements in vehicles or fuels.

Solid Waste/Landfills

Community

Landfill emissions from municipally owned landfills more than doubled between the previous inventory and current inventory. There are likely multiple causes for the increase in emissions. More than half of the emissions increases occurred at landfills that are currently open and were accepting waste between 2006 and 2015, and a smaller portion of the increase occurs at landfills closed prior to 2006. Because waste was deposited at the open landfills in the years between inventories, it is reasonable that emissions at the open landfills would increase as the new waste undergoes decay and releases additional methane not captured in the previous inventory. At landfills closed prior to 2006, however, emissions would be expected to decrease in the 2006–2015 timeframe, because no new waste would be added to increase CH_4 emissions. Thus, the portion of increased emissions at the closed landfills is likely due to differences in datasets between the inventories. Both the previous and current inventory used waste-in-place data available at the time of the analyses, but it is possible that methods used to quantify waste-in–place data at each landfill are not consistent. Because the waste-in-place data are the key component to the calculations, any inconsistencies in the collection or reporting of this data would result in diverging emissions estimates between the inventories. Indeed, the previous inventory used waste-in-place data provided by EPA, while the current inventory uses the most recent data provided directly by the County. The datasets are not consistent and were likely collected using different methods. Thus, although some upward trend in emissions is expected because of the deposition of new waste at open landfills, the increase in emissions at closed landfills is not expected and is likely representative of an artificial trend due to data inconsistencies.

Landfill emissions at the non-County-owned landfills are a very small portion of the County's community waste emissions, because most of the County's waste is deposited at County-owned landfills. However, the non-County-owned landfill waste emissions decreased as well between the two inventories, even though these landfills are still open and accepting waste from the County.

According to the California Department of Resources and Recycling, residents and employees in the County generated more waste in 2007 (approximately 342,000 tons) than in 2014 (approximately 243,000 tons), which appears to contradict the trend of increasing emissions between the 2007 inventory and 2014 inventory (California Department of Resources and Recycling 2017). However, as discussed above, the emissions from this sector are primarily a function of the waste-in-place data at the County-owned landfills. As discussed above, because the waste-in-place datasets are not consistent, the increasing trend in emissions is artificial.

Municipal

The trend in landfill emissions at municipally owned landfills is discussed above in the community inventory discussion. This source of emissions is the same for both the community and municipal inventories, so the trend discussion above applies here. Non-County-owned landfills are not part of a municipal inventory, so the discussion of emissions at non-County-owned landfills above does not apply to the municipal inventory.

Water

Community

Emissions related to water use in the County increased approximately seven-fold. Some of this substantial increase in emissions is likely due to population growth in the County, but it is probable that differences in methodology and reporting practices are the primary cause. In the previous inventory, only emissions associated with importing water into the County were included in the water sector, and the amount of water imported was estimated to be approximately 7.1 billion gallons in 2007. Energy emissions from treating imported water and distributing it locally after it enters the County were included in the building energy sector, and any emissions associated with water sourced from within the County were also included in the building energy sector. In the current inventory, emissions resulting from energy used to convey, treat, and distribute water locally are included in this sector and not the building energy sector, which is consistent with current standard practice. The current inventory includes both imported water and water sourced within the County in this sector, and water consumption is estimated to be over 32 billion gallons in 2014 (versus 7.1 billion gallons of only imported water included in the previous inventory sector). Including the water conveyance, treatment, and local distribution emissions in the water sector rather than the building energy sector is a more practical approach for GHG reduction planning, because such an approach makes it easier and more effective to identify strategies in the appropriate sector to reduce GHGs.

Emissions associated with heating and/or cooling water in houses, business, etc. are included in the building energy sector, because it is not feasible to separate these emissions from building energy emissions.

Additionally, the current inventory uses Urban Water Management Plans from the California Department of Water Resources for every community with an applicable plan to estimate a County-wide average per capita water consumption rate, which is then applied to the entire unincorporated County population. The previous inventory used imported water quantities from the County's general plan. Because of the substantial differences in both methodology and reporting, the substantial increase in water emissions between 2007 and 2014 is likely an artificial trend. While it is probable that water emissions increased between these 2 years, water consumption or emissions intensity did not likely increase by a factor of 7 given that the previous inventory included only imported water in this sector while the current inventory includes all estimated water consumption in this sector.

Municipal—Water and Wastewater Pumping Equipment

Water and wastewater pumping equipment emissions have decreased by 22% between the previous and current inventories. These emissions are the emissions that result from the electricity and natural gas consumed in pumping equipment owned by the County. Both the previous and current inventories collected data from the County's Special Districts department, which is responsible for operating the County-owned water and sewer pumping equipment. It is probable that the primary cause of the decrease in emissions is due to increased renewable energy production in FY 2015 compared to FY 2006. As described for other sectors, SCE, has increased its renewable energy portfolio, which has led to lower-emitting electricity. Thus, although the County's pumping equipment may have processed more water in 2015 than 2006, the intensity of the electricity and the associated emissions have decreased.

Given the scale of the decrease in emissions (22%) relative to the decrease in GHG intensity of the SCE electricity emission factors (10%; see discussion for Building Energy), it is possible other methodological factors are influencing the emissions trend as well. The previous inventory report noted that data from the Special District facilities may include electricity associated with non-pumping uses, because it was not possible to disaggregate the Special Districts data any further. The report also notes that pumping is likely the dominant source of energy and non-pumping energy values are likely small, however. Consequently, it is possible the previous inventory included non-pumping-related energy in this sector, while the current inventory does not include this source of emissions in this sector. The trend in water and wastewater pumping equipment, then, is likely downward to some extent given the improvements in SCE's renewable energy portfolio, but part of the downward trend may be due to methodology or data collection discrepancies between the inventories.

Municipal—Water Consumption in Municipal Facilities

Water consumption emissions in County-owned facilities were not included in the previous inventory. This source of emissions is included in the current inventory, using the same methods as described previously for the community inventory. Using water consumption estimates at all County facilities provided by the County departments, municipal facility water emissions were quantified. Because this source of emissions was not included in the previous inventory, there is no emissions trend.

Wastewater Treatment

Community

Between 2007 and 2014, wastewater treatment emissions increased substantially, by approximately 130%. The likely reason for this large change in emissions is the result of methodological differences and not changes in population or the nature of wastewater treatment in the County. In the previous inventory, statewide wastewater emissions from the ARB's GHG inventory were scaled to the County using the County's proportion of population relative to the state's population. The current inventory uses the most recent methods from the ICLEI 2013 Community Protocol, which, while also population-based, accounts for conditions specific to a local jurisdiction. The statewide emissions, used in the previous inventory, cover a wide range of communities and wastewater treatment facilities and is thus necessarily broad. Further, apportioning statewide emissions to the County using population assumes that the County's wastewater treatment facilities are simply represented by the statewide average in terms of emissions. In actuality, some areas have higher or lower emissions intensity wastewater treatment facilities than the statewide average.

The County's wastewater emissions may be higher than the statewide average due to a high proportion of septic tank users in the rural areas of the County. This effect would not be accounted for in a top-down approach using statewide emissions, as was done in the previous inventory, but is accounted for using the ICLEI 2013 Community Protocol methods.

Additionally, as discussed previously, the previous inventory only includes fugitive emissions and not building energy emissions from wastewater treatment plants in this sector. Because the current inventory includes both fugitive and wastewater treatment plant building energy emissions, the emissions reporting between the inventories are not consistent.

Because the scope of the methods used for the previous inventory is substantially different than the scope of the methods used for the current inventory, and because the reporting of emissions is not equivalent, the apparent upward trend in wastewater emissions is likely an artificial one. Wastewater treatment emissions are highly dependent on population, so there is likely a real upward trend in emissions between 2007 and 2014. The extent of that population-driven trend is not discernible when comparing the two inventories, however.

Municipal

Wastewater emissions for wastewater generated by County employees in County-owned facilities was not included in the previous inventory, because sufficient information was not available at the time. This source of emissions is included in the current inventory, using the same methods as described for the community inventory. Using the ICLEI 2013 Community Protocol methods and the number of County employees, municipal facility wastewater emissions were quantified. Because this source of emissions wasn't included in the previous inventory, there is no emissions trend.

Refrigerants

Community

Refrigerant emissions were not included in the previous inventory, because sufficient information was not available at the time. This source of emissions is included in the current community inventory, but, because this source of emissions was not included in the previous inventory, there is no emissions trend.

Municipal

Refrigerant emissions were not included in the previous inventory, because sufficient information was not available at the time. This source of emissions is included in the current municipal inventory, but, because this source of emissions was not included in the previous inventory, there is no emissions trend.

Agriculture

Community

Agriculture emissions experienced a 6% increase between the 2007 inventory and the current inventory. The primary reason for the increase in agriculture emissions is due to methodological differences between the inventories rather than a change in agricultural activity. The previous inventory summarized the emissions sources included in the SCAQMD GHG inventory, whereas the current inventory uses methods from the ICLEI 2013 Community protocol. Datasets for both inventories include information from the County Department of Agriculture. However, it is likely the current inventory includes a more comprehensive evaluation of livestock operations, because the previous inventory used data from the County agricultural commissioner in 1990 and forecasted to 2007 using agriculture growth projections from the Southern California Association of Governments (SCAG). In contrast, the current inventory uses data provided by the County agricultural commissioner for the actual inventory year (2014). Thus, using a 1990 dataset and forecasting versus using data from 2014 is the likely cause of the differences in the agriculture emissions.

However, comparing the crop reports in 2007 and 2014 from the County agricultural commissioner shows that the number of livestock in the County increased by approximately 7% between 2007 and 2014 (San Bernardino County Department of Agriculture/Weights and Measures 2007, 2014). While the livestock population for some animals decreased and others increased, the trend in total animals increased by 7%. Given that the increase in livestock animals is similar to the total increase in agriculture emissions, the small upward trend in emissions may be a realistic reflection of how agriculture activity has changed in the County between 2007 and 2014.

However, because of the differences in methodology and because livestock are only one component of the agriculture sector, it cannot be determined with certainty what trend agriculture emissions have followed between 2007 and 2014. While the County has grown between these years, the effects of the economic downtown and subsequent recovery during this timeframe make it difficult to estimate how the agriculture industry and its GHG emissions have been affected. Thus, any assessment of emissions trends between the inventories should be limited.

Stationary Sources and Cement Production

Community

Stationary source emissions increased by approximately 58% overall between the 2007 inventory and current inventory. The emissions from non-cement stationary sources in the current inventory are more than 2 $MTCO_2e$ higher than the previous inventory, while the emissions from cement sources are 15% lower in the current inventory than the previous inventory. The increase in emissions from non-cement sources is partially the result of an increase in stationary source activity in the 2007–2014 timeframe as the County experienced growth in economic activity. However, there are other reasons for the increase, which are related to differences in datasets and methodology between the two inventories. The previous inventory used fuel consumption data from the SCAQMD GHG inventory to estimate emissions for non-cement sources and used clinker[8] consumption data to estimate emissions for cement sources. For non-cement sources, the previous inventory methods included scaling the total countywide (incorporated plus unincorporated) emissions to the unincorporated County only by multiplying by the proportion of unincorporated County population. This approach was identified as a data limitation in the previous inventory, because population and stationary source activity are not necessarily correlated. The current inventory methods use the direct reporting emissions data from the ARB. Only emissions sources in unincorporated County zip codes were included from the ARB data.

The non-cement source emissions in the current inventory are directly reported to the ARB, so it is likely this is an accurate representation of emissions in the County. It is possible the SCAQMD dataset for the previous inventory may not have included all sources in the County, or the method of scaling using population was not an accurate approach. Alternatively, one or more very large sources of emissions could have begun operating in the timeframe between the inventories, resulting in the very large increase in emissions observed. Either way, caution should be used when comparing the emissions trend between inventories, because the trend observed from 2007–2014 may be artificially inflated due to dataset or methodology discrepancies or skewed by one or more large emissions sources.

[8] Clinker is an ingredient used in cement production.

Cement source emissions decreased modestly between the inventory years, by approximately 15%. The reasons for this decrease are likely partially due to the differences in methodology described above (clinker consumption versus ARB-reported emissions) but could also be the result of a decline in cement production in the County. Based on cement production data from the U.S. Geological Survey, cement shipments from Southern California decreased by approximately 33% between 2007 and 2014 (U.S. Geological Survey 2010, 2017). Thus, it is likely the trend in cement source emissions is a negative one between 2007 and 2014. However, the magnitude of that downward trend within the County cannot be determined with certainty, because of the differences in methods between the two inventories.

Because these emissions are largely not within the County's jurisdictional control, the trends experienced in stationary source and cement production emissions is not a critical component for the County's GHG planning efforts.

Residential Fires and Cooking/Residential Fuel Use

Community

The previous inventory included GHG emissions from miscellaneous sources, namely methane emissions generated by fires and cooking at residences, and these sources of emissions were a minor component of the previous inventory (approximately 0.01%). To quantify emissions, the previous inventory used countywide estimates for fire and cooking emissions and scaled to the unincorporated areas using population. Cooking emissions at residential uses are not typically included in GHG inventories as a separate sector (natural gas and electricity-based cooking are included in the building energy sector), because there are limited data sources for outdoor cooking, and such emissions are unlikely to be a large source of emissions. The current inventory focuses on residential fuel use for heating purposes, such as kerosene, LPG, and wood, as data on home heating sources are generally available. Thus, the sector of the previous inventory does not overlap completely with the sector of the current inventory. Nevertheless, both inventories include non-biogenic emissions from wood burning, but the current inventory also includes kerosene and LPG. Thus, the increase of 230% is not a realistic trend but is one caused by differences in methodology. This sector represents less than 0.05% of both inventories, however, and is a very small contributor of emissions.

Chapter 4
Recommendations

As discussed throughout Chapter 3, *Key Greenhouse Gas Inventory Trends*, there are substantial differences in methodologies and data sources between the 2007 and 2014 community inventory and the FY 2006 and FY 2015 municipal inventory. Since the County needs an accurate comparison of changes in GHG emissions over time in order to evaluate progress toward the County's GHG adopted reduction targets, ICF recommends the following:

1. Prepare a revised 2007 community inventory using 2014 inventory methods and updated datasets as feasible and use the revised 2007 inventory as the baseline for assessing progress toward meeting the County's adopted community GHG reduction target. The County may be able to use existing data from the San Bernardino Associated Governments (SANBAG) (now San Bernardino County Transportation Authority [SBCTA]) Regional GHG Reduction Plan which included some County data in its inventorying efforts, particularly in relation to VMT from the SCAG regional travel demand model.
2. Prepare a revised FY 2006 municipal inventory using FY 2015 inventory methods and updated datasets, as feasible, and use the revised FY 2006 inventory as the baseline for assessing progress toward meeting the County's adopted municipal GHG reduction target.

Chapter 5
References

California Air Resources Board. No date. EMFAC Web Database. Available: https://www.arb.ca.gov/emfac/.

California Air Resources Board.2016. Mobile Source Emissions Inventory – Categories – Off-Road Motor Vehicles. Available: https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

California Air Resources Board. 2017. California Greenhouse Gas Inventory – 2017 Edition. Last updated: June 6, 2017. Available: https://www.arb.ca.gov/cc/inventory/data/data.htm. Accessed: June 8, 2017.

California Air Resources Board, California Climate Action Registry, ICLEI-Local Governments for Sustainability, and the Climate Registry. 2010. Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories. Version 1.1. May. Available: https://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf.

California Department of Resources and Recycling. 2017. Disposal Reporting System: Single-year Countywide Origin Detail – San Bernardino County 2007 and 2014. Available: http://www.calrecycle.ca.gov/lgcentral/Reports/DRS/Origin/WFOrgin.aspx.

Center for Climate and Energy Solutions. 2011. The Greenhouse Effect. Available: http://www.c2es.org/facts-figures/basics/greenhouse-effect. Accessed: May 22, 2017.

Cook, J., D. Nuccitelli, S. Green, M. Richardson, B. Winkler, R. Painting, R. Way, P. Jacobs, and A. Skuce. 2013. Quantifying the Consensus on Anthropogenic Global Warming in the Scientific Literature. Environmental Research Letters 8(2):024024.

Hicks, Brock, Spatial Analyst and Planner, Calthorpe Analytics. Email to Cory Matsui (ICF) providing socioeconomic data for the County.

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. Accessed: May 22, 2017.

Local Governments for Sustainability USA (ICLEI). 2013. U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.1. July. Available: http://icleiusa.org/publications/us-community-protocol/.

San Bernardino County. 2011. Greenhouse Gas Emissions Reduction Plan. Available: http://www.sbcounty.gov/Uploads/lus/GreenhouseGas/FinalGHGFull.pdf.

San Bernardino County Department of Agriculture/Weights and Measures. 2007. Crop and Livestock Report. Available: http://cms.sbcounty.gov/Portals/13/CropReports/2007CropReport.pdf?ver=2010-07-09-122426-810. Accessed: August 1, 2017.

San Bernardino County Department of Agriculture/Weights and Measures. 2014. Annual Crop Report 2014. Available: http://cms.sbcounty.gov/Portals/13/CropReports/2014CropReport.pdf?ver=2015-07-16-090201-963. Accessed: August 1, 2017.

Southern California Edison. 2014. Power Content Label. Available: https://www.sce.com/wps/wcm/connect/a268aec1-0fc4-423e-9476-e3ac98ec7ede/2014_PCL.pdf?MOD=AJPERES. Accessed: May 24, 2017.

Southern California Edison. 2015. Corporate Responsibility Report. Available: https://www.sce.com/wps/wcm/connect/c0fceef5-e04a-4287-8301-8e66e3e5fbac/2014_Corporate+Responsibility+Report_FINAL+single-page.pdf?MOD=AJPERES&ContentCache=NONE. Accessed: May 24, 2017.

StanCOG 2005 as reported by Fehr & Peers 2012

U.S. Environmental Protection Agency. 2017. Inventory of U.S. Greenhouse Gas Emissions and Sinks. Last Updated: April 14. Available: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks. Accessed: May 22, 2017.

U.S. Geological Survey. 2010. 2007 Minerals Yearbook. Available: https://minerals.usgs.gov/minerals/pubs/commodity/cement/myb1-2007-cemen.pdf. Accessed: August 23, 2017.

U.S. Geological Survey. 2017. 2014 Minerals Yearbook. Available: https://minerals.usgs.gov/minerals/pubs/commodity/cement/myb1-2014-cemen.pdf. Accessed: August 23, 2017.

Appendix A
Inventory Methodology Details

Introduction

This appendix summarizes the data sources and general methods that were used to develop the community and municipal greenhouse gas (GHG) inventories for San Bernardino County. This will be referred to as the "inventory" in this appendix.

This appendix describes the general methods for developing the community and municipal GHG emissions for each emissions sector.

Inventory Update Year – 2014 and Fiscal Year 2015

The inventory update year for the community GHG inventory is 2014, while the inventory update year for the municipal GHG inventory is fiscal year (FY) 2015. FY 2015 began in July 2014 and ended in June 2015. These years were chosen, because it was anticipated that complete or nearly complete activity data would be available for all of the sectors in the inventory for this timeframe. Socioeconomic data for 2014 (including population, employment, and housing) was provided by Calthorpe Analytics. For sectors where 2014 or FY 2015 data was not available, appropriate scaling methodologies were developed to project data to the inventory years.

Inventory Protocol

The 2013 *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (ICLEI - Local Governments, 2013) was used to quantify community emissions wherever applicable and appropriate. The California Air Resources Board's (ARB) *Local Governments Operations Protocol* (LGOP) was used to develop the municipal inventory (California Air Resources Board et. al. 2010).

Inventory Differences Overview

The following section summarizes the key differences in data sources, methods, and emissions sources between the previous community and municipal inventories and the current community and municipal inventories. Tables A-1 and A-2 outline the reasons for differences between the inventories for each sector.

Table A-1. Community Inventory Differences Summary Table

Emissions Sector	Reasons for Inventory Differences
Building Energy	• Increased renewable energy sources. Building energy efficiency improvements. • Some water and wastewater related energy emissions were included in this sector in the previous inventory. In this inventory, water and wastewater emissions are included their respective sectors to the extent possible. • Current inventory includes small amount of electricity from an additional provider not included in the previous inventory (City of Needles electric utility customers located in unincorporated County)
On-Road Transportation	• Vehicles become cleaner with time • Retirement of older, higher emitting vehicles • Previous inventory used Countywide data and scaled to the unincorporated County using population • Current inventory uses specific data to the unincorporated County
Off-Road Vehicles and Equipment	• Methodology differences. Previous emissions estimate is likely an overestimate.
Solid Waste/Landfills	• Differences in datasets are likely the reason for the large increase: o Previous inventory used U.S. EPA landfill waste data o Current inventory uses landfill waste data provided by County. • Current inventory includes two additional landfills that were not included in the previous inventory (Cajon and Heaps Peak landfills) • EPA waste data is lower than County's, which explains the increase in emissions.
Water Conveyance/Water Use	• Previous inventory includes any imported water energy in this sector (i.e. the energy required to move water from its source to the unincorporated County border). All other water energy is included in Building Energy sector. • Current inventory includes all water-related energy in this sector to the extent possible (i.e. water conveyance, water pre-treatment, local distribution).
Wastewater Treatment	• Previous inventory only includes fugitive emissions in this sector (i.e. energy consumed at the wastewater treatment plants is not included in this sector). Energy emissions for treating wastewater are included in Building Energy sector. • Current inventory includes all wastewater-related emissions in this sector to the extent possible (fugitive + energy emissions).
Agriculture	• Emissions are similar, but there are differences in methodology

	• Previous inventory used 1990 agriculture data and projected to 2007 using SCAG population data. • Current inventory uses County's 2014 crop report
Refrigerants	• Insufficient data were available to include this sector at the time of the previous inventory.
Residential Fuel Use	• Previous inventory only includes wood burning • Current inventory includes wood burning, kerosene, and liquefied petroleum gas consumed in residences
County Total	• Overall, emissions have decreased due to decreases in the largest 2 sectors (on-road and building energy), despite large increases in other, smaller sectors (water, wastewater, waste).
Stationary Sources	• Previous inventory used South Coast AQMD Countywide data and scaled to the unincorporated areas using population • Current inventory uses direct emissions provided by CA Air Resources Board, by zip code
Cement Production	• Previous inventory used clinker production as a proxy for emissions • Current inventory uses direct emissions provided by ARB, by zip code and emissions source category

Table A-2. Municipal Inventory Differences Summary Table

Emissions Sector	Reasons for Inventory Differences
Building Energy	• Increased renewable energy sources. • Building energy efficiency improvements. • The previous inventory and current inventory include data from the same County departments. A comprehensive building by building consistency check could not be conducted, however.
Streetlights and Traffic Signals	• Differences in datasets. Current inventory likely includes more comprehensive data.
Vehicle Fleet	• Vehicles become cleaner with time • Retirement of older, higher emitting vehicles • Current inventory includes additional vehicles that were purchased between FY 2006 and FY 2015
Solid Waste/Landfills	• Differences in datasets are likely the reason for the large increase: • Previous inventory used U.S. EPA landfill waste data

	• Current inventory uses landfill waste data provided by County. • Current inventory includes two additional landfills that were not included in the previous inventory (Cajon and Heaps Peak landfills) • EPA waste data is lower than County's, which explains the increase in emissions.
Employee Commute	• Methodology differences. Previous emissions estimate is likely an underestimate. • Current inventory includes additional County employees hired between FY 2006 and FY 2015.
Water & Wastewater Pumping Equipment	• Increased renewable energy sources. • Differences in datasets: previous inventory dataset may have included some non-pumping energy that couldn't be subtracted out
Water Consumption	• The previous inventory did not include this source, which includes energy emissions associated with water consumption in County facilities (by non-County owned equipment).
Wastewater Treatment	• Insufficient data were available to include this sector at the time of the previous inventory.
Refrigerants	• Insufficient data were available to include this sector at the time of the previous inventory.
Municipal Total	• Overall, emissions have increased, which is primarily driven by the increase in waste/landfill emissions. As discussed for that sector, it is likely that the increase is due to differences in datasets between the inventories. The current inventory uses data provided directly by the County, while the previous inventory used data available at the time from the U.S. EPA.

Emission Sectors

The following section includes detailed methods and supporting information for the inventory. This section is organized by sector. For each sector, the following information is provided:

- Overview: a brief description of the emission calculation(s).
- Methods Used in Previous Inventory: a brief description of the methods used in the County's 2007 community and FY 2006 municipal GHG inventories.
- Data and Models: a list of data and models that were used to calculate emissions.
- Inventory Methods: the detailed methodology for calculating emissions for both the community and municipal inventories for 2014 and FY 2015.

Building Energy (Community and Municipal), Streetlights and Traffic Signals (Municipal), and Water and Wastewater Pumping Equipment (Municipal)

Overview

The building energy sector includes GHG emissions from electricity and natural gas consumption for residential, commercial, industrial, institutional, and municipal buildings in the County. Although separate sectors, streetlights and traffic signals, and water and wastewater pumping equipment are also discussed here, because the methodologies are the same as the building energy methodology.

Methods Used in Previous Inventory

The County's previous inventory for the building energy sector used data provided by the utility providers in the County (for community) and by the County itself (for municipal). The energy consumption data (electricity and natural gas) for the County was multiplied by an electricity emissions factor for Southern California Edison. Natural gas consumption was multiplied by GHG emission factors representative of natural gas. Similarly, municipal building energy emissions from County-owned buildings were quantified using the same energy generation emission factors. Emissions from municipal street lighting and traffic signals, and water pumping were determined using the same methods.

Data and Models for Current Inventory

Community

- Electricity consumption (kWh) provided by Southern California Edison (SCE), Bear Valley Electric (BVE) for residential, commercial, industrial, institutional, and other buildings
- Number of customers by type (i.e. residential, commercial) in the City of Needles Electric Utility territory

- Natural gas consumption (therms) provided by SoCal Gas Company and Southwest Gas for residential, commercial, industrial, institutional, and other buildings
- Utility specific electricity GHG emission factors for SCE and regional average emission factors from the U.S. Environmental Protection Agency (U.S. EPA) for BVE, City of Needles, and for methane (CH_4) and nitrous oxide (N_2O) (Edison International 2015; U.S. EPA 2014)
- GHG emission factors for natural gas (Climate Registry 2016)

Municipal

- Electricity and natural consumption from the following County departments and other entities for all owned and leased buildings associated with County operations: Special Districts (data for Special District facilities, streetlights/traffic lights, and water and wastewater pumping equipment owned by the County), County Libraries, Real Estate Services, Arrowhead Regional Medical Center, and SoCalGas Company.
- In addition to the electricity GHG factors for community, electricity GHG emission factors for regional average emission factors from the (U.S. EPA) for City of Colton Electric Utility and Nevada (U.S. EPA 2017).

Inventory Methods for the Current Inventory

Community and Municipal: Community energy data was obtained individually through the electricity and natural gas providers, as indicated above. Municipal building energy data was obtained through the relevant County departments. The Special Districts department provided energy consumption data for the Special Districts facilities; the streetlights and traffic lights operated by the County; and the water and wastewater pumping equipment owned by the County. Although streetlights, traffic lights, and pumping equipment owned by the County are included in separate sectors, the methodology to calculate emissions for these sources are essentially identical to the building energy sector, because the calculation involves multiplying electricity by utility emission factors. Thus, the methodology for these sectors is not discussed further.

CO_2 emissions from electricity provided by all utilities that serve the County were calculated by multiplying electricity use by the utility-specific CO_2 emission factors for delivered electricity, as cited above. The 2014 emission factors represent the emissions related to electricity deliveries in the County in 2014 (and FY 2015 for the municipal inventory)[1]. Methane (CH_4) and nitrous oxide (N_2O) emissions for both utilities were calculated using U.S. EPA eGRID year 2014 emission factors for the CAMX/WECC region (this region represents electricity primarily generated in California, and the latest year of emission factor currently available is 2014.).

The community inventory includes emissions for residential, commercial, industrial, and institutional buildings. The municipal inventory includes emissions for all municipal buildings (those that are owned and those in which the County leases space). Water use and wastewater-treatment related energy use was subtracted from the building energy sector to avoid double counting. The energy emissions associated with water and wastewater are included in the respective sectors.

[1] The two primary emission factors used in the analysis are for SCE and eGRID, which are equal to 573 and 569 pounds of carbon dioxide equivalent per megawatt hour in 2014, respectively.

Transmission and distribution (T&D) electricity losses, which occur between the points of generation and the points of consumption, were also included in the building energy sector. The T&D loss value used in the inventory was 4.79% (U.S. EPA 2017). The CAMX/WECC emission factors cited above were used to estimate GHG emissions for this electricity.

GHG emissions from natural gas consumption were calculated by multiplying the natural gas consumption data by emission factors from the Climate Registry, for both community and municipal energy. The streetlights and traffic signals component of the municipal inventory does not involve any natural gas consumption.

On-Road Transportation (Community); Vehicle Fleet and Employee Commute (Municipal)

Overview

This sector includes GHG emissions from fuel combusted by on-road vehicles. For the municipal inventory, this includes County vehicle fleet emissions and employee commutes.

Methods Used in Previous Inventory

Community: The 2007 inventory used the countywide SCAQMD GHG inventory emissions for on-road sources and apportioned emissions to the unincorporated County using population. Emissions were based on the EMFAC program assumptions, which includes all VMT in the County (including pass-through trips).

Municipal: The County's municipal on-road transportation emissions, which includes employee commute and vehicle fleet emissions, were determined using employee commute survey data from and vehicle fleet fuel consumption data from provided by the County. Emissions were quantified using gasoline and diesel fuel emission factors (for vehicle fleet emissions) and on-road grams of CO_2 per mile emission factors (for employee commute emissions).

Data and Models for Current Inventory

- Traffic model results for the Community inventory provided by Fehr and Peers for 2014. The traffic model used the origin-destination method for VMT for the unincorporated County. This method assigns the VMT to the County using the following protocol: 100% of trips that start and end in the County, 50% of the trips that start in the County but end outside of the County, and 50% of the trips that start outside of the County but end in the County. No through trips are included.
- ARB's EMFAC2014 model emission factors[2]
- Total number of municipal employees (19,460)
- Employee commute data for municipal employees, conducted in 2015

[2] The Emissions Factor (EMFAC) model is a transportation model issued by the California Air Resources Board. It includes a set of emission factors that represent the local vehicle fleet, speeds, and environmental conditions that can be useful in performing project-level air quality modeling

- Fuel consumption by fuel type (diesel, gas, etc.) for all County-owned vehicles and other equipment (i.e. diesel-powered generators) for FY 2015 provided by County Fleet Management department
- Fuel emissions factors (Climate Registry 2016)

Inventory Methods for Current Inventory

Community: Quantification of on-road transportation emissions followed the 2013 Community Protocol. Community VMT data was provided by Fehr and Peers for 2014.

To determine passenger VMT for the County, Fehr and Peers apportioned one-half of the trip distance for any trip with an origin or destination within the County. This eliminates apportioning through-trips on freeways or major arterials to the County, while adding regional traffic burden to land uses generating trips on a 50/50 split. This is the current recommended approach of the State's Regional Targets Advisory Committee (RTAC) and provides a better accounting of VMT associated with land use jurisdiction than approaches that apportion VMT on a pro-rata share or on the basis of VMT that occurs within the boundaries of a jurisdiction. This approach can also help to reveal potential differences in VMT generation that can be useful during future land use and GHG reduction planning. The EMFAC2014 model was used to determine emission factors, and those factors were multiplied by VMT to quantify GHG emissions.

Municipal: Municipal GHG emissions include employee commute and vehicle fleet emissions. Employee commute emissions were estimated using employee commute survey data conducted at 10 County sites that are considered regulated sites by the SCAQMD (sites with more than 250 employees). The survey asked municipal employees how they get to and from work (i.e. drive alone, carpool, motorcycle, bus, walk, bicycle, telecommute). The responses from all the sites were aggregated and computed into percentages (i.e. 86% of all surveyed employees drove alone, 0.5% took the bus), and the percentages were then applied to all County employees. A one-way commute trip distance of 16 miles was assumed, based on survey responses. Employee commute VMT was then calculated based on the aforementioned assumptions, and VMT was multiplied by the appropriate emission factors from the EMFAC model.

Vehicle fleet emissions were estimated using the County's most recent fuel consumption data, mileage data, and other vehicle fleet data, provided by the County Fleet Management department. Fuel consumption data was multiplied by the appropriate fuel emission factors from the Climate Registry (Climate Registry 2016).

Off-Road Vehicles and Equipment (Community Only)

Overview

This sector includes GHG emissions from small off-road equipment (e.g., recreational, harbor craft, rail yard, private airport, lawn and garden, agricultural, commercial, and industrial equipment).

Methods Used in Previous Inventory

The previous inventory reported the findings of the SCAQMD GHG inventory, which, in turn, used the ARB's OFFROAD model to quantify emissions (California Air Resources Board 2016). County-wide emissions were apportioned to the unincorporated areas using population.

Data and Models for Current Inventory

- ARB's OFFROAD model
- Fuel emissions factors (Climate Registry 2016)
- County socioeconomic data provided by Calthorpe Analytics
- Agricultural acreage provided by PlaceWorks

Inventory Methods for Current Inventory

Community: The 2013 Community Protocol recommends using the U.S. EPA's NONROAD model, but this analysis uses ARB's OFFROAD model because it is more specific to California communities than the NONROAD model.

ARB's OFFROAD model provides estimates for emissions at the county level for a variety of off-road equipment types, including construction equipment, lawn and garden equipment, airport ground support equipment, and recreational equipment. This analysis was based on the model's default assumption of annual hours of operation for all equipment in the County. Emissions resulting from the use of agricultural equipment were included under this sector.

Emission were apportioned from each equipment type (i.e. construction, industrial, lawn) by the relevant socioeconomic metric for the County (i.e. population, employment, households). For instance, lawn equipment emissions are modeled for the entire County (incorporated plus unincorporated) and are apportioned to the unincorporated County using the percentage of households in the unincorporated areas relative to the whole County. Households were assumed to be the most relevant metric to lawn equipment. For other equipment, such as construction or industrial equipment, employment data was used to scale emissions, as these metrics are most relevant to those equipment types. Agricultural equipment emissions were apportioned to the unincorporated County using agricultural acreage data rather than socioeconomic data.

Solid Waste/Landfills (Community and Municipal)

Overview

This sector includes GHG emissions associated with the decomposition of waste generated by the County.

Methods Used in Previous Inventory

The County's previous community GHG inventory used waste-in-place and methane capture data for County operated landfills from the U.S. Environmental Protection Agency and the first-order decay model outlined by the Intergovernmental Panel on Climate Change (IPCC).

Data and Models for Current Inventory

- Tons of waste sent to County-operated landfills in 2014-2015 provided by the County Solid Waste Management Division
- ARB's First Order Decay Model (California Air Resources Board 2010)

- Waste disposal tons from residential and commercial uses in San Bernardino County in 2014, from the California Department of Resources Recycling and Recovery (CalRecycle 2017)
- Waste material profile data for San Bernardino County, from the California Department of Resources Recycling and Recovery (CalRecycle 2017)
- Waste emission factors from the 2013 Community Protocol (ICLEI 2013)

Inventory Methods for Current Inventory

Emissions from solid waste were estimated using a waste-in-place methodology that accounts for waste generated and disposed of in landfills operated by the County. A first order decay (FOD) model created by the ARB and based on IPCC methodology was used to estimate emissions from waste that decays in landfills (California Air Resources Board 2010). The FOD model accounts for all waste generated by the Community that is sent to County-operated landfills, which is the vast majority of waste in the County. A small portion of the County's waste is sent to non-County operated landfills. Data from CalRecycle for these landfills was used to determine the emissions attributed to "waste generation" emissions from the community from waste not accounted for in the County operated emissions.

For municipal emissions, it was assumed that all waste generated as part of County operations is sent to County-operated landfills. The total municipal emissions are then equal to the FOD model emissions results for the County-operated landfills.

Water Use (Community and Municipal)

Water consumption-related emissions originate from energy used to transport, treat, and pump water to the County, including water consumed at County-owned facilities. Emissions from water use were estimated for the following sources: 1) the energy associated with water usage *inside* the County (such as local pumps distributing water within the County) and 2) energy associated with water transport from *outside* the County (such as regional pumps delivering water to the County's borders). Electricity used to treat and distribute water locally is captured within the building energy sector; all attempts were made to avoid any double counting of this energy use and resulting emissions by subtracting water-related emissions from the building energy sector.

Overview

This sector includes GHG emissions associated with water consumption in the County.

Methods Used in Previous Inventory

Water consumption emissions were estimated in the previous inventory by using imported water quantities supplied to the County and energy intensity factors from the California Energy Commission to calculate electricity associated with imported water. GHG emissions were quantified by multiplying energy consumption and the utility GHG emission factor.

Data and Models for Current Inventory

- Water demand quantities for areas in the County with urban water management plans, compiled by PlaceWorks

- County socioeconomic data provided by Calthorpe Analytics
- Water-related electricity intensity factors for Southern California from the 2013 Community Protocol
- Water consumption at County facilities provided by County departments
- Utility specific electricity GHG emission factors for SCE and regional average emission factors from the U.S. EPA for all other utility CO_2 estimates, and for CH_4 and N_2O
- Number of municipal employees

Inventory Methods for Current Inventory

Community: Water data from all relevant urban water management plans in the County were compiled and provided by PlaceWorks. From this data, per capita water estimates were calculated for each region. Because the urban water management plans were not available for every water provider in the County, the per capita water estimates were applied to the entire unincorporated County's population to ensure that the estimates of water consumption would be comprehensive. Energy use to supply, treat, and distribute water was calculated by using the water energy emission factors for Southern California in the 2013 Community Protocol. GHG emissions were then calculated using the appropriate utility emission factors. Water-related energy use was subtracted from the building energy sector to avoid double counting.

Municipal: Municipal water consumption was provided by individual County departments. Data was provided from water billing data as feasible but was estimated based on building square footage for buildings where water-specific data was not available. Total gallons of water consumed in municipal buildings were multiplied by the same energy intensity factors discussed above and multiplied by the utility GHG emission factors.

Wastewater Treatment (Community and Municipal)

Overview

This sector includes GHG emissions from the treatment of industrial, residential, commercial, and municipal wastewater produced within the County.

Methods Used in Previous Inventory

In the previous inventory, statewide wastewater emissions from the ARB's GHG inventory were scaled to the County using the County's proportion of population relative to the state's population.

Data and Models for Current Inventory

- 2013 Community Protocol population-based equations for emissions calculations (ICLEI – 2013).
- County socioeconomic data provided by Calthorpe Analytics
- Total number of municipal employees (19,460)

Inventory Methods for Current Inventory

Community: Wastewater flows and the resulting fugitive emissions were determined using population based equations in the 2013 Community Protocol. GHG emissions from electricity consumption at wastewater treatment plants were calculated according to the 2013 Community Protocol, by multiplying wastewater flow totals by energy intensity factors for the treatment of wastewater. After calculating the community wastewater emissions, a per capita rate of emissions was calculated based on the unincorporated County population. The per capita rate of emissions was then applied to the number of municipal employees to calculated wastewater emission generated from municipal employees.

Refrigerants (Community and Municipal)

Overview

This sector includes GHG emissions from the leakage of refrigerants that contain or consist of HFC compounds that contribute to global warming. These chemicals are used in refrigeration, fire suppression equipment, air conditioners, and chillers. Through the installation, use, and disposal of these systems and products, leaks are likely to occur. Although the leaks are generally small, emissions may be significant because these chemicals typically have high global warming potentials (GWPs).

Methods Used in Previous Inventory

Refrigerant emissions were not included in the County's previous GHG inventory.

Data and Models for Current Inventory

- Statewide refrigerant emissions from the ARB's 2014 GHG inventory (California Air Resources Board 2017)
- California statewide population (California Department of Finance 2016)
- Refrigerant purchases and usage in County-owned equipment, provided by the Special Districts department and Arrowhead Regional Medical Center
- The U.S. EPA's *Accounting Tool to Support Federal Reporting of HFC Emissions* (U.S. EPA 2017)
- GWPs from the LGOP and the IPCC (California Air Resources Board et. al. 2010; Intergovernmental Panel on Climate Change 2013)

Inventory Methods for Current Inventory

Community

Because refrigerant data at the County level is generally not available, the Community inventory uses a top-down population-based approach. Statewide refrigerant emissions were obtained from the ARB's 2014 GHG inventory. To calculate County-level refrigerant emissions, a per-capita rate of emissions was calculated for the statewide inventory. The per capita rate of emissions was then multiplied by the number of people in the unincorporated County.

Municipal

The 2013 Community Protocol, the LGOP, and a U.S. EPA tool were used to quantify emissions from municipal refrigerant use. Total refrigerant purchases by refrigerant type and by weight were obtained from the County Special Districts department and for the Arrowhead Regional Medical Center. Given that there are many more buildings owned or leased by the County that have refrigerant-consuming equipment than the Special Districts and Arrowhead Regional Medical Center buildings, data collection efforts would have been overly burdensome. The U.S. EPA's Accounting Tool to Support Federal Reporting of HFC Emissions was used to close the gap for all other buildings where purchase or consumption data was not available. The EPA's tool is intended for municipal uses and calculates refrigerant use based on square footage and building type (i.e. school, office, hospital, etc.).

For the equipment for which refrigerant consumption data was easily available from the County (equipment in Special Districts facilities and Arrowhead Regional Medical Center), the refrigerant quantities were multiplied by the applicable GWP from the IPCC and/or LGOP.

Agriculture (Community Only)

Overview

This sector includes GHG emissions from manure management (fugitive emissions of methane and nitrous oxide), enteric fermentation (fugitive emissions of methane and nitrous oxide), and fertilizer use (fugitive emissions of nitrous oxide). Other emission sources from agriculture were excluded because they are not covered in the 2013 Community Protocol.

Methods Used in Previous Inventory

The County's previous inventory estimated agriculture-related emissions associated with farming operations, including enteric fermentation and manure management, and waste burning and disposal. Livestock-related agricultural emissions were quantified using livestock population data from the County Department of Agriculture, Weights, and Measures for 1990 and projected to 2007 using population data. Waste burning and disposal emissions were calculated using emission factors from the ARB. The agriculture emissions for the unincorporated areas were then calculated by using the unincorporated County's ratio of population relative to the whole County.

Data and Models for Current Inventory

- San Bernardino County Crop Report for 2014 (San Bernardino County 2014)
- U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (U.S. Department of Agriculture n.d.)
- Emissions factors from the 2013 Community Protocol (ICLEI 2013)

Inventory Methods for Current Inventory

Emissions from agricultural vehicles were based on countywide activity levels of these vehicles, based on the OFFROAD model outputs (these emissions were included in the off-road vehicles and

Equipment sector). It should be noted that the 2013 Community Protocol does not include agricultural vehicle-related emissions with other agricultural emissions.

Manure management emissions were calculated using livestock population numbers estimated from the County Agriculture Commissioner for dairy cows, beef cows, other cattle, chickens, and turkeys for the entire County. Standard emissions factors from U.S. EPA and ARB, and 2013 Community Protocol equations specific to manure management were used. Similarly, emissions resulting from enteric fermentation were calculated using livestock population numbers from the Agriculture Commissioner for cows, standard emissions factors from ARB and U.S. EPA, and 2013 Community Protocol equations specific to enteric fermentation.

Because the crop report applies to the entire County, emissions were scaled to only the unincorporated County through consultation with the agricultural commissioner. The County agriculture commissioner indicated that 90% of dairy facilities in the County are located in the City of Chino and 10% are located in the Victorville and Barstow areas (Lampman pers. comm.). Based on a review of Google Earth imagery, it was assumed that the dairies located in the Victorville and Barstow areas are not located within incorporated areas and are therefore located in the unincorporated County. Thus, only 10% of the livestock emissions calculated using the countywide crop report were included in the inventory total to approximate the unincorporated County's portion of livestock emissions.

Emissions resulting from fertilizer use were calculated using the crop acreage data in the countywide crop report as the basis for the fertilizer analysis. The quantities of fertilizer applied to the crops were calculated using the USDA's National Agricultural Statistics Service data, which provides estimates for the average amounts of fertilizer applied per acre for different crop types in California. Data years for the USDA fertilizer data range from 1990 to 2015, though some years do not have any data. An average was taken across all years to estimate an average fertilizer application rate for each crop type. Using the total fertilizer quantities applied to crops in the County in 2014 and the 2013 Community Protocol equations for fertilizer use, N_2O emissions emitted from the fertilizer were quantified. Consistent with the 2013 Community Protocol, agricultural waste burning and disposal emissions were not included in the inventory.

Residential Fuel Use (Community Only)

Overview

Calculation of GHG emissions from residential combustion of fossil fuels, *excepting* natural gas (accounted for in the building energy use sector). This includes propane, kerosene, and wood.

Methods Used in Previous Inventory

The previous inventory included GHG emissions from miscellaneous sources, namely methane emissions generated by fires and cooking at residences, and these sources of emissions were a minor component of the previous inventory (approximately 0.01%). To quantify emissions, the previous inventory utilized countywide estimates for fire and cooking emissions from the SCAQMD inventory and scaled to the unincorporated areas using population.

Data and Models for Current Inventory

- County socioeconomic data provided by Calthorpe Analytics
- U.S. Census data on home heating fuels from the American Community Survey (U.S. Census. 2014)
- Energy Information Administration's Residential Energy Consumption Survey dataset for home heating fuels (Energy Information Administration 2009)
- EIA State Energy Data System (SEDS) (Energy Information Administration 2017)
- Fuel combustion emission factors from the Climate Registry (Climate Registry 2017)

Inventory Methods for Current Inventory

The County used quantification methods consistent with the 2013 Community Protocol to quantify GHG emissions from residential fuel combustion. The number of households in the County that use each type of fuel was determined using statewide information from the Energy Information Administration (EIA) and the American Community Survey. Fuel consumption for each fuel type was calculated using state-level fuel use from the EIA's State Energy Data System. The fuel use was then multiplied by fuel combustion emission factors from the Climate Registry protocols to determine emissions.

Community Emissions Sectors for Informational Purposes Only

The following sectors are presented as informational items but were not added to the emissions total for the community inventory or forecast.

Stationary Sources (Community Only)

Overview

This sector includes GHG emissions from nonresidential stationary (typically industrial) combustion of fossil fuels of any type *except* natural gas (accounted for in the building energy use sector) and fugitive emissions from industrial processes in the County.

Methods Used in Previous Inventory

The previous inventory utilized fuel consumption data from the SCAQMD GHG inventory to estimate emissions for non-cement sources and used 2008 ARB emissions and clinker[3] consumption data to estimate emissions for cement sources. For non-cement sources, the previous inventory methods included scaling the total countywide (incorporated+ unincorporated) emissions to the unincorporated County by multiplying by the proportion of unincorporated County population. This approach was identified as a data limitation in the previous inventory, because population and stationary source activity are not necessarily correlated. For cement sources, 2008 cement plant

[3] Clinker is an ingredient used in cement production

emissions were obtained from the ARB and adjusted for 2007 using the change in clinker data between 2007 and 2008.

Data and Models for Current Inventory

- GHG emissions data from the ARB's online GHG Emissions Reporting Tool and the Integrated Emissions Mapping Tool (California Air Resources Board 2017)

Inventory Methods for Current Inventory

GHG emissions data for all facilities that emit more than 10,000 MT CO_2e per year in the County were provided by the ARB by zip code and county. The county level emissions were allocated to the unincorporated County using each facility's zip code.

Literature Cited

Printed

California Air Resources Board, California Climate Action Registry, ICLEI-Local Governments for Sustainability, and the Climate Registry. 2010. *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*. Version 1.1. May. Available: <https://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf>.

California Air Resources Board. 2017. *California Greenhouse Gas Emission Inventory – 2017 Edition*. Available: <https://www.arb.ca.gov/cc/inventory/data/data.htm>. Accessed: August 22, 2017.

California Air Resources Board. 2017. *Mandatory GHG Reporting – Reported Emissions*. Available: < https://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm>. Accessed: June 13, 2017.

California Department of Finance. 2016. E-4 Population Estimates for Cities, Counties, and the State, 2011-2016 with 2010 Census Benchmark, Table 2. Available: <http://www.dof.ca.gov/forecasting/demographics/Estimates/E-4/2011-20/>. Accessed: August 22, 2017.

California Department of Resources and Recycling. 2017. *Disposal Reporting System: Single-year Countywide Origin Detail – San Bernardino County 2007 and 2014*. Available: <http://www.calrecycle.ca.gov/lgcentral/Reports/DRS/Origin/WFOrgin.aspx>.

Climate Registry. 2016. *The Climate Registry's 2016 Default Emission Factors*. Available: < https://www.theclimateregistry.org/wp-content/uploads/2014/11/2016-Climate-Registry-Default-Emission-Factors.pdf>. Accessed: August 22, 2017.

Edison International. 2015. *Corporate Responsibility Report*. Page 28. Available: <https://www.sce.com/wps/wcm/connect/c0fceef5-e04a-4287-8301-8e66e3e5fbac/2014_Corporate+Responsibility+Report_FINAL+single-page.pdf?MOD=AJPERES&ContentCache=NONE>. Accessed: August 22, 2017.

Energy Information Administration. 2009. *Residential End Use Consumption Survey*. Table CE4.10 End Use Consumption by Fuel, Averages, West Homes. Available: < https://www.eia.gov/consumption/residential/data/2009/c&e/ce4.10.xlsx> and <https://www.eia.gov/consumption/residential/data/2009/index.php?view=consumption#end-use-by-fuel >. Accessed: June 17, 2017.

Energy Information Administration. 2017. *State Energy Data System (SEDS): 1960 - 2015*. Available: < https://www.eia.gov/state/seds/seds-data-complete.php?sid=US#Consumption >. Accessed: June 17, 2017.

ICLEI – Local Governments for Sustainability USA. 2013. *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.1*. July. Available: <http://icleiusa.org/publications/us-community-protocol/>.

Intergovernmental Panel on Climate Change. 2013. Fifth Assessment Report, Chapter 8, Table 8.7: Available: <http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf>. Accessed: August 22, 2017.

San Bernardino County. 2014. *Annual Crop Report 2014*. Available: <http://cms.sbcounty.gov/Portals/13/CropReports/2014CropReport.pdf?ver=2015-07-16-090201-963 >. Accessed: August 01, 2017.

U.S. Census. 2014. *American Community Survey*. Table B25040: House Heating Fuel for San Bernardino County. Available: <http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t>. Accessed: June 17, 2017.

U.S. Department of Agriculture. n.d. *National Agricultural Statistics Service*. Available: <https://quickstats.nass.usda.gov/ Accessed: May 27, 2017.

U.S. Environmental Protection Agency. 2017. Emissions & Generation Resource Integrated Database (eGRID). eGRID2014. Available: < https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>. Accessed: August 22, 2017.

U.S. Environmental Protection Agency. 2017. Reducing Hydrofluorocarbon (HFC) Use and Emissions in the Federal Sector through SNAP. Available: < https://www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector-through-snap#accounting-tool>. Accessed: August 22, 2017.

Personal Communications

Lampman, Allen, Assistant Agricultural Commissioner/Sealer of Weights & Measures, County of San Bernardino. Phone conversation with Cory Matsui (ICF) about the locations of dairy facilities in the County.

Appendix A
Inventory Methodology Details

Introduction

This appendix summarizes the data sources and general methods that were used to develop the community and municipal greenhouse gas (GHG) inventories for San Bernardino County. This will be referred to as the "inventory" in this appendix.

This appendix describes the general methods for developing the community and municipal GHG emissions for each emissions sector.

Inventory Update Year – 2014 and Fiscal Year 2015

The inventory update year for the community GHG inventory is 2014, while the inventory update year for the municipal GHG inventory is fiscal year (FY) 2015. FY 2015 began in July 2014 and ended in June 2015. These years were chosen, because it was anticipated that complete or nearly complete activity data would be available for all of the sectors in the inventory for this timeframe. Socioeconomic data for 2014 (including population, employment, and housing) was provided by Calthorpe Analytics. For sectors where 2014 or FY 2015 data was not available, appropriate scaling methodologies were developed to project data to the inventory years.

Inventory Protocol

The 2013 *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (ICLEI - Local Governments, 2013) was used to quantify community emissions wherever applicable and appropriate. The California Air Resources Board's (ARB) *Local Governments Operations Protocol* (LGOP) was used to develop the municipal inventory (California Air Resources Board et. al. 2010).

Inventory Differences Overview

The following section summarizes the key differences in data sources, methods, and emissions sources between the previous community and municipal inventories and the current community and municipal inventories. Tables A-1 and A-2 outline the reasons for differences between the inventories for each sector.

Table A-1. Community Inventory Differences Summary Table

Emissions Sector	Reasons for Inventory Differences
Building Energy	• Increased renewable energy sources. Building energy efficiency improvements. • Some water and wastewater related energy emissions were included in this sector in the previous inventory. In this inventory, water and wastewater emissions are included their respective sectors to the extent possible. • Current inventory includes small amount of electricity from an additional provider not included in the previous inventory (City of Needles electric utility customers located in unincorporated County)
On-Road Transportation	• Vehicles become cleaner with time • Retirement of older, higher emitting vehicles • Previous inventory used Countywide data and scaled to the unincorporated County using population • Current inventory uses specific data to the unincorporated County
Off-Road Vehicles and Equipment	• Methodology differences. Previous emissions estimate is likely an overestimate.
Solid Waste/Landfills	• Differences in datasets are likely the reason for the large increase: o Previous inventory used U.S. EPA landfill waste data o Current inventory uses landfill waste data provided by County. • Current inventory includes two additional landfills that were not included in the previous inventory (Cajon and Heaps Peak landfills) • EPA waste data is lower than County's, which explains the increase in emissions.
Water Conveyance/Water Use	• Previous inventory includes any imported water energy in this sector (i.e. the energy required to move water from its source to the unincorporated County border). All other water energy is included in Building Energy sector. • Current inventory includes all water-related energy in this sector to the extent possible (i.e. water conveyance, water pre-treatment, local distribution).
Wastewater Treatment	• Previous inventory only includes fugitive emissions in this sector (i.e. energy consumed at the wastewater treatment plants is not included in this sector). Energy emissions for treating wastewater are included in Building Energy sector. • Current inventory includes all wastewater-related emissions in this sector to the extent possible (fugitive + energy emissions).
Agriculture	• Emissions are similar, but there are differences in methodology

	• Previous inventory used 1990 agriculture data and projected to 2007 using SCAG population data. • Current inventory uses County's 2014 crop report
Refrigerants	• Insufficient data were available to include this sector at the time of the previous inventory.
Residential Fuel Use	• Previous inventory only includes wood burning • Current inventory includes wood burning, kerosene, and liquefied petroleum gas consumed in residences
County Total	• Overall, emissions have decreased due to decreases in the largest 2 sectors (on-road and building energy), despite large increases in other, smaller sectors (water, wastewater, waste).
Stationary Sources	• Previous inventory used South Coast AQMD Countywide data and scaled to the unincorporated areas using population • Current inventory uses direct emissions provided by CA Air Resources Board, by zip code
Cement Production	• Previous inventory used clinker production as a proxy for emissions • Current inventory uses direct emissions provided by ARB, by zip code and emissions source category

Table A-2. Municipal Inventory Differences Summary Table

Emissions Sector	Reasons for Inventory Differences
Building Energy	• Increased renewable energy sources. • Building energy efficiency improvements. • The previous inventory and current inventory include data from the same County departments. A comprehensive building by building consistency check could not be conducted, however.
Streetlights and Traffic Signals	• Differences in datasets. Current inventory likely includes more comprehensive data.
Vehicle Fleet	• Vehicles become cleaner with time • Retirement of older, higher emitting vehicles • Current inventory includes additional vehicles that were purchased between FY 2006 and FY 2015
Solid Waste/Landfills	• Differences in datasets are likely the reason for the large increase: • Previous inventory used U.S. EPA landfill waste data

	• Current inventory uses landfill waste data provided by County. • Current inventory includes two additional landfills that were not included in the previous inventory (Cajon and Heaps Peak landfills) • EPA waste data is lower than County's, which explains the increase in emissions.
Employee Commute	• Methodology differences. Previous emissions estimate is likely an underestimate. • Current inventory includes additional County employees hired between FY 2006 and FY 2015.
Water & Wastewater Pumping Equipment	• Increased renewable energy sources. • Differences in datasets: previous inventory dataset may have included some non-pumping energy that couldn't be subtracted out
Water Consumption	• The previous inventory did not include this source, which includes energy emissions associated with water consumption in County facilities (by non-County owned equipment).
Wastewater Treatment	• Insufficient data were available to include this sector at the time of the previous inventory.
Refrigerants	• Insufficient data were available to include this sector at the time of the previous inventory.
Municipal Total	• Overall, emissions have increased, which is primarily driven by the increase in waste/landfill emissions. As discussed for that sector, it is likely that the increase is due to differences in datasets between the inventories. The current inventory uses data provided directly by the County, while the previous inventory used data available at the time from the U.S. EPA.

Emission Sectors

The following section includes detailed methods and supporting information for the inventory. This section is organized by sector. For each sector, the following information is provided:

- Overview: a brief description of the emission calculation(s).
- Methods Used in Previous Inventory: a brief description of the methods used in the County's 2007 community and FY 2006 municipal GHG inventories.
- Data and Models: a list of data and models that were used to calculate emissions.
- Inventory Methods: the detailed methodology for calculating emissions for both the community and municipal inventories for 2014 and FY 2015.

Building Energy (Community and Municipal), Streetlights and Traffic Signals (Municipal), and Water and Wastewater Pumping Equipment (Municipal)

Overview

The building energy sector includes GHG emissions from electricity and natural gas consumption for residential, commercial, industrial, institutional, and municipal buildings in the County. Although separate sectors, streetlights and traffic signals, and water and wastewater pumping equipment are also discussed here, because the methodologies are the same as the building energy methodology.

Methods Used in Previous Inventory

The County's previous inventory for the building energy sector used data provided by the utility providers in the County (for community) and by the County itself (for municipal). The energy consumption data (electricity and natural gas) for the County was multiplied by an electricity emissions factor for Southern California Edison. Natural gas consumption was multiplied by GHG emission factors representative of natural gas. Similarly, municipal building energy emissions from County-owned buildings were quantified using the same energy generation emission factors. Emissions from municipal street lighting and traffic signals, and water pumping were determined using the same methods.

Data and Models for Current Inventory

Community

- Electricity consumption (kWh) provided by Southern California Edison (SCE), Bear Valley Electric (BVE) for residential, commercial, industrial, institutional, and other buildings
- Number of customers by type (i.e. residential, commercial) in the City of Needles Electric Utility territory

- Natural gas consumption (therms) provided by SoCal Gas Company and Southwest Gas for residential, commercial, industrial, institutional, and other buildings
- Utility specific electricity GHG emission factors for SCE and regional average emission factors from the U.S. Environmental Protection Agency (U.S. EPA) for BVE, City of Needles, and for methane (CH_4) and nitrous oxide (N_2O) (Edison International 2015; U.S. EPA 2014)
- GHG emission factors for natural gas (Climate Registry 2016)

Municipal

- Electricity and natural consumption from the following County departments and other entities for all owned and leased buildings associated with County operations: Special Districts (data for Special District facilities, streetlights/traffic lights, and water and wastewater pumping equipment owned by the County), County Libraries, Real Estate Services, Arrowhead Regional Medical Center, and SoCalGas Company.
- In addition to the electricity GHG factors for community, electricity GHG emission factors for regional average emission factors from the (U.S. EPA) for City of Colton Electric Utility and Nevada (U.S. EPA 2017).

Inventory Methods for the Current Inventory

Community and Municipal: Community energy data was obtained individually through the electricity and natural gas providers, as indicated above. Municipal building energy data was obtained through the relevant County departments. The Special Districts department provided energy consumption data for the Special Districts facilities; the streetlights and traffic lights operated by the County; and the water and wastewater pumping equipment owned by the County. Although streetlights, traffic lights, and pumping equipment owned by the County are included in separate sectors, the methodology to calculate emissions for these sources are essentially identical to the building energy sector, because the calculation involves multiplying electricity by utility emission factors. Thus, the methodology for these sectors is not discussed further.

CO_2 emissions from electricity provided by all utilities that serve the County were calculated by multiplying electricity use by the utility-specific CO_2 emission factors for delivered electricity, as cited above. The 2014 emission factors represent the emissions related to electricity deliveries in the County in 2014 (and FY 2015 for the municipal inventory)[1]. Methane (CH_4) and nitrous oxide (N_2O) emissions for both utilities were calculated using U.S. EPA eGRID year 2014 emission factors for the CAMX/WECC region (this region represents electricity primarily generated in California, and the latest year of emission factor currently available is 2014.).

The community inventory includes emissions for residential, commercial, industrial, and institutional buildings. The municipal inventory includes emissions for all municipal buildings (those that are owned and those in which the County leases space). Water use and wastewater-treatment related energy use was subtracted from the building energy sector to avoid double counting. The energy emissions associated with water and wastewater are included in the respective sectors.

[1] The two primary emission factors used in the analysis are for SCE and eGRID, which are equal to 573 and 569 pounds of carbon dioxide equivalent per megawatt hour in 2014, respectively.

Transmission and distribution (T&D) electricity losses, which occur between the points of generation and the points of consumption, were also included in the building energy sector. The T&D loss value used in the inventory was 4.79% (U.S. EPA 2017). The CAMX/WECC emission factors cited above were used to estimate GHG emissions for this electricity.

GHG emissions from natural gas consumption were calculated by multiplying the natural gas consumption data by emission factors from the Climate Registry, for both community and municipal energy. The streetlights and traffic signals component of the municipal inventory does not involve any natural gas consumption.

On-Road Transportation (Community); Vehicle Fleet and Employee Commute (Municipal)

Overview

This sector includes GHG emissions from fuel combusted by on-road vehicles. For the municipal inventory, this includes County vehicle fleet emissions and employee commutes.

Methods Used in Previous Inventory

Community: The 2007 inventory used the countywide SCAQMD GHG inventory emissions for on-road sources and apportioned emissions to the unincorporated County using population. Emissions were based on the EMFAC program assumptions, which includes all VMT in the County (including pass-through trips).

Municipal: The County's municipal on-road transportation emissions, which includes employee commute and vehicle fleet emissions, were determined using employee commute survey data from and vehicle fleet fuel consumption data from provided by the County. Emissions were quantified using gasoline and diesel fuel emission factors (for vehicle fleet emissions) and on-road grams of CO_2 per mile emission factors (for employee commute emissions).

Data and Models for Current Inventory

- Traffic model results for the Community inventory provided by Fehr and Peers for 2014. The traffic model used the origin-destination method for VMT for the unincorporated County. This method assigns the VMT to the County using the following protocol: 100% of trips that start and end in the County, 50% of the trips that start in the County but end outside of the County, and 50% of the trips that start outside of the County but end in the County. No through trips are included.
- ARB's EMFAC2014 model emission factors[2]
- Total number of municipal employees (19,460)
- Employee commute data for municipal employees, conducted in 2015

[2] The Emissions Factor (EMFAC) model is a transportation model issued by the California Air Resources Board. It includes a set of emission factors that represent the local vehicle fleet, speeds, and environmental conditions that can be useful in performing project-level air quality modeling

- Fuel consumption by fuel type (diesel, gas, etc.) for all County-owned vehicles and other equipment (i.e. diesel-powered generators) for FY 2015 provided by County Fleet Management department
- Fuel emissions factors (Climate Registry 2016)

Inventory Methods for Current Inventory

Community: Quantification of on-road transportation emissions followed the 2013 Community Protocol. Community VMT data was provided by Fehr and Peers for 2014.

To determine passenger VMT for the County, Fehr and Peers apportioned one-half of the trip distance for any trip with an origin or destination within the County. This eliminates apportioning through-trips on freeways or major arterials to the County, while adding regional traffic burden to land uses generating trips on a 50/50 split. This is the current recommended approach of the State's Regional Targets Advisory Committee (RTAC) and provides a better accounting of VMT associated with land use jurisdiction than approaches that apportion VMT on a pro-rata share or on the basis of VMT that occurs within the boundaries of a jurisdiction. This approach can also help to reveal potential differences in VMT generation that can be useful during future land use and GHG reduction planning. The EMFAC2014 model was used to determine emission factors, and those factors were multiplied by VMT to quantify GHG emissions.

Municipal: Municipal GHG emissions include employee commute and vehicle fleet emissions. Employee commute emissions were estimated using employee commute survey data conducted at 10 County sites that are considered regulated sites by the SCAQMD (sites with more than 250 employees). The survey asked municipal employees how they get to and from work (i.e. drive alone, carpool, motorcycle, bus, walk, bicycle, telecommute). The responses from all the sites were aggregated and computed into percentages (i.e. 86% of all surveyed employees drove alone, 0.5% took the bus), and the percentages were then applied to all County employees. A one-way commute trip distance of 16 miles was assumed, based on survey responses. Employee commute VMT was then calculated based on the aforementioned assumptions, and VMT was multiplied by the appropriate emission factors from the EMFAC model.

Vehicle fleet emissions were estimated using the County's most recent fuel consumption data, mileage data, and other vehicle fleet data, provided by the County Fleet Management department. Fuel consumption data was multiplied by the appropriate fuel emission factors from the Climate Registry (Climate Registry 2016).

Off-Road Vehicles and Equipment (Community Only)

Overview

This sector includes GHG emissions from small off-road equipment (e.g., recreational, harbor craft, rail yard, private airport, lawn and garden, agricultural, commercial, and industrial equipment).

Methods Used in Previous Inventory

The previous inventory reported the findings of the SCAQMD GHG inventory, which, in turn, used the ARB's OFFROAD model to quantify emissions (California Air Resources Board 2016). County-wide emissions were apportioned to the unincorporated areas using population.

Data and Models for Current Inventory

- ARB's OFFROAD model
- Fuel emissions factors (Climate Registry 2016)
- County socioeconomic data provided by Calthorpe Analytics
- Agricultural acreage provided by PlaceWorks

Inventory Methods for Current Inventory

Community: The 2013 Community Protocol recommends using the U.S. EPA's NONROAD model, but this analysis uses ARB's OFFROAD model because it is more specific to California communities than the NONROAD model.

ARB's OFFROAD model provides estimates for emissions at the county level for a variety of off-road equipment types, including construction equipment, lawn and garden equipment, airport ground support equipment, and recreational equipment. This analysis was based on the model's default assumption of annual hours of operation for all equipment in the County. Emissions resulting from the use of agricultural equipment were included under this sector.

Emission were apportioned from each equipment type (i.e. construction, industrial, lawn) by the relevant socioeconomic metric for the County (i.e. population, employment, households). For instance, lawn equipment emissions are modeled for the entire County (incorporated plus unincorporated) and are apportioned to the unincorporated County using the percentage of households in the unincorporated areas relative to the whole County. Households were assumed to be the most relevant metric to lawn equipment. For other equipment, such as construction or industrial equipment, employment data was used to scale emissions, as these metrics are most relevant to those equipment types. Agricultural equipment emissions were apportioned to the unincorporated County using agricultural acreage data rather than socioeconomic data.

Solid Waste/Landfills (Community and Municipal)

Overview

This sector includes GHG emissions associated with the decomposition of waste generated by the County.

Methods Used in Previous Inventory

The County's previous community GHG inventory used waste-in-place and methane capture data for County operated landfills from the U.S. Environmental Protection Agency and the first-order decay model outlined by the Intergovernmental Panel on Climate Change (IPCC).

Data and Models for Current Inventory

- Tons of waste sent to County-operated landfills in 2014-2015 provided by the County Solid Waste Management Division
- ARB's First Order Decay Model (California Air Resources Board 2010)

- Waste disposal tons from residential and commercial uses in San Bernardino County in 2014, from the California Department of Resources Recycling and Recovery (CalRecycle 2017)
- Waste material profile data for San Bernardino County, from the California Department of Resources Recycling and Recovery (CalRecycle 2017)
- Waste emission factors from the 2013 Community Protocol (ICLEI 2013)

Inventory Methods for Current Inventory

Emissions from solid waste were estimated using a waste-in-place methodology that accounts for waste generated and disposed of in landfills operated by the County. A first order decay (FOD) model created by the ARB and based on IPCC methodology was used to estimate emissions from waste that decays in landfills (California Air Resources Board 2010). The FOD model accounts for all waste generated by the Community that is sent to County-operated landfills, which is the vast majority of waste in the County. A small portion of the County's waste is sent to non-County operated landfills. Data from CalRecycle for these landfills was used to determine the emissions attributed to "waste generation" emissions from the community from waste not accounted for in the County operated emissions.

For municipal emissions, it was assumed that all waste generated as part of County operations is sent to County-operated landfills. The total municipal emissions are then equal to the FOD model emissions results for the County-operated landfills.

Water Use (Community and Municipal)

Water consumption-related emissions originate from energy used to transport, treat, and pump water to the County, including water consumed at County-owned facilities. Emissions from water use were estimated for the following sources: 1) the energy associated with water usage *inside* the County (such as local pumps distributing water within the County) and 2) energy associated with water transport from *outside* the County (such as regional pumps delivering water to the County's borders). Electricity used to treat and distribute water locally is captured within the building energy sector; all attempts were made to avoid any double counting of this energy use and resulting emissions by subtracting water-related emissions from the building energy sector.

Overview

This sector includes GHG emissions associated with water consumption in the County.

Methods Used in Previous Inventory

Water consumption emissions were estimated in the previous inventory by using imported water quantities supplied to the County and energy intensity factors from the California Energy Commission to calculate electricity associated with imported water. GHG emissions were quantified by multiplying energy consumption and the utility GHG emission factor.

Data and Models for Current Inventory

- Water demand quantities for areas in the County with urban water management plans, compiled by PlaceWorks

- County socioeconomic data provided by Calthorpe Analytics
- Water-related electricity intensity factors for Southern California from the 2013 Community Protocol
- Water consumption at County facilities provided by County departments
- Utility specific electricity GHG emission factors for SCE and regional average emission factors from the U.S. EPA for all other utility CO_2 estimates, and for CH_4 and N_2O
- Number of municipal employees

Inventory Methods for Current Inventory

Community: Water data from all relevant urban water management plans in the County were compiled and provided by PlaceWorks. From this data, per capita water estimates were calculated for each region. Because the urban water management plans were not available for every water provider in the County, the per capita water estimates were applied to the entire unincorporated County's population to ensure that the estimates of water consumption would be comprehensive. Energy use to supply, treat, and distribute water was calculated by using the water energy emission factors for Southern California in the 2013 Community Protocol. GHG emissions were then calculated using the appropriate utility emission factors. Water-related energy use was subtracted from the building energy sector to avoid double counting.

Municipal: Municipal water consumption was provided by individual County departments. Data was provided from water billing data as feasible but was estimated based on building square footage for buildings where water-specific data was not available. Total gallons of water consumed in municipal buildings were multiplied by the same energy intensity factors discussed above and multiplied by the utility GHG emission factors.

Wastewater Treatment (Community and Municipal)

Overview

This sector includes GHG emissions from the treatment of industrial, residential, commercial, and municipal wastewater produced within the County.

Methods Used in Previous Inventory

In the previous inventory, statewide wastewater emissions from the ARB's GHG inventory were scaled to the County using the County's proportion of population relative to the state's population.

Data and Models for Current Inventory

- 2013 Community Protocol population-based equations for emissions calculations (ICLEI – 2013).
- County socioeconomic data provided by Calthorpe Analytics
- Total number of municipal employees (19,460)

Inventory Methods for Current Inventory

Community: Wastewater flows and the resulting fugitive emissions were determined using population based equations in the 2013 Community Protocol. GHG emissions from electricity consumption at wastewater treatment plants were calculated according to the 2013 Community Protocol, by multiplying wastewater flow totals by energy intensity factors for the treatment of wastewater. After calculating the community wastewater emissions, a per capita rate of emissions was calculated based on the unincorporated County population. The per capita rate of emissions was then applied to the number of municipal employees to calculated wastewater emission generated from municipal employees.

Refrigerants (Community and Municipal)

Overview

This sector includes GHG emissions from the leakage of refrigerants that contain or consist of HFC compounds that contribute to global warming. These chemicals are used in refrigeration, fire suppression equipment, air conditioners, and chillers. Through the installation, use, and disposal of these systems and products, leaks are likely to occur. Although the leaks are generally small, emissions may be significant because these chemicals typically have high global warming potentials (GWPs).

Methods Used in Previous Inventory

Refrigerant emissions were not included in the County's previous GHG inventory.

Data and Models for Current Inventory

- Statewide refrigerant emissions from the ARB's 2014 GHG inventory (California Air Resources Board 2017)
- California statewide population (California Department of Finance 2016)
- Refrigerant purchases and usage in County-owned equipment, provided by the Special Districts department and Arrowhead Regional Medical Center
- The U.S. EPA's *Accounting Tool to Support Federal Reporting of HFC Emissions* (U.S. EPA 2017)
- GWPs from the LGOP and the IPCC (California Air Resources Board et. al. 2010; Intergovernmental Panel on Climate Change 2013)

Inventory Methods for Current Inventory

Community

Because refrigerant data at the County level is generally not available, the Community inventory uses a top-down population-based approach. Statewide refrigerant emissions were obtained from the ARB's 2014 GHG inventory. To calculate County-level refrigerant emissions, a per-capita rate of emissions was calculated for the statewide inventory. The per capita rate of emissions was then multiplied by the number of people in the unincorporated County.

Municipal

The 2013 Community Protocol, the LGOP, and a U.S. EPA tool were used to quantify emissions from municipal refrigerant use. Total refrigerant purchases by refrigerant type and by weight were obtained from the County Special Districts department and for the Arrowhead Regional Medical Center. Given that there are many more buildings owned or leased by the County that have refrigerant-consuming equipment than the Special Districts and Arrowhead Regional Medical Center buildings, data collection efforts would have been overly burdensome. The U.S. EPA's Accounting Tool to Support Federal Reporting of HFC Emissions was used to close the gap for all other buildings where purchase or consumption data was not available. The EPA's tool is intended for municipal uses and calculates refrigerant use based on square footage and building type (i.e. school, office, hospital, etc.).

For the equipment for which refrigerant consumption data was easily available from the County (equipment in Special Districts facilities and Arrowhead Regional Medical Center), the refrigerant quantities were multiplied by the applicable GWP from the IPCC and/or LGOP.

Agriculture (Community Only)

Overview

This sector includes GHG emissions from manure management (fugitive emissions of methane and nitrous oxide), enteric fermentation (fugitive emissions of methane and nitrous oxide), and fertilizer use (fugitive emissions of nitrous oxide). Other emission sources from agriculture were excluded because they are not covered in the 2013 Community Protocol.

Methods Used in Previous Inventory

The County's previous inventory estimated agriculture-related emissions associated with farming operations, including enteric fermentation and manure management, and waste burning and disposal. Livestock-related agricultural emissions were quantified using livestock population data from the County Department of Agriculture, Weights, and Measures for 1990 and projected to 2007 using population data. Waste burning and disposal emissions were calculated using emission factors from the ARB. The agriculture emissions for the unincorporated areas were then calculated by using the unincorporated County's ratio of population relative to the whole County.

Data and Models for Current Inventory

- San Bernardino County Crop Report for 2014 (San Bernardino County 2014)
- U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (U.S. Department of Agriculture n.d.)
- Emissions factors from the 2013 Community Protocol (ICLEI 2013)

Inventory Methods for Current Inventory

Emissions from agricultural vehicles were based on countywide activity levels of these vehicles, based on the OFFROAD model outputs (these emissions were included in the off-road vehicles and

Equipment sector). It should be noted that the 2013 Community Protocol does not include agricultural vehicle-related emissions with other agricultural emissions.

Manure management emissions were calculated using livestock population numbers estimated from the County Agriculture Commissioner for dairy cows, beef cows, other cattle, chickens, and turkeys for the entire County. Standard emissions factors from U.S. EPA and ARB, and 2013 Community Protocol equations specific to manure management were used. Similarly, emissions resulting from enteric fermentation were calculated using livestock population numbers from the Agriculture Commissioner for cows, standard emissions factors from ARB and U.S. EPA, and 2013 Community Protocol equations specific to enteric fermentation.

Because the crop report applies to the entire County, emissions were scaled to only the unincorporated County through consultation with the agricultural commissioner. The County agriculture commissioner indicated that 90% of dairy facilities in the County are located in the City of Chino and 10% are located in the Victorville and Barstow areas (Lampman pers. comm.). Based on a review of Google Earth imagery, it was assumed that the dairies located in the Victorville and Barstow areas are not located within incorporated areas and are therefore located in the unincorporated County. Thus, only 10% of the livestock emissions calculated using the countywide crop report were included in the inventory total to approximate the unincorporated County's portion of livestock emissions.

Emissions resulting from fertilizer use were calculated using the crop acreage data in the countywide crop report as the basis for the fertilizer analysis. The quantities of fertilizer applied to the crops were calculated using the USDA's National Agricultural Statistics Service data, which provides estimates for the average amounts of fertilizer applied per acre for different crop types in California. Data years for the USDA fertilizer data range from 1990 to 2015, though some years do not have any data. An average was taken across all years to estimate an average fertilizer application rate for each crop type. Using the total fertilizer quantities applied to crops in the County in 2014 and the 2013 Community Protocol equations for fertilizer use, N_2O emissions emitted from the fertilizer were quantified. Consistent with the 2013 Community Protocol, agricultural waste burning and disposal emissions were not included in the inventory.

Residential Fuel Use (Community Only)

Overview

Calculation of GHG emissions from residential combustion of fossil fuels, *excepting* natural gas (accounted for in the building energy use sector). This includes propane, kerosene, and wood.

Methods Used in Previous Inventory

The previous inventory included GHG emissions from miscellaneous sources, namely methane emissions generated by fires and cooking at residences, and these sources of emissions were a minor component of the previous inventory (approximately 0.01%). To quantify emissions, the previous inventory utilized countywide estimates for fire and cooking emissions from the SCAQMD inventory and scaled to the unincorporated areas using population.

Data and Models for Current Inventory

- County socioeconomic data provided by Calthorpe Analytics
- U.S. Census data on home heating fuels from the American Community Survey (U.S. Census. 2014)
- Energy Information Administration's Residential Energy Consumption Survey dataset for home heating fuels (Energy Information Administration 2009)
- EIA State Energy Data System (SEDS) (Energy Information Administration 2017)
- Fuel combustion emission factors from the Climate Registry (Climate Registry 2017)

Inventory Methods for Current Inventory

The County used quantification methods consistent with the 2013 Community Protocol to quantify GHG emissions from residential fuel combustion. The number of households in the County that use each type of fuel was determined using statewide information from the Energy Information Administration (EIA) and the American Community Survey. Fuel consumption for each fuel type was calculated using state-level fuel use from the EIA's State Energy Data System. The fuel use was then multiplied by fuel combustion emission factors from the Climate Registry protocols to determine emissions.

Community Emissions Sectors for Informational Purposes Only

The following sectors are presented as informational items but were not added to the emissions total for the community inventory or forecast.

Stationary Sources (Community Only)

Overview

This sector includes GHG emissions from nonresidential stationary (typically industrial) combustion of fossil fuels of any type *except* natural gas (accounted for in the building energy use sector) and fugitive emissions from industrial processes in the County.

Methods Used in Previous Inventory

The previous inventory utilized fuel consumption data from the SCAQMD GHG inventory to estimate emissions for non-cement sources and used 2008 ARB emissions and clinker[3] consumption data to estimate emissions for cement sources. For non-cement sources, the previous inventory methods included scaling the total countywide (incorporated+ unincorporated) emissions to the unincorporated County by multiplying by the proportion of unincorporated County population. This approach was identified as a data limitation in the previous inventory, because population and stationary source activity are not necessarily correlated. For cement sources, 2008 cement plant

[3] Clinker is an ingredient used in cement production

emissions were obtained from the ARB and adjusted for 2007 using the change in clinker data between 2007 and 2008.

Data and Models for Current Inventory

- GHG emissions data from the ARB's online GHG Emissions Reporting Tool and the Integrated Emissions Mapping Tool (California Air Resources Board 2017)

Inventory Methods for Current Inventory

GHG emissions data for all facilities that emit more than 10,000 MT CO_2e per year in the County were provided by the ARB by zip code and county. The county level emissions were allocated to the unincorporated County using each facility's zip code.

Literature Cited

Printed

California Air Resources Board, California Climate Action Registry, ICLEI-Local Governments for Sustainability, and the Climate Registry. 2010. *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*. Version 1.1. May. Available: <https://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf>.

California Air Resources Board. 2017. *California Greenhouse Gas Emission Inventory – 2017 Edition*. Available: <https://www.arb.ca.gov/cc/inventory/data/data.htm>. Accessed: August 22, 2017.

California Air Resources Board. 2017. *Mandatory GHG Reporting – Reported Emissions*. Available: < https://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm>. Accessed: June 13, 2017.

California Department of Finance. 2016. E-4 Population Estimates for Cities, Counties, and the State, 2011-2016 with 2010 Census Benchmark, Table 2. Available: <http://www.dof.ca.gov/forecasting/demographics/Estimates/E-4/2011-20/>. Accessed: August 22, 2017.

California Department of Resources and Recycling. 2017. *Disposal Reporting System: Single-year Countywide Origin Detail – San Bernardino County 2007 and 2014*. Available: <http://www.calrecycle.ca.gov/lgcentral/Reports/DRS/Origin/WFOrgin.aspx>.

Climate Registry. 2016. *The Climate Registry's 2016 Default Emission Factors*. Available: < https://www.theclimateregistry.org/wp-content/uploads/2014/11/2016-Climate-Registry-Default-Emission-Factors.pdf>. Accessed: August 22, 2017.

Edison International. 2015. *Corporate Responsibility Report*. Page 28. Available: <https://www.sce.com/wps/wcm/connect/c0fceef5-e04a-4287-8301-8e66e3e5fbac/2014_Corporate+Responsibility+Report_FINAL+single-page.pdf?MOD=AJPERES&ContentCache=NONE>. Accessed: August 22, 2017.

Energy Information Administration. 2009. *Residential End Use Consumption Survey*. Table CE4.10 End Use Consumption by Fuel, Averages, West Homes. Available: < https://www.eia.gov/consumption/residential/data/2009/c&e/ce4.10.xlsx> and <https://www.eia.gov/consumption/residential/data/2009/index.php?view=consumption#end-use-by-fuel >. Accessed: June 17, 2017.

Energy Information Administration. 2017. *State Energy Data System (SEDS): 1960 - 2015*. Available: < https://www.eia.gov/state/seds/seds-data-complete.php?sid=US#Consumption >. Accessed: June 17, 2017.

ICLEI – Local Governments for Sustainability USA. 2013. *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.1*. July. Available: <http://icleiusa.org/publications/us-community-protocol/>.

Intergovernmental Panel on Climate Change. 2013. Fifth Assessment Report, Chapter 8, Table 8.7: Available: <http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf>. Accessed: August 22, 2017.

San Bernardino County. 2014. *Annual Crop Report 2014*. Available: <http://cms.sbcounty.gov/Portals/13/CropReports/2014CropReport.pdf?ver=2015-07-16-090201-963 >. Accessed: August 01, 2017.

U.S. Census. 2014. *American Community Survey*. Table B25040: House Heating Fuel for San Bernardino County. Available: <http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t>. Accessed: June 17, 2017.

U.S. Department of Agriculture. n.d. *National Agricultural Statistics Service*. Available: <https://quickstats.nass.usda.gov/ Accessed: May 27, 2017.

U.S. Environmental Protection Agency. 2017. Emissions & Generation Resource Integrated Database (eGRID). eGRID2014. Available: < https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>. Accessed: August 22, 2017.

U.S. Environmental Protection Agency. 2017. Reducing Hydrofluorocarbon (HFC) Use and Emissions in the Federal Sector through SNAP. Available: < https://www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector-through-snap#accounting-tool>. Accessed: August 22, 2017.

Personal Communications

Lampman, Allen, Assistant Agricultural Commissioner/Sealer of Weights & Measures, County of San Bernardino. Phone conversation with Cory Matsui (ICF) about the locations of dairy facilities in the County.