

UNINCORPORATED COUNTY OF MARIN

GREENHOUSE GAS INVENTORY FOR UNINCORPORATED COMMUNITY EMISSIONS FOR THE YEAR 2022

MARCH 2024

PREPARED BY THE

MARIN CLIMATE & ENERGY PARTNERSHIP



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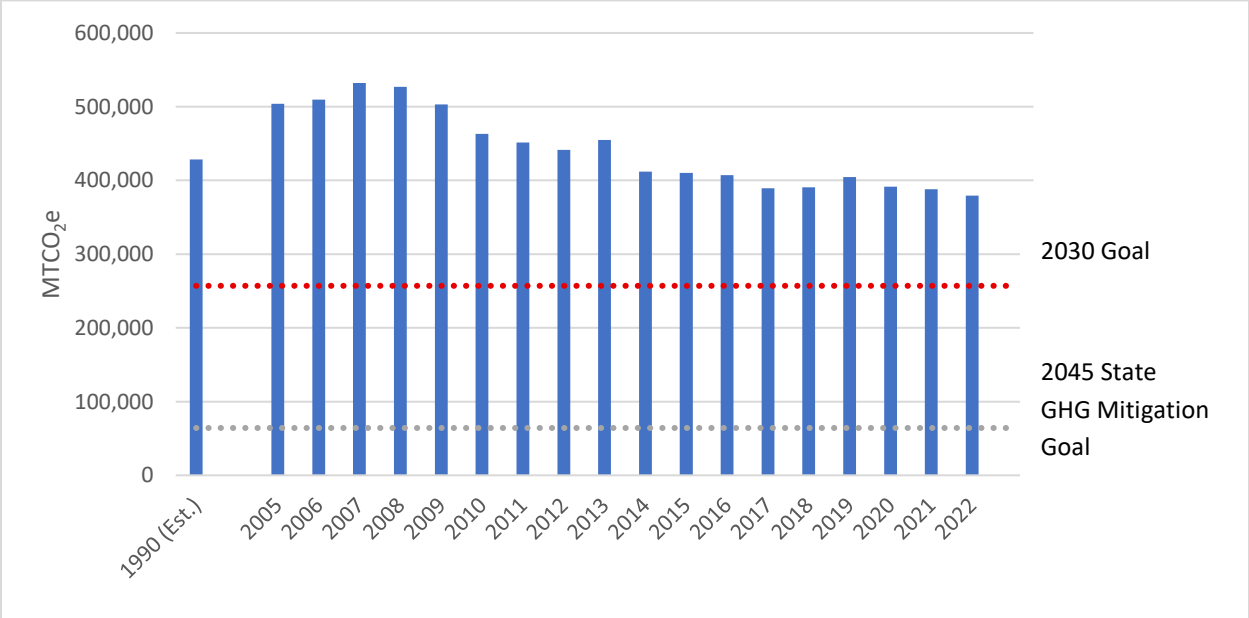
EXECUTIVE SUMMARY

THE TAKEAWAY:
UNINCORPORATED MARIN'S COMMUNITYWIDE EMISSIONS DOWN 25% SINCE 2005, EQUIVALENT TO 11% BELOW 1990 LEVELS.

The County publishes annual community greenhouse gas (GHG) emissions estimates through the Marin Climate & Energy Partnership (MCEP). Annual inventories help the County to monitor its progress in meeting its Climate Action Plan (CAP) goal to reduce community emissions 40% below the 1990 level by 2030 through mitigation measures. The County's CAP goal also establishes targets for reducing emissions 60% below the 2005 level by 2030 through mitigation and sequestration measures. Ultimately, the County's goal is to achieve carbon neutrality by 2045.

This report reviews emissions generated from the unincorporated Marin area ("the County") from 2005 through 2022, the most recent year data is available. The inventory shows that the County has reduced emissions 25% since 2005, which is equivalent to 11% below estimated 1990 levels. Emissions dropped from about 503,952 metric tons carbon dioxide equivalents (MTCO_{2e}) in 2005 to 379,422 MTCO_{2e} in 2022. The community emissions trend and targets are shown below. The County needs to reduce emissions another 122,410 MTCO_{2e} to meet its 2030 mitigation target and another 315,170 MTCO_{2e} to meet the State net zero emissions goal for 2045, which includes a GHG mitigation target of 85% below 1990 levels.

FIGURE 1: UNINCORPORATED COUNTY GREENHOUSE GAS EMISSIONS AND TARGETS



Recognizing the need for a collaborative approach to greenhouse gas reductions, town, city, and county leaders launched the Marin Climate and Energy Partnership (MCEP) in 2007. The County of Marin is a member of MCEP and works with representatives from the Marin cities and towns to address and streamline the implementation of a variety of greenhouse gas reduction measures. Funding for this inventory was provided by the Marin County Energy Watch Partnership, which administers public goods charges collected by PG&E. Community inventories are available on the MCEP website at marinclimate.org and are used to update the [Marin Sustainability Tracker](#).

INTRODUCTION

PURPOSE OF INVENTORY

The objective of this greenhouse gas emissions inventory is to identify the sources and quantify the amounts of greenhouse gas emissions generated by the activities of the unincorporated Marin communities in 2022. This inventory provides a comparison to 2005 emissions and estimated 1990 emissions and identifies the sectors where significant reductions in greenhouse gas emissions have occurred. In some instances, previous year emissions were updated with new data and/or recalculated to ensure the same methodology was employed for all inventory years. In particular, the Metropolitan Transportation Commission released an updated traffic model in 2023, which raised vehicle miles traveled (VMT) estimates after 2015.

GENERAL METHODOLOGY

This inventory uses national standards for the accounting and reporting of greenhouse gas emissions. The [U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, version 1.2 \(July 2019\)](#) was used for the quantification and reporting of community emissions. Quantification methodologies, emission factors, and activity and source data are detailed in the appendix.

Community emissions are categorized according to eight sectors:

- Built Environment - Electricity
- Built Environment – Natural Gas
- Transportation
- Off-Road Vehicles and Equipment
- Waste
- Water
- Wastewater
- Agriculture

CALCULATING EMISSIONS

Emissions are quantified by multiplying the measurable activity data – e.g., kilowatt hours of electricity, therms of natural gas, and gallons of diesel or gasoline – by emissions factors specific to the energy source. Most emissions factors are the same from year to year. Emission factors for electricity, however, change from year to year due to the specific sources that are used to produce electricity. For example, electricity that is produced from coal generates more greenhouse gases than electricity that is generated from natural gas and therefore has a higher emissions factor. Electricity that is produced solely from renewable energy sources such as solar and wind has an emissions factor of zero.

This inventory calculates individual greenhouse gases – e.g., carbon dioxide, methane, and nitrous oxide – and converts each greenhouse gas emission to a standard metric, known as “carbon dioxide equivalents” or CO₂e, to provide an apple-to-apples comparison among the various emissions. Table 1 shows the greenhouse gases identified in this inventory and their global warming potential (GWP), a measure of the amount of warming each gas causes when compared to a similar amount of carbon dioxide. Methane, for example, is 28 times as potent as carbon dioxide over 100 years; therefore, one metric ton of methane is equivalent to 28 metric tons of carbon dioxide. Greenhouse gas emissions are reported in this inventory as metric tons of carbon dioxide equivalents, or MTCO₂e.

TABLE 1: GREENHOUSE GASES

Gas	Chemical Formula	Emission Source	Global Warming Potential
Carbon Dioxide	CO ₂	Combustion of natural gas, gasoline, diesel, and other fuels	1
Methane	CH ₄	Combustion, anaerobic decomposition of organic waste in landfills and wastewater	28
Nitrous Oxide	N ₂ O	Combustion, wastewater treatment	265

Source: IPCC Fifth Assessment Report (2014)

TYPES OF EMISSIONS

Emissions from each of the greenhouse gases can come in a number of forms:

- **Stationary or mobile combustion** resulting from the on-site combustion of fuels (natural gas, diesel, gasoline, etc.) to generate heat or electricity, or to power vehicles and equipment.
- **Purchased electricity** resulting from the generation of power from utilities outside the jurisdictional boundary.
- **Fugitive emissions** resulting from the unintentional release of greenhouse gases into the atmosphere, such as leaked refrigerants and methane from waste decomposition.
- **Process emissions** from physical or chemical processing of a material, such as wastewater treatment.

UNDERSTANDING TOTALS

The totals listed in the tables and discussed in the report are a summation of emissions using available estimation methods. Each inventoried sector may have additional emissions sources associated with them that were unaccounted for due to a lack of data or robust quantification methods. For example, greenhouse gas emissions associated with air travel and the production of goods outside the community's boundary are not included in the inventory. Additionally, the community inventory does not include refrigerants released into the atmosphere from the use of air conditioning in cars and buildings.

COMMUNITY INVENTORY

COMMUNITY INVENTORY SUMMARY

In 2005, the activities taking place in unincorporated Marin County resulted in approximately 503,952 metric tons of CO₂e. In 2022, those activities resulted in approximately 379,422 metric tons of CO₂e, a reduction of 25% from 2005 levels, which is equivalent to 11% below estimated 1990 levels.

The community inventory tracks emissions in seven sectors:

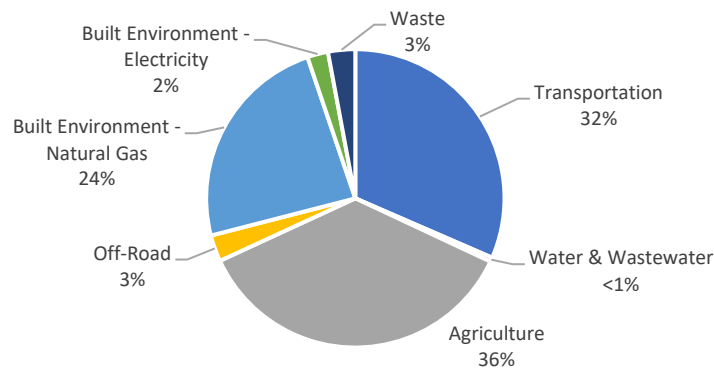
- The **Built Environment – Electricity** sector represents emissions generated from the use of electricity in unincorporated Marin homes and commercial, industrial, and governmental buildings and facilities.
- The **Built Environment – Natural Gas** sector represents emissions generated from the use of natural gas in unincorporated Marin homes and commercial, industrial, and governmental buildings and facilities. Propane used as a primary heating source is also included, although it represents less than 1% of emissions in this sector.
- The **Transportation** sector includes tailpipe emissions from passenger vehicle trips originating and ending in unincorporated Marin areas, as well as a share of tailpipe emissions generated by medium and heavy-duty vehicles and buses travelling on Marin County roads. The sector also includes emissions from Marin Transit and Golden Gate Transit buses and the SMART train as these vehicles travel within the unincorporated area. Electricity used to power electric vehicles is embedded in electricity consumption reported in the Built Environment - Electricity sectors.
- The **Waste** sector represents fugitive methane emissions that are generated over time as organic material decomposes in the landfill. Although most methane is captured or flared off at the landfill, approximately 25% escapes into the atmosphere.
- The **Off-Road** sector represents emissions from the combustion of gasoline and diesel fuel from the operation of off-road vehicles and equipment used for construction and landscape maintenance.
- The **Water** sector represents emissions from energy used to pump, treat, and convey potable water from the water source to unincorporated Marin water users.
- The **Wastewater** sector represents stationary, process and fugitive greenhouse gases that are created during the treatment of wastewater generated by the community, as well as emissions created from electricity used to convey and treat wastewater.
- The **Agriculture** sector includes methane emissions from enteric fermentation and manure decomposition and treatment, and nitrogen oxide emissions from fertilizer application.

Table 2 shows how emissions in each sector have changed since 2005. The greatest reductions have occurred in the Built Environment - Electricity sector (73,034 MTCO₂e), followed by the Transportation sector (22,462 MTCO₂e) and the Built Environment – Natural Gas sector (19,988 MTCO₂e). The likely reasons for the largest emissions decreases are described in the remainder of this report. Figure 2 shows the relative contribution of emissions from these sectors in 2022. Agriculture is the largest sector, representing 36% of community emissions, followed by the Transportation sector (32%) and the Built Environment – Natural Gas sector (24%).

TABLE 2: EMISSIONS SUMMARY BY SECTOR (MTCO₂E), 2005 THROUGH 2022

Year	Built Environment - Electricity	Built Environment - Natural Gas	Transportation	Waste	Water	Wastewater	Off-Road	Agriculture	Total	% Change from 2005
2005	81,581	110,354	142,015	22,779	2,743	2,677	12,958	128,845	503,952	
2006	75,494	110,774	142,896	22,447	2,488	2,620	13,235	139,634	509,588	1%
2007	105,848	108,837	144,732	20,061	2,824	2,949	14,356	132,541	532,148	6%
2008	112,719	107,759	141,723	16,677	2,732	2,989	13,079	129,096	526,775	5%
2009	104,606	106,059	140,675	14,364	2,775	2,800	12,163	119,528	502,969	0%
2010	71,508	107,735	130,514	14,027	1,513	2,399	11,658	123,860	463,212	-8%
2011	64,592	109,730	130,257	13,752	1,102	2,429	11,532	118,147	451,540	-10%
2012	66,567	103,369	131,422	14,119	1,143	2,478	11,449	110,834	441,380	-12%
2013	61,456	103,192	131,542	14,191	1,312	2,475	11,396	129,132	454,696	-10%
2014	53,725	85,330	129,898	14,356	1,201	2,343	11,363	113,862	412,078	-18%
2015	51,645	85,417	128,734	14,888	946	2,316	11,321	114,823	410,092	-19%
2016	41,663	90,601	125,307	17,424	710	2,203	11,257	117,950	407,116	-19%
2017	20,579	92,996	125,322	18,228	232	1,977	11,181	118,665	389,179	-23%
2018	22,151	92,427	124,395	16,195	10	1,929	11,070	122,371	390,547	-23%
2019	21,741	94,754	124,201	15,451	15	1,790	10,870	135,585	404,407	-20%
2020	14,638	94,190	122,915	14,331	6	1,802	10,642	132,858	391,381	-22%
2021	12,760	93,630	121,750	11,575	6	1,768	10,753	135,783	388,023	-23%
2022	8,546	90,366	119,553	11,177	3	1,748	10,867	137,159	379,422	-25%
Change from 2005	-73,034	-19,988	-22,462	-11,602	-2,739	-928	-2,091	8,314	-124,530	
% Change from 2005	-90%	-18%	-16%	-51%	-100%	-35%	-16%	6%	-25%	

FIGURE 2: EMISSIONS BY SECTOR, 2022

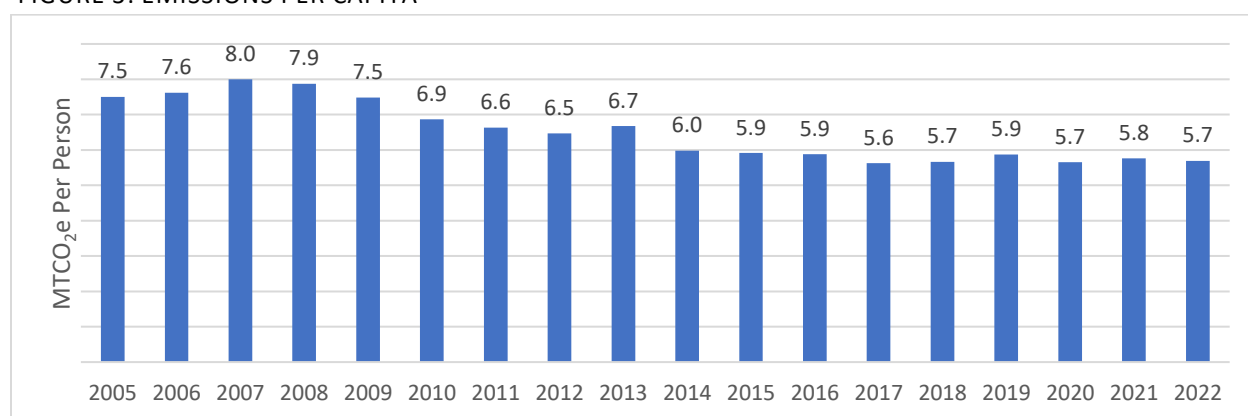


PER CAPITA EMISSIONS

Per capita emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing one community's emissions with neighboring cities and against regional and national averages. That said, due to differences in emission inventory methods, it can be difficult to produce directly comparable per capita emissions numbers. Per capita emission rates may be compared among Marin jurisdictions, although some jurisdictions may have higher rates due to the presence of commercial and industrial uses.

Dividing the total communitywide GHG emissions by residents yields a result of 7.5 metric tons CO₂e per capita in 2005. Per capita emissions decreased 24% between 2005 and 2022, falling to 5.7 metric tons per person. Figure 3 shows the trend in per capita emissions over time. It is important to understand that this number is not the same as the carbon footprint of the average individual living in Marin, which would include lifecycle emissions, emissions resulting from air travel, the manufacturing and distribution of products and food, etc.

FIGURE 3: EMISSIONS PER CAPITA



SECTOR SPOTLIGHTS

The following sections provide a year-by-year analysis of the changes in GHG emissions from some highlighted sectors: electricity, natural gas, transportation, waste, water use, and agriculture. Whenever possible, each section discusses the change in emissions from previous years and the likely influence of state and local programs or policies and external factors on reducing emissions.

BUILT ENVIRONMENT - ELECTRICITY

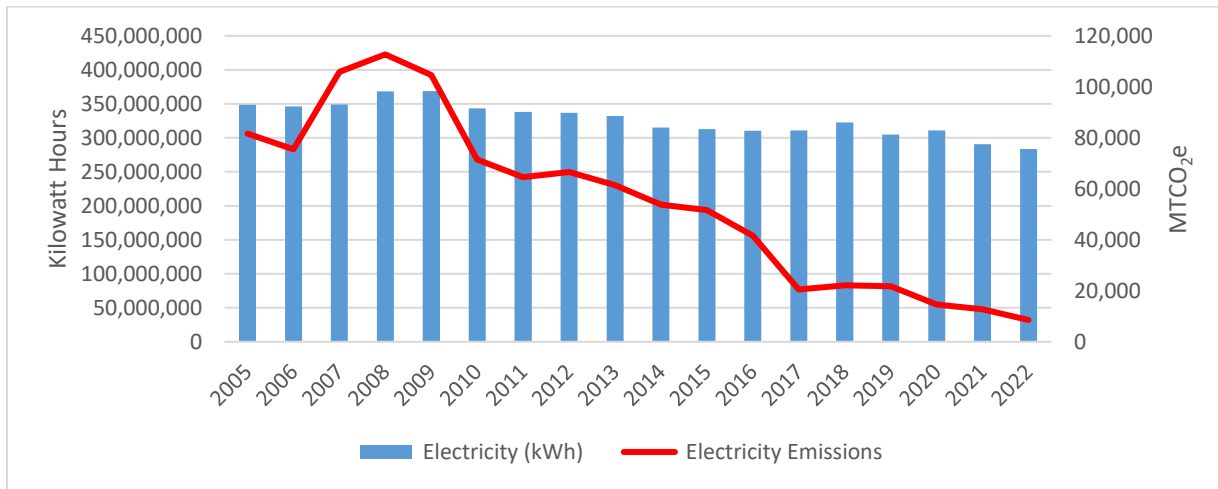
Purchased electricity use in homes and businesses in unincorporated Marin decreased about 19% between 2005 and 2022. Greenhouse gas emissions from electricity consumption decreased 90% since 2005, as shown in Figure 4. This is primarily due to the lower carbon intensity of electricity. PG&E has been steadily increasing the amount of renewable energy in its electricity mix. In 2022, PG&E electricity came from a mix of renewable (38%), large hydroelectric (8%), nuclear (49%), and natural gas (5%) energy sources and was 95% GHG-free.¹ MCE Light Green electricity came primarily from renewable (60%) and hydroelectric (40%) sources and was 95% GHG-free.² In 2022,

¹ PG&E 2022 Power Content Label, <https://www.pge.com/content/dam/pge/docs/account/billing-and-assistance/power-content-label.pdf>. Nuclear and large hydro sources are considered GHG-free.

² MCE 2022 Power Content Label, <https://www.mcecleanenergy.org/energy-suppliers/>.

about 4.7% of MCE electricity purchased by unincorporated Marin customers was 100% renewable Deep Green electricity. The County also purchases Deep Green for its government operations.

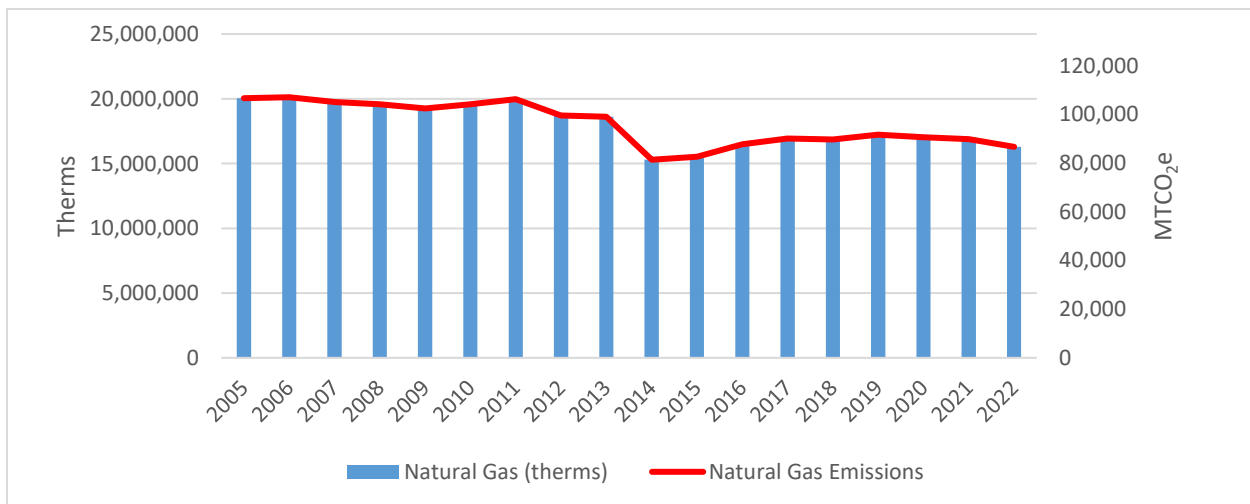
FIGURE 4: ELECTRICITY CONSUMPTION AND EMISSIONS



BUILT ENVIRONMENT - NATURAL GAS

Natural gas is used in residential and commercial buildings to provide space and water heating and power appliances. Use of natural gas is highly variable typically depending on the weather conditions. This variability has led natural gas use consumption in unincorporated Marin to fluctuate from year to year, from a high of 20.0 million therms in 2005 to a low of 15.3 million therms in 2014. Reduction in energy use may also be attributed to energy efficiency programs and rebates, the County’s green building ordinances, and State building codes. Natural gas consumption declined 4% between 2020 and 2022 and was 19% below the 2005 level in 2022. Unlike electricity emissions which reflect the power content mix, natural gas emissions track the amount of natural gas consumed (Figure 5). The County’s Climate Action Plan’s target is to reduce natural gas consumption and emissions 36% below the 2005 level by 2030.

FIGURE 5: NATURAL GAS CONSUMPTION AND EMISSIONS



TRANSPORTATION

Transportation activities accounted for approximately 32% of unincorporated Marin’s emissions in 2022. According to the transportation model and annual data the County uses to calculate passenger and commercial vehicle miles, vehicle miles traveled (VMT) have increased approximately 6% since 2005.

On-road transportation emissions decreased 16% due to more fuel-efficient and alternatively fueled vehicles (Figure 6). As shown in Figure 7, most transportation emissions come from passenger vehicles, accounting for 83% of transportation emissions in 2022. Marin County continues to be a leader in zero emission vehicles (ZEVs) – second only to Santa Clara County – with 15,449 ZEVs in Marin at the end of 2022, or about 7.5% of registered automobiles. ZEVs include battery electric cars, plug-in hybrid electric cars, hydrogen fuel cell cars, and zero-emission motorcycles. The County’s Climate Action Plan targets 45% of passenger vehicles registered in Marin to be ZEVs by 2030 and a 58% reduction in transportation emissions.

FIGURE 6: VEHICLE MILES TRAVELED AND TRANSPORTATION EMISSIONS

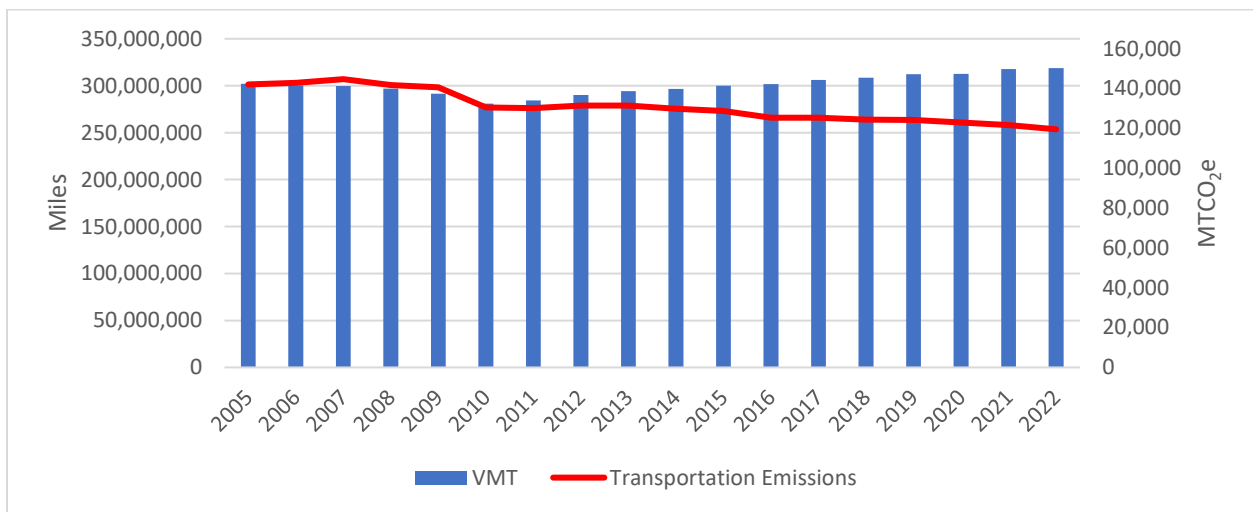
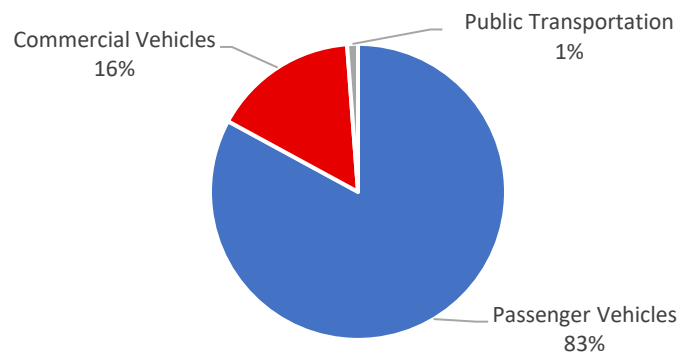


FIGURE 7: TRANSPORTATION EMISSIONS BY VEHICLE CATEGORY, 2022

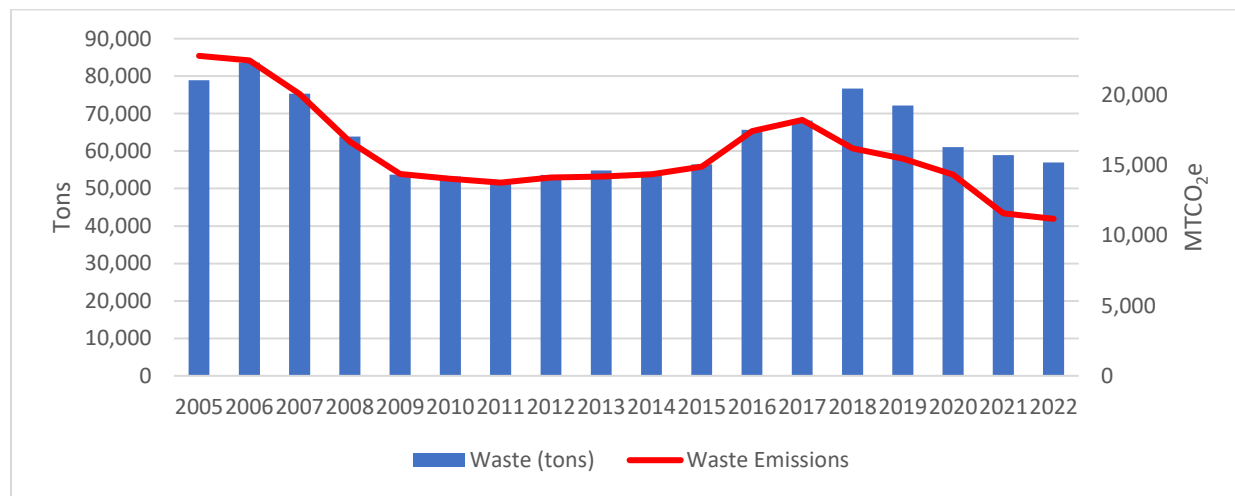


While it is difficult to pinpoint exactly how each land use and transportation policy affects emissions, the County has undertaken many efforts to reduce transportation emissions. The County encourages workforce housing and has made it easier for residents to use carbon-free modes of transportation, such as bicycling and walking, through improvements to the transportation network.

WASTE

Waste generated by the community decreased 3% between 2021 and 2022 and was 28% below the 2005 level by 2022 as shown in Figure 8 (based on countywide disposal data). Total landfilled waste includes alternative daily cover.³ Emissions from waste disposal decreased 51% due to the lower organic content of landfilled waste (based on statewide waste characterization studies) and material used for alternative daily cover. The Climate Action Plan’s target is to reduce waste disposal emissions 70% below the 2005 level by 2030.

FIGURE 8: DISPOSED WASTE AND EMISSIONS



WATER

The Marin Municipal Water District (Marin Water) and the North Marin Water District (NMWD) serve most of the water customers in unincorporated Marin. Water consumption decreased 3% between 2021 and 2022 and was 32% below the 2005 level in 2022. Emissions, which are based on an estimate of energy used to pump, treat, and convey water from the water source to communities, dropped nearly 100% between 2005 and 2022 due to water agencies’ use of carbon-free electricity. Marin Water purchases MCE Deep Green for its electricity needs, and the Sonoma County Water Agency, which supplies approximately 25% of Marin Water’s water, uses renewable and carbon-free sources for its electricity.

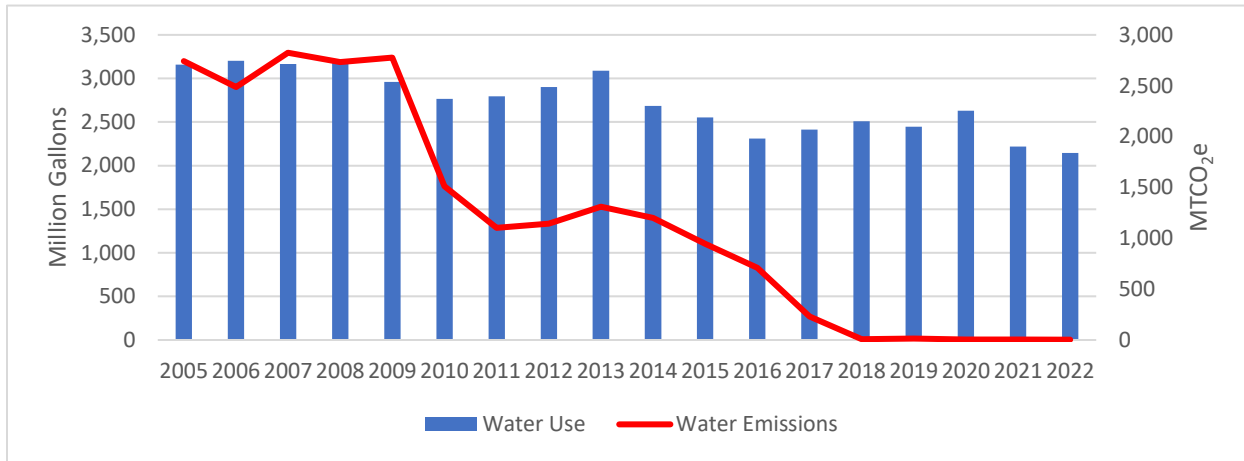
Marin Water and NMWD provide rebates and programs to reduce water use. MMWD provides rebates to replace fixtures with high-efficiency clothes washers and to purchase cisterns and rain barrels. MMWD also provides free home and landscape water-use evaluations as well as free high-efficiency showerheads and faucet aerators.

NMWD provides rebates and programs to reduce water use. Rebates are available to replace lawns with low water use planting and for the purchase and installation of mulch. NMWD also provides rebates for pool covers, rainwater

³ Alternative daily cover is material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging.

catchment, greywater systems, weather-based irrigation controllers, and replacement of washing machines and toilets with high-efficiency fixtures. NMWD provides free home and landscape water-use evaluations.

FIGURE 9: WATER USE AND EMISSIONS



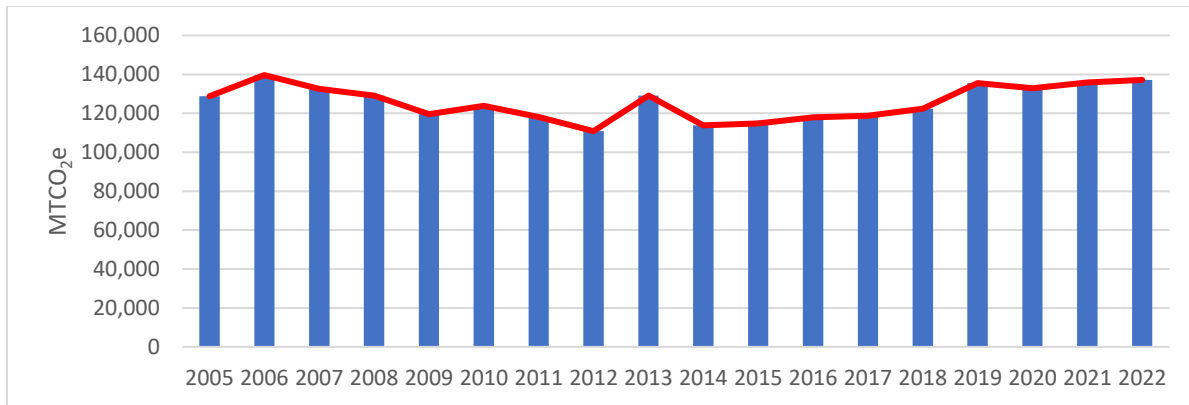
The County’s Climate Action Plan’s goal is to reduce annual water consumption 31% below the 2005 level to 2,192 million gallons, an amount achieved in 2022.

AGRICULTURE

Of all the local CAPs in Marin, the unincorporated County’s is the only one to include emissions from agriculture. 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). Agricultural emissions have increased 6% since 2005. (Figure 10). Emissions from enteric fermentation and the management of manure make up the biggest share and hence drive agricultural emissions. Emissions reductions from carbon sequestration, which are quantified in the CAP, are not balanced against agricultural emissions here.

Certain agricultural variables, such as composition of feed for cattle or chickens, can significantly alter livestock emissions factors. Detailed data on how feed proportions have changed since 2012 and was not collected for the GHG assessment. As a proxy, emission factors used in the 2012 inventory are used for all inventory years. As a result, emissions are dependent upon livestock counts and acreage under agricultural production. Livestock counts can vary significantly from year to year, and some are estimated due to privacy concerns.

FIGURE 10: AGRICULTURE EMISSIONS



Marin County’s climate action ambitions not only seek to reduce, but also mitigate GHG emissions by using its agricultural resources to sequester carbon into soils and plant material. The [County’s 2020 CAP](#) details this strategy, AG-C1: Carbon Farming. The 2020 CAP estimated the full carbon sequestration potential of Marin’s agriculture and working lands (e.g., 60 farms and ranches across 30,000 acres) to reach an annual total of 55,752 MTCO₂e by 2030. However, the ability to confirm and track implemented projects against this potential remains challenging.

Recently, the Marin Resource Conservation District (RCD) used established methodology to estimate carbon sequestered on projects verified through carbon farm plans⁴ as implemented through RCDs programs⁵. From 2014 to 2022, RCD evaluated 20 farm and ranch plans across approximately 9,000 acres of which 5,394 acres and 29,231 linear feet of practices were implemented (Table 3). RCD calculated, as of present day, an average of 4,439 metric tons of CO₂ equivalents per year was sequestered from practices implemented.

Once fully implemented, these 20 plans can sequester approximately 25,007 metric tons of CO₂e per year. Currently, seven new plans are underway in Marin County, covering an additional 4,300 acres of agricultural land.

⁴ Carbon farm plans are practices that farmers and ranchers can implement to sequester C on their working lands. These practices include Conservation Cover, Residue and Tillage Management (no-till) • Critical Area Planting, Filter Strip Compost Application, Nutrient Management, Forage Biomass Planting Prescribed Grazing, Range Planting, Riparian Forest Buffer, Riparian Restoration, Tree & Shrub Establishment, Silvopasture Establishment, and Windbreak/Shelterbelt Establishment. For more information on carbon farming see <https://www.carboncycle.org/what-is-carbon-farming/>

⁵ RCD accounts for public lands. It does not account for private lands or carbon farm plan projects applied through the USDA Natural Resource Conservation Service (NRCS) or California Department of Food and Agriculture’s (CDFAs) Healthy Soils program.

TABLE 3. ANNUAL CARBON SEQUESTERED ACROSS BY CARBON FARM PRACTICES FROM 2014 TO 2022

Carbon Farm Practice	Area Implemented to Date (2014-2022)	Units	Annual C Sequestered (mtCO2e)
Compost Application	859	Acres	3,822
Conservation Cover	1	Acres	0
Critical Area Planting	2	Acres	3
Filter Strip	0	Acres	0
Forage Biomass Planting	458	Acres	163
Hedgerow Planting	13,791	Linear Feet	26
Prescribed Grazing	3,773	Acres	118
Range Planting	255	Acres	128
Riparian Forest Buffer	18	Acres	31
Riparian Restoration	1	Acres	1
Silvopasture Establishment	24	Acres	33
Tree & Shrub Establishment	5	Acres	85
Windbreak/Shelterbelt Establishment	15,440	Linear Feet	29
Total Acreage	5,394	Acres	4,439

Moving forward the County of Marin and Marin RCD will continue to estimate annual carbon sequestered as data becomes available and methodology improves. The County and RCD will also support the improvement of tracking carbon sequestered from carbon farm plan projects implemented across the County. This will likely include measuring carbon sequestered from Natural Resource Conservation Service’s (NRCS) and California Department of Farming and Agriculture (CDFA) programs as well as projects implemented on private land.

APPENDIX: COMMUNITY INVENTORY DETAIL

Community GHG Emissions Summary Table

Jurisdiction: Unincorporated County of Marin

Inventory Year: 2022

Population: 66,644 (CA Department of Finance)

Number of Households: 26,205 (CA Department of Finance)

Date Prepared: February 23, 2024

Reporting Framework: Communitywide Activities

ID	Emissions Type	Source or Activity	Included, Required Activities	Included, Optional Activities	Excluded (IE, NA, NO or NE)	Notes	Emissions (MTCO ₂ e)
1.0	Built Environment						
1.1	Use of fuel in residential and commercial stationary combustion equipment	Both	•				90,366
1.2	Industrial stationary sources	Source			NE		
1.3	Power generation in the community	Source			NO		
1.4	Use of electricity in the community	Activity	•			Includes transmission and distribution losses	8,546
1.5	District heating/cooling facilities in the community	Source			NE		
1.6	Use of district heating/cooling facilities in the community	Activity			NE		
1.7	Industrial process emissions in the community	Source			NO		
1.8	Refrigerant leakage in the community	Source			NE		
2.0	Transportation and Other Mobile Sources						
2.1	On-road passenger vehicles operating within the community boundary	Source			IE	Obtained data for preferred activity-based method instead	
2.2	On-road passenger vehicles associated with community land uses	Activity	•				98,866
2.3	On-road freight and service vehicles operating within the community boundary	Source			IE	Obtained data for preferred activity-based method instead	
2.4	On-road freight and service vehicles associated with community land uses	Activity	•				18,950
2.5	On-road transit vehicles associated with community land uses	Activity		•			1,412
2.6	Transit rail vehicles operating with the community boundary	Source			NO		326
2.7	Use of transit rail travel by the community	Activity			NE		
2.8	Inter-city passenger rail vehicles operating within the community boundary	Source			NO		
2.9	Freight rail vehicles operating within the community boundary	Source			NO		
2.10	Marine vessels operating within the community boundary	Source			NE		

2.11	Use of ferries by the community	Activity			NE		
2.12	Off-road surface vehicles and other mobile equipment operating within the community boundary	Source		•			10,867
2.13	Use of air travel by the community	Activity			NE		
3.0	Solid Waste						
3.1	Operation of solid waste disposal facilities in the community	Source			NE		
3.2	Generation and disposal of solid waste by the community	Activity	•			Includes alternative daily cover	11,177
4.0	Water and Wastewater						
4.1	Operation of water delivery facilities in the community	Source			IE	Energy use is included in 1.1 and 1.4.	
4.2	Use of energy associated with use of potable water by the community	Activity	•				16
4.3	Use of energy associated with generation of wastewater by the community	Activity	•				3
4.4	Process emissions from operation of wastewater treatment facilities located in the community	Source			NE		
4.5	Process emissions associated with generation of wastewater by the community	Activity	•				841
4.6	Use of septic systems in the community	Source			NE		908
5.0	Agriculture						
5.1	Domesticated animal production	Source		•			73,742
5.2	Manure decomposition and treatment	Source		•			63,131
6.0	Upstream Impacts of Communitywide Activities						
6.1	Upstream impacts of fuels used in stationary applications by the community	Activity			NE		
6.2	Upstream and transmission and distribution (T&D) impacts of purchased electricity used by the community	Activity			IE	Transmission and distribution losses included in 1.4.	
6.3	Upstream impacts of fuels used by water and wastewater facilities for water used and wastewater generated within the community boundary	Activity			IE	Included in 4.2 and 4.3.	
6.4	Upstream impacts of select materials (concrete, food, paper, carpets, etc.) used by the whole community.	Activity			NE		

Legend

IE – Included Elsewhere: Emissions for this activity are estimated and presented in another category of the inventory. The category where these emissions are included should be noted in the explanation.

NE – Not Estimated: Emissions occur but have not been estimate or reported (e.g., data unavailable, effort required not justifiable).

NA – Not Applicable: The activity occurs but does not cause emissions; explanation should be provided.

NO – Not Occurring: The source or activity does not occur or exist within the community.

Community Emissions Data Sources and Calculation Methodologies

Sector/ID	Emissions Source	Source and/or Activity Data	Emission Factor and Methodology
1.0 Built Environment			
1.1 Stationary Combustion	Stationary Combustion (CO ₂ , CH ₄ & N ₂ O)	Known and estimated fuel use (meter readings by PG&E) and estimated fuel use (American Community Survey 5-Year Estimates, and U.S. Energy Information Administration Household Site Fuel Consumption data). Industrial natural gas consumption estimated from 2016 data.	Default CO ₂ , CH ₄ & N ₂ O emission factors by fuel type (U.S. Community Protocol v. 1.1 Tables B.1 and B.3). U.S. Community Protocol v. 1.1, Appendix C, Method BE.1.1 and BE.1.2.
1.4 Electricity Use	Electricity Use (CO ₂ , CH ₄ & N ₂ O)	Estimated and known electricity use (meter readings by PG&E and MCE) and estimated direct access electricity consumption.	Verified utility-specific emission factors (PG&E and MCE) and eGrid subregion default emission factors. U.S. Community Protocol v. 1.1, Appendix C, Method BE.2.1.
	Electric Power Transmission and Distribution Losses (CO ₂ , CH ₄ & N ₂ O)	Estimated electricity grid loss for Western region from eGrid.	U.S. Community Protocol v. 1.1, Appendix C, Method BE.4.1.
2.0 Transportation and Other Mobile Sources			
2.2 On-Road Passenger Vehicle Operation	On-Road Mobile Combustion (CO ₂)	Estimated passenger vehicle miles traveled associated with origin and destination land uses (Metropolitan Transportation Commission, CAPVMT Data Portal 2.0 (mtcanalytics.org)).	CO ₂ for on-road passenger vehicles quantified in the EMFAC2021 v.1.0.2 model. Passenger vehicle emissions calculated according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.1.A.
	On-Road Mobile Combustion (CH ₄ & N ₂ O)	Estimated vehicle miles traveled associated with origin and destination land uses (Metropolitan Transportation Commission, CAPVMT Data Portal 2.0 (mtcanalytics.org)).	CH ₄ and N ₂ O for on-road passenger vehicles quantified in the EMFAC2021 v.1.0.2 model. Passenger vehicle emissions calculated according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.1.A.
2.4 On-Road Freight and Service Truck Freight Operation	On-Road Mobile Combustion (CO ₂)	Estimated commercial vehicle miles traveled within the boundary (Metropolitan Transportation Commission utilizing Plan Bay Area 2050).	CO ₂ for on-road commercial vehicles quantified in the EMFAC2021 v.1.0.2 model. Emissions allocated utilizing LEHD data according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.2.A.
	On-Road Mobile Combustion (CH ₄ & N ₂ O)	Estimated commercial vehicle miles traveled within the boundary (Metropolitan Transportation Commission utilizing Plan Bay Area 2050).	CH ₄ and N ₂ O for on-road commercial vehicles quantified in the EMFAC2021 v.1.0.2 model. Emissions allocated utilizing LEHD data according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.2.A.
2.5 On-Road Transit Operation	On-Road Mobile Combustion (CO ₂)	Estimated vehicle miles traveled within the boundary (Marin Transit and Golden Gate Transit) and estimated diesel fuel efficiency for transit fleet (Golden Gate Transit). Fuel type provided by Marin Transit and Golden Gate Transit.	Renewable diesel emission factor provided by NEXGEN . U.S. Community Protocol v. 1.1, Appendix D, Method TR.4.A.
	On-Road Mobile Combustion (CH ₄ & N ₂ O)	Estimated vehicle miles traveled within the boundary (Marin Transit and Golden Gate Transit) and estimated diesel fuel efficiency for transit fleet (Golden Gate Transit). Fuel type provided by Marin Transit and Golden Gate Transit.	Renewable diesel emission factor provided by NEXGEN . U.S. Community Protocol v. 1.1, Appendix D, Method TR.4.B.
2.6 Passenger Rail	Mobile Combustion (CO ₂ , CH ₄ & N ₂ O)	Estimated train-miles by multiplying the number of train cars per day (in both directions, according to the SMART published	U.S. Community Protocol v. 1.1, Appendix D, Method TR.5. Emission factors from Equation TR.5.2.

		schedule) by the railway track mileage located within the community boundary (Marin Map). Average Diesel Multiple Unit fuel efficiency provided by SMART.	
2.12 Off-Road Vehicles and Equipment	Off-Road Mobile Combustion (CO ₂)	Estimated fuel use from OFFROAD 2021 v.1.0.1 for Lawn and Garden and Construction and Agriculture equipment. Lawn and Garden and Construction categories are allocated by share of countywide households. Prior to 2018, OFFROAD2021 only includes diesel ag equipment over 25 horsepower. Prior years were adjusted by adding the difference between 2017 and 2018 to years 2005-2017.	CO ₂ emissions calculated according U.S. Community Protocol v. 1.1, Appendix D, Method TR.8. Emission factors provided in Table TR.1.6.
	Off-Road Mobile Combustion (CH ₄ & N ₂ O)	Estimated fuel use from OFFROAD 2021 v.1.0.1 for Lawn and Garden and Construction and Agriculture equipment. Lawn and Garden and Construction categories are allocated by share of countywide households. Prior to 2018, OFFROAD2021 only includes diesel ag equipment over 25 horsepower. Prior years were adjusted by adding the difference between 2017 and 2018 to years 2005-2017.	CH ₄ and N ₂ O emissions calculated according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.8. Emission factors provided in the Local Government Operations Protocol Table G.11 and G.14.
3.0 Solid Waste			
3.2 Solid Waste Generation and Disposal	Fugitive Emissions from Landfilled Waste (CH ₄)	Estimated landfilled tons based on reporting to CalRecycle by Marin County Solid and Hazardous Waste JPA and allocated to jurisdiction based on share of countywide population. Waste characterization based on the Statewide Waste Characterization Study (2008, 2014, 2018, and 2021) and Alternative Daily Cover by Jurisdiction of Origin and Material Type as reported to CalRecycle.	Emission factors calculated utilizing U.S. Community Protocol for Accounting and Report of Greenhouse Gas Emissions, Version 1.1, July 2013, Appendix E, Method SW.4.
4.0 Water and Wastewater			
4.2 Water Supply & Conveyance, Treatment and Distribution	Electricity Use (CO ₂)	Water consumption (district-wide gpcd) and electricity usage provided by Marin Municipal Water District (MMWD) and North Marin Water District (NMWD). Water consumption for Stinson Beach Water District estimated based on 2012 inventory. Electricity use for Stinson Beach Water District estimated using CEC report, "Refining Estimates of Water-Related Energy Use in California," 2006. Assumed 3,500 kWh /MG. Sonoma County Water Agency (SCWA) water delivery amount provided by SCWA .	Verified utility-specific emission factors (PG&E, MCE and SCWA). Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.14.
	Electricity Use (CH ₄ & N ₂ O)	Water consumption (district-wide gpcd) and electricity usage provided by Marin Municipal Water District (MMWD) and North Marin Water District (NMWD). Water consumption for Stinson Beach Water District estimated based on 2012 inventory. Electricity use for Stinson Beach Water District estimated using CEC report, "Refining Estimates of Water-	eGrid subregion default emission factors. Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.14.

		Related Energy Use in California," 2006. Assumed 3,500 kWh /MG.	
4.5 Treatment of Wastewater	Stationary Emissions from Combustion of Digester Gas (CH ₄)	Known amount of digester gas produced per day and known percent of methane in digester gas provided by Sewerage Agency of Southern Marin (SASM), Central Marin Sanitation Agency, Sausalito-Marín City Sanitation Agency, and Novato Sanitary District. Known amount of digester gas produced per day (2016) and known percent of methane in digester gas (2017) provided by Las Gallinas Valley Sanitary District. Estimated service population and percent of methane in digester gas provided by Sanitary District No. 5.	SASM emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.1.a. Sanitary District No.5 emissions calculated according to Method WW.1.(alt).
	Stationary Emissions from Combustion of Digester Gas (N ₂ O)	Known amount of digester gas produced per day and known percent of methane in digester gas provided by Sewerage Agency of Southern Marin (SASM), Central Marin Sanitation Agency, Sausalito-Marín City Sanitation Agency, and Novato Sanitary District. Known amount of digester gas produced per day (2016) and known percent of methane in digester gas (2017) provided by Las Gallinas Valley Sanitary District. Estimated service population and percent of methane in digester gas provided by Sanitary District No. 5.	SASM emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.2.a. Sanitary District No.5 emissions calculated according to Method WW.2.(alt).
	Process Emissions from Wastewater Treatment Plant without Nitrification or Denitrification	Estimated population served by wastewater treatment plant provided by SASM and Central Marin Sanitation Agency.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.8.
	Process Emissions from Wastewater Treatment Plant with Nitrification or Denitrification	Estimated population served by wastewater treatment plant provided by Sanitary District No. 5, Las Gallinas Valley Sanitary District, Sausalito-Marín City Sanitation Agency, and Novato Sanitary District.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.7.
	Fugitive Emissions from Effluent Discharge (N ₂ O)	Estimated population served by wastewater treatment plant provided by SASM, Sanitary District No.5, Central Marin Sanitation Agency, Sausalito-Marín City Sanitation Agency, and Novato Sanitary District. Assumed significant industrial or commercial input.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.12(alt).
	Fugitive Emissions from Effluent Discharge (N ₂ O)	Estimated population served by wastewater treatment plant provided by Las Gallinas Valley Sanitary District. Assumed no significant industrial or commercial input.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.12.

5.0 Agriculture			
5.1	Domesticated animal production	Estimated livestock population from the County of Marin Department of Agriculture, Weights and Measures.	Emissions calculated according to 2015 CAP inventory method.
5.2	Manure decomposition and treatment	Estimated livestock population from the County of Marin Department of Agriculture, Weights and Measures.	Emissions calculated according to 2015 CAP inventory method.