Memo

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To: Stefan Heisler and Darcy Goulart (City of Rancho Cordova)

From: Alyssa Way, Dan Krekelberg, and Honey Walters (Ascent Environmental)

Subject: City of Rancho Cordova Climate Action Plan, Greenhouse Gas Emissions Inventory Technical Memorandum

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INTRODUCTION

In 2009, the County of Sacramento prepared a baseline inventory for the unincorporated county and the incorporated cities, including specifically a 2005 baseline year inventory for the City of Rancho Cordova (City). The Sacramento Area Council of Governments (SACOG) 2020 Metropolitan Transportation Plan / Sustainable Communities Strategy (MTP/SCS) Draft Environmental Impact Report included a greenhouse gas (GHG) emissions inventory and forecast for 2016, 2030, 2040, and 2050 that included the City. Though the City was considered in both efforts, an updated communitywide GHG emissions inventory using the latest methodologies with a more recent 2019 baseline year has been prepared for the City's Climate Action Plan (CAP).

The CAP is intended to reduce GHG emissions for the target year of 2030. This initial preparation of a GHG emissions inventory provides a foundation for the forthcoming phases of the CAP process, which includes forecasting future emissions, developing GHG emissions reduction targets, defining GHG emissions reduction measures, and preparing a CAP to reduce GHG emissions from activities occurring in the city. This technical memorandum provides the results of the 2019 GHG emissions inventory, as well as associated methods, assumptions, emissions factors, and data sources.

ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of two main parts:

- Section 1: Summary of Inventory Results presents an overview of the 2019 community inventories for each sector.
- Section 2: Data, Methods, and Assumptions summarizes data, methods, and assumptions used in the 2019 inventory and provides activity data and GHG emissions estimates by sector.

1 SUMMARY OF INVENTORY RESULTS

1.1 COMMUNITY INVENTORY

The city's GHG emissions inventory for 2019 was estimated based on methodologies and guidance provided by ICLEI – Local Governments for Sustainability (ICLEI) (discussed further in Section 2.2.1). Based on the modeling conducted, community activities in 2019 generated approximately 710,486 metric tons of carbon dioxide equivalent ($MTCO_2e$). Major emissions sectors included on-road transportation, residential and nonresidential building energy use, solid waste, water use, and wastewater generation. The 2019 inventory will serve as the City's GHG emissions baseline, which will be used to set future emissions reductions targets. A description of each emissions sector, including key sources, is provided in further detail in Section 2, "Data, Methods, and Assumptions". Table 1 and Figure 1 present the overall 2019 community inventory and the contributions from each key sector.

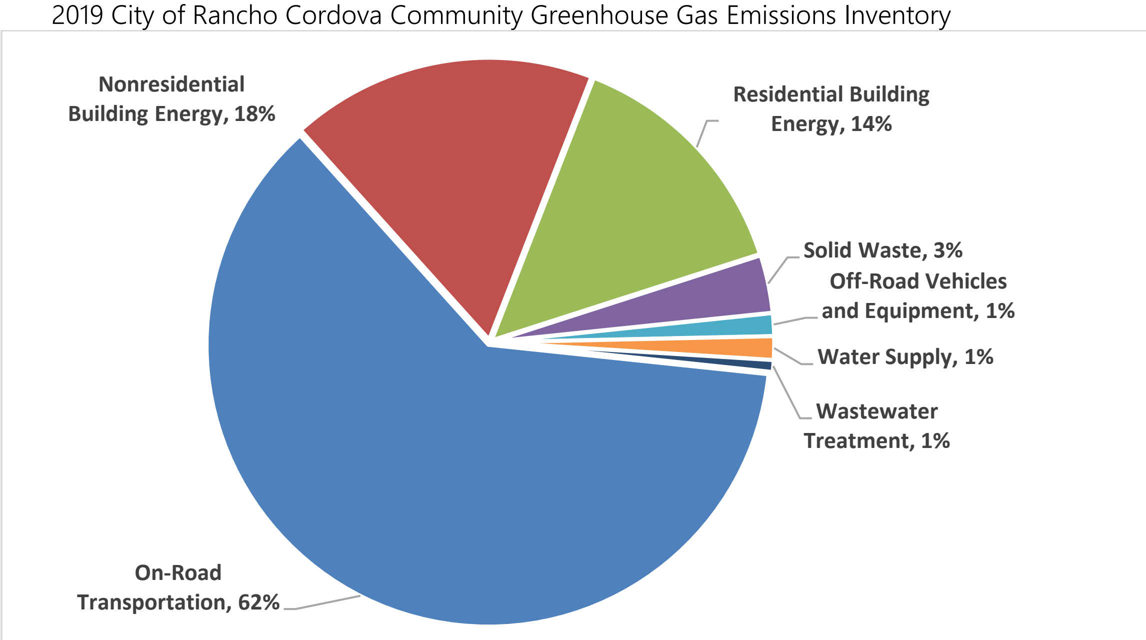
Table 1 2019 City of Rancho Cordova Community Greenhouse Gas Emissions Inventory

Sectors	$MTCO_2e$/year	Percent of Total
On-Road Transportation	417,093	62%
Nonresidential Building Energy	118,801	18%
Residential Building Energy	95,575	14%
Solid Waste	22,397	3%
Off-Road Vehicles and Equipment	8,778	1%
Water Supply	9,071	1%
Wastewater Treatment	4,540	1%
Total	676,255	100%

Notes: $MTCO_2e$/year = metric tons of carbon dioxide equivalent per year

Source: Ascent Environmental 2021

Figure 1 2019 City of Rancho Cordova Community Greenhouse Gas Emissions Inventory



Source: Ascent Environmental 2021

2 DATA, METHODS, AND ASSUMPTIONS

2.1 OVERALL ASSUMPTIONS AND DATA

2.1.1 Utility Emissions Factors

Emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) per unit of electricity and natural gas can vary by location and from year to year depending on numerous factors. Utility-specific factors for GHG emissions were obtained and used in the 2019 inventory to estimate GHG emissions from electricity and natural gas consumption. Sources for electricity and natural gas emissions factors are shown below.

- Electricity: Utility electricity emissions factors for CO_2, CH_4, and N_2O were obtained from the Sacramento Municipal Utility District (SMUD) and the U.S. Environmental Protection Agency's (EPA's) Emissions & Generation Resource Integrated Database (eGRID). For 2019, SMUD's CO_2 emissions factor was interpolated using the 2018 emissions factor provided by Southern California Edison (SCE) and the requirements of the Renewables Portfolio Standard included in Senate Bill (SB) 100. The same approach was taken for CH_4 and N_2O emissions factors from eGRID's 2018 Annual Output Emissions Rates (EPA 2020).
- Natural Gas: Utility natural gas emissions factors for CO_2, CH_4, and N_2O were obtained from The Climate Registry's (TCR's) 2020 Default Emission Factors (TCR 2020).

Specific utility emissions factors used in the inventory calculations are shown below in Table 3.

Table 3 2019 City of Rancho Cordova Utility Emissions Factors

Source and Unit	2019 Emissions Factor
SMUD – Electricity	
g CO_2/kWh	232.10
g CH_4/kWh	0.015
g N_2O/kWh	0.002
g CO_2e/MWh	233.01
PG&E – Natural Gas	
g CO_2/therm	5306
g CH_4/therm	0.47
g N_2O/therm	0.01
g CO_2e/therm	5322

Notes: CH_4 = methane; CO_2 = carbon dioxide; g= grams, MWh = megawatt-hours; N_2O = nitrous oxide; SMUD = Sacramento Municipal Utility District; PG&E = Pacific Gas and Electric Company.

Source: Utility emissions factors provided by SMUD and The Climate Registry (TCR). Ascent Environmental 2021

2.1.2 Global Warming Potentials

GHG emissions other than CO_2 generally have a stronger insulating effect and thus, a greater ability to warm the earth's atmosphere through the greenhouse effect. This effect is measured in terms of a pollutant's Global Warming Potential (GWP). CO_2 has a GWP factor of one while all other GHGs have GWP factors measured in multiples of one relative to the GWP of CO_2. This conversion of non-CO_2 gases to one unit enables the reporting of all emissions in terms of carbon dioxide equivalent (CO_2e), which allows consideration of all GHGs in comparable terms and makes it easier to communicate how various sources and types of emissions contribute to climate change. $MTCO_2e$ is the standard unit for reporting emissions.

Consistent with the best available science, these inventories use GWP factors published in the Sixth Assessment Report (AR6) from the Intergovernmental Panel on Climate Change (IPCC), where CH_4 and N_2O have GWP factors of 27.9 and 273, respectively (IPCC 2021). This means that CH_4 and N_2O are approximately 28 and 273 times stronger than CO_2 in their potential to warm Earth's atmosphere, respectively. It should be noted that the California Air Resources Board's (CARB) Statewide GHG Inventory which is associated with the 2017 Scoping Plan uses the Fifth Assessment Report (AR5). Under AR5 CH_4 is approximately 28 times stronger than CO_2 and N_2O is 265 times stronger than CO_2. The GWP can be toggled in the GHG Inventory and Forecast Workbook to compare the change in emissions between the Assessment Reports.

2.1.3 Population and Employment

Population and employment data were used to scale activity levels for certain emissions sources and sectors. Population and employment data were obtained from the California Department of Finance and the Employment Development Department 2019.

2.2 COMMUNITY INVENTORIES DATA AND ASSUMPTIONS

2.2.1 Sector-Specific Assumptions and Methods for Community Inventories

Several inventory protocols have been developed to provide guidance for communities and local governments to account for emissions accurately and consistently. In coordination with other partners, ICLEI has developed guidance for local-scale accounting of emissions that many local governments use to develop their GHG inventories. The most recent guidance for community-scale emissions inventories is ICLEI's Community Protocol, Version 1.2, published in July 2019 (ICLEI 2019). GHG emissions from livestock were not included in the inventory due to a lack of available information about the number of cattle grazing within City limits.

The following summarizes data sources and methods used in estimating community GHG emissions in 2019:

- Building Energy: Annual electricity and natural gas usage data for the city and utility emissions factors were provided by SMUD (see Table 5 above). Additional emissions factors were obtained from eGRID and TCR. Annual nonresidential backup generator usage was provided by Sacramento Metropolitan Air Quality Management District (SMAQMD). Emissions factors for backup generator fuels was obtained from TCR.
- Transportation: For the on-road transportation sector, daily vehicle miles traveled (VMT) were obtained from Fehr & Peers for the city, using the SB 375 Regional Technical Advisory Committee's (RTAC's) origin-destination method. Vehicle emissions factors were derived from CARB's 2021 Emissions FACtor (EMFAC2021) model. Off-road vehicle emissions were estimated from CARB's OFFROAD2007 and OFFROAD2021 models and scaled by population, employment, or share of road miles.
- Solid Waste: Emissions associated with waste generated by residents and businesses in the city were estimated using disposal data available from the California Department of Resources Recycling and Recovery (CalRecycle) for landfills receiving waste from the city. Landfill gas (LFG) collection information was available from EPA.

- Water Supply: Using guidance provided by ICLEI, water supply emissions were estimated using approximate water consumption volumes obtained from the Sacramento County Water Agency, Golden State Water Company, and California American Water in combination with region-specific energy intensity factors obtained from the California Public Utilities Commissions (CPUC).
- Wastewater: Emissions from wastewater treatment depend on the types of treatment processes and equipment that centralized wastewater treatment plants (WWTPs) use. Emissions in this sector are also generated from onsite wastewater treatment systems. Data regarding treatment processes, population served, digester gas combustion, and daily nitrogen load were obtained from Sacramento Area Sewer District and Regional San to estimate emissions from centralized WWTPs.

2.2.2 Building Energy

Residential and nonresidential building energy use in 2019 resulted in approximately 214,376 $MTCO_2e$. This sector generated approximately 30 percent of the City's emissions in 2019 and represents the second largest emissions sector in the inventory. Most of these emissions were a result of electricity and natural gas use in homes and businesses, primarily for lighting and heating, ventilation, air condition, and cooling (HVAC), as well as to power appliances. A small proportion of nonresidential building energy emissions are associated with diesel consumption in backup generators. In 2019, electricity from both residential and nonresidential buildings accounted for approximately 67 percent of emissions from the building energy sector. Natural gas use accounted for approximately 32 percent, and backup generators accounted for less than 1 percent, of emissions from the building sector in 2019. Annual electricity, natural gas, and backup generator usage and GHG emissions are shown in Table 4.

Table 4 2019 City of Rancho Cordova Community Building Energy Use Greenhouse Gas Emissions

Source	Quantity	GHG Emissions	Percentage
Electricity	MWh/year	$MTCO_2e$/year	% Energy Total
Residential	202,727	47,238	22
Nonresidential	416,664	97,089	45
Electricity Total	*619,391*	144,327	67
Natural Gas	therms/year	$MTCO_2e$/year	% of Energy Total
Residential	9,082,624	48,336	23
Nonresidential	3,902,601	20,769	10
Natural Gas Total	*12,985,225*	69,105	32
Backup Generators	gallons	$MTCO_2e$/year	% of Energy Total
Nonresidential	92,209	943	<1
Energy Combined		$MTCO_2e$/year	% of Energy Total
Residential	NA	95,575	45
Nonresidential	NA	118,801	55
Grand Total	NA	214,376	100

Notes: Totals in columns may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$/year = metric tons of carbon dioxide equivalent per year; MWh = megawatt-hours; NA = not applicable.

Source: Ascent Environmental 2021

RESIDENTIAL ENERGY

Residential energy emissions result indirectly from electricity consumption and directly from onsite combustion of natural gas. SMUD and PG&E are the providers of residential energy in the city. Annual residential electricity usage data for 2019 in the city were obtained from SMUD, expressed as MWh per year (MWh/year). To calculate the $MTCO_2e$ of residential electricity consumption, emissions factors (shown in Table 3) for CO_2, CH_4, and N_2O were applied to electricity consumption data.

Annual residential natural gas consumption for 2019 in the city was obtained from PG&E, expressed as therms per year (therms/year). CO_2, CH_4, and N_2O emissions factors for natural gas were applied to consumption data to estimate $MTCO_2e$ from residential natural gas usage.

NONRESIDENTIAL ENERGY

Nonresidential energy emissions, which are generated by commercial and industrial uses, result indirectly from electricity consumption and directly from onsite combustion of natural gas. SMUD provided nonresidential electricity in the city. Nonresidential natural gas in the city was provided by PG&E in 2019.

Annual nonresidential electricity usage data for 2019 were obtained from SMUD, expressed as MWh/year, and annual nonresidential natural gas consumption in the city was obtained from PG&E, expressed as therms/year. Portions of PG&E supplied commercial and industrial natural gas data was excluded due to the 15/15 Rule[1]. Emissions associated with nonresidential energy consumption were quantified using the same methods as described above for residential energy calculations.

Data for annual nonresidential backup generators were obtained from SMAQMD, expressed as gallons per year (gallons/year) for diesel fuel. Emissions factors obtained from TCR were applied to fuel consumption data to estimate GHG emissions associated with nonresidential backup generator usage.

2.2.3 On-Road Transportation

The on-road transportation sector represents the largest emissions-generator sector in the city. Based on modeling conducted, on-road transportation in the city resulted in approximately 417,093 $MTCO_2e$, or 62 percent of the City's 2019 inventory. The on-road transportation sector represents the largest emissions sector in the city. Annual VMT and GHG emissions from on-road transportation are shown in Table 5.

Table 5 2019 City of Rancho Cordova Community On-Road Transportation Greenhouse Gas Emissions

Source	VMT/year	GHG Emissions ($MTCO_2e$/year)
On-Road Transportation	919,218,798	417,093

Notes: GHG = greenhouse gas; $MTCO_2e$/year = metric tons of carbon dioxide equivalent per year; VMT/year = vehicle miles traveled per year.

Source: Ascent Environmental 2021

On-road transportation emissions are primarily the result of the combustion of gasoline and diesel fuels in passenger vehicles (i.e., cars, light-duty trucks, and motorcycles), medium- and heavy-duty trucks, and other types of vehicles permitted to operate "on-road." To a smaller degree, emissions from on-road electric vehicles also result from upstream electricity generation; these emissions are represented in annual electricity emissions in the city. Due to lack of

[1] The 15/15 Rule originates from a California Public Utilities Commission (CPUC) ruling in 1997 that enacted privacy standards for utilities to help ensure customer anonymity when energy data is released to third parties without customer consent. The 15/15 Rule requires that aggregated data include a minimum of 15 customers with no one customer's load exceeding 15 percent of the group's energy consumption.

available data, emissions from the combustion of natural gas and other non-electric alternative fuels in on-road vehicles were not included in the community inventory and are assumed to have minimal contribution to total emissions.

Fehr & Peers conducted a study that provides daily VMT by city for the years 2016, 2027, 2035, and 2040. These VMT estimates are associated with trips that begin or end in the city. VMT estimates included 100 percent of vehicle trips that both originate from and end in the city (i.e., fully internal trips), 50 percent of trips that either end in or depart from the city (i.e., internal-external or external-internal trips), and zero percent of vehicle trips that are simply passing through the city boundaries (i.e., external-external, or "pass-through," trips). This vehicle trip accounting method is consistent with the RTAC origin-destination method established through SB 375 and CARB recommendations.

An overall emissions rate for countywide VMT was derived from EMFAC2021, CARB's statewide mobile source emissions inventory model. EMFAC2021 was used to generate emission rates for the county for the calendar year 2019 with all vehicle classes, model years, speeds, and fuel types. The countywide $MTCO_2e$ per mile emissions factor was calculated based on the distribution of VMT for each vehicle class and its emissions factor.

OFF-ROAD VEHICLES AND EQUIPMENT

Based on modeling conducted, off-road vehicles and equipment operating in the city emitted approximately 43,007 $MTCO_2e$, or 59 percent of the 2019 inventory. The largest emissions-generating off-road transportation categories include agricultural equipment, construction and mining equipment, railyard operations, and industrial equipment. The estimated annual emissions and scaling factors used are presented in Table 6 below by equipment type.

Table 6 2019 City of Rancho Cordova Community Off-Road Vehicles and Equipment Greenhouse Gas Emissions

Off-Road Vehicles and Equipment Type	GHG Emissions ($MTCO_2e$)	Scaling Method
Airport Ground Support	365	population
Commercial Harbor Craft	205	employment
Construction and Mining Equipment	4,276	service population
Entertainment Equipment	31	employment
Industrial Equipment	808	employment
Lawn and Garden Equipment	136	population
Light Commercial Equipment	475	employment
Military Tactical Support	5	employment
Pleasure Craft	351	population
Portable Equipment	1,406	employment
Railyard Operations	113	employment
Recreational Equipment	79	population
Transportation Refrigeration Units	529	service population
Total	8,779	N/A

Notes: GHG = greenhouse gas; $MTCO_2e$/year = metric tons of carbon dioxide equivalent per year; N/A = not applicable.

Source: Ascent Environmental 2021; based on modeling from OFFROAD2007 and OFFROAD2021.

Emissions from the off-road vehicles and equipment sector result from fuel combustion in off-road vehicles and equipment. Data associated with this sector were available from CARB's OFFROAD2007 and OFFROAD2021 models. These models provide emissions details at the State, air basin, or county level. Sacramento County emissions data from OFFROAD2007 and OFFROAD2021 were apportioned to the city using custom scaling factors depending on the off-road fleet type. For example, due to the likely correlation between commercial activity and employment, the city's portion of emissions from light commercial equipment in the county is assumed to be proportional to the number of jobs in the city as compared to the county as a whole.

OFFROAD2007 provides emissions details for all off-road vehicle and equipment types, but OFFROAD2017 only provides details for certain types of off-road vehicles and equipment that are relevant to the city (i.e., construction and mining equipment, industrial equipment, and transport refrigeration units). CARB recommends using OFFROAD2007 where desired information is unavailable from the OFFROAD2021 model, so data from both models were used (CARB 2020). Additionally, while OFFROAD2021 provides estimates of CO_2 emissions, it does not provide estimates for CH_4 and N_2O emissions. To estimate CH_4 and N_2O emissions from the vehicle and equipment types included in OFFROAD2017, ratios of CH_4 to CO_2 and N_2O to CO_2 were obtained from OFFROAD2007 and applied to CO_2 data from OFFROAD2021 to calculate CH_4 and N_2O emissions.

2.2.4 Solid Waste

Based on modeling conducted, the solid waste sector was responsible for approximately 22,397 $MTCO_2e$ in 2019, or 3 percent of the 2019 community GHG inventory. Community-generated solid waste emissions are associated primarily with the decomposition of solid waste generated by the city in landfills, while a smaller proportion of emissions are produced by the decomposition of alternative daily cover (ADC) generated by the county. Table 7 summarizes emissions from the solid waste sector. Additional details regarding calculation methods and assumptions are discussed below.

Table 7 2019 City of Rancho Cordova Community Solid Waste Greenhouse Gas Emissions

Source	Quantity (tons/year)	GHG Emissions ($MTCO_2e$/year)
Community-Generated Solid Waste	59,464	22,397

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2021

COMMUNITY-GENERATED SOLID WASTE

CH_4 emissions generated by community-generated solid waste occur from the decay of landfill disposed waste generated annually by residences and businesses in the city. A total of 56,877 tons of landfilled waste was reported for the city in 2019. In addition to landfilled waste, communities send ADC to landfills. ADC is non-earthen material used to cover an active surface of a landfill at the end of each operating day to control for vectors, fires, odors, blowing litter, and scavenging. This material can include compost, construction and demolition waste, sludge, green material, shredded tires, spray-on cement, and fabric. Given that ADC can also include organic material, CH_4 emissions from landfills result from organic decomposition in both waste disposal and ADC. ADC from the city was reported to be 2,587 tons in 2019. Data for landfilled waste and ADC were obtained from CalRecycle (CalRecycle 2021).

The amount of CH_4 released from community-generated waste depends on the LFG management systems of the landfills at which the waste is disposed. Information regarding the use of an LFG capture system was available from EPA's Landfill Methane Outreach Program. All facilities included an LFG capture system; therefore, the default LFG collection efficiency of 0.75 was applied to adjust emissions estimates, as recommended by the Community Protocol. Default waste characterization emissions factors obtained from EPA were used in calculations.

2.2.5 Water Supply

Based on modeling conducted, water supply emissions accounted for approximately 9,071 $MTCO_2e$ in 2019. GHG emissions associated with water supply occur from the indirect use of energy associated with water extraction, conveyance, treatment, and distribution to the point of use (e.g., residences, businesses). Energy consumption for supplying water was estimated by applying energy intensity factors (i.e., the total amount of energy required to produce a unit of water for a particular use) to water supply consumption values. Water supply emissions are estimated by applying electricity emissions factors to water consumption values. Table 8 presents water supply volume and energy consumption, as well as associated GHG emissions for the county in 2019. The methods used are explained in more detail below.

Table 8 2019 City of Rancho Cordova Community Water Supply Greenhouse Gas Emissions

	Quantity	GHG Emissions ($MTCO_2e$/year)
Water Supply (AF)	65,645	9,071

Notes: GHG = greenhouse gas; MGY = million gallons per year; $MTCO_2e$/year = metric tons of carbon dioxide equivalent per year; MWh/year = megawatt-hours per year.

Source: Ascent Environmental 2021

ENERGY INTENSITY FACTOR

An energy intensity factor, regarding water supply emissions, is defined by the amount of energy (e.g., electricity, natural gas) required to produce a unit of water for a particular use. Electricity is the primary source of energy used for water extraction, conveyance, treatment, and distribution in the Central Coast hydrologic region. Other energy sources may include fossil fuel-powered pumps and backup generators at treatment plants, but these sources that may be used were considered negligible. Thus, for purposes of this analysis, energy intensity is based on electricity use only and is expressed as kilowatt-hours per acre-foot (kWh/AF).

In 2015, the CPUC commissioned a study of hydrologic zones in California and their relative energy intensities for water extraction, conveyance, treatment, and distribution. The city is within the Sacramento River hydrologic zone, which has specific energy intensities by supply type (e.g., local surface water, imported deliveries). According to the City's Water Supply Evaluation water in the city is either sourced from surface water, groundwater, recycled water, or wholesale purchases.

ENERGY CONSUMPTION

To estimate water supply emissions, the energy intensity factors discussed above were applied to total water consumption volumes reported by each water supplier. GHG emissions were estimated using electricity emissions factors in 2019 as described in the building energy sector.

2.2.6 Wastewater Treatment

Based on modeling conducted, wastewater generation in 2019 resulted in emissions of approximately 4,540 $MTCO_2e$, one percent of total emissions, primarily from fugitive CH_4. Wastewater emissions were estimated in two components: (1) pumping-related energy for wastewater conveyance from the source to the treatment facility, and (2) wastewater treatment process emissions. Each is discussed separately below. GHG emissions associated with the treatment of wastewater from the city is shown in Table 9.

Table 9 2019 City of Rancho Cordova Wastewater Treatment Greenhouse Gas Emissions

Wastewater Emission Type	GHG Emissions ($MTCO_2e$/year)
Treatment Plants	4,540

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$/year = metric tons of carbon dioxide equivalent per year.

Source: Ascent Environmental 2021

Wastewater Conveyance

SASD and Regional San are the primary agencies responsible for sewer conveyance and wastewater treatment for the city. Emissions associated with wastewater conveyance are directly related to the energy required to convey the wastewater and the volume of water conveyed/pumped. To estimate GHG emissions, a regional wastewater conveyance energy intensity factor was calculated from total pumping energy data within SASD and Regional service area from 2015 and total wastewater treated in 2019. SASD pumping data were provided directly by SASD. Regional San pumping energy and treatment effluent volumes were provided directly by Regional San (pers. Comm. Steve Nebozuk, Regional San. 2016). Effluent volume was apportioned to the City of Cordova's population and the calculated energy intensity factor was applied to obtain total wastewater conveyance-related energy. GHG emissions were estimated using the same emissions factors described for the building sector.

According to the ICLEI Community Protocol, wastewater discharge and treatment energy intensities associated with septic tanks and other on-site systems are assumed negligible. Hauling emissions associated with maintenance of septic tanks are captured in the on-road vehicle sector and not included in this sector.

Wastewater Treatment Process Emissions

Wastewater generated by the city is treated at the Regional San WWTP. Treatment process emissions at the WWTP include electricity consumption for treatment, process N_20, wastewater effluent containing N_2O, and emissions from biogas combustion.

It was assumed that the entire city population is served by the Regional San WWTP. As such, process wastewater emissions may be slightly overestimated as some portion of the city use onsite septic tanks for wastewater treatment.

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