Appendix A: GHG Inventory

This appendix provides a description of existing and future projected greenhouse gas (GHG) emissions in Citrus Heights.

Citrus Heights Greenhouse Gas Emissions Inventory

A GHG emissions inventory was conducted for each incorporated city in Sacramento County, including the City of Citrus Heights, and the unincorporated area of Sacramento County (County) for the year 2005. The inventory estimated that communitywide GHG emissions in Citrus Heights totaled approximately 578,134 metric tons of carbon dioxide equivalent (CO_2e) emissions in 2005. Citrus Heights contributed approximately 4.2% of the GHG emissions generated in Sacramento County. On-road transportation emissions composed 42.8% of communitywide GHG emissions, followed by 27.7% from residential sources, and 10.8% from commercial/industrial sources (ICF Jones & Stokes 2009).

The inventory includes communitywide (i.e., those emissions attributable to all sources in Citrus Heights) and government-related operations (i.e., those emissions directly attributable to the City government operations). The GHG emissions associated with government operations are a subset of the total community-wide emissions. There is no available adopted or widely accepted methodology for evaluating GHG emissions from land use development. In the case of the City's inventory, GHG emissions associated with energy, transportation and waste (i.e., solid waste and wastewater), were modeled using the ICLEI-Local Governments for Sustainability Clean Air and Climate Protection (CACP) software, and other calculation methodologies that involved scaling of the statewide GHG emissions inventory prepared by the California Air Resources Board (ARB).

Community-wide Inventory

The purpose of the GHG emissions inventory is to assist policy makers and planners to identify the current emission sources, the relative contribution from each source, and the overall magnitude of the City's GHG emissions. This aids in development of more specific and effective policies and emissions control strategies to reduce GHG emissions consistent with State mandates (i.e., AB 32). The GHG emissions inventory is divided into the following GHG emission sectors: residential, commercial/industrial, industrial specific, on-road mobile sources, off-road mobile sources, waste, wastewater treatment, water-related, agriculture, and high GWP GHGs. All GHG emissions were presented in units of metric tons (MT) CO_2e/yr, which allows emissions of other GHGs such as CH_4 and N_2O to be normalized to a single unit of measure that accounts for GWP. Table A-1 and Figure A-1 summarize the 2005 GHG emissions inventory.

Government Operations Inventory

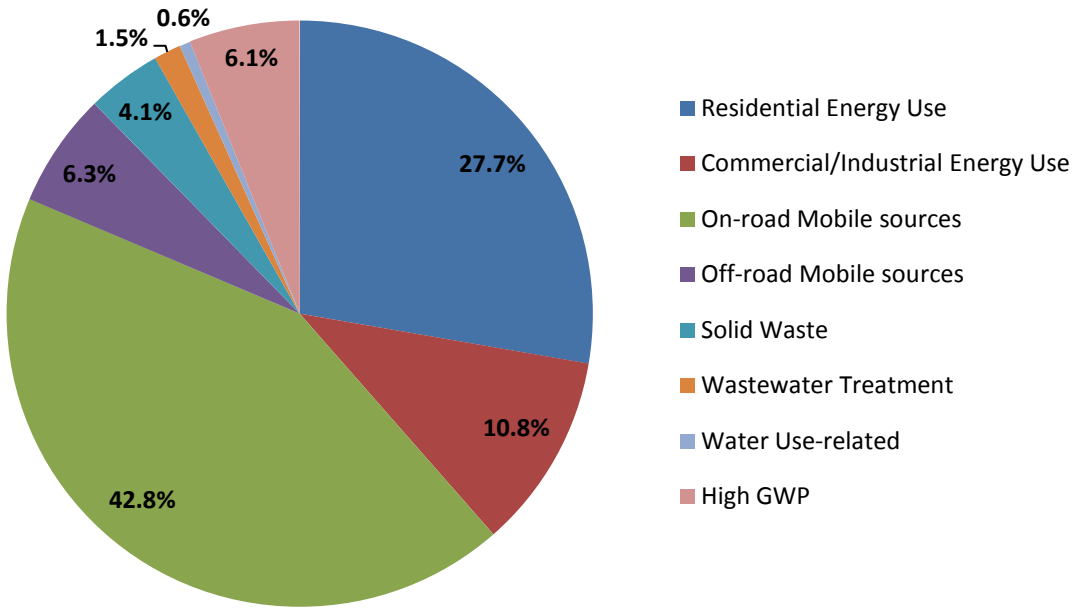
Government operations include buildings, facilities, vehicle fleets, employee commutes, streetlights and traffic signals, and solid waste disposal that are under the jurisdiction of the City. The City's contribution to all GHG emissions sectors is captured in the community-wide inventory summarized in Table A-1. Table A-2 and Figure A-2 summarize Citrus Heights' municipal GHG emissions for 2005.

Greenhouse Gas Emissions Baseline

There is currently no agency-adopted or recommended protocol to follow for preparation of community-wide GHG emissions inventories applicable to Citrus Heights. Thus, this field of practice and available tools and methods continue to evolve in the absence of standardized guidance. The City chose to refine certain aspects of the 2005 GHG emissions inventory that could potentially influence the Draft General Plan and development of the Greenhouse Gas Reduction Plan (GGRP). Thus, the GHG data presented in this section represents the emissions baseline relied upon for the GGRP. Sectors of the 2005 emissions inventory that were refined included on-road and off-road mobile-related emissions, wastewater treatment, and high GWP GHGs. Each is discussed in greater detail below and summarized in Table A-3 and Figure A-3.

Table A-1 2005 Community-wide Greenhouse Gas Emissions		
Community Sector	**Inventory Emissions**	
	MT CO_2e	**Percent**
Residential Energy Use	160,429	27.7%
Commercial/Industrial Energy Use	62,553	10.8%
On-road Mobile sources	247,463	42.8%
Off-road Mobile sources	36,627	6.3%
Solid Waste	23,679	4.1%
Wastewater Treatment	8,425	1.5%
Water Use-related	3,525	0.6%
High GWP	35,433	6.1%
Total	**578,134**	**100%**

Source: Data compiled by AECOM 2009 from the City of Citrus Heights Greenhouse Gas Emissions Inventory.
Notes: CO_2e = carbon dioxide equivalent; DMV = Department of Motor Vehicles; GHG = Greenhouse Gas; GWP = global warming potential; MT= metric tons.

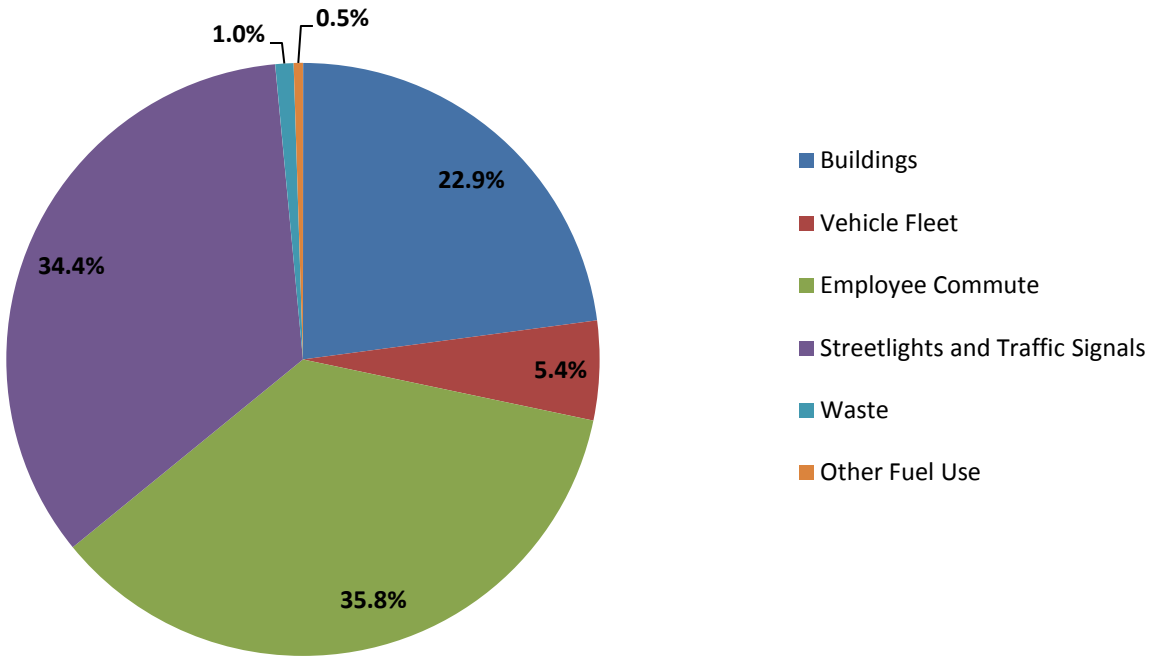


Source: ICF Jones & Stokes, 2009.

Citrus Heights Community-wide Greenhouse Gas Emissions Inventory (2005) **Figure A-1**

Table A-2 2005 Government-Related Greenhouse Gas Emissions		
Government Sector	**MT CO_2e**	**Percent**
Buildings	603	22.9%
Vehicle Fleet	143	5.4%
Employee Commute	945	35.8%
Streetlights and Traffic Signals	908	34.4%
Waste	25	1.0%
Other Fuel Use	14	0.5%
Total	2,638	100%

Notes: CO_2e = carbon dioxide equivalent; MT= metric tons.
Source: Data compiled by AECOM 2009 from the City of Citrus Heights' Greenhouse Gas Emissions Inventory

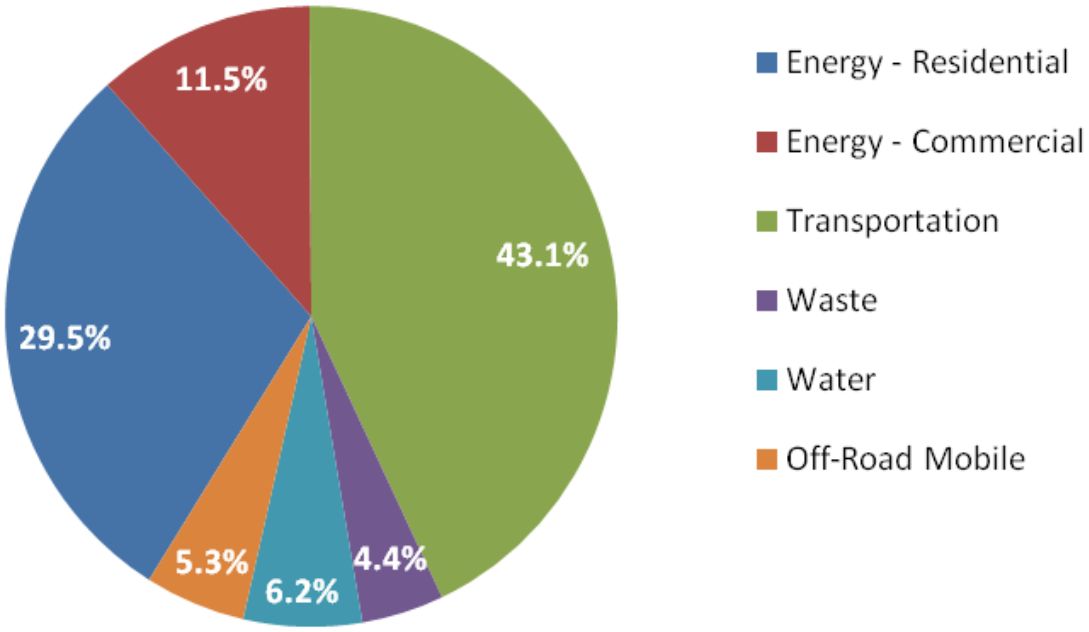


Source: ICF Jones & Stokes, 2009.

Citrus Heights Municipal Greenhouse Gas Emissions Inventory (2005) **Figure A-2**

Table A-3 2005 Community-wide Greenhouse Gas Emissions Baseline		
Community Sector	**Baseline Emissions**	
	MT CO_2e	**Percent**
Residential Energy Use	160,429	29.5%
Commercial/Industrial Energy Use	62,553	11.5%
On-road Mobile sources	234,231	43.1%
Off-road Mobile sources	28,877	5.3%
Solid Waste	23,679	4.4%
Wastewater Treatment	30,433	5.6%
Water Use-related	3,525	0.6%
Total	**543,727**	**100%**

Notes: CO2e = carbon dioxide equivalent; MT= metric tons.
Source: Data compiled by AECOM 2010 from the City of Citrus Heights' Greenhouse Gas Emissions Inventory



Source: Compiled by AECOM in 2010 from ICF Jones & Stokes, 2009

Citrus Heights Community-wide Greenhouse Gas Emissions Baseline (2005) **Figure A-3**

On-Road Mobile Sources

On-road mobile-source GHG emissions were calculated using a bottom-up method based on VMT data obtained from Fehr & Peers Transportation Consultants, which used select zone assignment of SACOG's current SACMET regional travel demand forecasting (TDF) model to calculate VMT for the City of Citrus Heights under existing conditions. Vehicle trips and associated VMT were categorized according to three types of trips:

- Internal–Internal (I-I) trips, which begin and end in Citrus Heights;
- Internal–External (I-X) trips, which begin in Citrus Heights and end outside Citrus Heights; and
- External–Internal (X-I) trips, which begin outside Citrus Heights and end inside Citrus Heights.

The methodology used to calculate VMT assigns 100 percent responsibility for all I-I trips and 50 percent I-X and X-I trips to the City. This methodology is consistent with the recommendations of the Regional Targets Advisory Committee, which is the body charged with making recommendations to ARB on implementation of SB 375. On-road mobile-source GHG emissions were estimated using emission factors from the ARB's Mobile Source Emission Factor Model (EMFAC 2007) using VMT by speed bin.

The revised on-road mobile-source GHG emissions estimates account for locally (City)-generated VMT on state highways (e.g., I-80) and do not include emissions associated with trips that originate and terminate outside of Citrus Heights. The original GHG emissions inventory did not distinguish between locally-generated or pass-through VMT. In addition, the original inventory did not calculate emissions according to speed bin. Thus, this refined calculation enables the City to more accurately identify the subset of mobile-source emissions that GGRP measures and actions can influence.

Off-road Mobile Sources

Off-road mobile-source GHG emissions were calculated using a top-down method. ARB's OFFROAD emissions model contains factors for types of off-road motor vehicles such as boats, agricultural equipment, off-highway vehicles, lawn and garden equipment, and rail. The OFFROAD model aggregates off-road emissions for all of Sacramento County. Under the current inventory calculation, the total off-road GHG emissions for all of Sacramento County were apportioned using the population of each jurisdiction (incorporated cities and unincorporated areas). This approach to allocating off-road mobile-source GHG emissions is not necessarily representative of the jurisdictions in which off-road emissions sources would exist. For example, under this method, some portion of agricultural equipment-related GHG emissions would be allocated to Citrus Heights, when most of this type of equipment would be located in the unincorporated area of the County. However, this approach may be appropriate for lawn and garden equipment emissions.

The revised off-road mobile-source GHG estimates removed emissions that are not applicable to Citrus Heights (e.g., use of agricultural equipment, boats, off-highway vehicles) from the countywide OFFROAD model, but retained emissions associated with equipment that is likely used within the City (e.g., landscape and construction equipment, air compressors, generators). These emissions were then apportioned by population to Citrus Heights.

Wastewater Emissions

Domestic wastewater treatment emissions were calculated using a bottom-up calculation method for GHG emissions generated by the Sacramento Regional Wastewater Treatment Plant (WWTP). The Sacramento Regional WWTP service area includes the cities of Citrus Heights, Elk Grove, Folsom Rancho Cordova, Sacramento, West Sacramento, and a portion of unincorporated Sacramento County. Wastewater is treated at the plant using secondary treatment processes, which results in methane formation. Emission factors for methane published by the IPCC for wastewater treatment and discharge were used, along with facility-specific information on average annual flow and influent biological oxygen demand (BOD). The GHG emissions from the Sacramento Regional WWTP were distributed on a per-capita basis for the entire Sacramento Regional County Sanitation District service area, and then

allocated to Citrus Heights based on the City's population. This method more accurately estimates GHG emissions from the wastewater treatment process specific to Citrus Heights.

High Global Warming Potential Greenhouse Gases

High GWP GHGs are associated with industrial processes, refrigerants, semi-conductor manufacturing, and electrical transmission. According to the City's inventory, there are no industrial-specific GHG emissions in Citrus Heights, which would indicate that there are likely few, if any, high GWP GHG emissions in the City. Thus, high GWP emissions were removed from the emissions baseline in Citrus Heights.

Greenhouse Gas Emissions Projections

The baseline inventory was used to project the City's 2020 GHG emissions assuming business-as-usual consumption trends continue. The projected 2020 inventory provides an emissions profile of Citrus Heights in 2020 if it were to continue on current GHG-producing trends. Each emissions sector is projected based on appropriate indicators (e.g., population projections, historical trends). The projected 2020 GHG emissions are based on applicable indicators for each emissions sector. This section describes the methodology used to project each emissions sector. See Table A-4 for a summary of the GHG emissions projection.

Table A-4
Communitywide Greenhouse Gas Emissions: 2005 and 2020

Communitywide Emissions Sector	2005 Baseline Emissions	2020 BAU Projections
	MT CO_2e	MT CO_2e
Building Energy Use (Commercial and Residential)	222,982	212,374
On-road Mobile sources (Transportation)	234,231	248,963
Off-road Mobile sources	28,877	30,693
Solid Waste	23,679	25,168
Wastewater and Water Use	33,958	39,198
Total	**543,727**	**556,396**
% Change from 2005		**+2.3%**

Notes: BAU = "business as usual"; CO_2e = carbon dioxide equivalent; MT= metric tons. Totals may not appear to add due to rounding.

[1] Off-road mobile-source emissions are related to emissions from off-road motor vehicles such as boats, agricultural equipment, off-highway vehicles, lawn and garden equipment, and rail.

Source: Data compiled by AECOM from the City of Citrus Heights Greenhouse Gas Emissions Inventory 2009 and modeled by AECOM 2010

Energy Consumption

In order to estimate GHG emissions associated with Citrus Heights' energy consumption in 2020, an annual average growth rate was applied to the 2005 baseline electricity and natural gas consumption data. The U.S. Department of Energy (DOE) Energy Information Administration (EIA) publishes an annual Energy Outlook Report that forecasts electricity and natural gas consumption by land use type (i.e., residential, commercial, and industrial) for regions throughout the U.S. For Citrus Heights' 2020 energy projections, the Pacific region forecasts from the 2010 Annual Energy Outlook were used to calculate the annual average growth rate in electricity and natural gas consumption for residential, commercial, and

industrial land uses (EIA 2010[1]). SMUD-specific emission factors were used to calculate 2020 energy-related GHG emissions.

Transportation

Citrus Heights' 2020 local roadway VMT was projected using anticipated general plan population growth between 2005 and 2020 of 6.3%. Transportation-related CO2, CH4, and N2O emissions were calculated using similar methods as those described above for the baseline inventory. However, year 2020 parameters from EMFAC2007 were used to generate emission factors.

Solid Waste

Citrus Heights' 2020 solid waste GHG emissions were projected using anticipated general plan population growth between 2005 and 2020 of 6.3%.

Water Consumption

Citrus Heights' projected 2020 water consumption emissions were projected using anticipated general plan population growth between 2005 and 2020 of 6.3%.

[1] Energy Information Administration. 2010. Annual Energy Outlook 2010: Supplemental Tables: Consumption & Prices by Sector & Census Division. Available at < http://www.eia.doe.gov/oiaf/aeo/supplement/supref.html>. Accessed February 20, 2010.