

## MEMORANDUM

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SUBJECT Santa Rosa Community-wide Greenhouse Gas Emissions Inventories – Summary of Results

### 1. Introduction

A community-wide greenhouse gas (GHG) emissions inventory identifies GHG emissions that result from activities of residents, employees, and other community members occurring within the community. Municipal agencies like the City of Santa Rosa (City) prepare community-wide GHG inventories to better understand the sources and quantities of GHGs attributed to day-to-day activities. The City has past community-wide GHG inventories for the calendar years 2000 and 2007 and City operations GHG inventories for the calendar years 2000, 2007, and 2010.

As part of the update to the General Plan and concurrent preparation of a GHG Reduction Strategy, the City contracted with PlaceWorks to review and update the 2007 baseline inventory and prepare a new current-year inventory. These inventories will provide a foundation for the City of Santa Rosa’s GHG Reduction Strategy, which is being prepared as part of the General Plan Update. The GHG Reduction Strategy will serve as the City’s strategic plan to reduce community-wide GHG emissions through 2045 and beyond.

This memo describes the updates to the 2007 inventory, the baseline against which emissions reductions can be measured, provides a summary of the 2007 and 2019 inventory results, and discusses how GHG emissions have changed between the 2007 baseline year and 2019. This memo contains the following sections:

- An overview of the methods used to prepare and update the GHG inventories (**Section 2**).
- A summary of the updates to the 2007 inventory and the results (**Section 3**).
- A summary of the 2019 GHG inventory results in the City boundary (**Section 4**).
- A discussion of how community-wide GHG emissions have changed between 2007 and 2019 (**Section 5**).
- A summary of the 2019 GHG inventory results in the planning area (**Section 6**).
- Next steps (**Section 7**).
- Technical details are in the **appendices**, including a discussion of the major changes between 2007 and 2019.

## 2. GHG Inventory Methods

### PROTOCOLS

A series of guidance documents called protocols provide recommendations on how to assess community-wide GHG emissions. Protocols indicate which sectors are analyzed in local government GHG inventories and emissions from those sectors are measured. Following protocols is a standardized approach for all GHG inventories and results in reliable estimates of local emission levels that can be compared across multiple years and communities.

PlaceWorks updated the City's existing 2007 GHG inventory and prepared a new 2019 GHG inventory with data provided by the City following standard protocols, methods, and best practices recommended by the California Governor's Office of Planning and Research. PlaceWorks followed two protocols: (1) the United States Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (U.S. Community Protocol), and (2) the Global Protocol for Community-Scale Greenhouse Gas Inventories (Global Protocol) to assess GHG emissions from sources that are not covered in the U.S. Community Protocol.

### UNITS OF MEASURE AND EMISSION FACTORS

GHG emissions are generated by various activities that are common in daily life. Some daily activities release GHG emissions in the location of the activity, such as emissions from combustion of natural gas used in community homes or businesses. Other activities cause GHG emissions to be released elsewhere, such as GHG emissions from power plants in other communities that generate the electricity that is used in Santa Rosa. In a few cases, the activity occurs partially in Santa Rosa and partially elsewhere, such as emissions from vehicle trips between Santa Rosa and another community. Overall, the community-wide inventory is an assessment of GHG emissions that are attributed to Santa Rosa, although the emissions themselves or even the activities may not actually occur within the Santa Rosa city limits or planning area.

The community-wide GHG inventories include emissions from three GHGs: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). Although there are other GHGs inventoried by the state and federal governments, local government inventories focus on the primary GHGs that are the most abundant at the community level and have known data sources. GHGs are measured in a unit called carbon dioxide equivalent (CO<sub>2</sub>e), which is a standard unit of measure for GHGs analyzed in the inventory. Carbon dioxide equivalent is a metric measurement used to compare the relative potency of GHGs based on their global warming potential (GWP) by converting the amounts of gases to the equivalent amount of CO<sub>2</sub>. (**Table 1** shows the GWPs used in Santa Rosa's inventories.) These inventories report amounts of GHGs in metric tons of CO<sub>2</sub>e (MTCO<sub>2</sub>e), equal to 1,000 kilograms or approximately 2,205 pounds.

The project team calculated most of the GHG emissions using data on GHG-generating activities in combination with emission factors. An emissions factor describes how many metric tons of carbon dioxide-equivalent emissions are released per unit of an activity. (Refer to **Appendix A, Table A-1**, for the emissions factors applied to the 2007 and 2019 inventories.) Some sectors, including agriculture and off-road emissions, do not have specific emission factors, because they are calculated using formulae or models.

## SECTORS

Consistent with the U.S. Community Protocol, the City's community-wide GHG inventory assesses GHG emissions from the following categories of activities, known as sectors.

- **Transportation.** GHG emissions created by driving on-road vehicles, including passenger and freight vehicles, in Santa Rosa. In the 2019 inventory, this sector also includes emissions from fuel use on SMART trains.
- **Residential energy.** GHG emissions attributed to the use of electricity and natural gas in residential buildings.
- **Nonresidential energy.** GHG emissions attributed to the use of electricity and natural gas in nonresidential buildings.
- **Solid waste.** GHG emissions released from trash collected from residents and businesses in Santa Rosa.
- **Off-road equipment.** GHG emissions from equipment that does not provide on-road transportation, such as tractors for construction or equipment used for landscape maintenance.
- **Agriculture.** GHG emissions from fertilizer used for crop cultivation.
- **Water and wastewater.** This sector accounts for the electricity used to process and transport from the water used by and the wastewater generated from city community members, as well as direct emissions from processing wastewater.
- **Land use and sequestration.** Emissions released into the atmosphere from development of previously undeveloped land and GHG emissions absorbed and stored in trees and soils on locally controlled lands as part of healthy ecosystems.
- **Stationary sources.** Emissions from fuel use at major industrial facilities permitted by state and regional air quality authorities. Stationary source emissions are informational and are not included in the community total.
- **Wildfire and controlled burns.** Emissions released by wildfires and controlled burns.

### 3. 2007 Community-wide Inventory Results (City Boundary) and Updates

In 2007, the City prepared a community-wide inventory to serve as the baseline year of analysis for the 2012 Climate Action Plan and ongoing climate action activities. PlaceWorks updated Santa Rosa's existing 2007 inventory to be consistent with current guidance and best practices, including the addition of new sectors and the use of updated methodologies for calculating GHG emissions.

- **Global Warming Potentials.** The project team updated these values to be consistent with the Fifth Intergovernmental Panel on Climate Change (IPCC) Assessment report.
- **Sectors and Subsectors.** The project team added emissions from land use and sequestration activities to the 2007 inventory.
- **Sector-Specific Methods.** The project team updated activity and emissions data for the on-road transportation and off-road equipment sectors, updated agricultural acreage, and updated emissions factors for the solid waste sector using state databases or models.

## UPDATE TO GLOBAL WARMING POTENTIALS

One major revision to the 2007 GHG inventory was to revise the global warming potentials (GWPs) to account for the relative difference in potencies of different GHGs. These numbers have changed as the science of GHGs have advanced. Santa Rosa’s existing inventories used GWPs from IPCC’s Second Assessment Report, released in 1995. PlaceWorks updated these values to use the GWPs from the Fifth IPCC Assessment Report,<sup>1</sup> released in 2013. The GHG inventories use GWPs from the Fifth IPCC Assessment Report because the Sixth Assessment Report has not yet been finalized and its GWPs are not yet being used for inventories as a standard metric of comparison. **Table 1** shows the GWPs by gas in both the second and the fifth assessment reports.

**Table 1: Change in GWPs by GHG**

GAS	SECOND ASSESSMENT REPORT GWP	FIFTH ASSESSMENT REPORT GWP
Carbon dioxide (CO <sub>2</sub> )	1	1
Methane (CH <sub>4</sub> )	21	28
Nitrous oxide (N <sub>2</sub> O)	310	265

## UPDATES TO SECTORS AND SUBSECTORS

PlaceWorks added emissions from land use and sequestration activities to the 2007 inventory. This sector accounts for GHG emissions from the conversion of land from open space or agricultural to urban land uses (a carbon source) and carbon dioxide absorbed by street trees in urban areas (a carbon sink, or something that removes GHGs from the atmosphere).

Wildfire emissions, which include emissions associated with wildfires and controlled burns, are typically provided for informational purposes to supplement community-wide GHG inventories. However, because there were no wildfires occurring in 2007, wildfire emissions are not included in the 2007 community-wide GHG inventory.

PlaceWorks did not change data sources of data for sectors included in the 2007 inventory nor update transportation modeling.

## UPDATES TO SECTOR-SPECIFIC METHODS

PlaceWorks made the following additional updates to the 2007 inventory:

- Updated the emissions associated with on-road transportation and off-road equipment using data from EMFAC 2021, the latest emissions model for these two sectors developed by the California Air Resources Board (CARB). As part of this update, PlaceWorks updated emissions associated with off-road equipment using data from EMFAC 2021, the latest and most accurate emissions model for off-road emissions developed by CARB. Using EMFAC 2021 instead of EMFAC 2007 to

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<sup>1</sup> IPCC, 2013: *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. 659–740. [https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5\\_Chapter08\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf).

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calculate off-road emissions yielded an increase in off-road emissions in the updated 2007 inventory compared with the original inventory.

- Updated the agriculture sector’s fertilizer emissions estimates using geographic information system (GIS) acreage data from the California Department of Conservation’s Farmland Mapping and Monitoring and Program (FMMP) database for the mapping of agricultural land.
- Updated emissions factors, sourced from CalRecycle, for the solid waste sector.
- Updated vehicle miles traveled (VMT) data and emissions factors for on-road vehicles to reflect the most current and accurate data available. The original inventory used CARB’s EMFAC 2007 model as a way of estimating emissions from VMT, which only provided CO<sub>2</sub> emissions from the transportation sector. PlaceWorks used the latest model, EMFAC 2021, to provide a more accurate assessment of VMT emissions from the transportation sector.

**RESULTS OF UPDATES TO 2007 COMMUNITY-WIDE INVENTORY (CITY BOUNDARY)**

PlaceWorks updated the 2007 community-wide inventory to reflect changes to methods and protocols since 2010. This update resulted in changes to the results of most sectors, with notable increases in the off-road and agriculture sectors and decreases in the water and wastewater and waste sectors. The transportation and energy sectors experienced minor changes. Using the new methods of calculating community-wide emissions for 2007, the results show a 1 percent decrease in total emissions. **Table 2** shows the results of the updates to the 2007 baseline inventory.

**Table 2: Updates to 2007 Community-Wide Baseline Inventory**

SECTOR	ORIGINAL RESULTS	UPDATED RESULTS	PERCENTAGE CHANGE
Transportation	684,280	666,180	-3%
Nonresidential energy	209,880	209,570	Less than 1%
Residential energy	259,640	257,100	-1%
Off-road equipment	17,670	108,820	516%
Solid Waste	139,770	54,350	-61%
Water and wastewater	9,840	4,850	-51%
Agriculture	170	220	29%
Land use and sequestration	-	3,200	-
<b>Total Annual MTCO<sub>2</sub>e</b>	<b>1,321,250</b>	<b>1,304,290</b>	<b>-1%</b>
<b>Stationary sources<sup>1</sup></b>	<b>28,440</b>	<b>28,440</b>	<b>-</b>

**Notes:** All numbers are rounded to the nearest 10. Totals may not equal the sum of individual rows.

<sup>1</sup> Stationary sources are not included in the community-wide GHG inventory total. They are provided as informational items.

**4. 2019 GHG Inventory Results in City Boundary**

As part of the preparation of the City’s GHG Reduction Strategy, PlaceWorks prepared a community-wide inventory for the year 2019. The City selected 2019 as the most recent year because the COVID-19 pandemic resulted in significant changes in activity for various sectors, many of which may not reflect “normal” levels for 2020 and 2021, making them less useful as a good foundation for estimating future emissions. The 2019 inventory covers all the sectors in the 2007 inventory plus some subsector activity

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data that reflects changes in the community since 2007. For example, in the transportation sector, PlaceWorks estimated emissions from the SMART rail ridership in the city limits of Santa Rosa in 2019 based on annual passenger mileage of trips. As in 2007, wildfire emissions are not included in the 2019 community-wide GHG inventory because there were no wildfires occurring in 2019. In 2019, Santa Rosa’s community-wide GHG emissions totaled 949,310 MTCO<sub>2</sub>e, as shown in **Table 3**. This emissions level represents a decrease in emissions of 28 percent since 2007.

**Table 3: 2019 GHG Inventory Results in City Boundary**

SECTOR	2019	2019 PROPORTION OF TOTAL
Transportation	507,560	53%
Nonresidential energy	153,140	16%
Residential energy	148,190	16%
Off-road equipment	117,980	12%
Solid waste	32,480	3%
Water and wastewater	1,610	Less than 1%
Agriculture	200	Less than 1%
Land use and sequestration	(11,850)	-1%
<b>Total Annual MTCO<sub>2</sub>e</b>	<b>949,310</b>	<b>100%</b>
<b>Stationary sources<sup>1</sup></b>	<b>12,400</b>	<b>-</b>

**Notes:** All numbers are rounded to the nearest 10. Totals may not equal the sum of individual rows.

<sup>1</sup> Stationary sources are not included in the community-wide GHG inventory total. They are provided as informational items.

Transportation remained the highest-emitting sector, representing 53 percent of emissions in 2019. The transportation sector is followed by the nonresidential energy, residential energy, and off-road equipment as the second, third, and fourth-highest emitting sectors, respectively, in 2019.

In the 2019 community-wide GHG inventory, PlaceWorks included activity data and emissions from the local public power provider, Sonoma Clean Power (SCP). The City joined SCP in 2014, so there are no SCP emissions in the 2007 community-wide inventory. SCP provides two types of electricity purchase options for its customers, CleanStart and EverGreen. CleanStart is the default service powered by a diverse mix of energy that, in 2019, was 96 percent carbon-free (sourced from 50 percent renewable energy, 46 percent hydroelectric power, and 3 percent from other sources). EverGreen is 100 percent locally generated renewable power offered at all times of the day and night, by sourcing solar energy when the sun is shining and geothermal energy during the night.<sup>2</sup>

Because of street trees’ ability to absorb carbon dioxide, GHG emissions from the land use and sequestration sector have a net negative effect on community-wide emissions in Santa Rosa. This sector sequesters approximately 1 percent of community-wide emissions.

<sup>2</sup> Sonoma Clean Power. 2022. Evergreen. Sonoma Clean Power. Retrieved online at <https://sonomacleanpower.org/programs/evergreen>.

## 5. Summary of Change in GHG Emissions, 2007 and 2019

Between 2007 and 2019, Santa Rosa’s community-wide GHG emissions decreased by 27 percent. While most community-wide sectors experienced a decrease in emissions during this time, the off-road sector experienced an increase in emissions. The land use and sequestration sector also contributed to a decrease in net community-wide GHG emissions, as these sectors serve as a carbon sink. **Table 4** and **Figure 1** show community-wide emissions by sector in 2007 and 2019, including how emissions changed over time during this period.

**Table 4: Community-Wide GHG Inventory Results, 2007 and 2019**

SECTOR	2007	2019	PERCENTAGE CHANGE
Transportation	666,180	507,560	-24%
Nonresidential energy	209,570	153,140	-27%
Residential energy	257,100	148,190	-42%
Off-road equipment	108,820	117,980	8%
Solid waste	54,350	32,480	-40%
Water and wastewater	4,850	1,610	-67%
Agriculture	220	200	-9%
Land use and sequestration	3,200	-11,850	-470%
<b>Total Annual MTCO<sub>2</sub>e</b>	<b>1,304,290</b>	<b>949,310</b>	<b>-27%</b>

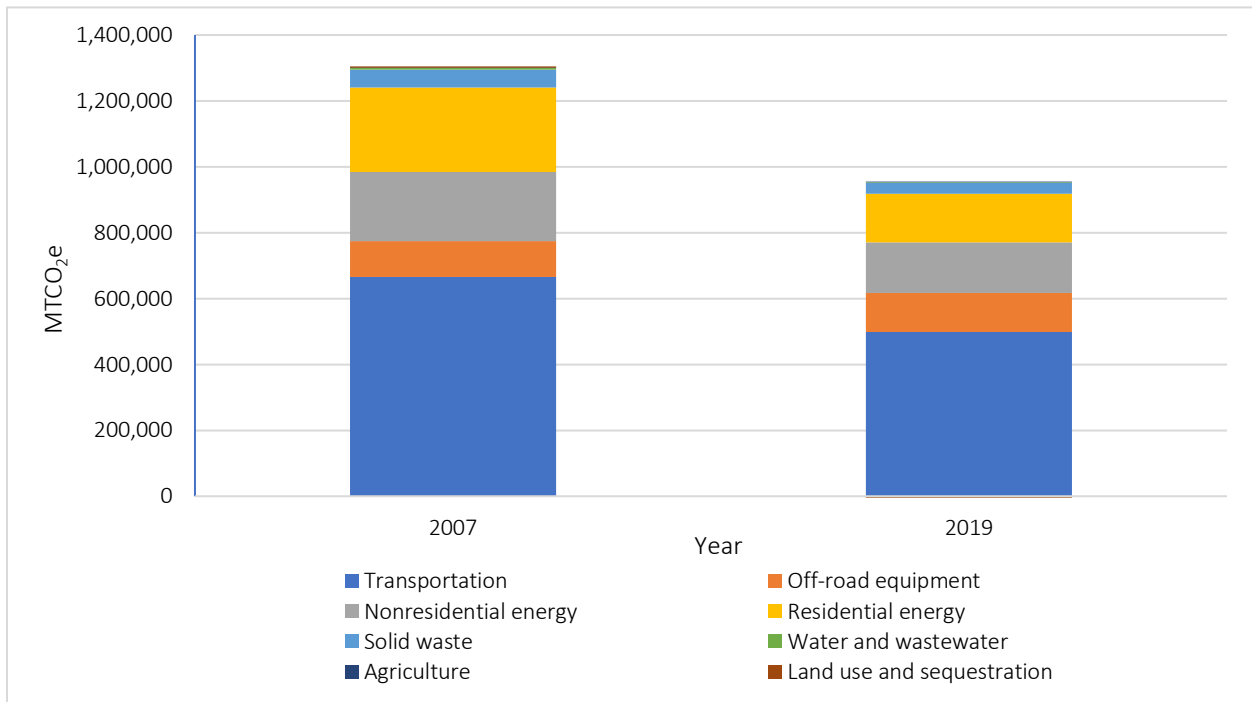
**Note:** All numbers are rounded to the nearest 10. Totals may not equal the sum of individual rows.

Santa Rosa’s community-wide GHG emissions decreased between 2007 and 2019 despite significant population growth. The sectors that experienced significant decreases in annual GHG emissions between 2007 and 2019 are the land use and sequestration sector (470 percent decline), the water and wastewater sector (67 percent decline), the residential energy sector (42 percent decline), the solid waste sector (40 percent decline), the nonresidential energy sector (27 percent decline), and the transportation sector (24 percent decline).

The large drop in land use and sequestration-related emissions comes from a decrease in greenfield development (i.e., conversion of agricultural lands or open space to developed areas). While residential electricity use declined approximately 6 percent between 2007 and 2019, likely due to increases in energy efficiency, much of the decline in residential energy GHG emissions is attributed to the community’s transition to renewable and carbon-free sources of electricity. Similarly, the dramatic decline in emissions from the nonresidential sector is due to a significant increase in renewable and carbon-free electricity supplies.

A decrease in the water and wastewater sector is in part attributed to the increased availability of renewable and carbon-free electricity and a decrease in natural gas use, although changes to the method used to calculate these emissions also play a part. The decrease in solid waste-related emissions appears to be due to changes in methods and data sources. Changes to transportation-related emissions are a result of decreases in total VMT (a function of changes in VMT modeling) combined with increased vehicle fuel efficiency.

**Figure 1. GHG Inventory Results in City Boundary, 2007 and 2019**



Appendix B and Appendix C provide details of sector-specific activity and emissions, respectively.

## 6. 2019 GHG Inventory Results in Planning Area

The GHG emission inventory results discussed in previous sections of this memo are for the city limits of Santa Rosa. This is the area formally incorporated as part of the City, covering approximately 41.1 square miles. The GHG Reduction Strategy, as part of Santa Rosa’s General Plan Update, also assesses emissions from the Santa Rosa Planning Area, which is the area where the City has an interest in determining land use. The Planning Area includes the incorporated city, the sphere of influence (surrounding land that receives services from the City or may in the future), the urban growth boundary (land that may be annexed to receive City services in the future), as well as additional areas around Santa Rosa. The Planning Area covers approximately 49.3 square miles, including the city limits.

Using the land use and demographics in the Planning Area, combined with per-capita activity data for the city limits, the PlaceWorks team estimated the total GHG emissions for the entirety of the Planning Area. In 2019, Santa Rosa’s community-wide GHG emissions for the entire Planning Area totaled 1,010,860 MTCO<sub>2</sub>e, as shown in **Table 5**.



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**Table 5: 2019 Community-Wide GHG Inventory Results**

SECTOR	2019	2019 PROPORTION OF TOTAL
Transportation	540,760	53%
Nonresidential energy	162,330	16%
Residential energy	158,190	16%
Off-road equipment	126,040	13%
Solid waste	34,600	3%
Water and wastewater	1,720	Less than 1%
Agriculture	280	Less than 1%
Land use and sequestration	(13,060)	-1%
<b>Total Annual MTCO<sub>2</sub>e</b>	<b>1,010,860</b>	<b>100%</b>

**Note:** All numbers are rounded to the nearest 10. Totals may not equal the sum of individual rows.

As in the City boundary inventories, in the Planning Area, the transportation sector was the highest-emitting sector, followed by nonresidential energy, residential energy, and off-road equipment, as the second, third, and fourth-highest emitting sectors, respectively, in 2019. As in the City boundary inventory, the land use and sequestration sector has a net negative effect on community-wide emissions in Santa Rosa. This sector sequesters approximately 1 percent of community-wide emissions. **Appendix D** and **Appendix E** provide details of sector-specific activity and emissions, respectively.

## 7. Next Steps

Following City staff review of these GHG inventory results and completion of any revisions, PlaceWorks will continue to develop the Climate Action Strategy by preparing 2030, 2045, and 2050 forecasts of community-wide GHG emissions and developing goals, policies, and strategies to reduce community-wide GHG emissions.

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## Appendix A. Community-Wide Emissions Factors, 2007 and 2019

Table A-1 shows the emissions factors, which are the emissions per unit activity (expressed in MTCO<sub>2e</sub>) for 2007 and 2019. Some sectors, including agriculture and off-road emissions, do not have specific emission factors, because they are calculated using formulae or models.

**Table A-1. Emissions Factors Used in the Santa Rosa Community-wide GHG Inventory, 2007 and 2019**

SECTOR	UNIT	2007	2019	PERCENTAGE CHANGE, 2007-2019	SOURCE
On-road transportation (light and medium-duty vehicles)	MTCO <sub>2e</sub> / mile	0.000409	0.000347	-15%	California Air Resources Board
On-road transportation (heavy-duty vehicles)	MTCO <sub>2e</sub> / mile	0.001029	0.000790	-23%	California Air Resources Board
On-road transportation (all vehicles)	MTCO <sub>2e</sub> / mile	0.000490	0.000400	-18%	California Air Resources Board
PG&E electricity	MTCO <sub>2e</sub> / kWh	0.000419	0.000025	-94%	PG&E
SCP electricity (CleanStart)	MTCO <sub>2e</sub> / kWh	-	0.000018	-	SCP
SCP electricity (EverGreen)	MTCO <sub>2e</sub> / kWh	-	0.000019	-	SCP
Direct access electricity	MTCO <sub>2e</sub> / kWh	0.000419	0.000186	-56%	California Energy Commission
Natural gas	MTCO <sub>2e</sub> / therm	0.005323	0.005324	0%	US Community Protocol
Municipal Solid Waste (MSW)	MTCO <sub>2e</sub> / ton	0.296216	0.286062	-3%	CalRecycle
Alternative Daily Cover (ADC)	MTCO <sub>2e</sub> / ton	0.245671	0.245671	-	CalRecycle

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## Appendix B. Activity Data in City Boundary, 2007 and 2019

Santa Rosa’s community-wide activity and consumption patterns changed noticeably between 2007 and 2019. The subsectors that experienced the largest increase in activity during this period (in terms of percentage change) were the direct access electricity sector (1,134 percent increase in kilowatt hours [kWh] for electricity), the indirect wastewater sector (377 percent increase in kWh used for water and wastewater), and the indirect water sector (123 percent increase in millions of gallons of water consumed). Changes in direct access electricity are likely due to how Pacific Gas and Electricity Company (PG&E) reports this data, while changes in electricity related to water and wastewater are the result of method changes since the 2007 inventory was originally prepared.

The community-wide sectors that experienced a decrease in activity, despite a growth in resident population and employment, were the residential electricity and natural gas sectors (6 percent decrease in kWh and 6 percent decrease in therms), the agriculture sector (8 percent decrease in agricultural acreage), the vehicle transportation sector (15 percent decrease in light-duty VMT and 22 percent decrease in heavy-duty VMT), and the solid waste tonnage (39 percent).

Decreases in residential electricity and natural gas use are likely attributed to increases in energy efficiency for household appliances and lighting. The apparent decrease in activity in the vehicle transportation and solid waste sectors may be a result of changes in modeling and accounting for these activities, despite the growth in population and employment in Santa Rosa between the two inventory years. VMT numbers come from different versions of the County’s transportation model, so the underlying demographic assumptions and methods are likely different. For solid waste, data used for the 2007 inventory was disaggregated from countywide data using the 2007 Out-of-County Disposal By Jurisdiction data from CalRecycle, whereas 2019 data was sourced from a report of total annual waste tonnage sent to landfills from the City of Santa Rosa.

**Table B-1. Community-Wide Activity Data by Sector in City Boundary, 2007 and 2019**

SECTOR	UNITS	2007	2019	PERCENTAGE CHANGE
<b>TRANSPORTATION</b>				
<b>VEHICLE TRANSPORTATION</b>				
Light-duty vehicles	VMT	1,185,500,850	1,006,013,930	-15%
Heavy-duty vehicles	VMT	176,356,860	136,710,280	-22%
<b>Total</b>	<b>VMT</b>	<b>1,361,857,710</b>	<b>1,142,724,210</b>	<b>-16%</b>
<b>SMART RAIL</b>				
Passenger miles	Miles	-	623,560	-
<b>OFF-ROAD EQUIPMENT</b>				
Off-road equipment <sup>1</sup>	N/A	-	-	-

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SECTOR	UNITS	2007	2019	PERCENTAGE CHANGE
<b>NONRESIDENTIAL ENERGY</b>				
<b>NONRESIDENTIAL NATURAL GAS</b>				
Total	Therms	13,475,990	15,051,190	12%
<b>NONRESIDENTIAL ELECTRICITY</b>				
Nonresidential PG&E electricity	kWh	456,798,860	32,149,070	-93%
Nonresidential SCP EverGreen electricity	kWh	-	1,708,000	-
Nonresidential SCP CleanStart electricity	kWh	-	303,108,000	-
Direct access electricity	kWh	12,870,570	158,816,910	1,134%
<b>Total</b>	<b>kWh</b>	<b>469,669,430</b>	<b>495,781,980</b>	<b>6%</b>
<b>RESIDENTIAL ENERGY</b>				
<b>RESIDENTIAL NATURAL GAS</b>				
<b>Total</b>	<b>Therms</b>	<b>28,386,390</b>	<b>26,568,570</b>	<b>-6%</b>
<b>RESIDENTIAL ELECTRICITY</b>				
Residential PG&E electricity	kWh	365,546,110	47,454,820	-87%
Residential SCP EverGreen electricity	kWh	-	1,706,000	
Residential SCP CleanStart electricity	kWh	-	294,889,000	
<b>Total</b>	<b>kWh</b>	<b>365,546,110</b>	<b>344,049,820</b>	<b>-6%</b>
<b>SOLID WASTE</b>				
Municipal solid waste	Tons	176,850	113,030	-36%
Alternative daily cover	Tons	7,990	620	-92%
<b>Total</b>	<b>Tons</b>	<b>184,840</b>	<b>113,650</b>	<b>-39%</b>
<b>WATER AND WASTEWATER</b>				
Indirect water	Millions of Gallons (MG)	7,720	17,200	123%
Indirect water	kWh	11,102,520	24,424,570	120%

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SECTOR	UNITS	2007	2019	PERCENTAGE CHANGE
Indirect wastewater	kWh	2,084,830	9,951,510	377%
Septic systems	Population served	220	220	0%
<b>Total (electricity)</b>	<b>kWh</b>	<b>13,195,290</b>	<b>34,393,500</b>	<b>161%</b>
<b>AGRICULTURE</b>				
Fertilizer application	Acres of crop land	2,360	2,160	-8%
<b>LAND USE AND SEQUESTRATION</b>				
Development activities	Acres of developed farmland	3,850	1,450	-62%
Street tree sequestration	Acres of urban area	21,190	21,450	1,321%

<sup>1</sup> There is no activity data for the off-road sector because emissions from off-road equipment are estimated from a model developed by CARB rather than from measurable metrics such as fuel consumption.

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## Appendix C. Emissions Inventory in City Boundary, 2007 and 2019

Santa Rosa’s community-wide GHG emissions decreased between 2007 and 2019 despite significant population growth.

The four sectors that experienced the largest decrease in annual GHG emissions between 2007 and 2019 are the water and wastewater sector (67 percent decline), residential energy sector (42 percent decline), nonresidential energy sector (27 percent decline), and solid waste sector (40 percent decline). The dramatic decline in emissions from the water and energy sectors is attributed to the increased availability of renewable and carbon-free electricity and an associated decrease in natural gas use. While residential electricity use declined slightly (by approximately 6 percent between 2007 and 2019) due to increases in energy efficiency, much of the decline in emissions is attributed to the widespread adoption of SCP’s CleanStart, with a higher proportion of electricity sourced from renewable energy than PG&E.

However, there were three subsectors that experienced a substantial increase in GHG emissions, listed below in descending order:

1. Agricultural equipment subsector of the off-road equipment sector (1,233 percent increase in emissions).
2. Direct access electricity subsector of the nonresidential energy sector (1,134 percent increase in emissions).
3. Transportation Refrigeration Units (TRU) subsector of the off-road equipment sector (97 percent increase in emissions).

The increase in agricultural equipment emissions is likely the result of an increase in large-scale agricultural activity and the increase in TRU emissions are attributed to an increase in service population in Santa Rosa between 2007 and 2019, along with changes in how these emissions are estimated by the State. Direct access emissions are higher because of how PG&E counts and reports this electricity.

**Table C-1. Community-Wide GHG Emissions Data by Sector, 2007 and 2019**

SECTOR	2007	2019	PERCENTAGE CHANGE
<b>TRANSPORTATION</b>			
<b>VEHICLE TRANSPORTATION</b>			
Light-duty vehicles	484,700	348,670	-28%
Heavy-duty vehicles	181,480	158,780	-13%
<b>Total MTCO<sub>2</sub>e</b>	<b>666,180</b>	<b>499,270</b>	<b>-24%</b>
<b>SMART RAIL</b>			
SMART Rail MTCO <sub>2</sub> e	-	110	-

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SECTOR	2007	2019	PERCENTAGE CHANGE
<b>OFF-ROAD EQUIPMENT</b>			
Agricultural	60	800	1,233%
Construction and Mining	8,600	9,920	15%
Industrial	6,120	5,750	-6%
Lawn and Garden	57,220	64,060	12%
Light Commercial	1,660	1,600	-4%
Pleasure Craft	27,010	27,330	1%
Portable Equipment	6,420	6,740	5%
Recreational	1,420	1,170	-18%
Transportation Refrigeration Units	310	610	97%
<b>Total MTCO<sub>2</sub>e</b>	<b>108,820</b>	<b>117,980</b>	<b>8%</b>
<b>NONRESIDENTIAL ENERGY</b>			
<b>NONRESIDENTIAL NATURAL GAS</b>			
<b>Nonresidential natural gas MTCO<sub>2</sub>e</b>	<b>71,740</b>	<b>80,130</b>	<b>12%</b>
<b>NONRESIDENTIAL ELECTRICITY</b>			
Nonresidential PG&E electricity	191,270	820	-100%
Nonresidential SCP Evergreen electricity	-	30	-
Nonresidential SCP CleanStart electricity	-	5,660	-
Direct access electricity	5,390	66,500	1,134%
<b>Total MTCO<sub>2</sub>e</b>	<b>196,660</b>	<b>73,010</b>	<b>-63%</b>
<b>RESIDENTIAL ENERGY</b>			
<b>RESIDENTIAL NATURAL GAS</b>			
<b>Residential natural gas MTCO<sub>2</sub>e</b>	<b>151,120</b>	<b>141,440</b>	<b>-6%</b>
<b>RESIDENTIAL ELECTRICITY</b>			
Residential PG&E electricity	153,060	1,210	-99%
Residential SCP EverGreen electricity	-	30	-
Residential SCP CleanStart electricity	-	5,510	-
<b>Total MTCO<sub>2</sub>e</b>	<b>153,060</b>	<b>6,750</b>	<b>-96%</b>

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SECTOR	2007	2019	PERCENTAGE CHANGE
<b>SOLID WASTE</b>			
Municipal solid waste	52,390	32,330	-38%
Alternative daily cover	1,960	150	-92%
<b>Total MTCO<sub>2</sub>e</b>	<b>54,350</b>	<b>32,480</b>	<b>-40%</b>
<b>WATER AND WASTEWATER</b>			
Indirect water	4,650	440	-91%
Indirect wastewater	870	180	-79%
Direct wastewater process	30	30	0%
Septic systems	960	960	0%
<b>Total MTCO<sub>2</sub>e</b>	<b>6,510</b>	<b>1,610</b>	<b>-75%</b>
<b>AGRICULTURE</b>			
<b>Fertilizer application MTCO<sub>2</sub>e</b>	<b>220</b>	<b>200</b>	<b>-9%</b>
<b>LAND USE AND SEQUESTRATION</b>			
Development activities	4,140	1,590	-62%
Street tree sequestration	(940)	(13,440)	1330%
<b>Total MTCO<sub>2</sub>e</b>	<b>3,200</b>	<b>(11,850)</b>	<b>-470%</b>

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## Appendix D. Activity Data in Planning Area, 2019

Table D-1. Activity Data by Sector in Planning Area, 2019

SECTOR	UNITS	2019
<b>TRANSPORTATION</b>		
<b>VEHICLE TRANSPORTATION</b>		
Light-duty vehicles	VMT	1,008,601,860
Heavy-duty vehicles	VMT	137,038,890
<b>Total</b>	<b>VMT</b>	<b>1,145,640,750</b>
<b>SMART RAIL</b>		
Passenger miles	Miles	664,350
		-
<b>OFF-ROAD EQUIPMENT</b>		
Off-road equipment <sup>2</sup>	N/A	-
		-
<b>NONRESIDENTIAL ENERGY</b>		
<b>NONRESIDENTIAL NATURAL GAS</b>		
<b>Total</b>	<b>Therms</b>	<b>15,954,250</b>
<b>NONRESIDENTIAL ELECTRICITY</b>		
Nonresidential PG&E electricity	kWh	34,077,990
Nonresidential SCP EverGreen electricity	kWh	1,810,480
Nonresidential SCP CleanStart electricity	kWh	321,294,220
Direct access electricity	kWh	15,954,250
<b>Total</b>	<b>kWh</b>	<b>373,136,940</b>
<b>RESIDENTIAL ENERGY</b>		
<b>RESIDENTIAL NATURAL GAS</b>		
<b>Total</b>	<b>Therms</b>	<b>28,361,680</b>
		<b>26,568,570</b>
<b>RESIDENTIAL ELECTRICITY</b>		
Residential PG&E electricity	kWh	50,657,5340
Residential SCP EverGreen electricity	kWh	1,821,140
Residential SCP CleanStart electricity	kWh	314,790,990
<b>Total</b>	<b>kWh</b>	<b>367,269,660</b>

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SECTOR	UNITS	2019
<b>SOLID WASTE</b>		
Municipal solid waste	Tons	120,420
Alternative daily cover	Tons	660
<b>Total</b>	<b>Tons</b>	<b>121,080</b>
<b>WATER AND WASTEWATER</b>		
Indirect water	Millions of Gallons (MG)	18,330
Indirect water	kWh	26,022,390
Indirect wastewater	kWh	10,602,520
Wastewater process emissions	Population served	202,160
Septic systems	-	240
<b>Total (electricity)</b>	<b>kWh</b>	<b>36,624,910</b>
<b>AGRICULTURE</b>		
Fertilizer application	Acres of crop land	2,990
<b>LAND USE AND SEQUESTRATION</b>		
Development activities	Acres of developed farmland	1,690
Street tree sequestration	Acres of urban area	23,830

<sup>1</sup> There is no activity data for the off-road sector because emissions from off-road equipment are estimated from a model developed by CARB rather than from measurable metrics such as fuel consumption.

## Appendix E. Emissions Inventory in Planning Area, 2019

Table E-1. GHG Emissions Inventory Results by Sector in Planning Area, 2019

SECTOR	2019 (MTCO <sub>2</sub> E)
<b>TRANSPORTATION</b>	
<b>VEHICLE TRANSPORTATION</b>	
Light-duty vehicles	371,480
Heavy-duty vehicles	169,170
<b>Total</b>	<b>531,930</b>
<b>SMART RAIL</b>	
<b>TOTAL</b>	<b>120</b>
<b>OFF-ROAD EQUIPMENT</b>	
Agricultural	1,080
Construction and Mining	0
Industrial	10,570
Lawn and Garden	6,090
Light Commercial	68,380
Pleasure Craft	1,700
Portable Equipment	29,170
Recreational	7,140
Transportation Refrigeration Units	1,250
<b>Total</b>	<b>125,380</b>
<b>NONRESIDENTIAL ENERGY</b>	
<b>NONRESIDENTIAL NATURAL GAS</b>	
<b>Total</b>	<b>84,940</b>
<b>NONRESIDENTIAL ELECTRICITY</b>	
Nonresidential PG&E electricity	34,077,990
Nonresidential SCP EverGreen electricity	1,810,480
Nonresidential SCP CleanStart electricity	321,294,220
Direct access electricity	15,954,250
<b>Total</b>	<b>373,136,940</b>

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SECTOR	2019 (MTCO <sub>2</sub> E)
<b>RESIDENTIAL ENERGY</b>	
<b>RESIDENTIAL NATURAL GAS</b>	
Total	150,990 26,568,570
<b>RESIDENTIAL ELECTRICITY</b>	
Residential PG&E electricity	50,657,530
Residential SCP EverGreen electricity	1,821,140
Residential SCP CleanStart electricity	314,790,990 314,790,987
Total	367,269,660 367,269,659
<b>SOLID WASTE</b>	
Municipal solid waste	34,440 50,657,534
Alternative daily cover	160
Total	34,600 314,790,987
<b>WATER AND WASTEWATER</b>	
Indirect water	470 26,022,386
Indirect wastewater	190 10,602,522
Wastewater process emissions	30 185,400
Septic systems	1,020 185,400
Total	1,710
<b>AGRICULTURE</b>	
Fertilizer application	280
<b>LAND USE AND SEQUESTRATION</b>	
Development activities	1,870
Street tree sequestration	(14,930)
<b>Land use and sequestration total</b>	<b>(13,060)</b>
<b>Total for all sectors</b>	<b>1,010,870</b>



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