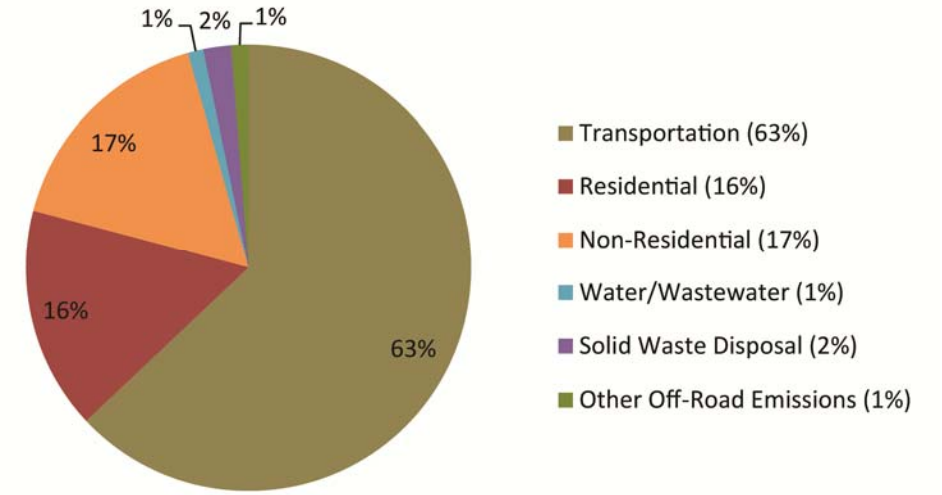
2 EXISTING GREENHOUSE GAS EMISSIONS INVENTORY

This chapter summarizes existing greenhouse gas (GHG) emissions in the City of Vacaville resulting from the following GHG emission-generating sources:

- Transportation
- Residential energy use
- Non-residential energy use
- Moving and treating water/wastewater
- Solid waste disposal
- Other off-road emissions (e.g. from lawnmowers and construction equipment)

Vacaville's baseline, or current, GHG inventory was compiled for the year 2008.[1] Vacaville's average annual communitywide GHG emissions in 2008 were 949,340 metric tons of carbon dioxide equivalent (MTCO2e). (See Chapter 1 for an explanation of carbon dioxide equivalent.) The results of the inventory are shown in Figure 2-1.

FIGURE 2-1 ***GREENHOUSE GAS INVENTORY***



Appendix B provides the technical documentation for this inventory. An explanation of these GHG emission-generating sources and how they were calculated in Vacaville is presented below.

[1] Energy use (purchased electricity and natural gas), water use, and waste disposal fluctuate based on meteorological conditions (e.g. precipitation and temperatures), so it is recommended that a three-year average be used. A three-year average between 2006 and 2008 was obtained for energy use and waste disposal; however, three years of data were unavailable for water use.

TRANSPORTATION EMISSIONS

Cars and trucks release GHGs when they burn gasoline and diesel fuel. Vacaville's emissions from cars and trucks, also called transportation emissions, were calculated based on the trips to and from the homes, schools, shopping centers, office buildings, and other destinations in Vacaville.[2] For the purposes of the Energy and Conservation Action Strategy, transportation emissions include 100 percent of trips that both begin and end within Vacaville. For trips from Vacaville to somewhere else and trips from somewhere else to Vacaville (external-internal trips), only 50 percent of the trip length is included as part of the City's inventory. For trips that pass through Vacaville, such as cars driving from San Francisco to Sacramento on Interstate 80, no emissions are included as part of the City's inventory. Vacaville's total transportation emissions are shown in Table 2-1.

TABLE 2-1 **BASELINE COMMUNITYWIDE GREENHOUSE GAS EMISSIONS FROM TRANSPORTATION SOURCES**

Vehicle Miles Traveled		GHG Emissions
Daily	Annual	MTCO2e /Year
3,075,130	1.067 Billion	598,040

Notes: Daily VMT is multiplied by 347 days/year to account for reduced traffic on weekends and holidays, consistent with the CARB methodology within the *Climate Change Scoping Plan Measure Documentation Supplement*. Emissions are rounded to the nearest tens place. MTCO2e = metric tons of carbon dioxide equivalent.
Source: EMFAC2011.

[2] Vehicle miles traveled (VMT) generated by land uses within the City was compiled by Kittelson & Associates for the City of Vacaville for 2008. GHG emissions from those VMT were compiled by LSA Associates using the California Air Resources Board's (CARB) Emissions Factors 2011 (EMFAC2011) program.

RESIDENTIAL EMISSIONS

"Residential land uses" refers to the single-family houses, apartments, mobile homes, townhouses and other residential units where people live. People's homes generate GHG emissions primarily from electricity and natural gas used for heating and cooking.[3] Pacific Gas and Electric Company (PG&E) provided residential purchased energy use and natural gas use for the years from 2006 to 2008. This data is shown in Table 2-2.

TABLE 2-2 **BASELINE COMMUNITYWIDE GREENHOUSE GAS EMISSIONS FROM RESIDENTIAL LAND USES**

Source	Energy Usage	GHG Emissions MTCO2e /Year
Residential Building Purchased Energy	253,500,590 kWh	66,760
Residential Building Natural Gas	12,966,918 therms	86,450
Total		**153,210**

Notes: Based on the three-year average energy use from 2006 to 2008. Excludes properties owned by another governmental entity that are outside the land use authority of the City of Vacaville (i.e. County or State jurisdiction). Based on PG&E's third-party verified GHG emission factors. Emissions are rounded to the nearest tens place.
kWh = kilowatt hours. A kilowatt hour is a unit of energy equivalent to one kilowatt of power expended for one hour of time. As an example, a small electric heater with one heating element can use 1 kilowatt.
Therms = A unit of heat equivalent to 100,000 British thermal units (BTUs). A BTU is the amount of heat required to raise 1 pound of water (approximately 1 pint), 1 degree Fahrenheit at or close to its point of maximum density.
MTCO2e = metric tons of carbon dioxide equivalent.
Source: PG&E, May 11, 2012, *Community Wide Inventory Report for Cities in Solano County 2003 to 2010.*

[3] GHG emissions are categorized by whether they are human-made (anthropogenic) or part of the natural atmospheric cycle (biogenic). Burning wood is considered a biogenic source of carbon dioxide (a GHG) because the carbon is associated with recently living organic material. Biogenic sources of GHG emissions are not included as part of the communitywide GHG inventory because the release of carbon dioxide simply restores the atmosphere to prior levels. This is consistent with the State GHG emissions inventory, which does not include biogenic sources of GHG emissions.

NON-RESIDENTIAL EMISSIONS

The non-residential category includes GHG emissions associated with commercial, office, and industrial land uses, such as hotels, office buildings, hospitals, gas stations, factories and warehouses. Like homes, non-residential land uses generate GHG emissions primarily from electricity and natural gas used for heating and cooking, as in restaurants. PG&E provided data on non-residential purchased energy use and natural gas use for years from 2006 to 2008, as shown in Table 2-3.

TABLE 2-3 **BASELINE COMMUNITYWIDE GREENHOUSE GAS EMISSIONS FROM NON-RESIDENTIAL LAND USES**

Source	Energy Usage	GHG Emissions MTCO2e /Year
Non-Residential Building Purchased Energy	303,085,739 kWh	79,820
Non-Residential Building Natural Gas	11,485,325 therms	76,570
Total		**156,390**

Notes: Based on the three-year average energy use from 2006 to 2008. Excludes properties owned by another government entity that are outside the land use authority of the City of Vacaville (i.e. County or State jurisdiction). Based on PG&E's third-party verified GHG emission factors. Emissions are rounded to the nearest tens place.
kWh = kilowatt hours. A kilowatt hour is a unit of energy equivalent to one kilowatt of power expended for one hour of time. As an example, a small electric heater with one heating element can use 1 kilowatt.
Therms = A unit of heat equivalent to 100,000 British thermal units (BTUs). A BTU is the amount of heat required to raise 1 pound of water (approximately 1 pint), 1 degree Fahrenheit at or close to its point of maximum density.
MTCO2e = metric tons of carbon dioxide equivalent.
Source: PG&E, May 11, 2012, *Community Wide Inventory Report for cities in Solano County 2003 to 2010.*

WATER/WASTEWATER EMISSIONS

Using water and flushing the toilet results in GHG emissions for two reasons: first, from the electricity required to move and treat potable (drinking) water, and second, from methane and nitrous oxide from sewage that are not captured within the wastewater treatment system. Table 2-4 shows GHG emissions from the city's water use and wastewater (sewage) generation.

Fugitive, or escaping, GHG emissions occur as a result of the wastewater treatment process, which generates emissions of nitrous oxide, a GHG. These are shown in Table 2-4 as Fugitive Emissions. For the purposes of comparison to other emissions sources, these emissions are converted to CO2e.

TABLE 2-4 **BASELINE COMMUNITYWIDE GREENHOUSE GAS EMISSIONS FROM WATER USE AND WASTEWATER TREATMENT**

	Energy (Megawatt Hours/Year)[a]	Energy Emissions (MTCO2e/ Year)[b]	Fugitive Emissions (MTCO2e/ Year)	Total GHG Emissions (MTCO2e/ Year)
Water Use	22,689	5,990	--	5,990
Wastewater Treatment	5,580	4,000[c]	690	4,690
Total	**28,269**	**9,990**	**690**	**10,680**

Notes: Emissions are rounded to the nearest tens place.
[a] Energy associated with water conveyance, treatment, and distribution, and wastewater treatment.
[b] Based on GHG emission factors provided by PG&E, GHG Inventory for Project EIR, Easterly Wastewater Treatment Plant, Ryan Hougham, E.I.T, December 29, 2009, and Vacaville General Plan Update and EIR water demand and wastewater treatment information.
[c] PG&E GHG Inventory for Project EIR, Easterly Wastewater Treatment Plant, Ryan Hougham, E.I.T, December 29, 2009. Treatment Plant is under City ownership, but also treats waste from outside the city. Specifically, there are 2,531 MTCO2e generated from waste from outside of the city, which was added to 1,472 MTCO2e from waste originating inside the city.
MTCO2e = metric tons of carbon dioxide equivalent.

The vast majority of households and businesses in Vacaville are connected to the City's sanitary sewer system.[4] Wastewater connected to the sanitary sewer system in Vacaville is treated at the Easterly Wastewater Treatment Plant (EWWTP). Treated water is discharged as fresh water into Old Alamo Creek.

SOLID WASTE DISPOSAL EMISSIONS

Trash, also referred to as "solid waste," produces a significant amount of methane, a powerful GHG. Most operating landfills in California have installed landfill gas recovery systems as a common way to reduce methane emissions from solid waste disposal. These systems capture the methane gas released from the rotting garbage in the landfill and convert it to a useable energy source. Although solid waste disposal sites produce carbon dioxide from bacteria or biological processes that occur in the landfill, known as biogenic carbon dioxide, these biogenic sources of GHG emissions are not included as part of a communitywide GHG inventory because they are part of a natural process and are not under the City's control.

The California Department of Resources Recycling and Recovery (CalRecycle) maintains a disposal reporting system (DRS) to document waste disposal by jurisdiction and facility; this system was used to access the data needed to identify GHG emissions from garbage generated in Vacaville. The CalRecycle DRS tracks solid waste disposal and "alternative daily cover" (ADC), which is used as a temporary overlay to cover exposed garbage to reduce insects and vermin. Typical ADC materials include green materials, sludge, ash and kiln residue, compost, construction, and demolition debris, and special foams and fabric; these materials contribute to the total solid waste disposal documented for Vacaville.

The US Environmental Protection Agency's (EPA's) Waste Reduction Model (WARM) software (Version 12) was used to calculate average annual GHG emissions from

[4] A small portion of households in the hillsides are on separate septic tank systems. For the purpose of this GHG emissions inventory, all wastewater was modeled as treated wastewater.

communitywide waste disposed in a given year. Pursuant to the Bay Area Air Quality Management District's (BAAQMD) methodology, a three-year average (2006 to 2008) was compiled. According to the CalRecycle DRS, between 2006 and 2008, Vacaville disposed of an average of 105,168 tons of solid waste and 5,864 tons of ADC, for a total disposal of 111,032 tons of solid waste. The vast majority (approximately 99 percent) of solid waste generated by the City is disposed at the Recology Hay Road Landfill, which has an active landfill methane gas collection system.[5] A landfill gas control efficiency of 75 percent was assumed based on the default value recommended by the Local Governments Operations Protocol (LGOP). This means that 75 percent of the landfill GHG emissions are controlled and therefore not released into the atmosphere. However, in reality, most large landfills, such as the Recology Hay Road Landfill, have more efficient tools for controlling GHG emissions, such as clay or geomembrane covers, which have a gas collection efficiency of 85 to 90 percent, respectively.[6] Therefore, GHG emissions estimates for Vacaville from waste disposal are conservative. Table 2-5 shows total GHG emissions from waste disposal for the city.

TABLE 2-5 **BASELINE COMMUNITYWIDE GREENHOUSE GAS EMISSIONS FROM WASTE DISPOSAL**

CO2e Generated (Metric Tons/Year)	Fugitive CO2e Not Captured (Metric Tons/Year)[a]
76,130	19,030

Notes: Biogenic carbon dioxide is not included because the carbon is associated with recently living material, which is part of a natural process and is not under the City's control. Highest emissions occur approximately three years after disposal. An aggregated three years of emissions was used to account for cumulative disposal. Emissions are rounded to the nearest tens place. MTCO2e = metric tons of carbon dioxide equivalent.
[a] Assumes a landfill gas control efficiency of 75 percent based on the LGOP.
Source: US EPA, February 2012, Waste Reduction Model (WARM), Version 12.

OTHER OFF-ROAD EMISSIONS

GHGs are also emitted from landscaping, light commercial and industrial, and construction equipment such as blowers, generators, and bulldozers that burn gas or diesel fuel. These

[5] PG&E, 2012, *Hay Road and Yuba Sutter Landfill Projects, Recology*, http://www.pge.com/myhome/environment/whatyoucando/climatesmart/climatesmartabout/projects/hayroadyubasutterlandfill.shtml, accessed June 8, 2012.

[6] BAAQMD, 2008, *Greenhouse Gas Mitigation Landfill Gas and Industrial, Institutional, and Commercial Boilers, Steam Generators and Process Heaters*, prepared by URS Corporation.

emissions are referred to as "off-road emissions" in this inventory and are summarized in Table 2-6.

TABLE 2-6 **BASELINE COMMUNITYWIDE GREENHOUSE GAS EMISSIONS FROM OTHER OFF-ROAD EMISSIONS**

Source	GHG Emissions (MTCO2e/Year)
Landscaping Equipment	850
Light Commercial and Industrial Equipment	3,050
Construction Equipment	8,100
Total	**11,990**

Notes: Emissions are rounded to the nearest tens place. MTCO2e = metric tons of carbon dioxide equivalent.
Source: Solano Transportation Agency, 2011, *Greenhouse Gas Inventory*.

This category includes GHG emissions from the following types of equipment used within Vacaville:

- Landscaping equipment, including blowers, mowers and other landscaping tools.
- Light commercial and industrial equipment, including generators, pressure washers, welders, and pumps.
- Off-road construction equipment such as bulldozers, cranes, backhoes, and water trucks.

The Solano Transportation Authority (STA) is responsible for countywide transportation planning in Solano County. In 2011, the STA prepared a GHG inventory for the seven cities within the county, including Vacaville. The emissions presented in Table 2-6 are based on the results of the GHG inventory for Solano County for the year 2005 completed by the engineering firm AECOM in May 2011 for STA.[7] AECOM used CARB's OFFROAD2007 modeling software to calculate these stationary sources of emissions on a countywide level.

[7] Solano Transportation Agency, 2011, *Greenhouse Gas Inventory*.

Pursuant to BAAQMD guidance, stationary emissions for the city were estimated based on the percentage of the Solano County inventory that represents Vacaville's GHG emissions.

GHG EMISSION-GENERATING SOURCES NOT INCLUDED

INDUSTRIAL GHG EMISSIONS

Vacaville has several major industrial sources of GHG emissions that are regulated by the Yolo-Solano County Air Quality Management District (YSAQMD). These uses include emergency diesel engines, removing contaminates from soils, energy used for utilities (e.g. electricity and wastewater treatment), and various manufacturing operations that use heating boilers and operate metal coating facilities. Between 2006 and 2008, 37 average annual permits were issued for diesel, propane, and natural gas stationary emissions sources.[8] The GHG emissions from these years are summarized in Table 2-7.

TABLE 2-7 **GHG EMISSIONS FOR INDUSTRIAL STATIONARY SOURCES IN VACAVILLE**

Year	Total GHG Emissions (MTCO2e/Year)
2006	21,080
2007	30,310
2008	25,460
Average	**25,620**

Note: Emissions are rounded to the nearest tens place. MTCO2e = metric tons of carbon dioxide equivalent.
Source: Cassandra Kirkbride, Air Quality Engineering Technician, May 30 2012, *Yolo-Solano Air Quality Management District Data Request*.

Industrial stationary source emissions are presented here for informational purposes, but are not included in the inventory because those emissions are under the jurisdiction of the YSAQMD and not the City of Vacaville.

CARBON STOCK/CARBON SEQUESTRATION

As described in Chapter 1, Vacaville has 2,500 acres of agricultural land. Development of agricultural land can result in the release of nitrous oxide emissions from exposing soil to

[8] Includes sources inside the Vacaville city limits only.

oxygen (i.e. soil oxidation) through activities such as tilling and draining. This also can release carbon dioxide emissions from removal of plant materials that store carbon. The amount of biological material from living or recently living organisms (i.e. biomass) stored in agricultural areas within the city boundary is not a substantial portion of Vacaville's GHG emissions. Therefore, carbon stock from agricultural biomass is not included in this GHG emissions inventory.

If future projects result in the removal of a significant amount of plants that is not planned for in the General Plan, then the net loss of biomass should be accounted for in the project's GHG emissions inventory. However, future projects that are consistent with the General Plan and this Energy and Conservation Action Strategy would not be required to account for removal of biomass in the project's inventory; only projects that are not consistent with the General Plan (e.g. development in an area that the General Plan designates as open space) would be required to account for biomass removal.

MUNICIPAL EMISSIONS

Emissions from City government operations, such as the electricity used in City office buildings, or gas burned by Vacaville Police Department cars, are a very small percentage of the overall emissions within the city limits of Vacaville. Therefore, the focus of this Energy and Conservation Action Strategy is on the communitywide GHG emissions and on measures to reduce those communitywide emissions. While this Strategy includes measures that the City will implement in order to reduce the emissions from its municipal operations, those reductions will not significantly affect the overall amount of GHGs emitted in Vacaville. Additionally, the GHG emissions reductions from changes to City government operations are too small to quantify accurately. Because the reductions from municipal measures were not quantified, the baseline municipal GHG emissions were not quantified as part of this inventory.[9]

[9] However, a municipal inventory was prepared separately by AECOM as part of a countywide effort led by STA.