Calculating Houston's
2007 Baseline Community Greenhouse Gas Emissions Inventory
Complete Report & Technical Appendices

June 2009

City of Houston, Mayor's Office of Environmental Planning

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PURPOSE STATEMENT

As government standards for air pollutants become stricter and the possibility of a cap-and-trade system becomes more likely, a 2007 baseline Houston community emissions inventory is financially and environmentally crucial in understanding Houston's emissions sources. Essentially, to determine feasible and realistic strategies to reduce emissions, the community must be able to identify where these emissions originate. Thus, to achieve measurable change, the Houston community must know where they are starting from.

This project aims to provide the community with a baseline inventory of emissions so that residents, businesses, and government are able to implement and set emission reduction strategies and goals. In the end, this inventory will allow the community to produce measurable progress. The City of Houston is one of the first-users or beta-testers of the new emissions tracker software called Project 2 Degrees (see Methodology section for additional discussion of software).

Thus, as the Mayor has indicated over the past five years, this project will help Houston achieve a reputation as a leader in energy efficiency and help residents and businesses achieve cost efficiency and improved air quality (City of Houston, January 2007).

ISSUE STATEMENT

It is well-documented that air pollutants are detrimental to the public health and well-being of communities. However, the factors that contribute to polluted air are magnified in Houston's current context: a growing population and growing economy.

According to the City of Houston Planning and Development Department, as of January 1, 2009, Houston is not only the fourth largest city in the U.S., but it also boasts a growing population of 2.25 million (2009). According to the Greater Houston Partnership (GHP), if the city of Houston were a state, it would rank 36th in population ahead of New Mexico (Population, 2009). Contributing to its growth, the city of Houston is vast; according to the Greater Houston Convention and Visitors Bureau, the city boasts a land area of 639 square miles, enough to contain the cities of New York, Washington, Boston, San Francisco, Seattle, Minneapolis, *and* Miami (2009). According to the City of Houston, by 2010, the city of Houston will reach a population of nearly 2.32 million (City of Houston, 2008).

Coupled with this growing population is a large, diverse, and growing economy. Not only is Houston home to more than 5000 energy firms, but it is also home the largest medical center in the world—The Texas Medical Center (GHP, Population, 2009). Moreover, Houston is home to one of the nation's busiest ports—the Port of Houston, which ranks first in the U.S. for international waterborne tonnage and second in total cargo tonnage (City of Houston, 2008). According to the GHP, the city of Houston ranks first in fastest job growth, first in the lowest cost of living among major metropolitan areas, and third in the number of Fortune 500 headquarters (Ratings, 2009).

A growing population and economy implies an increase in emissions from increased waste, transportation, and energy use. This increase in emissions coupled with an increased possibility of stricter air pollutant regulations as a result of a changing political climate illustrates the need for a baseline community emissions inventory. This baseline will allow residents, businesses, and the government to identify opportunities and strategies for emissions reduction and enable each sector to set goals for measured improvement.

METHODOLOGY

Objective

Given the causes and consequences of air pollutants in the city of Houston and the lack of an existing inventory to measure these emissions, this study aims to provide the Houston community with a 2007 Baseline Greenhouse Gas Emissions Inventory.

Protocol

Since an ICLEI – Local Governments for Sustainability community inventory protocol is still in the process of being produced, the City of Houston is utilizing the 2008 Local Government Operations Protocol (LGOP) and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for the community inventory. However, it is noted that according to ICLEI, the community inventory protocol will mirror the LGOP, which also incorporates the 2006 IPCC Guidelines (Yienger, 2009, personal communication). Also, it must be noted that the two existing documents that specifically address the Project 2 Degrees (P2D) software were heavily utilized and frequently cited the 2006 IPCC Guidelines. The rest of this section briefly describes the LGOP and 2006 IPCC Guidelines.

On September 25, 2008, version 1.0 of the LGOP for the quantification and reporting of greenhouse gas emissions inventories was published. This protocol was jointly developed by the California Air Resources Board (CARB), California Climate Action Registry (CCAR), ICLEI – Local Governments for Sustainability, and The Climate Registry. (TCR) The protocol was developed in partnership with the aforementioned entities and incorporated the various protocols developed for U.S. GHG emissions inventories, including the individual protocols by produced by CARB, CCAR, ICLEI, TCR, U.S. EPA, and the International Organization for Standarization (ISO). Additional information regarding this protocol can be found at http://www.project2degrees.org/Pages/Resources.aspx.

Unlike the LGOP's local government-centered protocol, the 2006 IPCC Guidelines for greenhouse gas emissions inventories is country-centric. As such many of the emissions factors are at the broad country level; however, this protocol provided invaluable decision trees and invaluable guidance on how to deal with possible data limitations. Additional information regarding this protocol may be found at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

Scope

This community baseline inventory is for the year 2007. The inventory comprises the geopolitical boundaries of Houston city limits as the map in Appendix A indicates. Any diversions from this locational scope will be noted in the following sector subsections.

According to the Project 2 Degrees (P2D) Guidance Manual, the scope of emissions sources is categorized into the following three categories (October 2008, pp. 19-20):

- **Scope 1:** All direct emissions from sources located within the geopolitical boundary of the local government.

- **Scope 2:** Indirect emissions that result as a consequence of activity within the jurisdiction's geopolitical boundary; limited to electricity generation, district heating, steam and cooling consumption.
- **Scope 3:** All other indirect and embodied emissions that occur as a result of activity within the geopolitical boundary.

The categorization between the 3 scopes will be indicated in each sector's methodology and assumptions discussed below.

Software

Project 2 Degrees (P2D) was released to a limited number of cities in 2008, the software currently only has the ability to calculate greenhouse gas (GHG) emissions; therefore, P2D was used to calculate the Community's GHG Inventory[1]. The categorical sectors estimated were energy use (electricity and natural gas), transportation (cars/buses, planes, trains, boats, and non-road), and waste (landfills and wastewater treatment plants). It is important to note that the City of Houston, as an active beta-tester of this program, along with the cities of New York and Toronto, have engaged in an iterative process with the P2D development team, ICLEI, and CCI to improve the software's capabilities and ease of use.

Project 2 Degrees (P2D)

P2D is a secure, password-protected, web-based emissions tracker program jointly created by Microsoft Corporation, ICLEI – Local Governments for Sustainability, and the Clinton Climate Initiative with the help of Ascentium Corporation and the Center for Neighborhood Technology (CNT). Also, P2D is compatible with internationally accepted protocols, including IPCC, WRI, and ICLEI. Houston was chosen as one of the first cities to use this software and is currently one of only ten cities actively learning and using this software. Since P2D is being developed iteratively to meet the fast pace and evolving nature of the climate change field, the input of the City of Houston is essential in the software's development (P2D, 2008).

As a web-based emissions measurement tool, P2D is available online 24 hours a day, seven days a week. Using the software, Houston can upload data about emissions-producing activities, including fuel and electricity consumption, overland vehicle traffic, air and sea vessel fuel use, waste production, industrial processes, and more. P2D calculates the emissions from those activities and tracks them via a "CO2 equivalent" (CO2e) measurement. Once emissions data is entered into Emissions Tracker, users can customize data and coefficients to ensure that emissions data is accurate at the local level and maps to the latest and best science available. (P2D, 2008, pp.10-11).

Version 1.0 of P2D was used to estimate the Houston community's GHG emissions in CO2e for energy use, transportation, and waste.

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[1] To estimate the 5 other major pollutants in the Houston area - NOx (nitrogen oxides), SOx (sulfur oxides), CO (carbon monoxide), VOCs (volatile organic compounds), and PM10 (particulate matter -10 microns or less in diameter), please see the Next Steps section of this report.

Pollutants

Using P2D, the greenhouse gas (GHG) emissions from the Houston community were estimated for 2007. It is important to note that the gases and global warming potentials for each of GHG emissions are from the IPCC's 1995 Second Assessment Report (SAR) and consistent with international practices (California, 2008)[2].

GHGs

Greenhouse gas emissions are reported in tons of equivalent carbon dioxide (CO2e), which is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential (California Climate Change Portal, 2007). According to P2D, GHGs include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), perfluorocarbon (PFCs), hydrofluorocarbon (HFCs), and sulfur hexafluoride (SF6) (2008)[3]. The IPCC and EPA confirm that these are the principle gases from manmade sources contributing to GHG emissions.

The major source of carbon dioxide is fossil fuel combustion, which makes up 94.4% of carbon dioxide emissions. Similarly, landfills, enteric fermentation (gas produced in the digestive systems of animals), and natural gas systems together contribute to 65.9% of the methane emissions. Approximately 77.9% of the nitrous oxide emissions come from agricultural soil management, while 75.6% of the fluorinated gases come from the substitution of ozone depleting substances. (Office of Atmospheric Programs, 2007)

Sectors

This report will estimate emissions from three major sectors—energy, transportation, and waste. The overall three-step methodology is depicted below. Although discussed in the waste sub-section, it is important to note there were three activities deemed de minimis because the total estimated emissions were likely to be less than five-percent of total emissions (California, 2008, pp. 136). These activities were select active landfill waste categories, industrial wastewater pre-treatment plants, and inactive landfills.

[2] The Second Assessment Report values are the default values in P2D.
[3] See pp. 118-121 of the P2D Emissions Tracker Help for a complete list of the gases and global warming potentials.

Figure 1: Overall Methodology Map

Step 1: Collect input data

Sector	Activity	Measure	Units	Contact Person[4]	Organization
Energy	Electricity	By zip code By sector	kWh	Alan Ahrens Dan Martinez	CNP
	Natural Gas	By zip code By sector	MMBtu	Dan Dippon Rick Buy	CNP
Transportation	Cars/ Buses	By vehicle type & fuel	VMT	Alan Clark	HGAC
	Trains	By fuel	Gallons	Theo Kosub	TCEQ
	Plane	By fuel	Gallons	Debayan Sen	Jacobs Consultancy
	Boats	By fuel	Gallons	Theo Kosub	TCEQ
	Non-Road	By fuel & type	Gallons	Anusuya Iyer	TCEQ
Waste	Active Landfill	By total organic waste	Tons/year	Elvi Yzaguirre	TCEQ
	COH WWTP	By total organic waste	Tons	Clyde Smith	COH – PWE
	Industrial WWTP	By total organic waste	Tons	Kim Laird	TCEQ & EPA

Step 2: Enter inputs into P2D software program

Step 3: Record & analyze GHG emissions outputs by category and scope.

This methodology and categorization yielded 1899 entries into the P2D software as the figure below shows. Briefly, there were a few data limitations.

In the energy sector, the natural gas and electricity data by Btu and kWh, respectively, were available by zip code and sector (or rate class). There were three major assumptions in the energy sector. First, since more than half the zip codes within Houston's Full Purpose City Limits straddle the city limit, land area and number of households was used to determine the percentage of electricity use within the city's limits. The flow chart and detailed explanation are provided in the energy sub-section. Second, CenterPoint's lighting electricity data, including streetlights and miscellaneous service lighting, is not metered; therefore, a lump-sum amount of electricity for lighting was disaggregated into each zip code based on the concentration of premises. Third, the transmission and distribution loss calculation was taken from ERCOT's

[4] See References section for all contact information.

2007 transmission and distribution loss factors. All assumptions for energy are provided in the energy sub-section below.

In the transportation sector, there were five major sub-sectors, each of which had unique assumptions and a few with data availability issues. The vehicle miles travelled and/or amount and type of fuel used data was gathered for the sub-sectors of cars, buses, train, and most of the nonroad data. However, for planes, boats, and the LNG and CNG nonroad fuel sub-sectors the direct emissions entry method was used due to raw data availability. Additional assumptions and methodology are found in the transportation sub-section.

Finally, for the waste sector, there were three major sub-sectors calculated, active landfills, City owned and operated wastewater treatment plants (WWTPs), and industrial WWTPs. It is important to note that data was gathered for two other sub-sectors; however, these sub-sectors, industrial pre-treatment wastewater treatment plants and inactive landfills, were deemed de minimis, according to the Local Government Operations Protocol, September 2008. The emissions from these categories are less than 5% of the total GHG emissions, and therefore, considered insignificant.

Figure 2: Number of P2D Entries

Sector *(sub-sectors)*	**# of Entries**
Energy	**1189**
Natural Gas - Residential	*97*
Natural Gas - Small Commercial	*98*
Natural Gas - Large Commercial	*96*
Natural Gas - Industrial	*46*
Natural Gas - Industrial/Transport	*36*
Electricity - Single Family Residential	*106*
Electricity - Multi-family Residential	*105*
Electricity - Mobile Home Residential	*83*
Electricity - Small Commercial	*102*
Electricity - Large Commercial and Industrial	*102*
Electricity - Streetlights	*106*
Electricity - Miscellaneous Lighting	*106*
Electricity - T&D Losses	*106*
Transportation	**519**
Cars/Buses	*448*
Nonroad	*27*
Trains	*39*
Planes	*3*
Boats	*2*
Waste	**191**
Active Landfills - Residential	*19*
Active Landfills - Commercial	*14*
Active Landfills - C&D	*22*
Active Landfills - Brush	*16*
COH WWTP	*40*
Industrial WWTP	*80*
Total	**1899**

The next three figures show the P2D data entry structure that was developed to enter each of the entries.

Figure 3: Energy P2D Data Input Structure

Natural Gas	
Sector	Energy
Record	Natural Gas
GHG Emission Name	"Zip Code_Sector"
Source	Stationary Fuel Combustion
Scope	1
Method	Stationary Fuel Combustion
Fuel	Natural Gas
Activity	Commercial/Residential/Industrial
Energy Combusted	See input section
Units	Btu

Electricity	
Sector	Energy
Record	Electricity
GHG Emission Name	"Zip Code_Sector"
Source	Electricity, Steam, and District Energy Consumption
Scope	2
Method	Grid Electricity Consumption
Source	Grid Average Electricity
Electricity Consumed	See input section
Units	kWh

Figure 4: Waste P2D Data Input Structure

Active Landfills	
Sector	Waste
Record	Active Landfills
GHG Emission Name	"Permit #_Name of Landfill_Type of Waste"
Source	Waste - Solid Waste
Scope	1 or 3
Method	Solid Waste Multi-year
Waste Management Type	Managed/Managed, semi-aerobic
Climate Type	Wet Tropical
Site Coverage	Managed and covered with CH4 oxidizing material
Recovered Methane (%)	See input section
Flared Methane (%)	See input section
Complete Historical Data	Yes/No
Waste Generated (Tons)	See input section
Waste Fraction by Disposal Type (%)	100% SWDS
Composition (%)	See input section

Industrial Pre-Treatment WWTPs, and Inactive Landfills
De minimis - less than 3% of total GHG emissions from Local Government Operations Protocol, September 2008 (California, 2008, pp. 25)

COH WWTP	
Sector	Waste
Record	COH WWTP
GHG Emission Name	"Name of WWTP"
Source	Waste - Wastewater
Scope	1
Method	Wastewater
Population Served	See input section
Total Organic Waste (tons)	See input section
Sludge Removed (tons)	See input section
Methane Captured (%)	0%
Wastewater Type	Industrial/Domestic
Wastewater Treatment Method	Aerobic Treatment Plant- Well-managed

Industrial WWTP	
Sector	Waste
Record	Industrial WWTP
GHG Emission Name	"EPA Permit Number_Name of WWTP"
Source	Waste - Wastewater
Scope	1
Method	Wastewater
Population Served	See input section
Total Organic Waste (tons)	See input section
Sludge Removed (tons)	0
Methane Captured (%)	0%
Wastewater Type	Industrial
Wastewater Treatment Method	Aerobic Treatment Plant- Well-managed

Figure 5: Transportation P2D Data Input Structure

On Road	
Sector	Transportation
Record	On Road
GHG Emission Name	"VehicleType_DayofWeek_TimeofDay"
Source	Mobile Fuel Combustion - Road
Scope	1
Method	Mobile Combustion
Vehicle Type	See input section
Fuel	See input section
Vehicle Efficiency	See input section
Units	mpg
Distance Traveled	See input section
Units	miles

Trains	
Sector	Transportation
Record	Trains
GHG Emission Name	"Rail Company_Segment Code_Train Type"
Source	Mobile Fuel Combustion - Nonroad
Scope	3 - line haul; 1- switchers
Method	Non-Road Combustion
Transportation Mode	Rail
Vehicle Type	Locomotives
Fuel	Diesel
Fuel Use	See input data
Units	Gallons

Planes	
Sector	Transportation
Record	Planes
GHG Emission Name	"Airport Code"
Source	Mobile Fuel Combustion - Nonroad
Scope	3
Method	Direct Entry
Gas	CO2
Value	See input section
Unit	Tons

Boats	
Sector	Transportation
Record	Boats
GHG Emission Name	"Type of Vessel"
Source	Mobile Fuel Combustion - Nonroad
Scope	3
Method	Direct Entry
Gas	CO2
Value	See input section
Unit	Tons

Non-Road: Diesel & Motor Gasoline Fuel	
Sector	Transportation
Record	Non-Road
GHG Emission Name	"Type of Equipment_Type of Fuel"
Source	Mobile Fuel Combustion - Nonroad
Scope	1
Method	Non-Road Combustion
Transportation Mode	Off-Road
Vehicle Type	Agricultural equipment/Construction equipment/Other nonroad
Fuel	Diesel or Motor Gasoline
Fuel Use	See input section
Units	Gallons

Non-Road: CNG & LPG Fuel	
Sector	Transportation
Record	Non-Road
GHG Emission Name	"Type of Equipment_Type of Fuel"
Source	Mobile Fuel Combustion - Nonroad
Scope	1
Method	Direct Entry
Gas	CO2/CH4/N2O
Value	See input section
Unit	Tons

The next three subsections provide the assumptions, methodology, and input data for each of the three sectors, with the following information provided for each[5]:

- **Time Frame**: Although the overall time frame is the year 2007, any deviations from this year due to data availability are noted and relevant adjustments or footnotes were made.

- **Location:** Although the general location scope for this community inventory is Houston city limits (as referenced in Appendix A), any deviations from this location due to data availability or disaggregation are noted.

- **Assumptions:** This section provides the assumptions used to quantify the input data.

- **Methodology:** This section provides the steps taken to obtain the data along with contact information for key data gatekeepers.

- **Input Data:** This section provides the raw, input data into P2D. Note the output from each software is provided in the "Results and Analysis" section of the report.

[5] Note that with this information the inventory may be replicated for a future year.

Energy Use

Briefly, all of the energy use data was collected from CenterPoint Energy. This sector was divided into two separate activities, electricity and natural gas. Each of these activities was recorded by zip code and by sector (or rate class). The details of this data collection process are outlined next.

Time Frame

The time frame of the data collected was for the year 2007.

Location

The location of this data was Houston city limits as mapped in Appendix A. However, several zip codes crossed city limits; therefore, the City of Houston GIS Department (L. Nierth, 2009, personal communication) determined the percent of total land area and of total households within City of Houston Full Purpose City Limits by zip code. The household percentage was applied to those zip codes that crossed City Limits. The list of zip codes and percent of households inside City Limits used for this analysis is found in the figure below.

Figure 6: Table of Zip Codes Within Houston City Limits

Zip Code	Total Area of the Zip Code	Area of the Zip Code within the Full Purpose City Limit	Percentage of ZIP Code Area within the full Purpose City Limit	Total # of Single Family Households inside the ZIP Code	# of Single Family Households Within the Full-purpose City Limit	Percentage of Single Family Households within the Full-purpose City Limit
77002	58,532,931	58,532,931	100%	103	103	100%
77003	74,537,169	74,537,169	100%	2,081	2,081	100%
77004	171,180,023	171,180,023	100%	6,495	6,495	100%
77005	109,608,801	49,749,907	45%	7,773	1,959	25%
77006	62,844,969	62,844,969	100%	4,632	4,632	100%
77007	239,526,762	239,526,762	100%	9,428	9,428	100%
77008	182,273,682	182,273,682	100%	10,007	10,007	100%
77009	172,791,264	172,791,264	100%	10,898	10,898	100%
77010	2,052,422	2,052,422	100%	-	-	0%
77011	104,241,163	104,241,163	100%	4,022	4,022	100%
77012	127,933,572	124,749,801	98%	3,648	3,648	100%
77013	276,080,121	273,668,145	99%	2,817	2,815	100%

Zip Code	Total Area of the Zip Code	Area of the Zip Code within the Full Purpose City Limit	Percentage of ZIP Code Area within the full Purpose City Limit	Total # of Single Family Households inside the ZIP Code	# of Single Family Households Within the Full-purpose City Limit	Percentage of Single Family Households within the Full-purpose City Limit
77014	208,929,439	4,763,280	2%	5,336	-	0%
77015	632,121,480	143,759,043	23%	11,557	3,202	28%
77016	291,233,253	243,962,556	84%	9,191	9,061	99%
77017	260,618,492	243,722,743	94%	6,499	6,467	100%
77018	184,703,685	184,703,685	100%	9,185	9,185	100%
77019	83,755,978	83,755,978	100%	5,060	5,060	100%
77020	192,575,410	192,575,410	100%	6,666	6,666	100%
77021	164,054,588	164,054,588	100%	7,148	7,148	100%
77022	161,019,510	161,019,510	100%	6,696	6,696	100%
77023	159,433,186	159,433,186	100%	5,888	5,888	100%
77024	327,071,749	151,585,082	46%	9,373	4,944	53%
77025	121,141,634	118,527,807	98%	5,706	5,660	99%
77026	190,185,477	190,185,477	100%	7,004	7,004	100%
77027	94,919,204	94,919,204	100%	2,607	2,607	100%
77028	243,892,634	243,892,634	100%	5,854	5,854	100%
77029	355,419,371	253,203,381	71%	5,416	2,768	51%
77030	69,733,793	69,733,793	100%	1,742	1,742	100%
77031	90,412,483	79,012,495	87%	2,897	2,801	97%
77032	553,590,635	374,182,951	68%	1,996	176	9%
77033	167,898,955	167,898,955	100%	9,062	9,062	100%
77034	243,549,625	240,331,779	99%	6,161	6,125	99%
77034	19,112,900	19,070,727	100%	6,161	6,125	99%
77035	154,769,975	154,727,949	100%	6,819	6,819	100%

Zip Code	Total Area of the Zip Code	Area of the Zip Code within the Full Purpose City Limit	Percentage of ZIP Code Area within the full Purpose City Limit	Total # of Single Family Households inside the ZIP Code	# of Single Family Households Within the Full-purpose City Limit	Percentage of Single Family Households within the Full-purpose City Limit
77036	212,764,564	212,764,564	100%	5,120	5,120	100%
77037	190,751,675	63,124,220	33%	3,971	1,314	33%
77038	258,999,973	10,456,165	4%	4,607	53	1%
77039	282,663,719	16,342,438	6%	5,873	-	0%
77040	381,879,506	137,018,244	36%	10,436	2,899	28%
77041	575,940,880	230,561,066	40%	9,866	2,534	26%
77042	173,131,073	173,131,073	100%	4,148	4,148	100%
77043	214,139,566	214,139,566	100%	4,879	4,879	100%
77044	1,277,965,228	232,720,028	18%	7,999	154	2%
77045	363,460,944	363,310,307	100%	8,110	8,110	100%
77046	338,168	338,168	100%	-	-	0%
77047	395,812,519	223,834,371	57%	6,024	4,367	73%
77048	309,377,972	307,604,935	99%	4,015	3,998	100%
77049	673,102,320	40,401,116	6%	5,687	487	9%
77050	223,728,247	19,953,646	9%	977	622	64%
77051	155,717,211	155,717,211	100%	4,405	4,405	100%
77053	365,161,075	145,791,735	40%	10,334	7,779	75%
77054	150,075,786	150,075,786	100%	420	420	100%
77055	240,442,631	202,789,049	84%	7,485	5,866	78%
77056	98,579,881	98,579,881	100%	3,460	3,460	100%
77057	122,594,627	122,476,937	100%	4,511	4,511	100%
77058	323,025,643	109,818,809	34%	2,749	905	33%
77059	405,077,668	305,057,520	75%	5,723	4,627	81%

Zip Code	Total Area of the Zip Code	Area of the Zip Code within the Full Purpose City Limit	Percentage of ZIP Code Area within the full Purpose City Limit	Total # of Single Family Households inside the ZIP Code	# of Single Family Households Within the Full-purpose City Limit	Percentage of Single Family Households within the Full-purpose City Limit
77060	230,007,362	113,020,912	49%	3,764	1,839	49%
77061	224,458,432	224,458,432	100%	3,652	3,652	100%
77062	163,690,522	163,675,322	100%	8,203	8,203	100%
77063	121,030,477	112,673,365	93%	3,080	2,932	95%
77064	433,935,146	58,250,384	13%	11,861	-	0%
77065	226,115,926	56,939	0%	7,796	-	0%
77066	243,656,162	5,285	0%	8,482	-	0%
77067	154,885,892	43,818,170	28%	5,236	172	3%
77070	361,859,120	25,176,719	7%	11,249	135	1%
77071	122,806,939	98,051,348	80%	5,917	4,482	76%
77072	210,469,444	204,775,794	97%	10,727	10,041	94%
77073	360,886,459	630,022	0%	6,074	-	0%
77074	146,101,114	146,101,114	100%	5,132	5,132	100%
77075	315,714,959	315,211,308	100%	7,336	7,336	100%
77076	133,753,093	133,683,370	100%	6,211	6,211	100%
77077	269,178,705	269,086,078	100%	10,152	10,152	100%
77078	269,935,182	219,628,019	81%	4,013	4,011	100%
77079	188,871,972	188,871,972	100%	8,066	8,066	100%
77080	174,498,183	174,498,183	100%	6,827	6,827	100%
77081	87,654,440	86,355,054	99%	882	882	100%
77082	344,323,494	243,103,925	71%	9,812	5,105	52%
77083	273,183,731	12,509,178	5%	16,976	629	4%
77084	1,045,232,810	572,005,137	55%	22,914	457	2%

Zip Code	Total Area of the Zip Code	Area of the Zip Code within the Full Purpose City Limit	Percentage of ZIP Code Area within the full Purpose City Limit	Total # of Single Family Households inside the ZIP Code	# of Single Family Households Within the Full-purpose City Limit	Percentage of Single Family Households within the Full-purpose City Limit
77085	134,698,144	134,281,040	100%	4,067	4,067	100%
77085	3,366,461	3,366,461	100%	4,067	4,067	100%
77086	199,077,187	19,298,683	10%	5,969	1	0%
77087	183,444,158	183,444,158	100%	7,739	7,739	100%
77088	312,906,720	220,631,981	71%	13,498	9,495	70%
77089	296,881,752	161,797,173	54%	11,108	5,072	46%
77090	252,211,181	4,980,028	2%	4,857	-	0%
77091	198,088,712	198,088,712	100%	4,918	4,918	100%
77092	227,228,599	227,228,599	100%	5,481	5,481	100%
77093	334,533,041	206,053,831	62%	10,440	5,712	55%
77094	359,417,719	280,267,079	78%	2,914	1	0%
77095	415,413,555	21,403	0%	19,217	-	0%
77096	169,100,393	169,075,095	100%	8,075	8,075	100%
77098	48,931,949	48,931,949	100%	2,315	2,315	100%
77099	171,583,393	164,941,364	96%	7,702	7,272	94%
77336	1,174,651,388	177,380,880	15%	4,020	1,222	30%
77338	725,721,081	176,500,359	24%	8,144	262	3%
77339	433,219,507	388,212,577	90%	12,025	10,125	84%
77345	214,830,590	214,830,590	100%	8,162	8,162	100%
77346	537,073,899	44,724,620	8%	16,499	247	2%
77357	1,528,867,146	448,563	0%	13,103	-	0%
77365	1,018,727,053	39,594,280	4%	9,595	133	1%
77365	35,863,887	35,863,887	100%	9,595	133	1%

Zip Code	Total Area of the Zip Code	Area of the Zip Code within the Full Purpose City Limit	Percentage of ZIP Code Area within the full Purpose City Limit	Total # of Single Family Households inside the ZIP Code	# of Single Family Households Within the Full-purpose City Limit	Percentage of Single Family Households within the Full-purpose City Limit
77373	667,099,601	145,946	0%	17,416	-	0%
77375	2,100,623,944	648,136	0%	19,516	-	0%
77379	733,034,256	36,249	0%	21,492	-	0%
77386	1,151,534,696	40,358,891	4%	11,552	3	0%
77388	374,364,804	1,612	0%	13,201	-	0%
77396	763,984,185	265,744,138	35%	9,054	1,331	15%
77401	106,365,403	6,441,934	6%	6,270	41	1%
77429	1,491,552,578	952,651	0%	25,693	-	0%
77433	1,107,494,488	111,879	0%	7,944	-	0%
77447	2,892,025,752	323,125	0%	2,786	-	0%
77449	837,521,997	326,332	0%	25,517	-	0%
77450	535,945,109	147,892,591	28%	19,888	-	0%
77459	731,240,151	719,211	0%	18,803	50	0%
77469	2,253,709,987	9,996,567	0%	22,317	-	0%
77477	296,440,864	7,882,022	3%	6,700	543	8%
77478	728,847,112	7,131,902	1%	21,177	3	0%
77484	4,159,808,541	372,412	0%	950	-	0%
77489	379,307,770	124,979,817	33%	12,205	5,756	47%
77493	1,822,997,663	426,912	0%	5,436	-	0%
77494	1,086,782,287	1,791,956	0%	18,620	-	0%
77502	155,035,635	2,775,534	2%	8,392	12	0%
77503	329,307,976	5,695,496	2%	5,914	-	0%
77504	149,286,233	28,680,603	19%	3,468	139	4%

Zip Code	Total Area of the Zip Code	Area of the Zip Code within the Full Purpose City Limit	Percentage of ZIP Code Area within the full Purpose City Limit	Total # of Single Family Households inside the ZIP Code	# of Single Family Households Within the Full-purpose City Limit	Percentage of Single Family Households within the Full-purpose City Limit
77505	259,730,238	168,178	0%	6,408	-	0%
77506	270,061,428	7,289,406	3%	6,777	-	0%
77520	3,579,950,648	5,708,069	0%	10,561	-	0%
77530	524,715,850	14,112,973	3%	8,412	-	0%
77532	2,378,432,276	208,701,449	9%	8,736	171	2%
77546	699,223,522	71,867,852	10%	5,851	2	0%
77547	83,373,749	3,349,190	4%	2,509	17	1%
77562	485,234,993	1,768	0%	3,292	-	0%
77571	1,047,377,993	28,929,357	3%	11,335	-	0%
77581	780,246,737	1,796,797	0%	3,195	-	0%
77587	76,811,410	443,532	1%	3,207	2	0%
77598	395,166,188	99,621,620	25%	3,166	1,269	40%
773HH	285,812,127	283,454,231	99%	93	83	89%

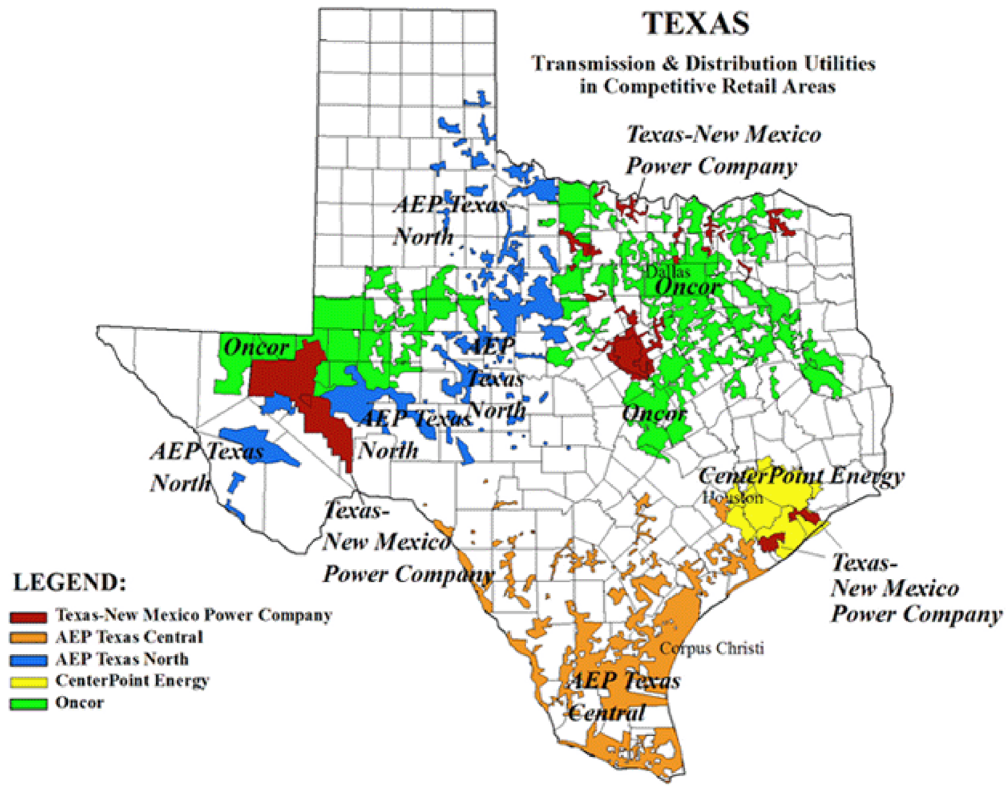
Assumptions

There are five distinct assumption categories that apply to this analysis.

(1) Disaggregation. As stated in the energy use summary, this energy use data, electricity and natural gas, was collected by zip code and by sector. Thus, each entry name contains the zip code and sector. There are three major disaggregation topics that were addressed in this process: overall scope, natural gas scope, and electricity scope.

Overall Scope. According to the Public Utilities Commission of Texas (PUCT) and seen below, there are five major transmission and distribution utilities in competitive retail areas of Texas (PUCT, 2007). As the map shows, in Houston, there is only one major provider, CenterPoint Energy, in yellow. Although, Texas-New Mexico Power Company and AEP Texas Central deliver electricity to areas close to Houston, these two power companies' service areas do not overlap with Houston's Full Purpose City Limits. Therefore, it was concluded that electricity data needed to be gathered from one power company, CenterPoint Energy.

Figure 7: Map of Texas Transmission and Distribution Utilities in Competitive Retail Areas, 2007



Natural Gas Scope Disaggregation. There are three major natural gas notes to be made. First, the data, gathered from Debra DePena and Dan Dippon (see References for contact information) at CenterPoint Energy, was retrieved in MCF at 14.65 psi; however, to enter this data into P2D, the units must be in Btus. Therefore, the following conversion was made based on Ms. DePena's calculations at CenterPoint:

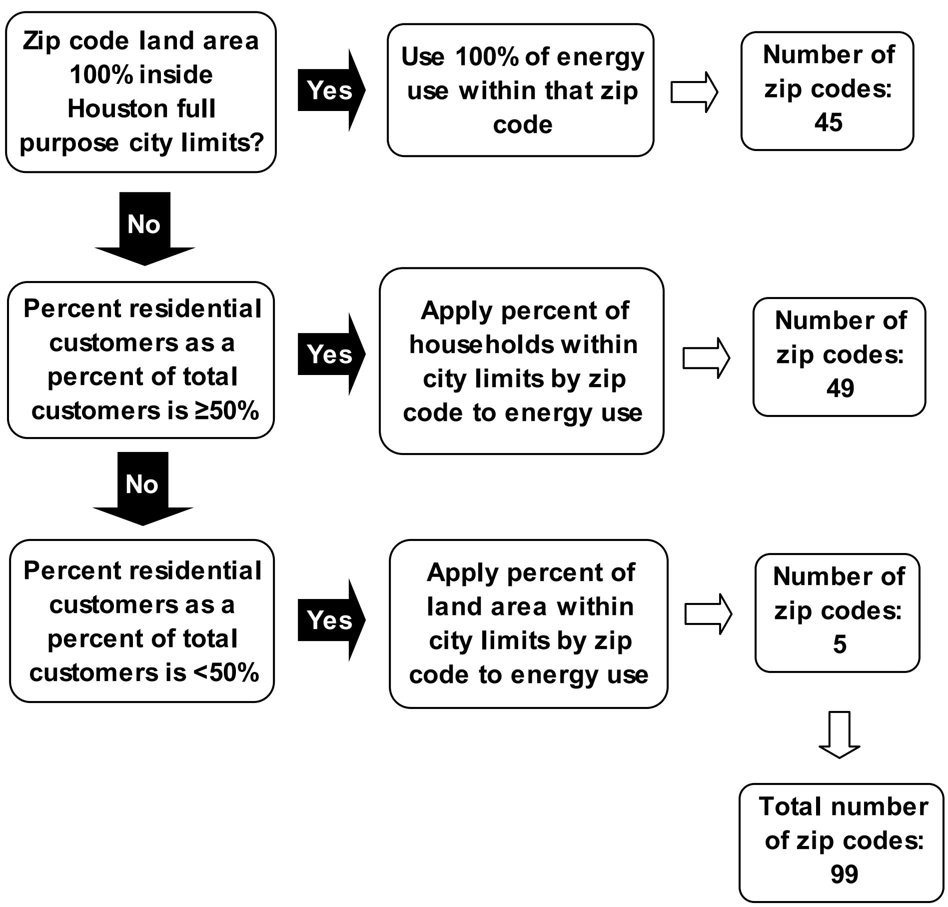
X MCF at 14.65 psi*(1000 CF/1 MCF)*(1017.2 Btu/1 CF) = Y Btu

Where:
CF = cubic feet
MCF = thousand (or mil) cubic feet
Btu = British Thermal Units
Psi = pounds per square inch
1017.2 Btu = 1 CF at 14.65 psi (given by CenterPoint based on the pressure used)
X = amount of natural gas used from CenterPoint Energy in MCF at 14.65 psi
Y = amount of natural gas used in Btu

Second, there were five categories given by CenterPoint, residential, small commercial, large commercial, industrial, and industrial/transport. The industrial/transport, in this context, references those end use locations in those zip codes where the company provides natural gas transportation service to those end use locations rather than natural gas sales service. Natural gas transportation service means that the company is transporting customer owned gas to the end use location, i.e. the company does not hold title to the gas used by the customer at the end use location. These companies are in large part industrial and therefore are classified as such in the software.

Finally, third, as mentioned previously, there are several zip codes that straddle Houston city limits; therefore, since the natural gas data, gathered from CenterPoint, was for the entire CenterPoint service area, the data required a scoping methodology to determine how much natural gas was used in Houston's city limits by zip code. The figure below indicates the scoping methodology used and resulting conclusions.

Figure 8: Determining Energy Scope by Zip Code



As can be seen, the first determination is whether or not the zip code's land area was entirely within Houston's Full Purpose City Limits (Appendix A). Forty-five zip codes are completely within the city's limits; therefore, all the natural gas usage in these zip codes was used. The remaining fifty-four straddle the city's limits; therefore, the next determination was based on the percent residential customers as a percent of total customers. If the residential percentage was greater than or equal to fifty percent, then the percent of households within city limits was used as a proxy for natural gas usage and was applied to the zip code natural gas usage. If the residential percentage was less than fifty percent, then the percent of land area within city limits was used as a proxy for natural gas usage and applied to the remaining five zip codes' natural gas usage. In sum, there were ninety-nine zip codes that used natural gas in 2007.

Electricity Scope Disaggregation. There are three major electricity notes to be made. First, the data, gathered from Dan Martinez and Theresa Debose at CenterPoint, requires several caveats, clarifications, and definitions from CenterPoint:

- **Data source**: The CenterPoint revenue year of 2007 was used to collect all data for this request. Any premise active during 2007 is included in this analysis. The premise categories presented are mutually exclusive and no duplicate addresses are presented in the data. A premise is defined by CenterPoint Energy as a specific meter location and may not consistently compare to a residential dwelling or commercial building frontage address. Premise counts represent a physical location and may not represent a precise customer count.

- **Data categories**:
    - Residential (single family, multi-family, and mobile home): defined by meter location street address designations as follows residential dwellings with no mobile home, apartment number, or fractional street block number in the physical address are defined as single family.
    - Non-residential (small commercial and large commercial/industrial): CenterPoint Energy rate classes as defined in its current tariff are used to define non-residential premise categories. Please refer to the CenterPoint Energy Tariff in Appendix B for complete rate class descriptions. Non-residential premises include traffic signal banks, advertising signs, and other structures that may not typify a commercial building. The lowest possible granularity of premise description has been provided for non-residential premises.
    - Transmission and Distribution Losses: The transmission and distribution (T&D) loss factors were gathered from ERCOT (ERCOT, 2007 & ERCOT, 2009). According, to the P2D help file and Jen McGraw of P2D, T&D losses account for approximately 7% - 10% of total electricity generation. According to ERCOT, in 2007, T&D losses accounted for approximately 8% of total generation. Therefore, this 8% T&D loss was accounted for under scope 3 in electricity. The calculation of this 8% loss is shown below:

$$Y + X = T \rightarrow Y + X = X/(P) \rightarrow X = (P*Y)/(1-P)$$

Where:

Y = Electricity Use (kWh) = Given

X = T&D Losses (kWh) = Unknown

$$T = \text{Total Electricity Generation (kWh)} = X/P = X/.08$$
$$P = \text{percent T\&D loss as a percentage of total generation} = .08$$

This calculation was performed by zip code for zip codes within city limits.

- **Location/Zip Code Scope:** The zip codes and electricity usage used in the analysis represent the physical location of electric meters in the city of Houston's full purpose city limits as identified/defined in the City of Houston request.

- **Meter Designation**: CenterPoint Energy provided the meter designation of IDR vs. non-IDR meters. The designation Non-IDR and IDR describe the data recording process used by the electric meter. Non-IDR meters provide a register value reading once each revenue month. IDR meters provide a meter reading for each 15 minute interval period in a day for the duration of the billing period. This disaggregation was not taken into account in the community inventory and the non-IDR and IDR meters were summed to get the resulting seven categories used – single family, multi-family, mobile home, small commercial, large commercial/industrial, streetlights, and miscellaneous lighting. However, it is important to note that the IDR meters are mainly large commercial/industrial, while the non-IDR meters are small commercial and residential.
  Second, as mentioned above, the zip code and rate class data categories provided by CenterPoint for the electricity data represent the electricity usage solely within the city's full purpose city limits as defined in Appendix A. Therefore, further scoping was not required for the electricity data.

  Third, the lighting data, streetlights and miscellaneous lights required further disaggregation because these types of lighting services are not metered; therefore, a total CenterPoint service area kilowatt hours used for lighting was provided. These lighting services are based on engineer estimations of how much electricity may be used based on the light bulb used and duration. The caveats and clarifications from Theresa DeBose at CenterPoint regarding the lighting data is provided below:

- **Data description**: *Street Lighting Services (SLS)* energy consumption for each 2007 revenue month. This non-metered lighting category includes both independently and municipally owned streetlights in the CenterPoint Energy service area. *Miscellaneous Lighting Services (MLS)* energy consumption for each 2007 revenue month. This non-metered lighting category includes security and guard lightings as well as neighborhood esplanade lighting.

- **Apportioning to Houston zip codes**: To apportion this energy, the percent premises within Houston city limits as a percent of premises within the entire CenterPoint service area was identified. According to CenterPoint Energy and verified by the Public Utilities Commission of Texas (PUCT), CenterPoint provided service to approximately 2 million premises and approximately 76 billion kWh of electricity in 2007 to the entire service area (PUCT, 2009 and D. Martinez, 2009, personal communication). Further, according to CenterPoint, in 2007 within the city's limits, CenterPoint provided service to almost 2 million premises and approximately 28.8 billion kWh of electricity, see figure below.

Figure 9: Determining Houston Premises and Electricty Use as a Percent of CenterPoint Service Area

	# of Premises	Total kWh Usage
Houston Full Purpose City Limits	1,934,255	28,768,615,528
Total CenterPoint Service Area	2,056,899	76,290,614,917
Houston as a % of Total CenterPoint Service Area	94%	38%

Therefore, as the figure below shows, 94% of the total lighting service kWh for streetlights and miscellaneous lights were used for Houston. This Houston lighting service amount was apportioned to zip codes based on the percentage of premises located in the respective zip codes. See the input data for final numbers by zip code.

Figure 10: Apportioning Lighting Services to Houston

	Streetlights (kWh)	Misc. Lighting (kWh)	Total (kWh)
CenterPoint Service Area	229,404,187	61,235,019	290,639,206
Houston City Limits (94% of CenterPoint)	215,725,807	57,583,839	273,309,646

(2) Coefficients. To begin, the software was set to the "ERCOT" region and "ERCOT All" sub-region. The default emission factors from 2004 for these settings are 1420.56 lbs CO_2/MWh, 0.021 lbs CH_4/MWh, and 0.015 lbs N_2O/MWh (California, 2008, p. 175). From the 2008 Texas State Energy Plan, the ERCOT blend of energy is presented below:

Figure 11: Houston Electricty Fuel Blend, 2007[6]

Type of Fuel	2007 ERCOT %
Natural Gas	45.5%
Coal	37.4%
Water	0.4%
Wind	2.9%
Nuclear	13.4%
Other	0.4%
Total	**100.0%**

The emission factors or coefficients[7] for both electricity and natural gas were set to default for the ERCOT region. The ERCOT region blend is the same blend as Houston

[6] (Governor's Competitiveness Council, July 2008)
[7] Emission factor/coefficients: a unique value for determining the amount of a GHG emitted for a given quantity of fossil fuel consumed. These factors are expressed in terms of the ratio of emissions of a particular pollutant (i.e.

after taking into account the City of Houston's 40MW purchase of wind energy in 2007. The following reapportioning methodology verifies the fact that the city blend is identical to the ERCOT blend.

First, the 2007 actual ERCOT percentage breakdown for electricity blend from the 2008 Texas State Energy Plan was used as the baseline allocation between fuels. ERCOT encompasses the approximately 5 generator/transmission/distribution companies in the Texas region as previously discussed, namely CenterPoint in Houston. From these electricity generator/transmission/distribution companies, there are approximately 40 "providers" (electricity companies that have direct consumer contact), for instance Reliant among others in this area. Given this organization, the ERCOT electricity blend breakdown was chosen as the baseline because, unlike breakdowns from the numerous "providers", ERCOT smoothes the market swings and competitive nature that could potentially skew the breakdowns from the 40 "providers" in the area.

Second, this ERCOT percentage breakdown was reallocated without wind by dividing the 2007 actual ERCOT blend by 97.1% or the net fuel percentage without wind.

Third, the reallocated Houston percentage breakdown was calculated by dividing the 40MW or 350,400,000 kWh of wind energy by total electricity use for Houston or 28.8 billion kWh. This wind energy as a percentage of total electricity use was plugged into the final blend. Finally, the remaining fuel types were calculated by dividing the reallocated 2007 ERCOT percentages by the remaining 98.8% of electricity (the percent of electricity left without the wind energy).

Despite the large wind energy purchase by the City of Houston, the purchase is not yet large enough to affect the blend of the entire community's fuel used to produce electricity. Therefore, the default, ERCOT blend is used in P2D.

(3) Scope. The scope for electricity use is Scope 2 or the indirect emissions that result as a consequence of activity within the jurisdiction's geopolitical boundary. Electricity use by the community is a consumption activity; therefore, these are indirect, scope 2 emissions. Whereas, the scope for natural gas is Scope 1 or all direct emissions from sources located within the geopolitical boundary of the local government. Natural gas combustion by the community is a direct, scope 1 power generation activity.

(4) Source. The source is an activity that causes the emissions; the eleven classification categories are from the IPCC guidelines. See Appendix C for the source categories and descriptions. Electricity use is classified as "Electricity, Steam, and District Energy Consumption" because the electricity recorded is what was consumed in 2007 by the

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carbon dioxide) to the quantity of fuel use (i.e. kilograms of coal). For instance, when burned, 1 ton of coal = 2.071 tons of CO_2 (P2D, 2008, p. 109).

community. Natural gas combustion is classified as "Stationary Fuel Combustion" because this is an activity related to utility power generation.

(5) Quantification. To quantify the electricity emissions, the grid electricity consumption or the amount of electricity consumed by a machine, building, or process in kilowatt hours was used. To calculate the natural gas emissions, the stationary fuel combustion or the amount of natural gas fuel used at a fixed location, like a boiler, generator, or power plant in Btus was used.

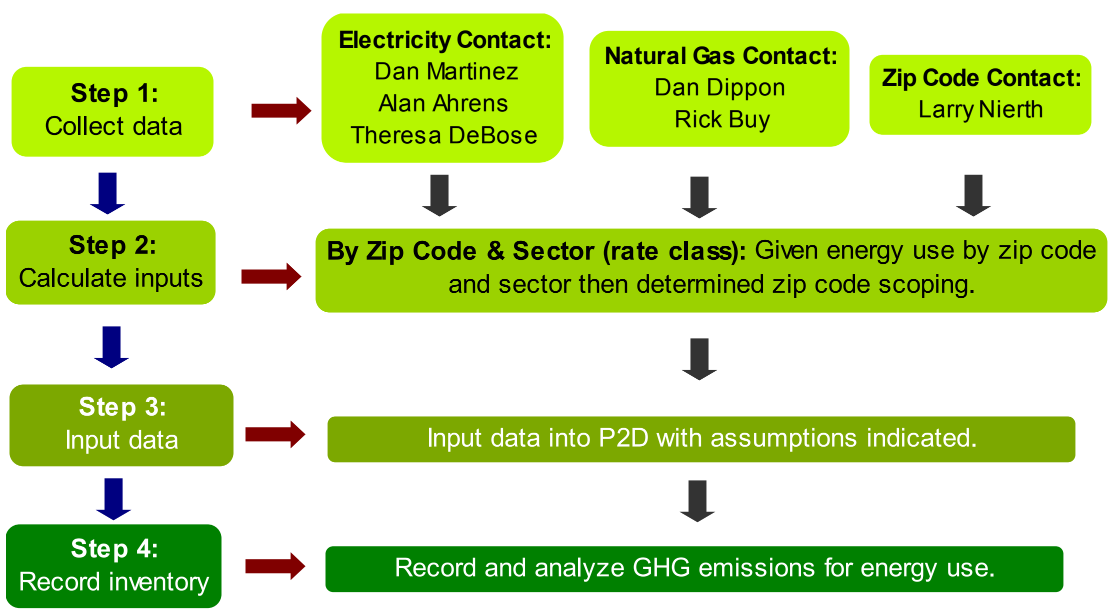
To calculate electricity and natural gas use by zip code, the kWh of electricity and Btus of natural gas were collected by zip code and rate class (or sector) within Houston city limits.

Methodology

To quantify the emissions from energy use, a four-step process took place as displayed in the figure below. For contact information, see references section.

As this methodology map indicates, the first step was data collection from several different CenterPoint Energy personnel. The next step was to calculate the input data based on the assumptions discussed previously. Then the data was input into the P2D program; the next section provides the raw, input data as entered into the software program. Finally, the last step was to record the emission outputs, which is presented in the "Results and Analysis" section.

Figure 12: Energy Use Methodology Map



Input Data

The input data for energy use is presented in two separate tables—electricity use and natural gas use. The table below presents the raw, input data for kWh of electricity use.

Figure 13: Electricity Input Data By Zip Code and Sector/Rate Class in kWh, 2007

Zip Code	Single Family Residential	Multi-family Residential	Mobile Homes Residential	Small Commercial	Large Commercial and Industrial	Streetlights	Misc Street Lighting	Total Usage	T&D Losses	Total Generation
77002	2,399,312	16,728,812	6,629	197,060,915	313,600,351	613,410	163,738	530,573,167	45,850,619	576,423,787
77003	18,569,739	10,640,468	0	92,167,240	92,447,296	743,676	198,510	214,766,929	18,559,545	233,326,475
77004	72,466,593	48,823,452	15,879	115,920,270	9,865,558	2,400,330	640,722	250,132,804	21,615,763	271,748,567
77005	171,811,065	15,679,926	0	86,349,503	966,999	1,547,021	412,947	276,767,461	23,917,454	300,684,916
77006	82,934,848	52,196,041	0	113,631,633	4,566,366	2,429,551	648,522	256,406,961	22,157,958	278,564,919
77007	122,244,318	45,865,942	81,866	153,138,269	38,792,040	2,899,312	773,915	363,795,662	31,438,183	395,233,845
77008	125,784,584	25,430,497	199,560	148,364,109	50,447,696	2,553,348	681,567	353,461,361	30,545,122	384,006,484
77009	119,148,921	18,479,700	571,677	111,994,812	6,247,598	2,293,374	612,172	259,348,254	22,412,136	281,760,390
77010	58,984	236,225	0	6,328,962	15,642,842	21,079	5,627	22,293,719	1,926,560	24,220,278
77011	38,007,977	9,090,338	8,140	79,377,130	35,989,928	978,445	261,177	163,713,135	14,147,622	177,860,757
77012	35,854,428	16,765,406	350,151	59,784,549	2,925,490	1,247,119	332,894	117,260,037	10,133,278	127,393,315
77013	33,062,806	19,237,063	2,974,711	55,451,545	13,058,317	1,046,701	279,397	125,110,540	10,811,696	135,922,236
77014	66,900,720	38,270,844	4,186,694	50,828,569	2,836,155	2,197,793	586,659	165,807,434	14,328,605	180,136,039
77015	157,939,983	41,421,818	8,087,718	180,783,899	171,185,653	3,293,902	879,243	563,592,216	48,704,031	612,296,248
77016	97,819,210	8,676,883	970,932	46,339,768	881,106	1,524,269	406,874	156,619,042	13,534,571	170,153,613
77017	76,430,164	17,848,451	260,174	108,083,526	10,146,492	1,627,545	434,442	214,830,793	18,565,064	233,395,858
77018	112,545,321	9,442,076	2,566,540	106,928,595	12,283,783	1,769,521	472,340	246,008,176	21,259,325	267,267,501
77019	145,700,523	40,731,768	13,119	78,475,764	18,379,715	1,953,656	521,491	285,776,036	24,695,950	310,471,986
77020	61,394,972	9,300,715	70,852	139,115,504	58,610,791	1,324,855	353,644	270,171,333	23,347,436	293,518,769
77021	80,140,194	33,272,882	13,439	94,699,933	18,219,615	2,021,243	539,532	228,906,837	19,781,476	248,688,313
77022	69,481,171	13,413,864	862,282	115,830,362	2,686,566	1,470,289	392,465	204,136,999	17,640,937	221,777,936
77023	64,448,790	15,892,378	938,500	129,394,016	4,966,625	1,479,434	394,906	217,514,649	18,796,995	236,311,645
77024	289,128,273	28,477,154	120,131	235,217,257	56,083,290	1,934,696	516,430	611,477,231	52,842,118	664,319,349
77025	90,047,052	32,358,301	18,700	105,607,481	14,222,195	2,080,799	555,429	244,889,957	21,162,691	266,052,649
77026	65,532,221	8,964,746	0	67,866,739	5,790,254	1,377,496	367,696	149,899,153	12,953,857	162,853,010

Zip Code	Single Family Residential	Multi-family Residential	Mobile Homes Residential	Small Commercial	Large Commercial and Industrial	Streetlights	Misc Street Lighting	Total Usage	T&D Losses	Total Generation
77027	59,504,710	45,839,335	0	129,384,727	125,152,058	1,693,905	452,155	362,026,890	31,285,331	393,312,221
77028	55,367,783	4,839,836	149,024	60,575,903	7,876,740	929,930	248,227	129,987,443	11,233,144	141,220,587
77029	53,358,976	4,772,577	280,092	171,147,412	30,162,243	1,045,028	278,950	261,045,278	22,558,788	283,604,066
77030	33,887,606	33,963,206	0	72,188,342	332,121,094	1,190,239	317,711	473,668,198	40,933,054	514,601,253
77031	41,226,551	17,218,536	67,074	39,539,070	15,028,907	968,185	258,438	114,306,761	9,878,064	124,184,825
77032	28,452,571	16,162,626	1,146,597	205,158,415	33,709,198	995,621	265,762	285,890,789	24,705,866	310,596,656
77033	95,252,503	7,990,824	18,553	45,127,793	21,281,398	1,513,339	403,957	171,588,367	14,828,177	186,416,544
77034	71,224,084	40,402,471	65,102	153,460,765	10,676,807	2,500,818	667,545	278,997,592	24,110,176	303,107,768
77035	94,470,572	45,938,529	12,660	72,422,452	100,751	2,360,849	630,183	215,935,996	18,660,573	234,596,569
77036	77,864,226	143,156,977	0	249,057,976	58,125,393	5,814,126	1,551,969	535,570,667	46,282,489	581,853,156
77037	47,242,205	7,913,959	7,353,033	97,664,717	14,118,152	970,861	259,153	175,522,080	15,168,117	190,690,197
77038	56,391,481	17,651,565	4,747,065	57,336,116	992,629	1,361,994	363,558	138,844,408	11,998,538	150,842,946
77039	70,144,617	14,478,027	5,238,250	118,887,957	6,465,047	1,340,246	357,753	216,911,896	18,744,907	235,656,804
77040	148,196,944	53,207,724	4,010,598	279,854,560	55,719,462	3,407,885	909,669	545,306,842	47,123,862	592,430,703
77041	160,864,887	10,937,072	4,034,272	387,134,084	109,053,958	2,148,497	573,500	674,746,270	58,309,648	733,055,918
77042	85,135,129	115,855,972	0	140,670,811	147,705,967	4,415,550	1,178,646	494,962,075	42,773,210	537,735,286
77043	79,703,447	21,304,755	15,391	158,276,761	12,857,186	1,544,456	412,263	274,114,258	23,688,172	297,802,430
77044	100,777,444	5,434,689	8,696,578	37,303,609	14,149,177	1,437,165	383,623	168,182,285	14,533,833	182,716,118
77045	99,214,069	8,498,815	1,975,404	59,471,457	10,057,608	1,520,811	405,951	181,144,116	15,653,958	196,798,073
77046	103,867	5,813,030	0	11,254,809	12,485,086	179,562	47,931	29,884,285	2,582,515	32,466,799
77047	68,053,317	4,653,197	6,399,743	46,793,222	66,617	1,206,522	322,058	127,494,676	11,017,726	138,512,402
77048	46,906,700	2,424,346	1,671,627	25,850,513	3,235,870	683,897	182,553	80,955,506	6,995,944	87,951,450
77049	97,753,236	8,097,891	2,340,348	76,087,217	89,591,952	1,571,334	419,437	275,861,415	23,839,157	299,700,572
77050	13,751,981	1,532,000	1,955,377	8,188,525	2,925,998	209,563	55,939	28,619,383	2,473,205	31,092,589
77051	39,960,290	13,062,226	33,181	0	0	931,826	248,733	54,236,256	4,686,943	58,923,198
77052	0	0	0	0	0	0	0	0	0	0
77053	109,629,328	510,362	4,432,418	34,325,890	18,472,529	1,392,553	371,715	169,134,795	14,616,146	183,750,941
77054	11,877,585	87,573,272	0	179,706,011	39,808,103	2,940,243	784,841	322,690,055	27,885,954	350,576,009
77055	112,420,914	46,119,148	21,082	222,796,916	9,532,393	2,732,576	729,408	394,352,437	34,078,813	428,431,249
77056	91,296,410	68,281,212	0	191,364,926	151,267,325	2,081,691	555,667	504,847,232	43,627,458	548,474,689
77057	106,694,513	99,274,053	0	212,902,277	33,237,415	3,695,295	986,388	456,789,941	39,474,484	496,264,424
77058	50,219,812	47,413,611	47,403	120,624,046	31,551,427	2,065,185	551,261	252,472,745	21,817,974	274,290,720

Zip Code	Single Family Residential	Multi-family Residential	Mobile Homes Residential	Small Commercial	Large Commercial and Industrial	Streetlights	Misc Street Lighting	Total Usage	T&D Losses	Total Generation
77059	115,866,414	0	0	14,218,599	150,772,106	807,583	215,569	281,880,270	24,359,289	306,239,559
77060	52,610,447	82,998,378	2,936,255	156,679,991	86,745,084	3,562,352	950,901	386,483,409	33,398,794	419,882,202
77061	50,521,821	32,154,460	0	110,621,653	9,714,121	1,853,057	494,638	205,359,749	17,746,604	223,106,353
77062	136,278,903	8,792,728	0	42,180,213	34,658,194	1,526,053	407,350	223,843,442	19,343,912	243,187,353
77063	64,115,846	84,198,547	0	157,949,439	28,104,021	3,262,674	870,908	338,501,434	29,252,328	367,753,763
77064	175,252,696	30,912,064	4,603,047	144,704,627	29,475,632	2,765,811	738,280	388,452,157	33,568,927	422,021,084
77065	75,737,183	49,176,303	78,380	138,580,250	492,421	2,230,248	595,322	266,890,107	23,063,882	289,953,989
77066	120,882,170	11,809,430	702,834	52,109,145	8,185,413	1,695,689	452,631	195,837,313	16,923,702	212,761,014
77067	80,679,682	38,094,733	2,051,604	74,509,006	11,567,657	2,308,207	616,131	209,827,021	18,132,653	227,959,673
77068	57,726,071	10,160,158	82,927	56,231,753	222,578	807,917	215,658	125,447,062	10,840,777	136,287,839
77069	96,603,841	32,793,848	99,789	94,468,596	1,731,545	1,596,986	426,285	227,720,889	19,678,990	247,399,879
77070	121,645,391	49,125,492	504,655	193,563,636	20,538,374	2,833,956	756,470	388,967,973	33,613,503	422,581,476
77071	94,206,090	30,725,275	56,208	0	0	1,740,970	464,718	127,193,261	10,991,679	138,184,940
77072	148,151,148	55,748,515	446,125	112,663,141	15,103,422	3,524,656	940,839	336,577,845	29,086,097	365,663,943
77073	93,841,716	21,046,625	391,404	117,664,342	11,876,694	2,194,894	585,884	247,601,559	21,397,020	268,998,579
77074	67,252,653	55,467,100	0	155,042,837	32,868,164	2,512,640	670,701	313,814,095	27,118,919	340,933,014
77075	87,652,073	25,850,398	4,404,858	77,753,059	23,129,687	2,061,393	550,249	221,401,717	19,132,905	240,534,622
77076	68,536,602	14,545,365	5,302,148	92,038,221	5,558,589	1,429,358	381,539	187,791,822	16,228,434	204,020,255
77077	184,208,744	119,233,797	0	171,300,155	30,109,837	5,350,499	1,428,212	511,631,245	44,213,713	555,844,957
77078	45,338,866	5,699,846	84,254	31,132,906	389,146	743,119	198,361	83,586,498	7,223,307	90,809,805
77079	155,898,453	36,506,792	64,304	123,303,470	70,082,376	2,053,586	548,165	388,457,146	33,569,358	422,026,505
77080	93,500,861	51,854,305	1,578,750	98,539,259	2,772,719	2,729,341	728,545	251,703,780	21,751,523	273,455,303
77081	17,142,233	94,349,787	286,515	149,543,825	34,862,821	3,388,590	904,519	300,478,290	25,966,477	326,444,766
77082	147,485,004	97,944,407	33,826	109,753,255	7,605,199	4,650,765	1,241,432	368,713,888	31,863,202	400,577,091
77083	232,099,804	27,799,916	1,220,615	95,587,178	4,069,461	3,551,534	948,013	365,276,522	31,566,155	396,842,676
77084	311,538,971	58,685,924	163,835	192,929,677	35,159,264	5,379,497	1,435,953	605,293,121	52,307,705	657,600,825
77085	47,737,828	3,007,346	467,146	14,942,852	1,933,551	746,242	199,195	69,034,159	5,965,735	74,999,894
77086	96,339,512	14,409,170	2,127,669	82,054,960	11,551,372	1,578,918	421,462	208,483,063	18,016,512	226,499,574
77087	87,799,709	17,661,644	1,913,752	144,430,265	5,871,653	1,889,415	504,343	260,070,781	22,474,575	282,545,356
77088	171,649,521	23,731,458	1,178,845	55,199,117	4,555,962	2,748,747	733,725	259,797,375	22,450,948	282,248,323
77089	183,631,939	25,169,914	61,658	64,997,984	4,758,309	2,760,681	736,910	282,117,395	24,379,780	306,497,176
77090	63,919,434	91,486,002	130,173	196,068,844	98,388,735	3,531,682	942,714	454,467,584	39,273,792	493,741,376

Zip Code	Single Family Residential	Multi-family Residential	Mobile Homes Residential	Small Commercial	Large Commercial and Industrial	Streetlights	Misc Street Lighting	Total Usage	T&D Losses	Total Generation
77091	57,791,833	31,176,995	217,533	87,069,692	26,810,486	1,888,746	504,164	205,459,449	17,755,219	223,214,669
77092	71,523,606	55,870,023	2,827,148	228,666,666	31,914,768	2,744,732	732,653	394,279,597	34,072,518	428,352,114
77093	111,089,582	15,694,009	5,956,017	119,932,852	2,963,997	2,073,550	553,494	258,263,501	22,318,395	280,581,896
77094	55,417,051	50,208	0	32,439,640	9,183,737	403,401	107,680	97,601,717	8,434,462	106,036,179
77095	242,716,941	25,095,153	39,336	106,691,810	87,957,572	2,972,252	793,385	466,266,449	40,293,416	506,559,865
77096	132,235,994	26,156,396	0	102,543,095	23,666,002	1,933,135	516,013	287,050,635	24,806,097	311,856,732
77097	0	0	0	0	0	0	0	0	0	0
77098	46,049,954	30,987,984	0	131,125,466	19,714,009	1,464,824	391,006	229,733,243	19,852,891	249,586,135
77099	120,550,001	64,156,989	26,430	121,033,521	7,566,330	3,500,900	934,498	317,768,668	27,460,662	345,229,330
77336	42,118,417	3,744,355	2,808,806	13,949,894	3,291,694	528,537	141,083	66,582,785	5,753,894	72,336,680
77338	115,503,559	19,864,775	1,303,931	233,348,356	13,933,437	2,392,412	638,608	386,985,078	33,442,146	420,427,224
77339	163,147,574	21,371,831	9,760	95,394,680	247,244	2,169,688	579,156	282,919,933	24,449,134	307,369,067
77345	168,750,444	8,461,019	0	0	0	1,373,593	366,654	178,951,710	15,464,496	194,416,206
77346	267,494,220	12,103,650	108,980	0	0	2,830,387	755,517	283,292,754	24,481,352	307,774,105
77396	130,933,296	15,250,682	9,532,404	70,567,676	15,368,953	2,214,969	591,243	244,459,223	21,125,469	265,584,692
77489	183,401,651	2,796,365	21,975	69,416,082	3,030,235	1,846,477	492,881	261,005,666	22,555,365	283,561,031
77477	91,984,330	52,958,587	5,722,200	204,205,815	25,977,334	2,680,491	715,505	384,244,263	33,205,293	417,449,556
77504	55,018,929	30,328,931	7,409,996	81,510,647	6,209,770	1,602,228	427,684	182,508,184	15,771,837	198,280,021
77532	140,163,616	12,045,867	7,799,348	55,391,726	34,420,238	1,609,812	429,708	251,860,315	21,765,050	273,625,365
77598	0	0	0	0	0	0	0	0	0	0
TOTAL	10,148,542,551	3,306,821,139	151,784,006	11,417,347,502	3,453,481,124	215,725,807	57,583,839	28,751,285,968	2,484,604,110	31,235,890,078

The table below presents the raw, input data for Btus of natural gas use.

Figure 14: Natural Gas Input Data By Zip Code and Sector/Rate Class in Btu, 2007

Zip Code	Residential	Small Commercial	Large Commercial	Industrial	Industrial/Transport	Total
77002	7,555,761,600	162,113,198,400	653,861,246,000	1,604,124,400	282,010,562,400	**1,107,144,892,800**
77003	74,980,863,600	52,791,662,800	45,972,354,000	55,264,476,000	244,267,356,400	**473,276,712,800**
77004	291,922,159,200	113,255,048,000	215,565,024,000	10,140,466,800	535,957,594,000	**1,166,840,292,000**
77005	26,043,318,706	20,700,540,806	17,269,248,528	0	186,091,853,371	**250,104,961,411**
77006	218,233,139,600	147,699,474,400	78,996,769,200	0	0	**444,929,383,200**

Zip Code	Residential	Small Commercial	Large Commercial	Industrial	Industrial/Transport	Total
77007	344,778,922,800	129,231,191,200	54,301,187,600	52,123,362,400	790,941,152,400	**1,371,375,816,400**
77008	400,554,033,200	115,133,816,400	143,128,177,600	12,792,307,200	486,027,314,800	**1,157,635,649,200**
77009	473,590,010,400	120,367,310,400	65,977,626,400	17,439,894,000	164,060,119,200	**841,434,960,400**
77010	0	9,181,247,200	32,932,867,200	0	129,653,329,200	**171,767,443,600**
77011	170,207,058,800	72,300,541,600	73,102,095,200	618,394,533,600	406,434,466,400	**1,340,438,695,600**
77012	138,565,018,400	44,302,111,600	111,351,866,800	0	44,901,242,400	**339,120,239,200**
77013	102,210,714,572	24,425,985,964	70,400,128,201	10,703,453,432	46,098,116,539	**253,838,398,709**
77014	0	0	0	0	0	**0**
77015	29,705,293,634	20,476,664,241	22,137,383,615	0	0	**72,319,341,490**
77016	345,177,435,313	30,060,693,142	29,060,742,820	0	29,577,266,808	**433,876,138,083**
77017	238,162,569,568	90,942,491,356	87,630,854,348	24,430,407,732	0	**441,166,323,004**
77018	363,861,594,800	100,330,504,800	51,438,786,800	0	0	**515,630,886,400**
77019	350,980,791,200	88,431,299,200	117,044,118,000	6,085,907,600	0	**562,542,116,000**
77020	250,381,745,600	77,330,595,600	97,737,662,000	36,078,049,600	123,477,908,000	**585,005,960,800**
77021	279,656,761,600	73,029,874,000	106,012,584,000	32,752,822,800	287,868,617,200	**779,320,659,600**
77022	265,254,226,800	89,232,852,800	156,309,055,200	8,716,386,800	97,660,354,800	**617,172,876,400**
77023	254,814,703,200	82,747,185,600	118,469,215,200	20,533,199,200	0	**476,564,303,200**
77024	168,225,585,750	54,533,831,412	132,437,390,342	0	41,282,319,444	**396,479,126,948**
77025	248,494,733,811	76,926,881,126	119,308,510,989	2,932,335,334	25,039,883,456	**472,702,344,717**
77026	293,615,797,200	68,792,218,800	76,204,555,200	4,775,754,000	242,085,462,400	**685,473,787,600**
77027	157,733,135,200	93,279,274,400	224,535,710,800	0	0	**475,548,120,400**
77028	205,993,172,000	31,791,568,800	33,890,052,400	9,044,942,400	131,959,321,600	**412,679,057,200**
77029	49,278,615,106	33,155,793,700	48,052,952,172	22,366,009,487	0	**152,853,370,466**
77030	99,285,840,400	66,003,056,400	362,874,910,800	7,986,037,200	2,211,953,277,200	**2,748,103,122,000**
77031	101,128,230,676	31,520,500,258	74,598,681,216	0	0	**207,247,412,150**
77032	487,491,066	6,655,515,187	51,833,297,648	1,865,284,397	4,110,374,998	**64,951,963,296**
77033	306,078,531,600	30,825,228,800	34,990,662,800	0	0	**371,894,423,200**
77034	198,218,449,962	70,645,333,416	193,647,281,330	0	0	**462,511,064,708**
77035	213,204,102,800	65,958,299,600	162,932,044,400	694,747,600	0	**442,789,194,400**
77036	162,326,810,400	209,848,360,000	506,887,035,200	0	0	**879,062,205,600**
77037	15,594,282,251	13,090,968,309	11,449,588,959	0	0	**40,134,839,520**
77038	25,767,710	97,138,531	495,799,555	0	0	**618,705,797**
77039						
77040	24,497,370,008	23,879,492,212	50,097,305,474	1,371,207,978	0	**99,845,375,673**

Zip Code	Residential	Small Commercial	Large Commercial	Industrial	Industrial/Transport	Total
77041	11,856,460,822	13,535,302,630	12,605,953,108	8,842,806,450	14,990,368,577	**61,830,891,588**
77042	203,059,567,200	98,749,776,000	300,776,885,200	0	0	**602,586,228,400**
77043	222,671,183,200	64,425,379,200	130,855,659,600	6,356,482,800	35,494,176,800	**459,802,881,600**
77044	446,681,002	50,616,889	0	0	0	**497,297,891**
77045	214,473,568,400	46,710,841,200	43,049,938,400	290,750,344,800	463,943,902,800	**1,058,928,595,600**
77046	0	6,382,930,000	41,304,423,200	0	61,801,003,200	**109,488,356,400**
77047	105,758,360,290	10,539,183,770	16,568,738,490	0	0	**132,866,282,550**
77048	134,428,326,403	15,291,189,202	65,060,246,270	0	0	**214,779,761,875**
77049	991,576,732	211,874,622	730,538,799	0	0	**1,933,990,154**
77050	17,710,592,281	901,955,309	635,645,228	0	0	**19,248,192,818**
77051	143,410,959,200	33,766,971,200	29,142,780,000	0	0	**206,320,710,400**
77052						
77053	122,832,594,286	12,308,842,212	6,472,291,020	0	0	**141,613,727,518**
77054	9,264,657,600	64,334,848,400	362,055,047,600	23,571,575,600	190,745,344,000	**649,971,473,200**
77055	188,587,610,534	132,791,586,502	197,447,666,662	6,005,060,544	37,538,407,021	**562,370,331,264**
77056	246,181,726,800	147,707,612,000	372,915,692,000	4,667,930,800	0	**771,472,961,600**
77057	222,537,930,000	194,192,634,800	332,354,842,000	0	0	**749,085,406,800**
77058	7,547,225,258	15,924,404,339	171,114,725,687	0	0	**194,586,355,284**
77059	196,410,513,267	1,878,857,914	32,004,692,544	0	0	**230,294,063,725**
77060	15,780,357,630	38,062,371,827	96,527,042,437	0	0	**150,369,771,894**
77061	151,645,193,200	59,094,234,000	170,919,098,800	41,197,617,200	0	**422,856,143,200**
77062	350,930,948,400	30,591,272,800	65,041,802,400	0	0	**446,564,023,600**
77063	123,125,899,837	101,683,185,498	299,735,117,786	33,702,334,243	0	**558,246,537,363**
77064	7,405,216	3,211,219,024	2,850,875,924	0	0	**6,069,500,164**
77065	0	0	0	0	0	**0**
77066	0	0	0	0	0	**0**
77067	314,964,791	737,446,604	1,745,515,200	0	0	**2,797,926,595**
77068	0	0	0	0	0	**0**
77069	0	0	0	0	0	**0**
77070	189,687,456	4,495,820,560	6,505,126,236	107,945,264	0	**11,298,579,516**
77071	140,415,530,001	22,804,154,146	51,496,654,291	0	0	**214,716,338,438**
77072	175,330,971,878	101,713,709,635	178,752,816,403	8,025,244,157	0	**463,822,742,074**
77073	0	0	0	0	0	**0**
77074	185,971,624,400	94,567,049,600	270,189,681,200	5,099,223,600	0	**555,827,578,800**

Zip Code	Residential	Small Commercial	Large Commercial	Industrial	Industrial/Transport	Total
77075	246,857,147,600	48,286,484,000	90,478,922,800	0	61,127,616,800	**446,750,171,200**
77076	235,188,846,400	69,199,098,800	74,910,676,800	0	0	**379,298,622,000**
77077	424,384,994,800	117,840,585,600	186,030,622,000	0	0	**728,256,202,400**
77078	119,648,150,000	21,676,532,000	53,858,705,600	7,897,540,800	4,314,962,400	**207,395,890,800**
77079	403,378,797,600	111,292,869,200	181,921,134,000	13,604,032,800	0	**710,196,833,600**
77080	267,376,106,000	79,836,976,400	256,628,370,800	15,044,388,000	0	**618,885,841,200**
77081	46,308,030,000	124,673,118,000	374,670,362,000	1,511,559,200	0	**547,163,069,200**
77082	121,732,758,992	31,061,178,512	66,356,024,800	0	0	**219,149,962,304**
77083	923,145,619	1,713,284,201	947,383,461	70,831,705	0	**3,654,644,986**
77084	424,884,440	1,403,390,152	1,412,016,008	0	80,602,928	**3,320,893,528**
77085	125,235,629,600	9,358,240,000	5,346,403,200	0	0	**139,940,272,800**
77086	4,577,400	2,054,744,000	3,143,961,760	0	7,690,845,760	**12,894,128,920**
77087	297,602,204,000	112,631,504,400	136,295,645,200	4,355,650,400	0	**550,885,004,000**
77088	243,652,445,776	23,900,506,547	45,036,468,968	0	0	**312,589,421,291**
77089	73,170,886,402	21,765,228,788	33,092,017,295	0	36,784,403,452	**164,812,535,937**
77090	3,580,544	1,022,428,408	1,492,639,280	0	0	**2,518,648,232**
77091	204,416,512,000	61,075,739,600	125,394,312,800	0	204,982,075,200	**595,868,639,600**
77092	199,126,054,800	151,446,839,200	195,075,564,400	60,828,560,000	12,675,329,200	**619,152,347,600**
77093	116,548,085,506	31,181,683,144	30,677,577,134	8,290,485,160	0	**186,697,830,944**
77094	522,861,144	8,298,337,944	7,719,937,680	0	0	**16,541,136,768**
77095	0	0	0	0	0	**0**
77096	346,833,666,800	77,108,846,000	246,381,098,000	4,514,333,600	0	**674,837,944,400**
77097						
77098	120,991,871,200	118,556,694,400	118,920,852,000	0	92,215,283,200	**450,684,700,800**
77099	124,122,129,242	67,992,447,334	152,021,809,466	4,895,287,206	0	**349,031,673,248**
77336	5,096,709,082	393,957,491	0	0	0	**5,490,666,573**
77338	162,979,853	839,507,366	515,956,390	0	0	**1,518,443,610**
77339	426,832,286,452	55,402,420,526	89,230,905,879	2,578,868,506	0	**574,044,481,364**
77345	522,265,064,800	14,023,119,200	20,848,531,200	0	0	**557,136,715,200**
77346	104,227,398	496,541,094	190,877,580	0	0	**791,646,072**
77396	6,091,487,959	2,191,189,174	4,016,930,938	766,781,635	0	**13,066,389,706**
77489	10,828,590,394	785,953,821	1,993,451,597	0	60,772,906,954	**74,380,902,765**
77477	6,566,408,467	1,020,027,816	609,132,928	0	0	**8,195,569,211**
77504	289,413,744	21,117,072	83,491,776	0	0	**394,022,592**

Zip Code	Residential	Small Commercial	Large Commercial	Industrial	Industrial/Transport	Total
77532	52,711,304	0	0	0	0	**52,711,304**
77598	17,885,884,323	5,588,191,640	19,176,063,166	2,694,568,903	0	**45,344,708,032**
TOTAL	**14,777,335,284,258**	**5,231,891,802,177**	**10,216,272,115,389**	**1,513,475,163,335**	**7,796,615,121,308**	**39,535,589,486,468**

Transportation

Briefly, the transportation sector was collected from three distinct sources—the City of Houston, Houston-Galveston Area Council (H-GAC), and the Texas Commission on Environmental Quality (TCEQ). This sector was divided into five transportation categories and further disaggregated by vehicle type and type of fuel. The on-road category (cars/buses) was quantified in vehicle miles traveled (VMT) and the non-road categories (trains, aviation, marine, and other non-road) were quantified in gallons of fuel used in 2007 or direct emissions entry. The details of this data collection process are outlined next.

Time Frame

The time frame for this data is for the year 2007; however, there are some deviations from this year as is noted in the assumptions below due to data availability.

Location

The data for this sector are for trips within Houston city limits (as defined by the map in Appendix A) for scope 1 and trips to/from Houston city limits for scope 3. The distinction between these two types of trips is discussed in the Assumptions section.

Assumptions

(1) Disaggregation. As the transportation summary stated, the transportation sector was categorized into five distinct categories—cars/buses, trains, aviation, marine, and other non-road. The next level of disaggregation was the scope of each category—within the community (scope 1) or depart/arrive into the community (scope 3). Next, the type of fuel used was defined. The last level of disaggregation was the vehicle type. Finally, depending on the emissions calculator used, either the vehicle miles traveled (VMT) or gallons of fuel used was required. Note that not all these pieces of information were required nor were these pieces of information available. However, for future inventories and record-keeping, this is the ideal structure and detail of data needed for the inventory. These categorical separations are depicted in the figure below.

Figure 15: Disaggregating Transportation Sector

Category	Scope	Fuel Type	Vehicle Type	VMT or Gallons
Cars/ Buses	1	Diesel	Buses	VMT
			Heavy Duty Vehicles	VMT
			Light Duty Trucks	VMT
			Motorcycles	VMT
			Passenger Cars	VMT
		Gasoline	Buses	VMT
			Heavy Duty Vehicles	VMT
			Light Duty Trucks	VMT
			Motorcycles	VMT
			Passenger Cars	VMT
	3	Diesel	Buses	VMT
			Heavy Duty Vehicles	VMT
			Light Duty Trucks	VMT

Category	Scope	Fuel Type	Vehicle Type	VMT or Gallons
			Motorcycles	VMT
			Passenger Cars	VMT
		Gasoline	Buses	VMT
			Heavy Duty Vehicles	VMT
			Light Duty Trucks	VMT
			Motorcycles	VMT
			Passenger Cars	VMT
Trains	1	Diesel	Locomotives	Gallons
	3	Diesel	Locomotives	Gallons
Aviation	1	Aviation Gasoline	Aircraft	Gallons
		Jet Kerosene	Aircraft	Gallons
	3	Aviation Gasoline	Aircraft	Gallons
		Jet Kerosene	Aircraft	Gallons
Marine	1	Gasoline/Diesel Oil	Ship/Boat	Gallons
		Motor Gasoline	Ship/Boat	Gallons
		Residual Fuel Oil	Ship/Boat	Gallons
	3	Gasoline/Diesel Oil	Ship/Boat	Gallons
		Motor Gasoline	Ship/Boat	Gallons
		Residual Fuel Oil	Ship/Boat	Gallons
Non-Road	1	Motor Gasoline	Agricultural Equipment	Gallons
			Construction Equipment	Gallons
			Other Non-Road	Gallons
		Diesel	Agricultural Equipment	Gallons
			Construction Equipment	Gallons
			Other Non-Road	Gallons
	3	Motor Gasoline	Agricultural Equipment	Gallons
			Construction Equipment	Gallons
			Other Non-Road	Gallons
		Diesel	Agricultural Equipment	Gallons
			Construction Equipment	Gallons
			Other Non-Road	Gallons

As the table also indicates and will be discussed in the quantification section, the on-road category was collected in vehicle miles traveled, whereas, the non-road categories were collected in gallons of fuel used or direct emissions entry.

(2) Coefficients. The default, pre-loaded emission factors and coefficients, which determine the amount of emissions emitted for a given quantity of activity entered in the software programs, were used. These values were collected from IPCC guidelines, UNFCC national reporting documents, and national environmental and energy agencies[8].

(3) Scope. The two scopes used for this sector are Scope 1 and Scope 3. Scope 1 activities are mobile combustion or tailpipe emissions generated from road vehicles, rail, sea, airborne, and non-road vehicles (construction equipment and landscaping equipment)

[8] Coefficients and their references can be viewed in the Administration section of Emissions Tracker (P2D, 2008).

operating within the community (P2D, October 2008). However, Scope 3 activities are mobile combustion or tailpipe emissions generated from road vehicles, rail, sea, and airborne departing from or arriving into the community (P2D, October 2008).

(4) Source. The source is an activity that causes the emissions. There are eleven classification categories from the IPCC guidelines. See Appendix C for the source categories and descriptions. On-road cars/buses are classified as "Mobile Fuel Combustion - Road" because the vehicle miles traveled and fuel used in 2005 by the community was on the road. The remaining categories—trains, aviation, marine, and other non-road—are classified as "Mobile Fuel Combustion - Nonroad" because these are activities that take place off the road.

(5) Quantification. To quantify the on-road activities, the "Mobile Combustion" calculator was used. The "Mobile Combustion" calculator calculated emissions for a specific class of vehicles using a specific fuel, such as all cars using diesel; the data required is either the amount of fuel used or total distance traveled. For all on-road calculations, the vehicle miles traveled was used. To quantify the non-road activities, the "Non-Road Combustion" calculator was used to calculate emissions for any vehicle not used on a public road, such as locomotives, ships, or tractors. The quantification requires fuel type, vehicle type, transportation mode, and total fuel used. When unavailable, the direct emissions were used. The assumptions and transformations for each of the five categories are depicted next.

Cars/Buses (On-Road). To determine the vehicle miles traveled (VMT) by fuel type, vehicle type, day of the week, and time of day, a five-step methodology was required.

First, a total VMT on weekdays (Monday to Thursday) in 2007 was retrieved from Alan Clark and David Gao at the HGAC, which was 55,428,838 miles each Monday to Thursday.

Second, this VMT was extrapolated to the remaining days of the week and the entire year using the 2004 Texas Transportation Institute (TTI) report. It is important to note that the extrapolated calculations were not holiday adjusted. Also, the ratios and data taken from the TTI report are 2004 numbers; therefore, all resulting calculations are conservative for two main reasons: (1) in 2004, there were more likely more SUVs on the road than smaller cars due to the increase in gas prices over the interim 3 years and (2) a hybrid car category does not exist in the MOBILE6 model used, so the resulting emissions calculation is likely slightly higher than actual.

Given these assumptions and caveats, the second step to determine the total VMT by day of the week was taken from the 2004 TTI report ratio between weekdays and Friday, Saturday, and Sunday. The figure below illustrates this calculation.

Figure 16: Disaggregating Car/Bus VMT by Day of the Week

VMT	Unit	Ratio/Calculation	Source
55,428,838	Per Monday -Thursday	Given	H-GAC, David Gao
61,347,053	Per Friday	1.1068	TTI, 2004
51,354,626	Per Saturday	0.9265	TTI, 2004
40,797,389	Per Sunday	0.7360	TTI, 2004
375,214,420	Per Week	Sum Monday - Sunday	Calculation
19,566,578,660	**Per Year**	**Per Week x 52**	Calculation

Third, using the 2004 TTI report ratios, the VMT mix by day of the week and time of day was calculated by multiplying the above VMT by the TTI factors shown below. The resulting 2007 VMT by time of day (Unit) is shown below.

Figure 17: Disaggregating Car/Bus VMT by Time of Day

2007 VMT	Unit	Factor[9]	Days	Source
2,660,525,469	Weekday AM	0.22966	209	TTI, 2004, pp. 139
3,096,339,143	Weekday Midday	0.26728	209	TTI, 2004, pp. 139
2,324,779,806	Weekday Overnite	0.200678	209	TTI, 2004, pp. 139
3,503,422,940	Weekday PM	0.30242	209	TTI, 2004, pp. 139
732,594,234	Friday AM	0.22965	52	TTI, 2004, pp. 140
849,254,243	Friday Midday	0.26622	52	TTI, 2004, pp. 140
641,933,105	Friday Overnite	0.20123	52	TTI, 2004, pp. 140
966,265,157	Friday PM	0.3029	52	TTI, 2004, pp. 140
272,251,412	Saturday AM	0.10195	52	TTI, 2004, pp. 141
780,836,812	Saturday Midday	0.2924	52	TTI, 2004, pp. 141
937,591,672	Saturday Overnite	0.3511	52	TTI, 2004, pp. 141
679,787,342	Saturday PM	0.25456	52	TTI, 2004, pp. 141
137,704,244	Sunday AM	0.06491	52	TTI, 2004, pp. 142
604,150,588	Sunday Midday	0.28478	52	TTI, 2004, pp. 142
788,887,694	Sunday Overnite	0.37186	52	TTI, 2004, pp. 142
590,749,298	Sunday PM	0.278463	52	TTI, 2004, pp. 142

Fourth, the vehicle mix was calculated by time of day and day of the week using the factors from the 2004 TTI report. However, before these factors are discussed, it is important to note that the MOBILE6 vehicle categorizations were used and are listed in the figure below.

Figure 18: On-Road Abbreviations and Definitions

Abbrev	Category in P2D	Type of Fuel
LDGV	Passenger Cars	Motor Gasoline
LDGT1	Light-Duty Truck	Motor Gasoline
LDGT2	Light-Duty Truck	Motor Gasoline
LDGT3	Light-Duty Truck	Motor Gasoline

[9] Due to rounding in factor numbers, will not add to 1; hence, VMT will not exactly sum to step 2 VMT breakdown.

Abbrev	Category in P2D	Type of Fuel
LDGT4	Light-Duty Truck	Motor Gasoline
HDGV2b	Heavy Duty Vehicle	Motor Gasoline
HDGV3	Heavy Duty Vehicle	Motor Gasoline
HDGV4	Heavy Duty Vehicle	Motor Gasoline
HDGV5	Heavy Duty Vehicle	Motor Gasoline
HDGV6	Heavy Duty Vehicle	Motor Gasoline
HDGV7	Heavy Duty Vehicle	Motor Gasoline
HDGV8a	Heavy Duty Vehicle	Motor Gasoline
HDGV8b	Heavy Duty Vehicle	Motor Gasoline
LDDV	Passenger Cars	Diesel
LDDT12	Light-Duty Truck	Diesel
HDDV2b	Heavy Duty Vehicle	Diesel
HDDV3	Heavy Duty Vehicle	Diesel
HDDV4	Heavy Duty Vehicle	Diesel
HDDV5	Heavy Duty Vehicle	Diesel
HDDV6	Heavy Duty Vehicle	Diesel
HDDV7	Heavy Duty Vehicle	Diesel
HDDV8a	Heavy Duty Vehicle	Diesel
HDDV8b	Heavy Duty Vehicle	Diesel
MC	Motorcycle	Gasoline
HDGB	Bus	Gasoline
HDDBT	Bus	Diesel
HDDBS	Bus	Diesel
LDDT34	Light-Duty Truck	Diesel

The following four tables in the figure below provide the factors used to determine the vehicle mix by time of day and day of the week. These factors were calculated from the 2004 TTI report by averaging the factors for freeway, arterial, and collectors by time of day, day of the week, and type of vehicle. It is important to note that the average was taken due to time constraints[10]. Two other important notes are that: (1) due to rounding in factor numbers, these factors will not add to 1 and (2) AM is 6am to 9am, MD is midday from 9am to 3pm, PM is 3pm to 7pm, and ON is overnight from 7pm to 6pm.

[10] Currently the import worksheets into P2D are not functional for the community inventory; therefore, it takes approximately 75 seconds to enter one entry into P2D, with approximately 60 seconds of that time waiting. So, for the 448 car/bus entries, there is approximately seven and half hours of waiting time. Thus, when the import worksheets become available, the more granular/detailed data may be used; however, at this time, the average of the three road types was used because the time of day, day of the week, vehicle type, and fuel type categories were the most important for now.

Figure 19: Disaggregating Car/Bus VMT by MOBILE6 Vehicle Type

2007 Weekday Averages VMT Mix					2007 Friday Averages VMT Mix				
Abbrev	AM	MD	PM	ON	Abbrev	AM	MD	PM	ON
LDGV	0.593	0.563	0.596	0.595	LDGV	0.644	0.622	0.646	0.645
LDGT1	0.06	0.057	0.06	0.06	LDGT1	0.055	0.053	0.056	0.056
LDGT2	0.198	0.189	0.201	0.201	LDGT2	0.184	0.178	0.186	0.186
LDGT3	0.045	0.043	0.046	0.046	LDGT3	0.042	0.041	0.043	0.043
LDGT4	0.021	0.02	0.021	0.021	LDGT4	0.019	0.019	0.02	0.02
HDGV2b	0.008	0.013	0.008	0.006	HDGV2b	0.005	0.008	0.005	0.003
HDGV3	0.003	0.005	0.003	0.004	HDGV3	0.002	0.003	0.002	0.001
HDGV4	0.001	0.002	0.001	0.001	HDGV4	8E-04	0.001	8E-04	6E-04
HDGV5	5E-04	9E-04	5E-04	4E-04	HDGV5	3E-04	5E-04	3E-04	2E-04
HDGV6	0.001	0.002	0.001	0.001	HDGV6	8E-04	0.001	8E-04	6E-04
HDGV7	5E-04	8E-04	5E-04	4E-04	HDGV7	3E-04	5E-04	3E-04	2E-04
HDGV8a	5E-04	8E-04	5E-04	4E-04	HDGV8a	3E-04	5E-04	3E-04	2E-04
HDGV8b	6E-05	1E-04	6E-05	4E-05	HDGV8b	4E-05	6E-05	4E-05	3E-05
LDDV	5E-04	5E-04	5E-04	5E-04	LDDV	6E-04	6E-04	6E-04	6E-04
LDDT12	5E-05	2E-04	5E-05	5E-05	LDDT12	4E-05	4E-05	4E-05	4E-05
HDDV2b	0.009	0.015	0.009	0.006	HDDV2b	0.006	0.01	0.006	0.004
HDDV3	0.004	0.007	0.004	0.003	HDDV3	0.003	0.005	0.003	0.002
HDDV4	0.003	0.004	0.003	0.002	HDDV4	0.002	0.003	0.002	0.001
HDDV5	0.002	0.003	0.002	0.001	HDDV5	0.001	0.002	0.001	8E-04
HDDV6	0.005	0.009	0.005	0.004	HDDV6	0.004	0.006	0.004	0.003
HDDV7	0.003	0.005	0.003	0.002	HDDV7	0.002	0.004	0.002	0.002
HDDV8a	0.006	0.01	0.006	0.004	HDDV8a	0.004	0.007	0.004	0.003
HDDV8b	0.028	0.047	0.022	0.039	HDDV8b	0.019	0.032	0.015	0.026
MC	0.001	0.001	0.001	0.001	MC	0.001	0.001	0.001	0.001
HDGB	0.002	2E-04	4E-04	2E-04	HDGB	3E-04	1E-04	2E-04	1E-04
HDDBT	0.002	8E-04	0.001	7E-04	HDDBT	0.001	5E-04	1E-03	4E-04
HDDBS	0.003	0.001	0.003	0.001	HDDBS	0.002	1E-03	0.002	8E-04
LDDT34	0.001	0.001	0.001	0.001	LDDT34	0.001	0.001	0.001	0.001

2007 Saturday Averages VMT Mix					2007 Sunday Averages VMT Mix				
Abbrev	AM	MD	PM	ON	Abbrev	AM	MD	PM	ON
LDGV	0.67	0.655	0.671	0.67	LDGV	0.629	0.62	0.629	0.629
LDGT1	0.055	0.054	0.055	0.055	LDGT1	0.065	0.064	0.065	0.065
LDGT2	0.182	0.178	0.183	0.183	LDGT2	0.216	0.213	0.217	0.217
LDGT3	0.039	0.038	0.039	0.039	LDGT3	0.045	0.034	0.045	0.045
LDGT4	0.018	0.018	0.018	0.018	LDGT4	0.02	0.02	0.021	0.021
HDGV2b	0.003	0.005	0.003	0.002	HDGV2b	0.002	0.003	0.001	0.001
HDGV3	0.001	0.002	0.001	8E-04	HDGV3	7E-04	0.001	6E-04	5E-04
HDGV4	5E-04	9E-04	5E-04	4E-04	HDGV4	4E-04	6E-04	3E-04	3E-04
HDGV5	2E-04	6E-04	2E-04	1E-04	HDGV5	1E-04	4E-04	1E-04	9E-05
HDGV6	5E-04	6E-04	5E-04	4E-04	HDGV6	3E-04	4E-04	3E-04	2E-04
HDGV7	2E-04	3E-04	2E-04	1E-04	HDGV7	1E-04	2E-04	1E-04	9E-05
HDGV8a	2E-04	3E-04	2E-04	1E-04	HDGV8a	1E-04	2E-04	1E-04	9E-05
HDGV8b	2E-05	4E-05	2E-05	2E-05	HDGV8b	2E-05	3E-05	1E-05	1E-05
LDDV	6E-04	6E-04	6E-04	6E-04	LDDV	6E-04	6E-04	6E-04	6E-04
LDDT12	4E-05	4E-05	4E-05	4E-05	LDDT12	5E-05	5E-05	5E-05	5E-05
HDDV2b	0.004	0.006	0.004	0.003	HDDV2b	0.003	0.004	0.002	0.002
HDDV3	0.002	0.003	0.002	0.001	HDDV3	0.002	0.002	0.001	9E-04
HDDV4	0.001	0.002	0.001	8E-04	HDDV4	9E-04	0.001	7E-04	5E-04
HDDV5	8E-04	0.001	7E-04	5E-04	HDDV5	6E-04	8E-04	5E-04	3E-04
HDDV6	0.002	0.004	0.002	0.002	HDDV6	0.001	0.003	0.002	0.001
HDDV7	0.001	0.002	0.001	1E-03	HDDV7	9E-04	0.002	9E-04	7E-04
HDDV8a	0.003	0.004	0.002	0.002	HDDV8a	0.002	0.003	0.002	0.001
HDDV8b	0.012	0.02	0.01	0.016	HDDV8b	0.008	0.014	0.005	0.011
MC	0.001	0.001	0.001	0.001	MC	0.001	0.001	0.001	0.001
HDGB	2E-04	8E-05	1E-04	7E-05	HDGB	1E-04	6E-05	1E-04	5E-05
HDDBT	7E-04	3E-04	6E-04	3E-04	HDDBT	5E-04	2E-04	4E-04	2E-04
HDDBS	0.001	6E-04	0.001	2E-04	HDDBS	9E-04	4E-04	7E-04	3E-04
LDDT34	0.001	0.001	0.001	0.001	LDDT34	0.001	0.001	0.001	0.001

Finally, the final step was to retrieve the 2007 average miles per gallon by the 28 MOBILE6 vehicle categories for Harris County. This was obtained from a March 31, 2008 HGAC report by Dr. Graciela Lubertino and Christine Smith entitled "Fuel Economy in Harris County". The figure below lists the average fuel efficiency of the 28 vehicle categories in Harris County. These Harris County-specific numbers were used instead of the default fuel efficiency provided in the P2D software.

Figure 20: Fuel Efficiency for 28 MOBILE6 Vehicle Categories in Harris County, 2007

Abbrev	Fuel Efficiency (mpg)
LDGV	23.5075655
LDGT1	18.26768288
LDGT2	18.26768284
LDGT3	14.03816041
LDGT4	14.03816398
HDGV2b	9.794588304
HDGV3	9.078641622
HDGV4	9.022625035
HDGV5	7.766559953
HDGV6	7.853433708
HDGV7	7.207233373
HDGV8a	6.832238782
HDGV8b	6.510381524
LDDV	31.60763415
LDDT12	21.65162718
HDDV2b	12.51675332
HDDV3	11.26102306
HDDV4	9.885361746
HDDV5	9.562000023
HDDV6	8.443839729
HDDV7	7.3326573
HDDV8a	6.368305316
HDDV8b	6.075316769
MC	48.88964027
HDGB	6.281329977
HDDBT	4.224546503
HDDBS	6.049766068
LDDT34	16.6542067

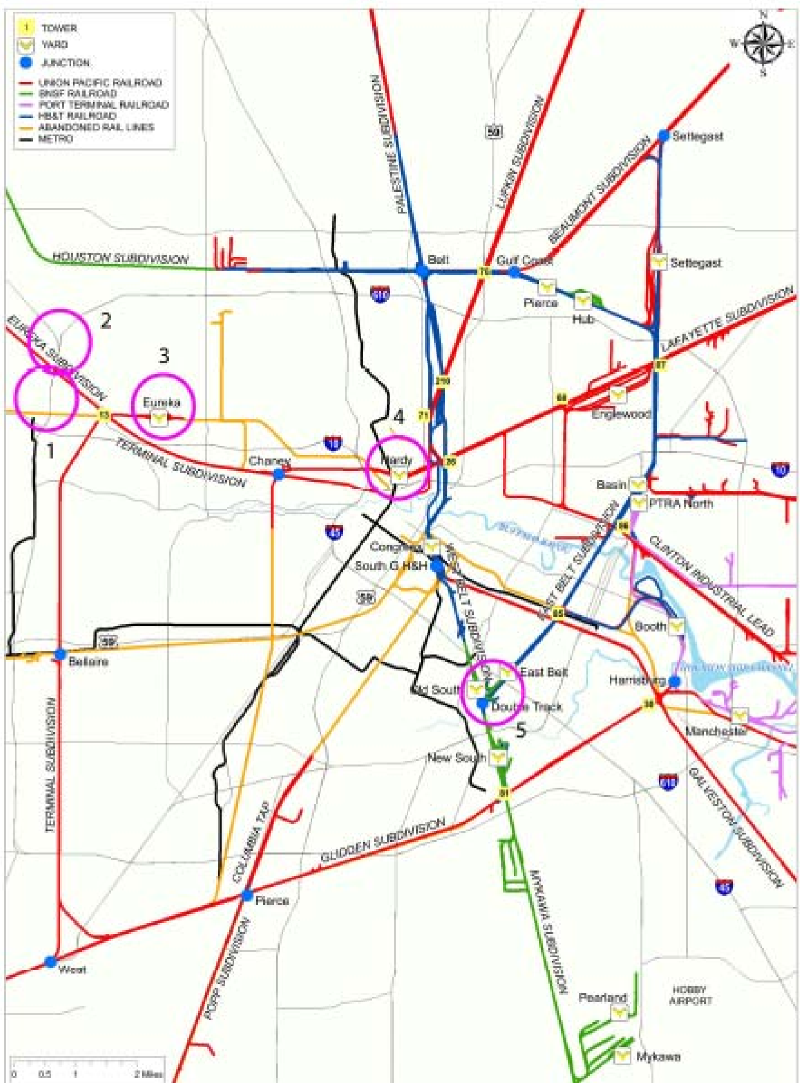
The final input numbers for cars/buses is provided in the input section.

Trains. The quantification of the train data has two important caveats. To begin, the source of this data is the 2006 Eastern Research Group (ERG) report prepared for the TCEQ and HARC entitled the "Texas Railroad Emissions Inventory Model (TREIM) and Results". This report collected fuel use data from all the railroad companies in Houston/Harris County. The first major caveat is that the fuel use data for Union Pacific is from 2003, the fuel use data for Burlington Northern Santa Fe (BNSF) is from 2004, and the remaining railroad companies' fuel use data is from 2003. However, according to

Karla Hardison and Theo Kosub at the TCEQ, fuel use between 2003 and 2007 has not changed significantly. Therefore, since this is the best, most recent data available, this data was used as a proxy for 2007.

The second major caveat is the scope of the data varied between scope 1 and scope 3. Scope 3 data, or trips that cross city limits, are line haul locomotives or trains. Scope 1 data, or trips that stay within city limits, are mainly switchers, or the trains that tow or push the locomotives into the yards. BNSF provided the location of each of their rail yards in the data set; however, Union Pacific did not. Therefore, the map below from the HGAC shows that circled in pink the Houston Union Pacific (UP) rail yard locations and therefore switchers at these locations are within city limits and scope 1. This distinction is made clear in the input data section.

Figure 21: Map of Union Pacific Rail Yard Locations, 2008[11]



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11 (HGAC, 2008)

Air. The quantification of the aviation data requires three main points. First, the fuel data for air transportation was not readily available; therefore, a direct entry of CO2 emissions was used for air. Second, the available CO2 emissions data was for the year 2005 and 2011. Finally, third, to calculate the CO2 emissions in 2007, we applied the equation of a line:

$$Y = Y0 + (X-X0)*((Y1-Y0)/(X1-X0))$$

Where:

Y = 2007 CO2 emissions
Y1 = 2011 CO2 emissions
Y0 = 2005 CO2 emissions
X = 2007
X1 = 2011
X0 = 2005

The figure below presents the data for 2005, 2007, and 2011. Since the air emissions were for trips that arrived into and departed from the Houston city limits, this is a scope 3 emission source.

Figure 22: Air Calculation Data

Place	2005	2007	2011
HOU	169,854	177,404	192,503
IAH	595,394	652,697	767,303
EFD	36,309	37,825	40,856
Total	**801,557**	**867,925**	**1,000,662**

Boats. Like air, the quantification of the boat/marine data requires three points. First, the amount of fuel used in 2007 was not readily available. However, second, the 2007 CO2 emissions were available from the Port of Houston Authority's "2007 Goods Movement Air Emissions Inventory at the Port of Houston" (or GMEI). Therefore, boats were entered as a direct emissions entry. Finally, third, the boat data was separated into ocean-going and harbor vessels. However, according to Ken Gathright, the Environmental Compliance Coordinator at the Port, all vessels leave the ship channel at least once; therefore, all of these emissions were categorized as scope 3.

Nonroad. The nonroad data requires five caveats and points. First, this data was received from Anasuya Iyer in the TCEQ, nonroad section using the EPA's NONROAD model. Second, the original data retrieved was for Harris County in 2007 by SCC classification (type of vehicle) and fuel category. The vehicle types are listed in the figure below. It is important to note that railroad equipment does not double count the railroad category. The railroad section is for locomotives and switchers, whereas, this railroad equipment category accounts for equipment specifically designed for repair, maintenance, and construction of rail lines including ballast handlers, rail/tie handlers, and rail straightening equipment (EPA, 2005). Moreover, the types of fuel are CNG, LPG, diesel, and gasoline.

Third, another important note is that to calculate the Houston city limit fuel used, Ms. Iyer provided the City with an estimated percent of nonroad pieces of equipment in Houston as a percent of total in Harris County. This percent was 56.1042%. The figure below presents this calculation.

Figure 23: Calculating Houston Nonroad Fuel Usage

Vehicle Type	Fuel Type	Total Harris County Gallons Used	Houston Gallons Used (56.1042%)
Agricultural Equipment	CNG	113,838	63,868
Agricultural Equipment	Diesel	55,501	31,139
Agricultural Equipment	Gasoline	4,821	2,705
Agricultural Equipment	LPG	16	9
Commercial Equipment	CNG	266,724,840	149,643,838
Commercial Equipment	Diesel	1,065,211	597,628
Commercial Equipment	Gasoline	814,734	457,100
Commercial Equipment	LPG	1,791,185	1,004,930
Construction and Mining Equipment	CNG	616,830	346,068
Construction and Mining Equipment	Diesel	2,892,757	1,622,958
Construction and Mining Equipment	Gasoline	298,314	167,367
Construction and Mining Equipment	LPG	246,730	138,426
Industrial Equipment	CNG	691,368,989	387,887,040
Industrial Equipment	Diesel	67,565	37,907
Industrial Equipment	Gasoline	719,598	403,725
Industrial Equipment	LPG	31,138,056	17,469,757
Lawn and Garden Equipment (Com)	Diesel	82,490	46,280
Lawn and Garden Equipment (Com)	Gasoline	276,617	155,194
Logging Equipment	Diesel	0	0
Logging Equipment	Gasoline	3	2
Pleasure Craft	Diesel	18,021	10,111
Pleasure Craft	Gasoline	603,918	338,824
Railroad Equipment	Diesel	9,402	5,275
Railroad Equipment	Gasoline	1	1
Railroad Equipment	LPG	131	73
Recreational Equipment	Diesel	8,015	4,497
Recreational Equipment	Gasoline	1,126,923	632,251
Recreational Equipment	LPG	3,579	2,008
	Total	**1,000,048,085**	**561,068,978**

Fourth, the data was recorded as scope 1 because this fuel was used within city limits. Finally, the P2D software does not have emission factors (EFs) for several gasoline nonroad vehicles, all CNG nonroad, and all LPG nonroad. Therefore, the emissions factors from the 2008 Local Government Operations Protocol (LGOP) were used as a proxy for these types of fuels and vehicles.

For LPG CH4 and N2O emissions, the petroleum products commercial/institutional emissions factors were used from Table G.3, pp. 172 of the 2008 LGOP. For CNG CH4 and N2O emissions, the natural gas commercial/institutional emissions factors were used from Table G.3, pp. 172 of the 2008 LGOP. For gasoline nonroad equipment, the other nonroad CH4 and N2O emissions factors from Table G.12, pp. 179 of the 2008 LGOP were used. For CO2 emissions for all three of these fuel types, Table G.9, pp. 177 of the 2008 LGOP were used. These emission factors are presented below.

Figure 24: Emissions Factors for Nonroad Fuel not in P2D

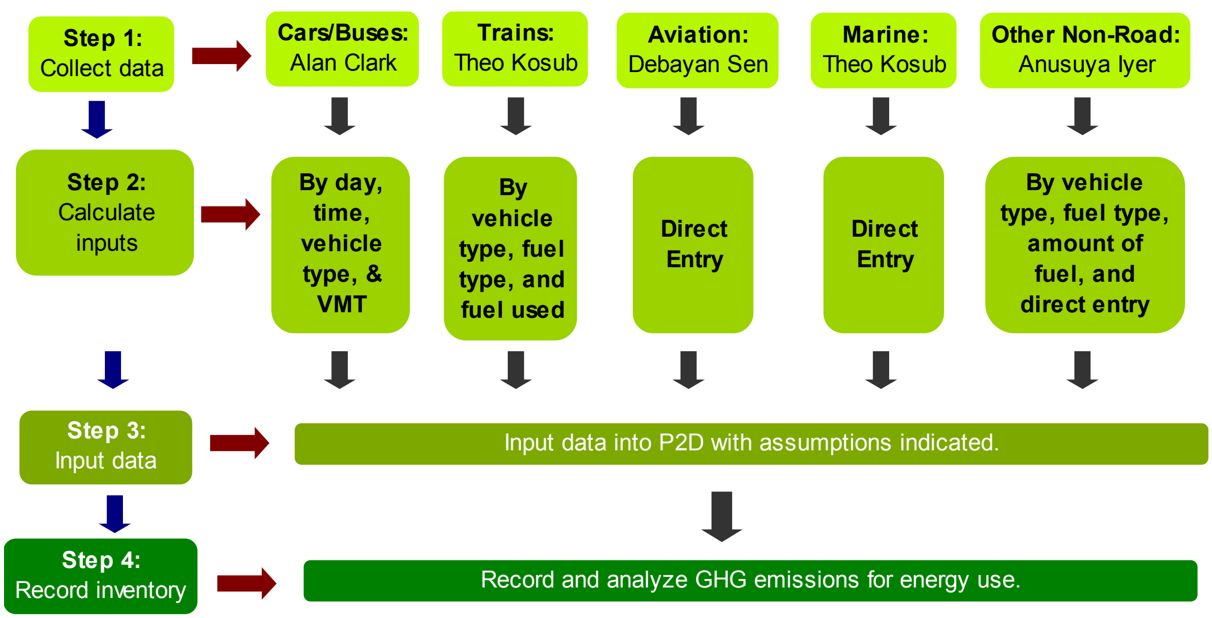
	CH4 (kg/gallon)	N2O (kg/gallon)	CO2 (kg/gallon)
LPG	0.001366881	0.000074557	5.79
CNG	0.000621310	0.000012426	0.007218759
Motor Gasoline	0.0005	0.00022	8.81

The input data is presented in the input data section of this section.

Methodology

To quantify the emissions from the Houston community's transportation sector, a four-step process took place as displayed in the figure below. For contact information, see references section.

Figure 25: Transportation Methodology Map



As the methodology illustrates, data for each of the five transportation categories comes from the City of Houston, Houston-Galveston Area Council, and the Texas Commission on Environmental Quality. Once collected, the data was formatted to fit the disaggregation categories and assumptions discussed above. Then the data was input into P2D. Finally, the emissions inventory for transportation was recorded and reported in the "Results and Analysis" section. The input data for transportation is presented in the following figures.

Input Data

Figure 26: Weekday On-Road VMT Input Data, Cars/Buses, 2007

Abbrev	AM	MD	PM	ON	Total
LDGV	1,577,342,542	1,742,181,228	2,088,193,639	1,382,996,395	**6,790,713,805**
LDGT1	158,585,143	175,332,475	211,153,169	140,171,591	**685,242,378**
LDGT2	527,918,580	583,669,321	702,914,400	466,621,123	**2,281,123,424**
LDGT3	119,798,052	132,550,357	159,765,662	106,009,494	**518,123,565**
LDGT4	55,092,033	60,956,493	73,472,151	48,751,097	**238,271,775**
HDGV2b	21,638,586	41,232,194	27,861,672	13,502,631	**104,235,082**
HDGV3	8,088,441	15,412,441	10,414,509	8,191,749	**42,107,139**
HDGV4	3,919,131	7,467,854	5,046,214	2,445,513	**18,878,712**
HDGV5	1,417,617	2,701,143	1,825,167	884,579	**6,828,505**
HDGV6	3,793,998	7,229,539	4,885,173	2,367,478	**18,276,188**
HDGV7	1,334,254	2,542,198	1,717,962	832,581	**6,426,994**
HDGV8a	1,334,254	2,542,198	1,717,962	832,581	**6,426,994**
HDGV8b	166,726	317,788	214,760	104,073	**803,346**
LDDV	1,406,088	1,553,021	1,861,369	1,232,753	**6,053,230**
LDDT12	120,965	519,153	161,041	106,940	**908,099**
HDDV2b	23,574,916	44,926,642	30,626,223	14,783,042	**113,910,824**
HDDV3	11,363,459	21,655,280	14,762,373	7,125,683	**54,906,795**
HDDV4	6,868,945	13,090,083	8,923,452	4,307,275	**33,189,754**
HDDV5	4,494,514	8,565,093	5,838,921	2,818,331	**21,716,860**
HDDV6	14,246,670	27,149,940	18,507,883	8,933,586	**68,838,080**
HDDV7	8,649,812	16,483,877	11,236,996	5,424,021	**41,794,706**
HDDV8a	15,603,450	29,735,693	20,270,572	9,784,456	**75,394,170**
HDDV8b	73,352,638	144,562,708	78,624,752	89,529,518	**386,069,615**
MC	2,660,525	3,096,339	3,503,423	2,324,780	**11,585,067**
HDGB	4,358,650	690,690	1,425,426	444,885	**6,919,652**
HDDBT	4,627,097	2,401,933	4,957,227	1,547,296	**13,533,553**
HDDBS	8,327,533	4,322,799	8,921,583	2,784,621	**24,356,537**
LDDT34	3,469,325	3,835,642	4,619,263	3,066,462	**14,990,692**
Total	**2,663,553,946**	**3,096,724,121**	**3,503,422,940**	**2,327,924,535**	**11,591,625,542**

Figure 27: Friday On-Road VMT Input Data, Cars/Buses, 2007

Abbrev	AM	MD	PM	ON	Total
LDGV	471,496,550	528,102,749	623,888,456	413,856,734	**2,037,344,489**
LDGT1	40,505,331	45,397,310	53,886,514	35,793,912	**175,583,067**
LDGT2	134,839,341	151,124,368	179,384,485	119,155,409	**584,503,603**
LDGT3	30,867,638	34,618,066	41,125,244	27,294,996	**133,905,943**
LDGT4	14,195,210	15,919,978	18,912,450	12,552,274	**61,579,913**
HDGV2b	3,432,863	6,627,807	4,414,801	2,139,242	**16,614,713**
HDGV3	1,283,188	2,477,473	1,650,252	799,656	**6,210,569**
HDGV4	621,777	1,200,421	799,584	387,449	**3,009,232**
HDGV5	224,906	434,195	289,235	140,155	**1,088,493**
HDGV6	601,924	1,162,091	774,107	375,103	**2,913,225**
HDGV7	211,671	408,633	272,197	131,896	**1,024,396**
HDGV8a	211,671	408,633	272,197	131,896	**1,024,396**
HDGV8b	26,471	51,097	34,045	16,476	**128,089**
LDDV	418,995	469,326	554,411	367,763	**1,810,495**
LDDT12	30,940	34,678	41,163	27,325	**134,106**
HDDV2b	4,384,528	8,466,385	5,689,273	2,744,842	**21,285,027**
HDDV3	2,113,388	4,080,921	2,742,325	1,323,067	**10,259,701**
HDDV4	1,277,522	2,466,800	1,657,660	799,763	**6,201,746**
HDDV5	835,914	1,614,093	1,084,633	523,304	**4,057,944**
HDDV6	2,649,647	5,116,389	3,438,132	1,658,777	**12,862,945**
HDDV7	1,608,728	3,106,374	2,087,423	1,007,086	**7,809,611**
HDDV8a	2,901,977	5,603,663	3,765,568	1,816,735	**14,087,942**
HDDV8b	13,612,822	27,142,703	14,546,349	16,588,985	**71,890,859**
MC	732,594	849,254	966,265	641,933	**3,190,047**
HDGB	211,231	110,884	226,235	70,441	**618,792**
HDDBT	860,798	451,916	922,010	287,051	**2,521,776**
HDDBS	1,549,193	813,331	1,659,335	516,564	**4,538,422**
LDDT34	887,538	994,703	1,180,712	784,292	**3,847,245**
Total	**732,594,356**	**849,254,243**	**966,265,061**	**641,933,127**	**3,190,046,786**

Figure 28: Saturday On-Road VMT Input Data, Cars/Buses, 2007

Abbrev	AM	MD	PM	ON	Total
LDGV	182,350,039	511,671,587	456,019,749	628,450,790	**1,778,492,165**
LDGT1	14,892,688	41,805,430	37,434,779	51,621,828	**145,754,725**
LDGT2	49,576,746	139,167,348	124,617,709	171,845,333	**485,207,136**
LDGT3	10,661,855	29,946,029	26,836,463	36,967,083	**104,411,431**
LDGT4	4,903,103	13,771,437	12,341,403	17,000,225	**48,016,167**
HDGV2b	808,750	3,909,676	1,964,699	1,975,506	**8,658,630**
HDGV3	302,308	1,461,388	734,397	738,416	**3,236,509**
HDGV4	146,480	708,115	355,823	357,785	**1,568,204**
HDGV5	52,989	447,029	128,729	129,450	**758,197**
HDGV6	141,798	504,134	344,494	346,346	**1,336,772**
HDGV7	49,867	241,044	121,138	121,824	**533,874**
HDGV8a	49,867	241,044	121,138	121,824	**533,874**
HDGV8b	6,225	30,140	15,137	15,220	**66,723**
LDDV	162,216	455,202	405,674	559,055	**1,582,147**
LDDT12	11,344	31,858	28,483	39,316	**111,001**
HDDV2b	1,033,103	4,995,013	2,532,231	2,534,592	**11,094,939**
HDDV3	656,525	2,407,684	1,220,581	1,221,682	**5,506,472**
HDDV4	359,372	1,455,376	737,796	738,478	**3,291,022**
HDDV5	227,784	952,309	482,740	482,172	**2,145,004**
HDDV6	497,694	3,018,559	1,530,269	1,531,681	**6,578,203**
HDDV7	379,056	1,832,702	929,088	929,935	**4,070,780**
HDDV8a	683,778	3,306,037	1,676,016	1,677,539	**7,343,369**
HDDV8b	3,203,591	15,981,830	6,460,631	15,312,028	**40,958,080**
MC	272,251	780,837	679,787	937,592	**2,670,467**
HDGB	49,777	65,382	100,790	65,038	**280,986**
HDDBT	202,855	266,422	410,660	265,026	**1,144,961**
HDDBS	365,080	479,408	739,019	159,506	**1,743,014**
LDDT34	325,386	913,397	817,920	1,127,892	**3,184,594**
Total	**272,372,528**	**780,846,416**	**679,787,342**	**937,273,162**	**2,670,279,449**

Figure 29: Sunday On-Road VMT Input Data, Cars/Buses, 2007

Abbrev	AM	MD	PM	ON	Total
LDGV	86,613,183	374,406,840	371,675,001	496,100,678	**1,328,795,703**
LDGT1	8,925,838	38,598,315	38,494,012	51,388,302	**137,406,467**
LDGT2	29,713,491	128,491,069	128,143,881	171,068,009	**457,416,450**
LDGT3	6,129,831	20,480,624	26,470,669	35,293,310	**88,374,434**
LDGT4	2,818,948	12,196,854	12,173,177	16,230,470	**43,419,449**
HDGV2b	274,399	2,043,801	836,875	1,113,673	**4,268,748**
HDGV3	102,567	763,948	333,104	416,296	**1,615,915**
HDGV4	49,697	370,163	150,503	201,719	**772,082**
HDGV5	17,970	232,840	74,927	72,946	**398,683**
HDGV6	48,114	264,312	200,520	195,276	**708,222**
HDGV7	16,919	126,026	70,516	68,686	**282,147**
HDGV8a	16,919	126,026	70,516	68,686	**282,147**
HDGV8b	2,116	15,748	8,802	8,573	**35,239**
LDDV	77,206	333,753	331,292	442,224	**1,184,475**
LDDT12	6,770	29,301	29,203	38,971	**104,246**
HDDV2b	350,448	2,610,575	1,473,585	1,428,255	**5,862,863**
HDDV3	222,934	1,258,325	710,278	688,462	**2,879,999**
HDDV4	121,992	760,646	429,357	416,138	**1,728,133**
HDDV5	77,316	497,679	280,941	272,298	**1,128,234**
HDDV6	168,651	1,577,598	890,515	863,122	**3,499,886**
HDDV7	128,584	957,840	540,673	524,058	**2,151,156**
HDDV8a	231,949	1,727,851	975,327	945,350	**3,880,477**
HDDV8b	1,088,116	8,374,897	3,181,126	8,678,264	**21,322,403**
MC	137,704	604,151	590,749	788,888	**2,121,492**
HDGB	16,883	34,195	58,583	36,762	**146,422**
HDDBT	68,802	139,357	238,722	149,810	**596,691**
HDDBS	123,824	250,823	429,652	269,616	**1,073,914**
LDDT34	194,342	840,394	838,135	1,118,879	**2,991,750**
Total	**137,745,514**	**598,113,951**	**589,700,639**	**788,887,721**	**2,114,447,826**

Figure 30: Train Input Data, 2007

Rail Company	Segment Code	Train Type	Scope	Fuel	Fuel Used (gallons)
Union Pacific	No. 1, 1190-0	General Line Haul	3	Diesel	206,973
Union Pacific	No. 2, 1190-0	General Line Haul	3	Diesel	289,658
Union Pacific	No. 1, 1191-0	General Line Haul	3	Diesel	13,885
Union Pacific	No. 2, 1191-0	General Line Haul	3	Diesel	19,092
Union Pacific	No. 1, 1196-0	General Line Haul	3	Diesel	66,555
Union Pacific	No. 2, 1196-0	General Line Haul	3	Diesel	46,589
Union Pacific	No. 1, 1197-0	General Line Haul	3	Diesel	109,620
Union Pacific	No. 2, 1197-0	General Line Haul	3	Diesel	76,734
Union Pacific	No. 1, 1660-0	General Line Haul	3	Diesel	104,400
Union Pacific	No. 1, 1660-0	General Line Haul	3	Diesel	114,188
Union Pacific	No. 2, 1660-0	General Line Haul	3	Diesel	168,998
Union Pacific	No. 2, 1660-0	General Line Haul	3	Diesel	138,578
Union Pacific	SIMN, 1660-0	General Line Haul	3	Diesel	8,091
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Baretable Intermodal	3	Diesel	216
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Loaded Unit Coal	3	Diesel	10,659
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Lite Engine	3	Diesel	150
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Empty Unit Coal	3	Diesel	6,223
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Loaded Unit Grain	3	Diesel	3,556
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Manifest (High Priority)	3	Diesel	148,491
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Manifest (Normal Priority)	3	Diesel	126,921
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Officer Specials	3	Diesel	47
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Intermodal Premium	3	Diesel	17,162
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Intermodal Guarantee	3	Diesel	106
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Intermodal D-Stack	3	Diesel	5,068
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Unit (Not Grain or Coal)	3	Diesel	87,830
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Vehicle (Auto)	1	Diesel	196
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Work Train	1	Diesel	100
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Empty Unit Grain	3	Diesel	36,406
Burlington Northern Santa Fe Railway	HOUSTON - MP 70.6 - 110.5	Yard Engines	1	Diesel	11,455
Burlington Northern Santa Fe Railway	Houston1	Switcher	1	Diesel	2,309,720
Port Terminal Rail Association	HoustonShip1	Switcher	1	Diesel	3,005,913

Rail Company	Segment Code	Train Type	Scope	Fuel	Fuel Used (gallons)
Rail Link	HoustonShip1	Switcher	1	Diesel	150,000
Trans Global	HoustonShip1	Switcher	1	Diesel	1,072,370
Union Pacific	BASIN1	Switcher	1	Diesel	31,392
Union Pacific	CONGRESS1	Switcher	1	Diesel	20,056
Union Pacific	ENGLEWOOD1	Switcher	1	Diesel	1,030,661
Union Pacific	EUREKA1	Switcher	1	Diesel	13,952
Union Pacific	HARDY1	Switcher	1	Diesel	75,841
Union Pacific	HOUSTON1	Switcher	1	Diesel	940,858

Figure 31: Direct Entry Air Data, 2007

Place	2007	Scope
HOU	177,404	3
IAH	652,697	3
EFD	37,825	3
Total	**867,925**	

Figure 32: Direct Entry Boat Data, 2007

GHG Emission Name	Scope	Gas	Value	Unit
Ocean-going Vessels	3	CO2	195,580	tpy
Harbor Vessels	3	CO2	5,276	tpy
		TOTAL	**200,856**	tpy

Figure 33: Nonroad Input Data, 2007

Vehicle Type	Fuel Type	Scope	Gallons	CH4	N2O	CO2
Agricultural Equipment	CNG	1		39.68168	0.79363	461
Commercial Equipment	CNG	1		92,975.13794	1,859.50276	1,080,243
Construction and Mining Equipment	CNG	1		215.01505	4.30030	2,498
Industrial Equipment	CNG	1		240,997.90308	4,819.95806	2,800,063
Agricultural Equipment	Diesel	1	31,139			
Commercial Equipment	Diesel	1	597,628			
Construction and Mining Equipment	Diesel	1	1,622,958			
Industrial Equipment	Diesel	1	37,907			
Lawn and Garden Equipment (Com)	Diesel	1	46,280			
Logging Equipment	Diesel	1				
Pleasure Craft	Diesel	1	10,111			
Railroad Equipment	Diesel	1	5,275			
Recreational Equipment	Diesel	1	4,497			
Agricultural Equipment	Gasoline	1	2,705			
Commercial Equipment	Gasoline	1		228.55006	100.56202	4,027,052
Construction and Mining Equipment	Gasoline	1	167,367			
Industrial Equipment	Gasoline	1		201.86234	88.81943	3,556,814
Lawn and Garden Equipment (Com)	Gasoline	1		77.59682	34.14260	1,367,256
Logging Equipment	Gasoline	1		0.00076	0.00034	13
Pleasure Craft	Gasoline	1		169.41175	74.54117	2,985,035
Railroad Equipment	Gasoline	1		0.00040	0.00018	7
Recreational Equipment	Gasoline	1		316.12545	139.09520	5,570,130
Agricultural Equipment	LPG	1		0.01258	0.00069	53
Commercial Equipment	LPG	1		1,373.61951	74.92470	5,818,544
Construction and Mining Equipment	LPG	1		189.21133	10.32062	801,484
Industrial Equipment	LPG	1		23,879.07757	1,302.49514	101,149,895
Railroad Equipment	LPG	1		0.10027	0.00547	425
Recreational Equipment	LPG	1		2.74447	0.14970	11,625

Waste

Briefly, the waste data was collected from various sources; however, the four main data sources were the Texas Commission on Environmental Quality (TCEQ), Houston-Galveston Area Council (H-GAC), U.S. EPA, and the City of Houston (COH). This sector was divided into two distinct categories—solid waste and wastewater. After the preliminary analysis, there were three categories entered into the software – active landfills, City of Houston owned and operated wastewater treatment plants (WWTPs), and industrial WWTPs. There were three de minimis categories as well.

For solid waste, this category was further subdivided into active landfills (LFs) and inactive/closed LFs. Of the 127 LFs associated with the Houston community; 104 of these LFs are inactive/closed (all of which are in side city limits) and 23 are active. Of the 23 active LFs, 9 are within city limits whereas 14 are outside of city limits.

The wastewater category was further subdivided into WWTPs that are owned and operated by the City of Houston and WWTPs that are operated by other entities, including pre-treatment WWTPs and industrial WWTPs. The assumptions, de minimis categories, and processes in calculating the waste inventory are outlined next.

Time Frame

For wastewater, data was collected for the year 2007. For solid waste, however, landfill emissions are more accurate as more data is available. Therefore, where available the complete historical data of the landfills was used and where unavailable the P2D software interpolated the complete historical data. From the TCEQ and HGAC, active landfill data from 1986 to 2007 was available; therefore, only landfills opened before 1986 required interpolation.

Location

For the waste sector, the "location" refers to two separate ideas—the location of the landfills or WWTP as well as the origin of the waste. Thus, there are two categories of waste in regards to location: (1) all waste produced within city limits and landfilled/treated within city limits (Scope 1) and (2) all waste produced within city limits and landfilled/treated outside city limits (Scope 3). The distinction is indicated in the "Input Data" section.

Assumptions

(1) <u>De Minimis Categories</u>: There are three de minimis categories to be explained in this assumption section – active landfill categories, inactive landfills, and industrial pre-treatment WWTPs.

Active Landfill Categories. In collecting active landfill waste data, there were 23 TCEQ categories of waste; however, emissions factors do not exist for more than half of these categories. Therefore, an analysis was conducted to determine that 15 of these categories were deemed de minimis (noted with NA in the P2D category columns below). The figure below presents the TCEQ categories on the left and the P2D matching categories across the top. Also, the Texas Administrative Code definitions are also provided to the right.

Figure 34: Categorizing Landfill Waste

<table>
<tr><th rowspan="2">TCEQ Categories</th><th colspan="8">P2D Categories</th><th rowspan="2">Definitions 30 TAC §330.3</th></tr>
<tr><th>Food</th><th>Garden/ Park</th><th>Paper/ Cardboard</th><th>Wood</th><th>Textiles</th><th>Nappies (disposable diapers)</th><th>Plastics/ Other Inert</th><th>Source</th></tr>
<tr><td>Commercial</td><td rowspan="3">19%</td><td rowspan="3">8%</td><td rowspan="3">27%</td><td rowspan="3">8%</td><td rowspan="3">2%</td><td rowspan="3">0%</td><td rowspan="3">37%</td><td rowspan="10">CA Statewide Waste Characterization Study, 12/2004</td><td></td></tr>
<tr><td>Commercial</td><td>All types of solid waste generated by stores, offices, restaurants, warehouses, and other nonmanufacturing activities, excluding residential and industrial wastes</td></tr>
<tr><td>Institutional</td><td>Material originating in schools, hospitals, prisons, research institutions, and other public buildings</td></tr>
<tr><td>Residential</td><td rowspan="4">17%</td><td rowspan="4">22%</td><td rowspan="4">22%</td><td rowspan="4">4%</td><td rowspan="4">4%</td><td rowspan="4">0%</td><td rowspan="4">31%</td><td></td></tr>
<tr><td>Residential</td><td>Any solid waste (including garbage, trash, and sanitary waste in septic tanks) derived from households (including single and multiple residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas); does not include brush</td></tr>
<tr><td>Recreational</td><td>Waste from public/private parks, beaches, or recreational areas</td></tr>
<tr><td>Litter</td><td>Rubbish (Nonputrescible solid waste (excluding ashes), consisting of both combustible and noncombustible waste materials. Combustible rubbish includes paper, rags, cartons, wood, excelsior, furniture, rubber, plastics, brush, or similar materials; noncombustible rubbish includes glass, crockery, tin cans, aluminum cans, and similar materials that will not burn at ordinary incinerator temperatures (1,600 degrees Fahrenheit to 1,800 degrees Fahrenheit) and putrescible waste (Organic wastes, such as garbage, wastewater treatment plant sludge, and grease trap waste, that are capable of being decomposed by microorganisms with sufficient rapidity as to cause odors or gases or are capable of providing food for or attracting birds, animals, and disease vectors)</td></tr>
<tr><td>Brush</td><td>0%</td><td>100%</td><td>0%</td><td>0%</td><td>0%</td><td>0%</td><td>0%</td><td>Cuttings or trimmings from trees, shrubs, or lawns and similar materials</td></tr>
<tr><td>C&D</td><td>0%</td><td>0%</td><td>0%</td><td>40%</td><td>10%</td><td>0%</td><td>50%</td><td>Waste resulting from C&D projects, includes materials that are directly or indirectly the by-products of construction work or from demolition of buildings and other structures; paper, cartons, gypsum board, wood, rubber, plastics, excelsior</td></tr>
</table>

	P2D Categories								
TCEQ Categories	**Food**	**Garden/ Park**	**Paper/ Cardboard**	**Wood**	**Textiles**	**Nappies (disposable diapers)**	**Plastics/ Other Inert**	**Source**	**Definitions 30 TAC §330.3**
Hazardous Waste									
NHIW Class 1	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**		Any industrial solid waste or mixture of industrial solid wastes that because of its concentration, or physical or chemical characteristics is toxic, corrosive, flammable, a strong sensitizer or irritant, a generator of sudden pressure by decomposition, heat, or other means, or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed, as further defined in §335.505 of this title (relating to Class 1 Waste Determination)
NHIW Class 1-A									Class 1 NHIW that has asbestos
NHIW Classes 2/3									Any individual solid waste or combination of industrial solid waste that are not described as Hazardous, Class 1, or Class 3 as defined in §335.506 of this title (relating to Class 2 Waste Determination); Inert and essentially insoluble industrial solid waste, usually including, but not limited to, materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable, as further defined in §335.507 of this title (relating to Class 3 Waste Determination)
Incinerator Ash									Hazardous waste
Medical Waste	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**		Treated and untreated special waste from health care-related facilities that is comprised of animal waste, bulk blood, bulk human blood, bulk human body fluids, microbiological waste, pathological waste, and sharps as those terms are defined in 25 TAC §1.132 (relating to Definitions) from the sources specified in 25 TAC §1.134 (relating to Application), as well as regulated medical waste as defined in 49 Code of Federal Regulations §173.134(a)(5), except that the term does not include medical waste produced on a farm or ranch as defined in 34 TAC §3.296(f) (relating to Agriculture, Animal Life, Feed, Seed, Plants, and Fertilizer), nor does the term include artificial, nonhuman materials removed from a patient and requested by the patient, including, but not limited to, orthopedic devices and breast implants. Health care-related facilities do not include: (A) single or multi-family dwellings; and (B) hotels, motels, or other establishments that provide lodging and related services for the public
Asbestos									Hazardous waste
Dead Animals									Hazardous waste

TCEQ Categories	P2D Categories: Food	Garden/ Park	Paper/ Cardboard	Wood	Textiles	Nappies (disposable diapers)	Plastics/ Other Inert	Source	Definitions 30 TAC §330.3
Sludge	NA	NA	NA	NA	NA	NA	NA		Any solid, semi-solid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water-supply treatment plant, or air pollution control facility, exclusive of the treated effluent from a wastewater treatment plant
Grease									Material collected in and from a grease interceptor in the sanitary sewer service line of a commercial, institutional, or industrial food service or processing establishment, including the solids resulting from dewatering processes
Grit									Grit trap waste includes waste from interceptors placed in the drains prior to entering the sewer system at maintenance and repair shops, automobile service stations, car washes, laundries, and other similar establishments
Septage									The liquid and solid material pumped from a septic tank, cesspool, or similar sewage treatment system
Contaminated Soil	NA	NA	NA	NA	NA	NA	NA		Hazardous waste
Tires									Other
Rejects/Spoils									Other
Other									Other

To determine that these active landfill categories of waste were de minimis, a two-step process was conducted. First, Volume 5 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was reviewed to determine whether the 15 waste types above were significant sources of emissions. Chapter 2 Section 2.4 ("Other Waste") states that in most countries GHG emissions from medical waste appear to be insignificant. In addition, emissions from hazardous wastes disposed of in solid waste landfills are also likely to be small.

For confirmation purposes, the TCEQ report "Municipal Solid Waste in Texas: A Year in Review – 2007 Data Summary and Analysis," published in September 2008 was reviewed. The figure below shows the typical waste composition of landfills in Texas in 2007.

Figure 35: Typical Waste Composition in Texas Landfills, 2007

Waste Type	**% of Total Tons Disposed**
Non-Hazardous Industrial Waste	
Class 1 (asbestos)	0.15%
Class 1 (other)	0.34%
Class 2 & 3	4.71%
Special Non-Industrial Waste	
Incinerator ash	0.01%
Treated medical waste	0.14%
Asbestos	0.34%
Dead animals	0.03%
Sludge	4.48%
Grease trap waste	0.07%
Grit trap waste	0.06%
Septage	0.06%
Contaminated soil	1.71%
Tire pieces	0.06%
Rejected materials	0.04%
Other	0.70%

Therefore, this research concludes that GHG emissions from these 15 waste types are considered de minimis[12] and are not included in the emissions inventory. Additionally, these waste types are not used by the P2D Emissions Tracker to calculate GHG emissions from solid waste.

Inactive Landfills. Similarly, it was concluded that inactive landfills were de minimis. After collecting (incomplete) inactive landfill data from the HGAC, there are 104 inactive or closed landfills all within Houston's city limits (scope 1). The range of years that these landfills were open from is 1932 to 1992 and the maximum number of years a landfill was open was for 36 years. The average number of years a landfill was open was 12 years and the average number of years a landfill has been closed is 30 years.

[12] According to the Local Government Operations Protocol Version 1.0, de minimis emissions can be from one or more sources, for one or more gases which, when summed, equal less than 5% of an organization's total emissions.

The methodology for determining the de minimis categorization required three major steps.[13] First, to estimate the amount of emissions produced by these inactive landfills, a single "inactive landfill" record was created in P2D to test the significance of this category. The "average" characteristics chosen were liberal in nature to be sure the emissions were truly de minimis. The figure below presents these characteristics.

Figure 36: Average Inactive Landfill Characteristics

Inactive Landfills	
Sector	Waste
Record	Inactive Landfills
GHG Emission Name	"Average Inactive Landfill Test"
Source	Waste - Solid Waste
Scope	1
Method	Solid Waste Multi-year
Waste Management Type	Uncategorized (due to lack of policies governing disposal methods)
Climate Type	Wet Tropical
Site Coverage	Managed, uncovered/unmananged
Recovered Methane (%)	0%
Flared Methane (%)	0%
Complete Historical Data	Yes (1965-1977)
Waste Generated (Tons)	150,000 tons/year (1965-1977) and 0 tons/year (1977-2007)
Waste Fraction by Disposal Type (%)	100% SWDS
Composition (%)	Average of residential and commerical percentages (Food 18%, Garden/Park 15%, Paper/Cardboard 25%, Wood 6%, Textiles 3%, Nappies 0%, and Plastics/Other Inert 34%)

The determination of the waste generated per year was calculated by interpolating back from 1986-2007 data to 1932-1985 data. The equation below presents the equation used.

$$Y = 224{,}436X - 443{,}545{,}975$$

Where

Y = Waste generated (tons)

X = Year

The figure below presents this data for the interpolated 1932-1985 data and the actual 1986-2007 data. The negative waste generation was given a value of 150,000 tons (approximately the waste generation in 1977). This data was input into the emissions tracker software for 1965-1977 (as explained above).

Figure 37: Estimated Waste Generation by Year, in tons, 1932-2007

Year	Estimated Waste (tons)
1932	-9,936,525
1933	-9,712,089

[13] Methodology for calculating emissions for Houston inactive landfills was co-developed by Jim Yienger (ICLEI), Jen McGraw (P2D), and Melissa Weitz (U.S. EPA).

Year	Estimated Waste (tons)
1934	-9,487,654
1935	-9,263,218
1936	-9,038,782
1937	-8,814,347
1938	-8,589,911
1939	-8,365,476
1940	-8,141,040
1941	-7,916,605
1942	-7,692,169
1943	-7,467,734
1944	-7,243,298
1945	-7,018,863
1946	-6,794,427
1947	-6,569,992
1948	-6,345,556
1949	-6,121,121
1950	-5,896,685
1951	-5,672,249
1952	-5,447,814
1953	-5,223,378
1954	-4,998,943
1955	-4,774,507
1956	-4,550,072
1957	-4,325,636
1958	-4,101,201
1959	-3,876,765
1960	-3,652,330
1961	-3,427,894
1962	-3,203,459
1963	-2,979,023
1964	-2,754,588
1965	-2,530,152
1966	-2,305,716
1967	-2,081,281
1968	-1,856,845
1969	-1,632,410
1970	-1,407,974
1971	-1,183,539
1972	-959,103
1973	-734,668
1974	-510,232
1975	-285,797
1976	-61,361
1977	163,074

Year	Estimated Waste (tons)
1978	387,510
1979	611,945
1980	836,381
1981	1,060,817
1982	1,285,252
1983	1,509,688
1984	1,734,123
1985	1,958,559
1986	1,818,486
1987	2,073,446
1988	2,482,212
1989	2,648,276
1990	3,397,471
1991	2,983,874
1992	3,110,279
1993	4,091,203
1994	4,558,834
1995	4,581,832
1996	4,205,523
1997	4,320,323
1998	4,914,202
1999	5,806,304
2000	6,427,488
2001	5,951,553
2002	6,374,769
2003	5,650,195
2004	6,211,770
2005	5,995,255
2006	5,793,003
2007	6,474,183

The second step was to estimate the emissions from this "average" landfill. P2D estimated emissions at 8240 tons in 2007. Multiplying this by 104 (the total number of inactive landfills in Houston) produces a tonnage of GHG emissions for all inactive landfills in Houston, which was 856,960 tons. Third, this is 2% of total emissions and thus considered de minimis, as shown in the figure below. Coupled with the incomplete data gathered for inactive and closed landfills in Houston and the small number of emissions calculated from this example, the inactive landfill category was deemed de minimis. However, given additional time and resources, this is a category that might be worth studying further, as will be mentioned in the next steps section.

Figure 38: Determining De Minimis Categorization

"Average" Landfill Emissions, 2007 (tons)	Number of Landfills	Emissions from all 104 Inactive Landfills (tons)	Total Emissions, 2007 (tons)	Inactive as a % of Total Emissions	De Minimis Threshold
8,240	104	856,960	37,292,540	2%	5%

Industrial Pre-Treatment WWTPs. According to Clyde Smith in the industrial pre-treatment permitting department, of the 80 pre-treatment facilities in the City of Houston, only 29 produce organic waste, and therefore, may potentially produce emissions. After estimating emissions from these 29 WWTPs, the total emissions from the pre-treatment process at these WWTPs was less than 5% of total emission. The figure below presents the aggregated data entered into the P2D software.

Figure 39: Aggregated Industrial Pre-Treatment WWTP Characteristics

	Industrial Pre-Treatment WWTP
Sector	Waste
Record	Industrial Pre-Treatment WWTP
GHG Emission Name	"COH Permit Number_Name of WWTP"
Source	Waste - Wastewater
Scope	1
Method	Wastewater
Population Served	0 (Nitrogen is not regulated by the City so not recorded by WWTPs)
Total Organic Waste (kg)	813,199
Sludge Removed (tons)	0
Methane Captured (%)	0%
Wastewater Type	Industrial
Wastewater Treatment Method	Aerobic Treatment Plant- Well-managed (various methods, but this is most common and most liberal estimate)

There are five major caveats or assumptions to these characteristics. First, the population served is zero because to determine the population served from an industrial WWTP, the total nitrogen per day in kg is required (California, 2008). Since, the amount of nitrogen in the wastewater is not regulated; these wastewater treatment plants do not report or record this number. Thus, the default used was zero; however, sensitivity analysis was performed around this number from 0 – 1,000,000 (EPA, March 2008, pp. 371-383; California, 2008, pp.105). If the population equivalent was 1,000,000 or 0, the emissions remain de minimis.

Second, the total organic waste was collected from Clyde Smith in Public Works and was 813,199 kg for all 29 WWTPs. Third, the sludge collected was input as 0 into the P2D emissions tracker; however, there is a small amount of sludge removed from a handful of these WWTPs. However, zero was used because this will provide a liberal estimate. Fourth, the amount of methane captured and used was 99% for Anheuser-Busch and 0% for the remaining 28 WWTPs. Thus, the methane captured was input as 0% for a more liberal estimate. Finally, the wastewater treatment method was aerobic for all the WWTPs except Anheuser-Busch (which has an anaerobic digester). Thus, the aerobic treatment plant method was chosen for a more liberal estimate. So the final emissions ranged from 0 tons to 30,830 tons (depending on the population equivalent used). Therefore, given the lack of data availability for nitrogen per day and that these emissions were only .083% of total emissions, the industrial pre-treatment WWTPs category was deemed de minimis.

(2) Disaggregation: The waste sector contains several different categories of waste that not only break down at different rates, but most importantly release emissions at different rates. Therefore, this inventory, unlike the government inventory, attempts to disaggregate waste at the smallest, feasible level to attain the most accurate emissions count.

The waste sector has two levels of disaggregation. The first level is the differentiation between solid waste and wastewater. Solid waste is defined as non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes hazardous substances (EPA, 2006, Solid Waste). This inventory includes waste from the Type 1[14] and Type 4[15] active landfills. Solid waste in this inventory includes commercial, residential, construction and demolition, and brush waste. On the other hand, wastewater refers to the spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter (EPA, 2006, Wastewater).

The second level is the differentiation between two different sources of solid waste and three different sources of wastewater data. The two types of solid waste data are active landfills and inactive/closed landfills, whereas the three different sources of wastewater are City of Houston owned WWTPs, industrial WWTPs, and industrial pre-treatment WWTPs.

As previously stated, there are 23 active landfills and 104 inactive landfills. In addition, according to the City's Public Works Department, there are 40 City of Houston WWTPs. According to the TCEQ (Kim Laird), there are 80 industrial WWTPs within city limits as defined in Appendix A. There are 176 industrial WWTPs in Harris County; this was narrowed down to 80WWTPs in city limits using a key map. Finally, there are 80 industrial pre-treatment WWTPs in city limits, from Clyde Smith, and 29 may have potentially produced emissions, as previously stated.

For a visualization of this disaggregation scheme, see the Waste Methodology Map below.

(3) Coefficients: The default, pre-loaded emission factors and coefficients, which determine the amount of emissions emitted for a given quantity of activity entered in the software programs, were used. These values were collected from IPCC guidelines, UNFCC national reporting documents, and national environmental and energy agencies[16]. Note that the wastewater treatment process assumed by the coefficient calculator does not assume primary sedimentation (J. Yienger, 2009, personal communication). This is important for Houston because, unlike most cities, Houston skips this step in the

[14] Type 1 Landfill: The standard landfill for the disposal of municipal solid waste (TCEQ, September 2008).
[15] Type 4 Landfill: A type 4 landfill accepts only brush, construction and demolition (C&D) debris, and other similar waste that will not putrefy (organic wastes) (TCEQ, September 2008).
[16] Coefficients and their references can be viewed in the Administration section of Emissions Tracker (P2D, 2008).

wastewater treatment process; thus, if primary sedimentation was assumed, the emissions factors would require adjustment.

(4) Scope: The scope for emissions from solid waste and wastewater treatment facilities within the Houston community is Scope 1. For the decomposition of solid waste which was generated within the community at a landfill site outside of the community, these emissions are inventoried as Scope 3.

(5) Source: There are two types of waste recorded in this waste sector. The first is wastewater or any activity related to the treatment and processing of wastewater (sewage), from domestic or industrial sources. The second is solid waste or any activity related to the landfilling, incineration or recycling of municipal solid waste (garbage), industrial waste, or waste from other streams.

(6) Quantification: There are two quantification methods, depending on the waste source—wastewater or solid waste (landfilling).

For wastewater, to calculate emissions produced from treating wastewater, the following seven pieces of information were collected for the 40 City of Houston owned and operated WWTPs and the industrial WWTPs. See Appendix D for the map of the 40 WWTP service areas, WWTP, and lift stations.

- **Location/Scope**: The origin of the wastewater and location of the wastewater treatment plant is required to determine whether the emissions are Scope 1 or Scope 3. For the City of Houston and industrial WWTPs, all are scope 1 because the wastewater is generated and treated in the city limits, as defined by the map in Appendix A.

- **Population Served**: The number of people served by each of the 40 COH WWTPs plus the calculated population served by the businesses in each of the 40 WWTP service areas was determined by the process below.

  To calculate the population served by the 40 WWTPs a three-step process took place, according to Anthony Powell in Public Works. First, the data regarding population served was retrieved from Info USA. Second, this data was overlaid with the WWTP service areas to determine the location of each person by service area. Finally, the total number of people in each service area was summed, the data will be presented after the business population calculation is explained.

  To calculate the population equivalent for the businesses/industry in each of the WWTP areas, the kg of total nitrogen per day divided by the nitrogen population equivalent of 0.026 kg N/person/day must be calculated (California, 2008). The nitrogen per day calculation was retrieved from Tinh Nguyen at the City of Houston. The data was sent over by month by wastewater treatment plant in mg/L. This was converted into kg/day by multiplying mg/L by 37.85412 L/gallons times 1,000,000 gallons/million gallons times 1x10^-6 kg/mg times

8.34 million gallons/day (the average flow per day from Ms. Nguyen). Finally, this was converted to the population equivalent by dividing by 0.026 kg N/person/day.

The sum of the domestic population plus the industrial equivalent population is the total population input value for each WWTP. This is presented below in the figure.

Figure 40: WWTP Population Input Data, 2007

WWTP Service Area	Domestic Population	Business Population Equivalent	Total Population
Northside Phase 1A	141,397	25,297	166,694
Almeda Sims	66,236	50,189	116,425
Beltway	19,333	26,511	45,844
Cedar Bayou	1,486	2,226	3,712
Chocolate Bayou	10,201	7,791	17,992
Clinton Park	935	2,428	3,363
Easthaven	2,264	18,821	21,085
Forest Cove	1,903	2,226	4,129
FWSD #23	15,693	2,934	18,627
Greenridge*	NA	2,327	2,327
Homestead	2,924	2,833	5,757
Imperial Valley	3,380	6,071	9,451
Intercontinental	9,220	1,619	10,839
Keegans Bayou	30,286	15,178	45,464
Kingwood	29,071	3,946	33,017
MC MUD #48	458	5,970	6,428
MUD #203	864	17,505	18,369
Metro Central	28,729	2,833	31,562
Northbelt	6,114	5,161	11,275
Northborough	996	21,958	22,954
Northeast	10,892	6,172	17,064
Northgate	2,331	4,655	6,986
Northwest	23,453	4,047	27,500
Park Ten	1,482	5,464	6,946
Sagemont	11,423	11,029	22,452
Sims Bayou**	33,745	19,731	53,476
Sims Bayou S.**	33,745	27,422	61,166
Southeast	12,647	5,262	17,909
Southwest	85,793	18,720	104,513
Tidwell Timbers	552	6,476	7,028
Turkey Creek	22,591	12,750	35,341
Upper Brays	28,883	2,833	31,716
WCID #111	4,820	4,958	9,778
WCID #47	9,114	4,351	13,465
WCID #76	1,476	2,732	4,208
West District	34,928	4,250	39,178
Westway	2,359	5,464	7,823
White Oak	6,698	2,125	8,823
Willow Run	1,463	1,619	3,082
Willowbrook	748	1,720	2,468
TOTAL	**700,632**	**375,606**	**1,076,238**

* Greenridge population data unavailable because a part of Fort Bend County.

**Sims Bayou and Sims Bayou South WWTPs service one service area, so domestic population split half-and-half.

A similar process took place to determine the population equivalent for the 80 WWTPs. If available, the kg of nitrogen per day was extracted from the EPA's ECHO (Enforcement and Compliance History Online) Database[17]. Like the calculation for the businesses for the 40 COH WWTPs, the kg of nitrogen per day was divided by the population equivalent of 0.026 kg N/person/day to return a population value for each of these 80 WWTPs. This data is presented in the input data section.

- **Total Organic Waste (in tons)**: The total organic waste treated in terms of mass units of Biochemical Oxygen Demand, 5-day test (BOD_5)[18] was calculated through a 2-step process for the 40 COH WWTPs. The total organic waste by WWTP in 2007 was collected from Clyde Smith. First, this data was converted from pounds per day to tons per year.

  Second, the total organic waste includes domestic and pre-treated industrial wastewater. However, the P2D software does not allow the user to indicate the amount of domestic wastewater versus the amount of industrially pre-treated wastewater. Therefore, according to the EPA U.S. Emissions Inventory methodology and the IPCC 2006 Guidelines (6.2.2.3 Choice of Activity Data, Equation 6.3), the total amount of comingled organic waste (industrially pre-treated and domestic) must be multiplied by a 1.25 multiplier to determine the total amount of organic waste (EPA, 2009, pp. 15). Therefore, the organic waste produced by the WWTP process is organic waste times 1.25 to adjust for the comingled industrially pre-treated wastewater. The final amount is in the input data section.

  For the 80 industrial WWTPs, the total mass of organic waste was collected from the EPA's ECHO database as well. The data can be found in the data input section.

- **Sludge Removed (in tons)**: The next variable required it the mass of sludge removed. This data was retrieved from Paul Zappi in Public Works. Not all WWTPs remove sludge; therefore, the ones that remove sludge are listed in figure below. Note that the emissions from the removed sludge are calculated separately, such as land filled sludge is in the solid waste-landfill emissions inventory section and the energy used to dry the sludge is in the energy section. This removed sludge includes the final forms of both land filled and/or land applied digested cake, lime-stabilized cake, and heat-dried fertilizer.

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[17] ECHO Database last accessed March 31, 2009 at http://www.epa-echo.gov/cgi-bin/effluentsquery.cgi. This database requires the EPA permit number, listed in the input data section, to access reported data by each WWTP.
[18] Biochemical Oxygen Demand (BOD): A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution (EPA, 2006, Biochemical Oxygen Demand).

Figure 41: Sludge Removed by WWTP, 2007

GHG Emission Name	Sludge Removed (tons)
Almeda Sims WWTP	9,492
Beltway WWTP	2,373
Chocolate Bayou WWTP	487
Greenridge WWTP	512
Imp. Valley WWTP	191
Int. Airport WWTP	925
Keegans Bayou WWTP	2,264
Kingwood Central WWTP	5,613
Metro Central WWTP	163
Northgate WWTP	43
Sims Bayou WWTP	7,758
69th Street WWTP	60,924
Southeast WWTP	866
Upper Brays WWTP	1,088
Total	**92,699**

For the 80 industrial WWTPs, the amount of sludge removed was zero for all these plants, as retrieved from the EPA's Permit Compliance System (PCS) database[19]. This data is provided in the input section as well.

- **Methane Captured (%)**: The amount of methane recovered for energy use is entered as a percentage. Note that emissions from methane recovery used to generate electricity are recorded in the energy portion of the emissions inventory. However, the City of Houston owned and operated WWTPs and the industrial WWTPs do not have any methane recovery; therefore, the percentage for all 120 WWTPs is 0%. This data was gathered from Clyde Smith for the COH WWTPs and the EPA's PCS database for the industrial WWTPs.

- **Wastewater Type**: Although the breakdown of wastewater type is 84% domestic and 16% industrially pre-treated (C. Smith, Personal Communication, 2009), this breakdown is not available in the P2D software. Therefore, as explained in the total organic waste point, the industrial wastewater was taken into account using a 1.25 multiplier supplied by the U.S. EPA. Therefore, the wastewater type entered in the software was domestic for the 40 COH WWTPs and industrial for the 80 industrial WWTPs.

- **Wastewater Treatment Method**: The treatment method, like the type of wastewater, is necessary to ensure that the proper Methane Correction Factor (MCF) is chosen in the emissions coefficient database. Note that Houston's WWTPs lack the primary sedimentation process most WWTPs undergo; however, the assumptions behind the wastewater emissions factors only take into account the biological processes that take place during treatment and the electricity used

[19] PCS database was last accessed March 31, 2009 at http://www.epa.gov/enviro/html/pcs/adhoc.html. This database requires the EPA permit number provided in the data input section.

during this process is in the energy sector (J. Yienger, Personal Communication, 2009). Therefore, the emissions factors do not need to be altered due to the lack of this primary sedimentation process. Finally, all 120 WWTPs are well-managed aerobic treatment plants as highlighted in the figure below. For the 80 industrial WWTPs, the aerobic treatment method was gathered from the PCS database and Kim Laird of the TCEQ. The figure below also provides the choices available in P2D for wastewater treatment.

Figure 42: Types of Wastewater Treatment Methods[20]

Domestic Wastewater	Industrial Wastewater
Aerobic treatment plant – not well managed	Aerobic treatment plant – not well managed
Aerobic treatment plant – well managed	Aerobic treatment plant – well managed
Anaerobic deep lagoon	Anaerobic deep lagoon
Anaerobic digester for sludge	Anaerobic digester for sludge
Anaerobic reactor	Anaerobic reactor
Anaerobic shallow lagoon	Anaerobic shallow lagoon
Latrine (3-5 persons), Dry climate	Untreated – stagnant rivers
Latrine (many persons), Dry climate	
Latrine, Wet climate	
Latrine, with sediment removal	
Septic system	
Untreated – open fast moving sewers	
Untreated – open stagnant sewers	
Untreated – stagnant rivers	

The figure below provides definitions for some of the wastewater treatment plant methods presented above.

Figure 43: WWTP Methods of Treatment Definitions

Term	Definition	Source
Aerobic treatment	Process by which microbes decompose complex organic compounds in the presence of oxygen and use the liberated energy for reproduction and growth, such processes include extended aeration, trickling filtration, and rotating biological contactors	EPA, 2006, Aerobic Treatment
Anaerobic treatment	A life or process that occurs in, or is not destroyed by, the absence of oxygen. Reduction of the net energy level and change in chemical composition of organic matter caused by microorganisms in an oxygen-free environment	EPA, 2006, Anaerobic Treatment

[20] Note: definitions of some terms may be found in the 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, found here (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf).

Term	Definition	Source
Anaerobic deep/shallow lagoon	A shallow or deep pond where sunlight, bacterial action, and oxygen work to purify wastewater; also used for storage of wastewater or spent nuclear fuel rods.	EPA, 2006, Lagoon
Anaerobic digester for sludge	In wastewater treatment, a closed tank; in solid-waste conversion, a unit in which bacterial action is induced and accelerated in order to break down organic matter and establish the proper carbon to nitrogen ratio.	EPA, 2006, Digester
Anaerobic reactor	Refers to those wastes that are normally unstable and readily undergo violent chemical change but do not explode.	EPA, 2006, Reactivity

The input data for wastewater is found in the input data section.

For solid waste (landfills), to calculate emissions produced over a range of years, there are nine assumptions and required data points, as listed and described below.

- **Location/Scope**: The origin of the waste and location of the landfill is required to determine whether the emissions are Scope 1 or Scope 3. Of the 23 active landfills, 14 are scope 3 and 9 are scope 1. Scope 3 means that the waste is generated inside Houston city limits, but landfilled outside city limits, whereas scope 1 means the waste is generated and landfilled inside city limits. The figure below presents the scope, type of landfill[21], and type of waste by landfill. The map found here and in Appendix E presents all the active landfills by type of landfill and the map found here and in Appendix F presents all active and inactive landfills.

Figure 44: Active Landfill Scope and Type of Waste

Permit	Landfill	Scope	Type of Landfill	Type of Waste
1301	Addicks-Fairbanks Landfill	1	Type 4	C&D, Brush
1307	Atascocita Landfill	3	Type 1	Residential, Commercial, C&D
203	Altair Landfill	3	Type 1	Residential
1535	Baytown Landfill	3	Type 1	Residential, Commercial, C&D
1505	Blue Ridge Landfill	3	Type 1	Residential, Commercial, C&D, Brush
1502	Chambers County Landfill	3	Type 1	Residential, Brush, C&D
1721	Coastal Plains Landfill	3	Type 1	Residential, Commercial, C&D
1921	Cougar Landfill	1	Type 4	C&D, Brush
1565	Fairbanks Landfill	1	Type 4	C&D, Brush
2270	Fort Bend Regional Landfill	3	Type 1	Residential, Commercial
1149A	Galveston County Landfill	3	Type 1	Residential, Commercial, C&D, Brush
1599	Greenhouse Road Landfill	1	Type 4	C&D
1540	Greenshadow Landfill	3	Type 4	C&D, Brush
2185	Hawthorne Park Landfill	1	Type 4	C&D, Brush
261A	McCarty Road Landfill	3	Type 1	Residential, Commercial, C&D, Brush
1849A	North County Landfill	3	Type 4	C&D
2240	Ralston Road Landfill	1	Type 4	C&D
1539	SeaBreeze Environmental Landfill	3	Type 1	Residential, Commercial, C&D
1752	Security Landfill	3	Type 1	Residential, Commercial, C&D
1797	Sprint Fort Bend County Landfill	3	Type 4	C&D, Brush
2304	Tall Pines Disposal Facility	1	Type 4	C&D
1586	WCT/Greenbelt/Olshan Landfill	1	Type 4	C&D
1193	Whispering Pines Landfill	1	Type 1	Residential, Commercial, C&D

- **Time Frame**: Since a more accurate estimation may be made with more data, landfill data was collected for the years 1986-2007 from the HGAC and TCEQ. This was the data that was readily available for the City of Houston's use. The P2D "Solid Waste Multi Year" calculator was used and required the year the landfill was opened to determine whether the 1986-2007 TCEQ data was complete. The year each landfill was opened was first retrieved from the U.S.

[21] Type 1 landfills are landfills that take both putrescible and non-putrescible municipal solid waste and type 4 landfills are landfills that only take non-putrescible, or inert, waste such as C&D (HGAC, 2005).

EPA's Landfill Methane Outreach Program (LMOP, 2009). If the year opened was unavailable through this database, the landfill was called to collect this information.

The next issue was to determine if complete historical data was available through the TCEQ's 1986-2007 database. If complete, then the "complete historical data" option in P2D was selected and the full data was entered. If there was incomplete data, then the "incomplete historical data" option in P2D was selected and the available data was entered and the remaining years of data were interpolated by P2D back to the open year. The interpolation uses a straight-line formula to calculate previous year data. The figure below presents the 23 active landfills with the open year and whether or not complete historical data was available and if not, what year to interpolate back to.

Figure 45: Active Landfill Time Frame for Data

Permit	Landfill	Open Year	TCEQ Available Data		P2D Interpolates To Year
			Data Start	Data End	
1301	Addicks-Fairbanks Landfill	1982	1986	2007	1982
1307	Atascocita Landfill	1993	1986	2007	Complete Historical Data
203	Altair Landfill	1976	1986	2007	1976
1535	Baytown Landfill	1984	1986	2007	1984
1505	Blue Ridge Landfill	1993	1986	2007	Complete Historical Data
1502	Chambers County Landfill	1983	1986	2007	1983
1721	Coastal Plains Landfill	1985	1986	2007	1985
1921	Cougar Landfill	1986	1986	2007	Complete Historical Data
1565	Fairbanks Landfill	1984	1986	2007	1984
2270	Fort Bend Regional Landfill	2001	1986	2007	Complete Historical Data
1149A	Galveston County Landfill	1973	1986	2007	1973
1599	Greenhouse Road Landfill	1985	1986	2007	1985
1540	Greenshadow Landfill	1982	1986	2007	1982
2185	Hawthorne Park Landfill	1994	1986	2007	Complete Historical Data
261A	McCarty Road Landfill	1976	1986	2007	1976
1849A	North County Landfill	1986	1986	2007	Complete Historical Data
2240	Ralston Road Landfill	1995	1986	2007	Complete Historical Data
1539	SeaBreeze Environmental Landfill	1986	1986	2007	Complete Historical Data
1752	Security Landfill	1986	1986	2007	Complete Historical Data
1797	Sprint Fort Bend County Landfill	1981	1986	2007	1981
2304	Tall Pines Disposal Facility	2004	1986	2007	Complete Historical Data
1586	WCT/Greenbelt/Olshan Landfill	2003	1986	2007	Complete Historical Data
1193	Whispering Pines Landfill	1978	1986	2007	1978

- **Waste Management Type**: The waste management type selects the relevant Methane Correction Factor from the coefficients. Note that Houston's waste management types are either anaerobic or semi-aerobic and the type is noted below. However, the figure just below provides the five options available in P2D and corresponding definitions from the P2D help file.

Figure 46: Waste Management Types for Landfills[22]

Waste Management Type	Definition
Anaerobic managed solid waste disposal sites	These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste.
Semi-aerobic managed solid waste disposal sites	These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system
Unmanaged solid waste disposal sites – deep and/or with high water table	All SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste
Unmanaged shallow solid waste disposal sites	All SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 meters
Uncategorized solid waste disposal sites	Only if countries cannot categorize their SWDS into above four categories of managed and unmanaged SWDS, the MCF for this category can be used

Four of the twenty-three active landfills are semi-aerobic and the remaining nineteen are anaerobic as indicated in the figure below.

Figure 47: 23 Active Landfills by Waste Management Type

[22] These definitions came from P2D, 2008, Project 2 Degrees Emission Tracker Help.

Landfill	Waste Management Type
Addicks-Fairbanks Landfill	Anaerobic managed solid waste disposal sites
Atascocita Landfill	Anaerobic managed solid waste disposal sites
Altair Landfill	Anaerobic managed solid waste disposal sites
Baytown Landfill	Anaerobic managed solid waste disposal sites
Blue Ridge Landfill	Semi-aerobic managed solid waste disposal sites
Chambers County Landfill	Semi-aerobic managed solid waste disposal sites
Coastal Plains Landfill	Anaerobic managed solid waste disposal sites
Cougar Landfill	Anaerobic managed solid waste disposal sites
Fairbanks Landfill	Anaerobic managed solid waste disposal sites
Fort Bend Regional Landfill	Anaerobic managed solid waste disposal sites
Galveston County Landfill	Semi-aerobic managed solid waste disposal sites
Greenhouse Road Landfill	Anaerobic managed solid waste disposal sites
Greenshadow Landfill	Anaerobic managed solid waste disposal sites
Hawthorne Park Landfill	Anaerobic managed solid waste disposal sites
McCarty Road Landfill	Semi-aerobic managed solid waste disposal sites
North County Landfill	Anaerobic managed solid waste disposal sites
Ralston Road Landfill	Anaerobic managed solid waste disposal sites
SeaBreeze Environmental Landfill	Anaerobic managed solid waste disposal sites
Security Landfill	Anaerobic managed solid waste disposal sites
Sprint Fort Bend County Landfill	Anaerobic managed solid waste disposal sites
Tall Pines Disposal Facility	Anaerobic managed solid waste disposal sites
WCT/Greenbelt/Olshan Landfill	Anaerobic managed solid waste disposal sites
Whispering Pines Landfill	Anaerobic managed solid waste disposal sites

- **Climate Type = Tropical, Wet:** According to the P2D software, the IPCC 2006 Guidelines for National Greenhouse Gas Inventories must be used to determine the climate of the Houston area so the correct Methane Generation Rate Constant is used in the waste emissions inventory (P2D, 2008).

  According to the Texas State Climatologist, 2005 was a drought year for Houston (Nielsen-Gammon & Mosier , 2005). Therefore, a thirty-year average from 1971-2000 from the National Oceanic and Atmospheric Administration (NOAA) was used for the mean annual temperature (MAP) and mean annual precipitation (MAP) (2009).

  However, only a 365-day total from 2000 for Houston's potential evapotranspiration (PET) was available from the TexasET Network, a branch of the Texas A&M System (2009). Thus, as the table below illustrates, the Houston climate was determined to be Tropical, Wet.

Figure 48: Calculating Houston's Climate

	IPCC Definition[23]	Houston
Temperate	MAT ≤ 20ºC	MAT = 20.44 ºC → MAT > 20 ºC → **TROPICAL**
Tropical	MAT > 20 ºC	
Dry	MAP/PET ≤ 1	MAP = 47.84", PET = 45.18" → MAP/PET = 1.06 → MAP/PET > 1 →

[23] MAT = Mean Annual Temperature; MAP = Mean Annual Precipitation; PET = Potential Evapotranspiration

	IPCC Definition[23]	Houston
Wet	MAP/PET > 1	**WET**

- **Site Coverage Type**: there are two choices for the type of site coverage – "Managed and Covered with a Methane Oxidizing Material" or "Managed and Uncovered or Unmanaged". This selection chooses the Methane Oxidation Factor from the coefficients. IPCC defaults assume that managed sites covered with CH_4 oxidizing material result in 10% oxidation and other coverage types result in no oxidation. All 23 active landfills have a "Managed and Covered with a Methane Oxidizing Material" site coverage type.

- **Flared and/or Recovered Methane (%):** The fraction of CH_4 recovered or flared from the solid waste disposal site was entered as a percentage. In P2D, the CH_4 emitted from the site was calculated net of this flared and recovered methane. This data was collected from three main sources.

  First, the 2007 Municipal Solid Waste Annual Report was retrieved for each landfill from the TCEQ. From this annual survey, the percent of methane recovered and flared was calculated, where available.

  Second, where unavailable, each of the landfill's operating company was contacted to retrieve this information. However, data for Waste Management's nine landfills (see figure below) could not be retrieved from Waste Management because of concern regarding conflicting emissions measurements, as WM is conducting an internal emissions inventory as well.

  Third, data for Waste Management's nine landfills was finally retrieved from a combination of the 2007 MSW survey and the EPA's LMOP database. The final results for recovered and flared methane are shown below.

Figure 49: Flared & Recovered Methane Percentages by Landfill & Operating Company

Operating Company	Landfill	Recovered CH4 (%)	Flared CH4 (%)
Waste Management/USA Waste	Addicks-Fairbanks Landfill	0%	100%
Waste Management/USA Waste	Atascocita Landfill	18%	82%
Clean Harbors/Altair Disposal	Altair Landfill	0%	0%
Waste Management/USA Waste	Baytown Landfill	12%	88%
Republic Waste Services (Allied-BFI)	Blue Ridge Landfill	0%	100%
Chambers County	Chambers County Landfill	0%	0%
Waste Management/USA Waste	Coastal Plains Landfill	12%	88%
Waste Management/USA Waste	Cougar Landfill	0%	0%
Waste Management/USA Waste	Fairbanks Landfill	0%	0%
Waste Corporation of America	Fort Bend Regional Landfill	0%	0%
Republic Waste Services (Allied-BFI)	Galveston County Landfill	0%	100%
G.O. Weiss	Greenhouse Road Landfill	0%	0%
Waste Management/USA Waste	Greenshadow Landfill	0%	100%
Waste Management/USA Waste	Hawthorne Park Landfill	0%	0%
Republic Waste Services (Allied-BFI)	McCarty Road Landfill	55%	45%
Republic Waste Services (Allied-BFI)	North County Landfill	0%	0%
Waste Corporation of America	Ralston Road Landfill	0%	0%
Republic Waste Services (Allied-BFI)	SeaBreeze Environmental Landfill	0%	100%
Waste Management/USA Waste	Security Landfill	16%	84%
Sprint	Sprint Fort Bend County Landfill	0%	0%
Waste Corporation of America	Tall Pines Disposal Facility	0%	0%
Waste Corporation of America	WCT/Greenbelt/Olshan Landfill	0%	0%
Republic Waste Services (Allied-BFI)	Whispering Pines Landfill	0%	100%

- **Solid Waste Generated (in tons, wet basis):** The total amount of solid waste generated at each site for the span of years listed in the time frame section is provided in the input data section. This data is presented in a series of 6 figures.

- **Waste Fraction by Disposal Type**: The percent of waste that is handled in each of the following four ways - % composted, % recycled, % incinerated, and % disposed of at a solid waste disposal site (SWDS). For all 23 of the active landfills, 100% of the waste disposed of was at a solid waste disposal site; therefore, the figure below presents the breakdown by waste fraction for all active landfills.

Figure 50: Waste Fraction by Disposal Type

Composted	Recycled	Incinerated	Disposed of at SWDS
0%	0%	0%	100%

- **Waste Composition**: The percent breakdown of the waste in each of the following waste categories – food, garden/park, paper/cardboard, wood, textiles, nappies (disposable diapers), and plastics/other inert – is required by P2D. The figure below and the figure in the de minimis section shows how the waste categories from the TCEQ annual survey were broken down for the emissions software. Since a comprehensive waste characterization study (at this level of detail) is not available for the city of Houston, Harris County, nor state of Texas, these percentage breakdowns are from the California Integrated Waste

Management Board's "2004 Statewide Waste Characterization Study" (Integrated Waste Management Board, 2004). When such a study becomes available for the city of Houston, Harris County, or state of Texas, those percentage breakdowns may be used.

Figure 51: Waste Composition Breakdown

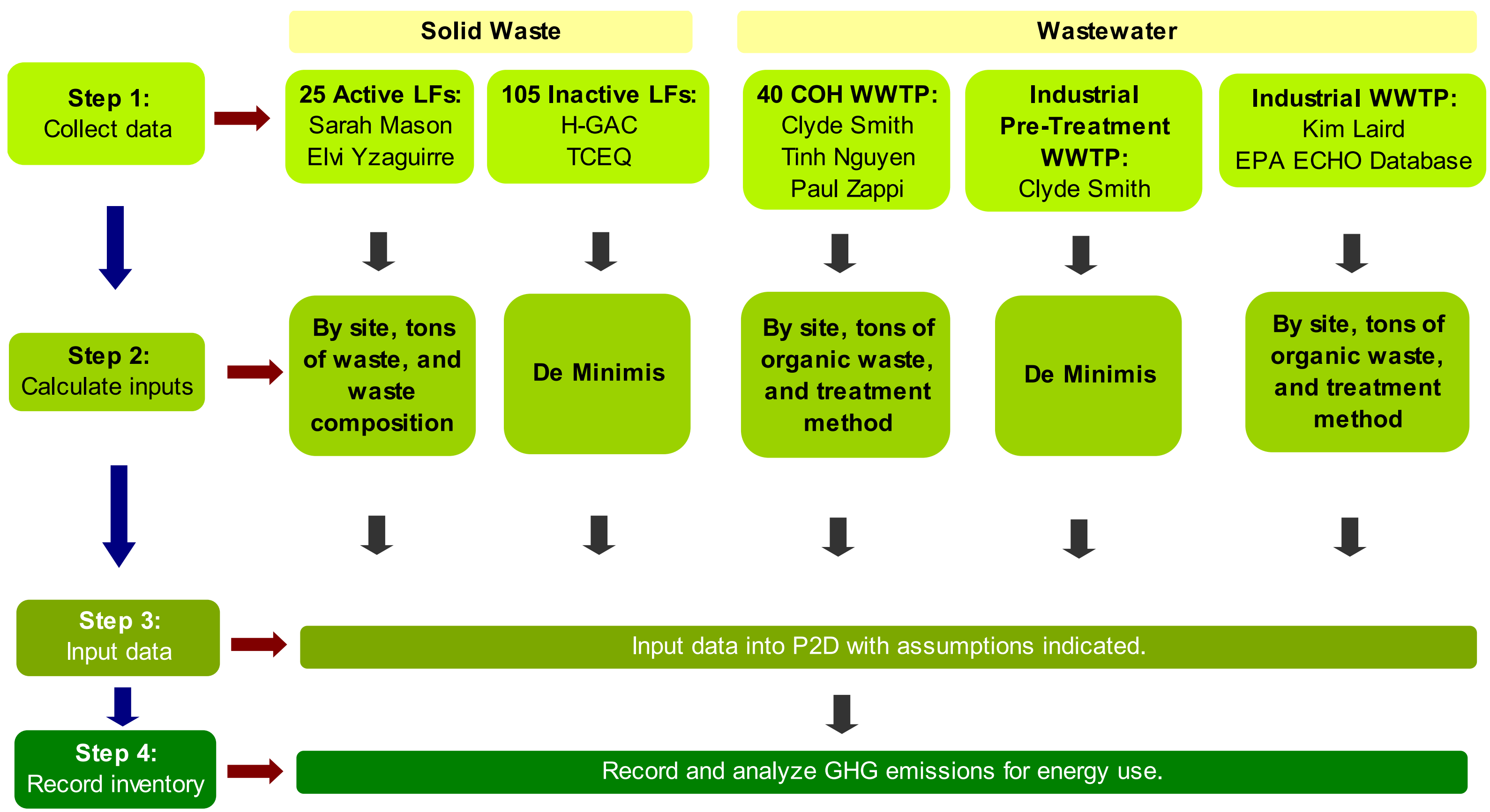
	Food	Garden/ Park	Paper/ Cardboard	Wood	Textiles	Nappies (disposable diapers)	Plastics/ Other Inert
Commercial	19%	8%	27%	8%	2%	0%	37%
Residential	17%	22%	22%	4%	4%	0%	31%
Brush	0%	100%	0%	0%	0%	0%	0%
C&D	0%	0%	0%	40%	10%	0%	50%

Given the assumptions and data points required for the waste sector, the following methodology section provides an overall map of how the data was collected and used.

Methodology

To quantify the emissions from the Houston community's waste sector, a four-step process took place as displayed in the figure below. For contact information, see references section. Also note that LF refers to landfill and WWTP refers to wastewater treatment plant. Below the methodology map is the complete input data for the waste sector.

Figure 52: Waste Methodology Map



Input Data

Figure 53: 40COH WWTP Input Data, 2007

GHG Emission Name	Scope	Population Served	Total Organic Waste (tons)	Sludge Removed (tons)	Methane Captured (%)	Wastewater Type	Wastewater Treatment Method
Almeda Sims WWTP	Scope 1	116,425	129	9492	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Beltway WWTP	Scope 1	45,844	87	2373	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Cedar Bayou WWTP	Scope 1	3,712	3	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Chocolate Bayou WWTP	Scope 1	17,992	16	487	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Clinton Park WWTP	Scope 1	3,363	4	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Easthaven WWTP	Scope 1	21,085	10	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Forest Cove WWTP	Scope 1	4,129	1	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
FWSD-23 WWTP	Scope 1	18,627	31	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Greenridge WWTP	Scope 1	2,327	14	512	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Homestead WWTP	Scope 1	5,757	10	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Imp. Valley WWTP	Scope 1	9,451	7	191	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Int. Airport WWTP	Scope 1	10,839	7	925	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Keegans Bayou WWTP	Scope 1	45,464	77	2264	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Kingwood Central WWTP	Scope 1	33,017	21	5613	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Metro Central WWTP	Scope 1	31,562	3	163	0%	Domestic	Aerobic Treatment Plant - Well-Managed
MUD 48 WWTP	Scope 1	6,428	9	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
MUD 203 WWTP	Scope 1	18,369	3	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Northbelt WWTP	Scope 1	11,275	13	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Northborough WWTP	Scope 1	22,954	4	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Northeast WWTP	Scope 1	17,064	24	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Northgate WWTP	Scope 1	6,986	14	43	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Northwest WWTP	Scope 1	27,500	64	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Park Ten WWTP	Scope 1	6,946	4	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Sagemont WWTP	Scope 1	22,452	17	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Sims Bayou WWTP	Scope 1	53,476	72	7758	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Sims Bayou S. WWTP	Scope 1	61,166	149	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
69th Street WWTP	Scope 1	166,694	898	60924	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Southeast WWTP	Scope 1	17,909	18	866	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Southwest WWTP	Scope 1	104,513	204	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Tidwell Timber WWTP	Scope 1	7,028	1	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Turkey Creek WWTP	Scope 1	35,341	26	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Upper Brays WWTP	Scope 1	31,716	49	1088	0%	Domestic	Aerobic Treatment Plant - Well-Managed
WCID-47 WWTP	Scope 1	13,465	34	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
WCID-76 WWTP	Scope 1	4,208	2	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
WCID-111 WWTP	Scope 1	9,778	17	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
West District WWTP	Scope 1	39,178	50	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Westway WWTP	Scope 1	7,823	3	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
White Oaks WWTP	Scope 1	8,823	11	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Willow Run WWTP	Scope 1	3,082	2	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
Willowbrook WWTP	Scope 1	2,468	10	0	0%	Domestic	Aerobic Treatment Plant - Well-Managed
COH WWTP Total		**1,076,238**	**2,121**	**92,699**	**0%**	**Domestic**	**Aerobic Treatment Plant - Well-Managed**

Figure 54: 80 Industrial WWTP Input Data, 2007

GHG Emission Name	Scope	Population Equivalent	Total Organic Waste (kg)	Sludge Removed (tons)	Methane Captured (%)	Wastewater Type	Wastewater Treatment Method
EPA Permit #TX0070530_Burlington Northern	1	0	208	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0007234_Texas Tile Mfg.	1	570	10,395	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0006254_Reed Hycalog LP	1	0	10,496	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0004022_Petroleum Coke	1	0	160,206	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0002976_Valero Refining	1	3,077	45,662	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0007072_Rhodia, Inc.	1	0	47,470	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0070955_SWS Holdings	1	0	1,641,768	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0075060_Oxid, LP	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0106208_South Coast Terminal	1	0	34,431	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0119334_South Coast Terminal	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0006386_NRG Texas LP	1	0	886,835	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0103578_Powell, James M. dba	1	0	2,017,987	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0119075_Cooper, Jerry Lynn	1	1	52	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0007064_Arkema Inc.	1	0	2,954	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0005584_Merisol USA LLC	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0008524_Greensport/Ship Chan	1	0	4,008	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0005576_Reichhold Holdings	1	81	3,766	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0007145_Magellan Terminals	1	0	1,551	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0007439_GB Biosciences	1	62,970	5,547	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0076945_Sequa Corp.	1	0	8,512	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0031534_HFOTCO LLC	1	0	566,953	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0085979_Haltermann, Inc.	1	0	14,404	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0091855_Stolthaven Houston	1	139	34,531	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0106542_Kinder Morgan Petcok	1	0	29,327,093	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0106542_ELG Metals	1	0	475,825	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0113972_Ameri-Forge Corp.	1	11,708,165	619,135,849	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0116076_Altivia Corp.	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0125369_Reagent Chemical	1	0	56,980	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0030571_Dallas Chemical Tech	1	0	93,470	0	0	Industrial	Aerobic treatment plant – well managed

GHG Emission Name	Scope	Population Equivalent	Total Organic Waste (kg)	Sludge Removed (tons)	Methane Captured (%)	Wastewater Type	Wastewater Treatment Method
EPA Permit #TX0003689_Goodyear Tire & Rubber	1	28,541	255,958	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0004961_Texas Petrochemicals	1	0	174,667	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0104051_Kinder Morgan Pet	1	0	3,454	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0106054_South Coast Terminal	1	0	3,195,318	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0118575_Gulf Reduction	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0106879_Federated Metals CRP	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0107956_Aramark U&CA Inc	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0008851_Texas Medical Center	1	0	228,976	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0078638_Halliburton Energy	1	137	879	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0007650_Ashbrook-Simon-Hartl	1	2	40	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0092037_West Rd WSC	1	0	26	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0107158_Lee, Jack Cheng	1	2	331	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0075370_Natl Oilwell Varco	1	0	9,389	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0086002_Univar USA Inc	1	0	527	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0074292_Toshiba International	1	24	2,906	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0062642_National Oilwell	1	5	820	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0089940_Weatherford Petco	1	0	229	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0000000_Atco-Valley Plaza	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0075078_1977 Kindred II	1	0	33	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0004014_E I Dupont	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0079561_Pegasus Polymers	1	795	16,820	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0003531_Equistar Chemicals	1	8,063	362,281	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0069493_Lyondell Chemical	1	1,260	86,394	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0087599_US Steel Tubular	1	34,569	87,505	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0088455_V&M Star	1	5	297	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0119326_McCarty Rd Landfill	1	0	929	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0129917_VAM USA	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0126292_US Steel Tubular	1	0	7,724,294	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0084298_Smith International	1	0	2,715	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0069736_Houston, City of	1	1,731	86,257	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0006408_NRG Texas LP	1	0	93,569	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0102008_CenterPoint Energy	1	1	139	0	0	Industrial	Aerobic treatment plant – well managed

GHG Emission Name	Scope	Population Equivalent	Total Organic Waste (kg)	Sludge Removed (tons)	Methane Captured (%)	Wastewater Type	Wastewater Treatment Method
EPA Permit #TX0118095_Quality Product Fin	1	0	179	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0076155_CenterPoint Energy	1	0	98	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0029564_Houston 1031 & FMC	1	0	2,170,209	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0052761_Shell Chem & Equilon	1	383	8,213	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0060933_Pilot Industries	1	0	447	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0124273_Texas United Pipe	1	0	0	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0119211_Set Environmental	1	0	482,402	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0093572_5510 Acorn LLC	1	0	24	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0079570_International Airport	1	5	166	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0118605_Skinner Lands	1	83	618,676	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0031429_15025 East Freeway	1	0	5	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0065986_Rescar Industries	1	0	453	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0100919_Energyco, LLC	1	0	3,263,310	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0104531_Channel Shipyard	1	12	117	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0106062_Sartomer Company Inc.	1	0	15,788,402	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0117552_Mirage Stop Inc.	1	1	55	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0125920_Marmac, LLC	1	0	57,978	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0053023_Caltex Holdings, LP	1	0	2,276,095	0	0	Industrial	Aerobic treatment plant – well managed
EPA Permit #TX0095559_KMCO, Inc.	1	52	4,387	0	0	Industrial	Aerobic treatment plant – well managed
TOTAL	**1**	**11,850,676**	**691,592,921**	**0**	**0**	**Industrial**	**Aerobic treatment plant – well managed**

Figure 55: Altair, North County, Atascocita, and Baytown Landfill Input Data, 1986-2007, in tons

Landfill	Altair Landfill			North County Landfill			Atascocita Landfill			Baytown Landfill			
Waste Type	**Res**	**Brush**	**C&D**	**Res**	**Brush**	**C&D**	**Res**	**Comm**	**C&D**	**Res**	**Comm**	**Brush**	**C&D**
1986	61,884	-	-	-	-	-				115,675	-	-	-
1987	97,567	-	-	7,612	-	-				120,229	-	-	-
1988	30,393	-	-	12,307	-	-				115,861	-	-	-
1989	102,909	-	-	15,459	-	-				106,296	-	-	-
1990	151,154	-	-	16,140	-	-				224,745	-	-	-
1991	65,490	-	-	17,044	-	-				216,229	-	-	-
1992	57,348	-	-	15,893	-	-				251,856	-	-	-
1993	68,200	-	-	31,177	-	-	460,074	-	-	252,510	-	-	-
1994	76,999	-	-	-	-	-	688,266	-	-	329,227	-	-	-
1995	55,429	-	-	-	-	-	662,474	-	-	253,289	-	-	-
1996	28,302	100	200	-	-	36,009	587,140	-	145	130,727	65,364	55,000	63,364
1997	19,048	-	-	-	26,697	-	448,318	200,314	98	87,331	43,666	37,593	43,666
1998	16,218	-	-	-	-	27,587	384,457	169,334	2,530	159,097	221,998	5,000	44,400
1999	17,017	-	-	-	-	53,790	154,478	308,956	154,478	152,473	304,947	-	152,519
2000	21,698	-	-	-	-	162,466	192,294	394,588	192,293	86,141	172,283	-	82,696
2001	18,129	-	-	-	-	95,479	211,365	422,731	211,365	103,557	207,113	-	103,557
2002	15,287	-	-	-	-	73,056	216,756	433,512	216,756	112,336	224,670	-	112,336
2003	13,704	-	-	-	-	58,557	246,837	263,292	312,660	49,242	23,325	-	126,991
2004	14,009	-	-	-	-	56,303	386,719	401,721	22,781	141,914	159,653	-	53,218
2005	13,070	-	-	-	-	65,864	437,413	447,828	62,488	126,204	141,980	-	47,326
2006	14,907	-	-	-	-	70,387	369,377	381,583	1,303	72,522	81,587	-	27,195
2007	14,970	-	-	-	-	63,521	546,250	512,291	79,671	71,821	69,457	-	26,346
Total by LF	**973,732**	**100**	**200**	**115,632**	**26,697**	**763,019**	**5,992,218**	**3,936,150**	**1,256,568**	**3,279,282**	**1,716,043**	**97,593**	**883,614**

Figure 56: Coastal Plains, Security, Addicks-Fairbanks, and Greenshadow Landfill Input Data, 1986-2007, in tons

Landfill	Coastal Plains Landfill			Security Landfill				Addicks-Fairbanks Landfill				Greenshadow Landfill		
Waste Type	**Res**	**Comm**	**C&D**	**Res**	**Comm**	**Brush**	**C&D**	**Res**	**Comm**	**Brush**	**C&D**	**Res**	**Brush**	**C&D**
1986	-	-	-	-	-	-	-	13,528	-	-	-	-	-	-
1987	58,489	-	-	-	-	-	-	13,654	-	-	-	-	-	-
1988	137,108	-	-	55,000	-	-	-	12,623	-	-	-	28,327	-	-
1989	224,812	-	-	85,276	-	-	-	11,739	-	-	-	47,562	-	-
1990	265,628	-	-	206,616	-	-	-	6,653	-	-	-	173,493	-	-
1991	229,683	-	-	209,766	-	-	-	-	-	-	-	112,574	-	-
1992	246,417	-	-	148,543	-	-	-	-	-	-	-	125,521	-	-
1993	306,101	-	-	251,316	-	-	-	-	-	-	-	111,780	-	-
1994	330,308	-	-	146,477	-	-	-	-	-	-	-	-	-	-
1995	280,274	-	-	130,418	-	-	-	9,706	-	-	-	-	-	-
1996	253,919	-	128	120,382	-	-	606	-	17	-	324	-	-	-
1997	185,390	57,601	30	132,650	33,410	-	2,324	-	-	-	-	-	-	-
1998	301,496	57,287	49	155,624	51,874	-	-	-	-	-	-	-	-	-
1999	142,948	285,896	142,948	98,139	98,138	7,737	69,636	-	-	-	-	-	-	-
2000	197,955	395,911	197,955	81,913	163,827	-	81,914	-	-	-	-	-	-	-
2001	193,575	387,151	193,575	83,407	166,815	-	83,407	-	-	-	-	-	-	-
2002	157,160	314,318	157,160	69,707	139,414	-	69,707	-	-	-	242	-	-	236
2003	296,670	85,704	145,038	128,741	128,741	-	64,371	-	-	-	50	-	-	380
2004	349,135	253,916	31,739	226,958	113,479	-	37,827	-	-	-	91	-	7,511	30,045
2005	283,352	188,902	48,324	236,288	118,144	-	39,381	-	-	-	2,160	-	16,265	65,061
2006	78,752	264,893	14,318	230,396	115,198	-	38,399	-	-	4,074	12,222	-	1,879	92,052
2007	89,770	259,336	9,974	235,854	115,783	-	40,310	-	-	9,180	36,720	-	2,847	92,053
Total by LF	**4,608,942**	**2,550,915**	**941,238**	**3,033,471**	**1,244,823**	**7,737**	**527,882**	**67,903**	**17**	**13,254**	**51,809**	**599,257**	**28,502**	**279,827**

Figure 57: Cougar, Hawthorn Park, Fairbanks, and Seabreeze Environmental Landfill Input Data, 1986-2007, in tons

Landfill	Cougar Landfill				Hawthorn Park Landfill			Fairbanks Landfill				Seabreeze Environmental Landfill		
Waste Type	Res	Comm	Brush	C&D	Res	Brush	C&D	Res	Comm	Brush	C&D	Res	Comm	C&D
1986								19,479	-	-	-	-	-	-
1987								82,299	-	-	-	-	-	-
1988								20,513	-	-	-	98,363	-	-
1989								25,999	-	-	-	106,518	-	-
1990								33,577	-	-	-	56,009	-	-
1991								-	-	-	-	50,017	-	-
1992	-	-	-	-				65,310	-	-	-	45,106	-	-
1993	-	-	-	-				218,407	-	-	-	91,269	-	-
1994	-	-	-	-	-	-	-	50,125	-	-	-	288,054	-	-
1995	14,042	-	-	-	1,639	-	-	282,403	-	-	-	318,462	-	-
1996	-	7,899	7,504	142,583	-	-	-	-	15,071	-	286,352	97,286	194,573	-
1997	-	9,756	7,982	168,982	-	-	-	13,291	-	7,974	244,549	119,285	243,757	-
1998	-	7,718	4,631	142,014	-	6,044	34,248	103	-	-	306,312	94,850	132,790	94,850
1999	-	-	-	280,879	-	-	100,034	-	-	-	258,391	77,837	140,105	77,837
2000	-	-	-	222,744	-	-	-	-	-	-	344,767	121,881	219,385	121,881
2001	-	-	-	206,513	-	-	-	-	-	-	383,305	152,224	274,001	152,223
2002	-	-	-	178,567	-	-	-	-	-	-	329,793	238,246	428,842	238,246
2003	-	-	16,566	149,095	-	-	2,545	-	-	32,074	288,667	303,342	455,013	202,228
2004	-	-	40,015	160,059	-	-	1,518	-	-	51,654	292,708	293,435	440,152	195,623
2005	-	-	36,421	145,684	-	-	990	-	-	48,915	277,182	281,478	422,217	187,652
2006	-	-	-	-	-	-	200	-	-	75,778	227,332	275,111	476,727	131,100
2007	-	-	21,942	160,904	-	9,194	30,780	-	-	42,521	150,757	359,156	413,839	147,263
Total by LF	**14,042**	**25,373**	**135,061**	**1,958,024**	**1,639**	**15,238**	**170,315**	**811,506**	**15,071**	**258,916**	**3,390,115**	**3,467,929**	**3,841,401**	**1,548,903**

Figure 58: Sprint Fort Bend, Greenhouse, Tall Pines, Ralston Road, Greenbelt, and Fort Bend Regional Landfill Input Data, 1986-2007, in tons

Landfill	Sprint Fort Bend		Greenhouse Road Landfill			Tall Pines	Ralston Road	Greenbelt	Fort Bend Regional	
Waste Type	**Brush**	**C&D**	**Res**	**Brush**	**C&D**	**C&D**	**C&D**	**C&D**	**Res**	**Comm**
1986	-	-	-	-	-					
1987	-	-	-	-	-					
1988	-	-	-	-	-					
1989	-	-	-	-	-					
1990	-	-	-	-	-					
1991	-	-	-	-	-					
1992	-	-	-	-	-					
1993	-	-	-	-	-					
1994	-	-	-	-	-					
1995	-	-	10,828	-	-		-			
1996	-	-	-	4,302	38,713		-			
1997	-	-	-	5,619	50,488		-			
1998	-	174,218	-	7,832	70,492		-			
1999	-	199,213	-	10,492	94,427		-			
2000	5,475	213,520	-	10,894	98,046		-			
2001	-	115,630	-	9,971	89,741		11,040			
2002	-	-	-	8,804	79,241		94,440			
2003	-	-	-	7,275	65,472		117,347	67,796		
2004	-	171,791	-	-	69,189		135,613	217,909	120	61
2005	-	191,400	-	5,535	73,799		141,086	194,317	27,563	67,776
2006	-	218,878	-	-	85,848		168,225	170,430	89,458	93,587
2007	-	248,575	-	5,196	89,735	266,292	196,675	157,377	158,604	158,603
Total by LF	**5,475**	**1,533,225**	**10,828**	**75,920**	**905,191**	**266,292**	**864,426**	**807,829**	**275,745**	**320,027**

Figure 59: McCarty Road, Whispering Pines, and Chambers County Landfill Input Data, 1986-2007, in tons

Landfill	McCarty Road Landfill				Whispering Pines Landfill				Chambers County Landfill			
Waste Type	Res	Comm	Brush	C&D	Res	Comm	Brush	C&D	Res	Comm	Brush	C&D
1986	1,105,375	-	-	-	250,475	-	-	-	11,345	-	-	-
1987	1,239,668	-	-	-	257,397	-	-	-	16,636	-	-	-
1988	1,510,205	-	-	-	285,077	-	-	-	16,992	-	-	-
1989	1,407,002	-	-	-	284,451	-	-	-	8,781	-	-	-
1990	1,535,539	-	-	-	412,704	-	-	-	18,500	-	-	-
1991	1,372,834	-	-	-	404,449	-	-	-	18,898	-	-	-
1992	1,510,456	-	-	-	341,136	-	-	-	27,933	-	-	-
1993	1,629,611	-	-	-	324,608	-	-	-	27,872	-	-	-
1994	1,746,842	-	-	-	209,243	-	-	-	33,725	-	-	-
1995	1,697,381	-	-	-	91,407	-	-	-	30,132	-	-	-
1996	215,700	400,587	82,699	597,465	27,664	51,375	5,975	23,901	10,578	11,755	588	588
1997	226,024	419,758	73,040	550,802	33,631	62,458	8,944	35,551	19,661	3,679	-	723
1998	245,468	455,870	79,323	598,187	25,197	46,794	6,701	26,635	23,763	7,454	330	700
1999	300,656	558,362	99,534	617,760	13,341	24,776	4,532	18,014	25,003	7,808	756	378
2000	271,171	504,523	87,554	661,098	23,189	43,077	6,166	24,520	28,085	8,794	756	189
2001	219,789	408,925	70,964	535,832	31,647	58,789	8,415	33,464	29,897	9,388	806	201
2002	263,942	491,033	85,220	643,373	25,962	48,231	6,844	27,374	10,201	7,366	155	112
2003	577,113	466,184	21,539	30,192	44,569	36,678	-	259	5,975	4,308	91	65
2004	463,801	401,147	13,331	22,549	51,033	37,146	-	362	981	18,292	-	-
2005	472,503	257,709	4,746	77,990	11,729	3,216	-	4,202	4,724	-	835	8,519
2006	661,575	283,530		154,067	79	-	-	-	28	-	525	9,403
2007	342,540	146,803	1,784	88,316	179,185	2,566	-	11,074	9,364	-	325	9,861
Total by LF	**19,015,195**	**4,794,430**	**619,733**	**4,577,630**	**3,328,173**	**415,105**	**47,577**	**205,356**	**379,074**	**78,844**	**5,167**	**30,740**

Figure 60: Galveston County and Blue Ridge Landfill Input Data and Totals by Year, 1986-2007, in tons

Landfill	Galveston County Landfill				Blue Ridge Landfill				Total by Year
Waste Type	Res	Comm	Brush	C&D	Res	Comm	Brush	C&D	
1986	240,725	-	-	-					**1,818,486**
1987	179,895	-	-	-					**2,073,446**
1988	159,443	-	-	-					**2,482,212**
1989	221,472	-	-	-					**2,648,276**
1990	296,713	-	-	-					**3,397,471**
1991	286,890	-	-	-					**2,983,874**
1992	274,760	-	-	-					**3,110,279**
1993	273,078	-	-	-	45,200	-	-	-	**4,091,203**
1994	324,963	-	-	-	334,605	-	-	-	**4,558,834**
1995	321,563	-	-	-	422,385	-	-	-	**4,581,832**
1996	56,811	105,507	9,106	100,512	102,124	189,660	14,494	62,424	**4,205,523**
1997	60,546	112,443	8,036	83,918	113,234	210,292	19,502	88,262	**4,320,323**
1998	58,002	107,718	7,698	80,391	125,382	232,854	20,266	92,416	**4,914,202**
1999	35,077	65,142	24,223	136,119	131,196	243,651	20,125	96,536	**5,806,304**
2000	60,968	113,261	8,107	84,512	191,437	355,587	30,905	141,062	**6,427,488**
2001	56,001	104,033	7,447	77,626	112,482	208,932	18,159	82,883	**5,951,553**
2002	69,104	128,375	9,189	95,790	147,418	273,823	23,799	108,628	**6,374,769**
2003	163,175	73,970	382	2,848	497,707	64,452	4,436	4,530	**5,650,195**
2004	88,249	129,714	698	10,750	497,840	110,383	4,122	4,507	**6,211,770**
2005	105,977	70,652	473	2,567	365,672	91,418	5,887	64,372	**5,995,255**
2006	136,328	90,885	-	-	369,040	158,160	-	45,664	**5,793,003**
2007	140,339	93,226	128	9,385	371,330	157,656	154	16,580	**6,474,183**
Total by LF	**3,610,079**	**1,194,926**	**75,487**	**684,417**	**3,827,050**	**2,296,868**	**161,848**	**807,864**	**99,870,480**

Results and Analysis

Preliminary results and analysis of this 2007 GHG Emissions Inventory are presented here. Additional analysis is provided in the 2007 Emissions Briefer.

Energy Analysis

The energy analysis section is broken into three parts – electricity, natural gas, and total energy analysis. Each analysis is presented by scope, sector, and zip code.

Electricity

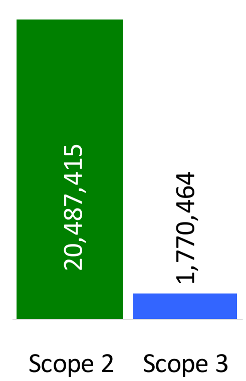
This sub-section provides the emissions inventory for the Electricity record of the 2007 emissions inventory. Displayed below is the general emissions inventory in table format.

Figure 61: Electricity Emissions Inventory, 2007

Sector	Emissions (tons)	Percent of Total
Residential	**9,696,098**	**43.6%**
Electricity Single Family Residential	7,231,586	32.5%
Electricity Multi-Family Residential	2,356,354	10.6%
Electricity Mobile Home Residential	108,157	0.5%
Commercial	**8,135,703**	**36.6%**
Electricity Small Commercial	8,135,703	36.6%
Industrial	**2,460,860**	**11.1%**
Electricity Large Commercial and Industrial	2,460,860	11.1%
Lighting	**194,753**	**0.9%**
Electricity Streetlights	153,721	0.7%
Electricity Miscellaneous Lighting	41,033	0.2%
Electricity Transmission and Distribution Losses	**1,770,464**	**8.0%**
TOTAL	**22,257,878**	**100.0%**

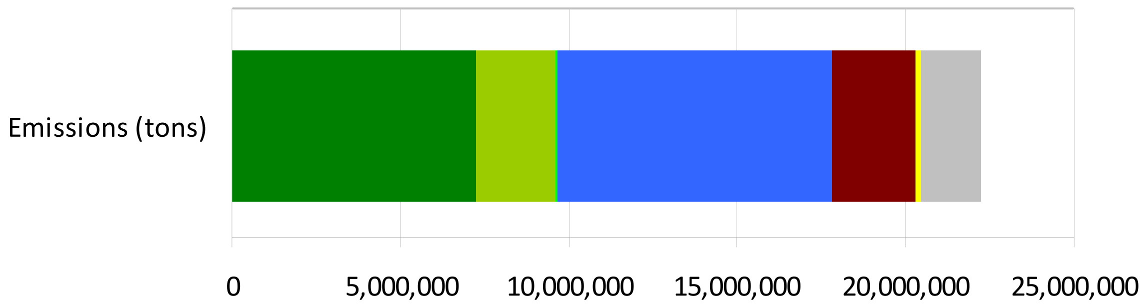
Scope. The analysis by scope shows that of the 872 electricity entries, 763 were scope 2 and 109 were scope 3. The scope 3 emissions are transmission and distribution (T&D) losses, whereas scope 2 is the total electricity consumption within city limits. By GHG emissions, scope 2 emissions are 92% of total emissions and scope 3 emissions are 8% of total emissions. The figure to the left provides the actual emissions by scope. This analysis illustrates that most of the electricity emissions are due to electricity consumption; however, there is still a significant amount of transmission and distribution loss as evidenced by this figure.

Figure 62: Electricity Emissions Analysis by Scope, in tons of CO2E, 2007



Sector. The analysis by sector is presented below. From the 2007 U.S. GHG emissions inventory, the total U.S. 2007 electricity use GHG emissions in tons of CO2E was 2,642,460,672 tons (EPA, 2009). In comparison to Houston's GHG emissions from electricity use, 22,257,878 tons of CO2E, this is only 0.83% of the U.S. electricity use emissions. The figure below presents the electricity emissions broken down by sector in 2007.

Figure 63: Electricity Emissions Analysis by Sector, 2007

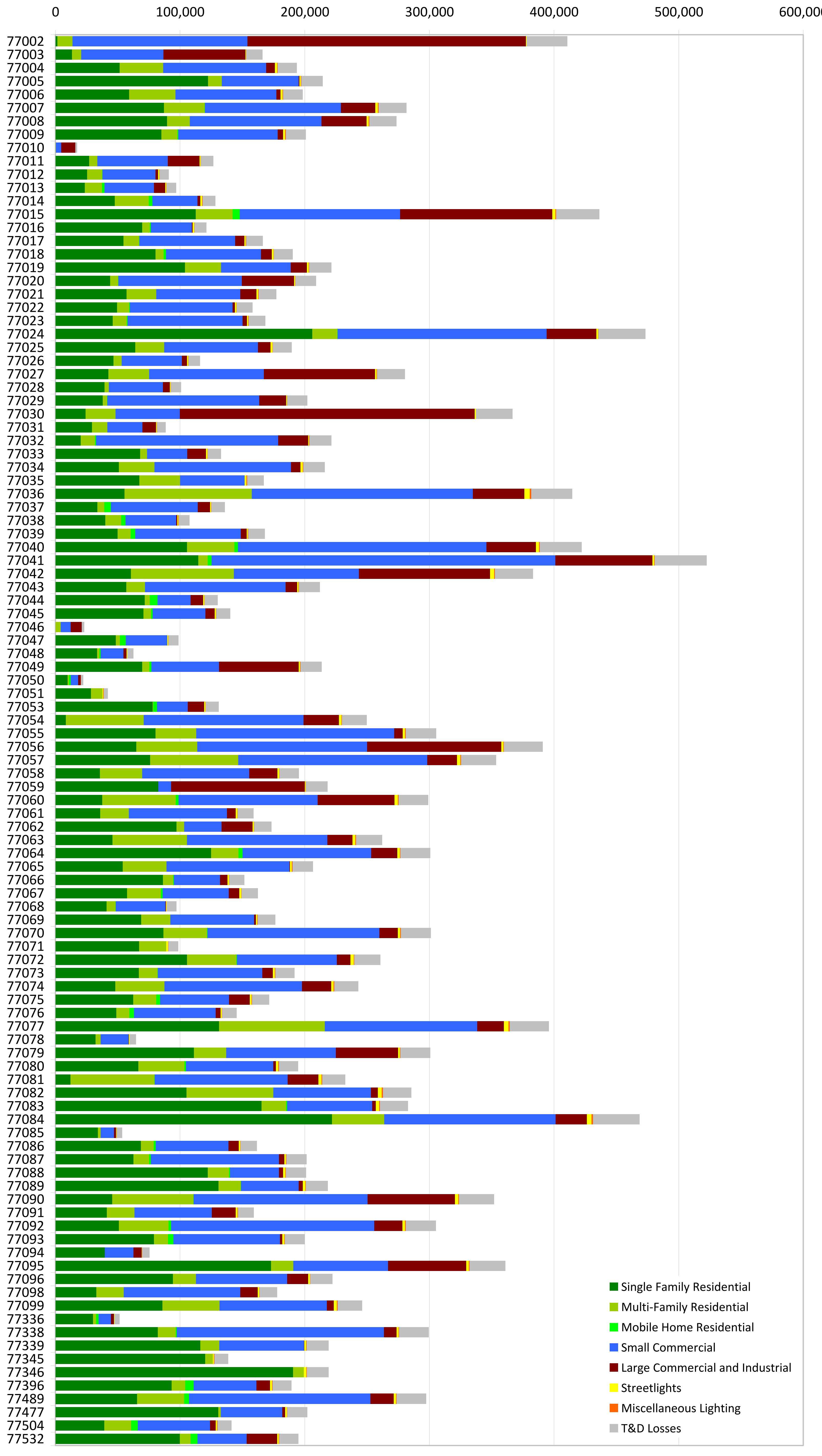


	Emissions (tons)	Percent of Total
TOTAL	22,257,878	100.0%
T&D Losses	1,770,464	8.0%
Miscellaneous Lighting	41,033	0.2%
Streetlights	153,721	0.7%
Large Commercial and Industrial	2,460,860	11.1%
Small Commercial	8,135,703	36.6%
Mobile Home Residential	108,157	0.5%
Multi-Family Residential	2,356,354	10.6%

As the figure shows, total residential electricity use comprises 43.6% of total electricity emissions, whereas, the second largest source, small commercial is 36.6% of total emissions. This analysis illustrates that great strides can be made in energy efficiency efforts targeted at residents (or residential builders), largely single family, and small commercial businesses.

Zip Code. The general at a glance analysis by zip code is presented below. This analysis shows that there are a few select zip codes that

Figure 64: Electricity Emissions Analysis by Zip Code and Sector, in tons of CO2E, 2007



Natural Gas

This sub-section provides the emissions inventory for the Natural Gas record of the 2007 emissions inventory. Displayed below is the general emissions inventory in table format.

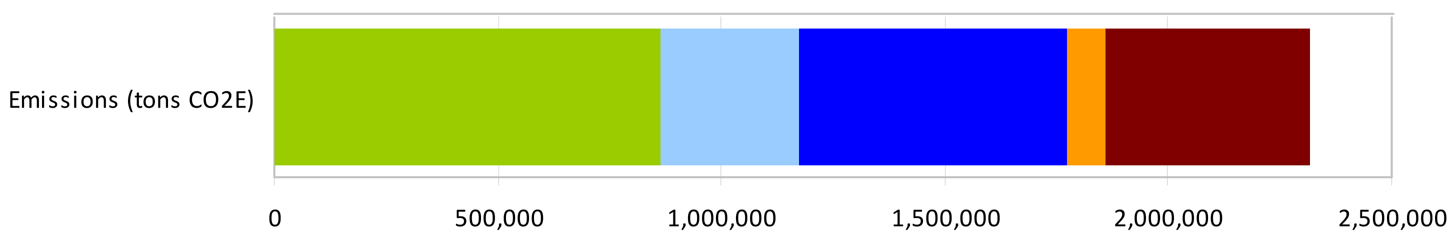
Figure 65: Natural Gas Emissions Inventory, 2007

Sector	Emissions (tons CO2E)	Percent of Total
Residential	**866,589**	**37%**
Commercial	**905,929**	**39%**
Large Commercial	599,114	26%
Small Commercial	306,815	13%
Industrial	**545,973**	**24%**
Industrial/Transport	457,218	20%
Industrial	88,755	4%
Total	**2,318,491**	**100%**

Scope. The analysis by scope shows that all 545 natural gas entries were scope 1. Therefore, all of the natural gas consumption in city limits is due to the usage patterns of those residing within city limits

Sector. The analysis by sector is presented below. From the 2007 U.S. GHG emissions inventory, the total U.S. 2007 natural gas use GHG emissions in tons of CO2E was 1,346,252,803 tons. In comparison to Houston's GHG emissions from natural gas use, 2,318,491 tons of CO2E, this is only 0.17% of the U.S. natural gas use emissions. The figure below presents the natural gas emissions broken down by sector in 2007.

Figure 66: Natural Gas Emissions Analysis by Sector, 2007

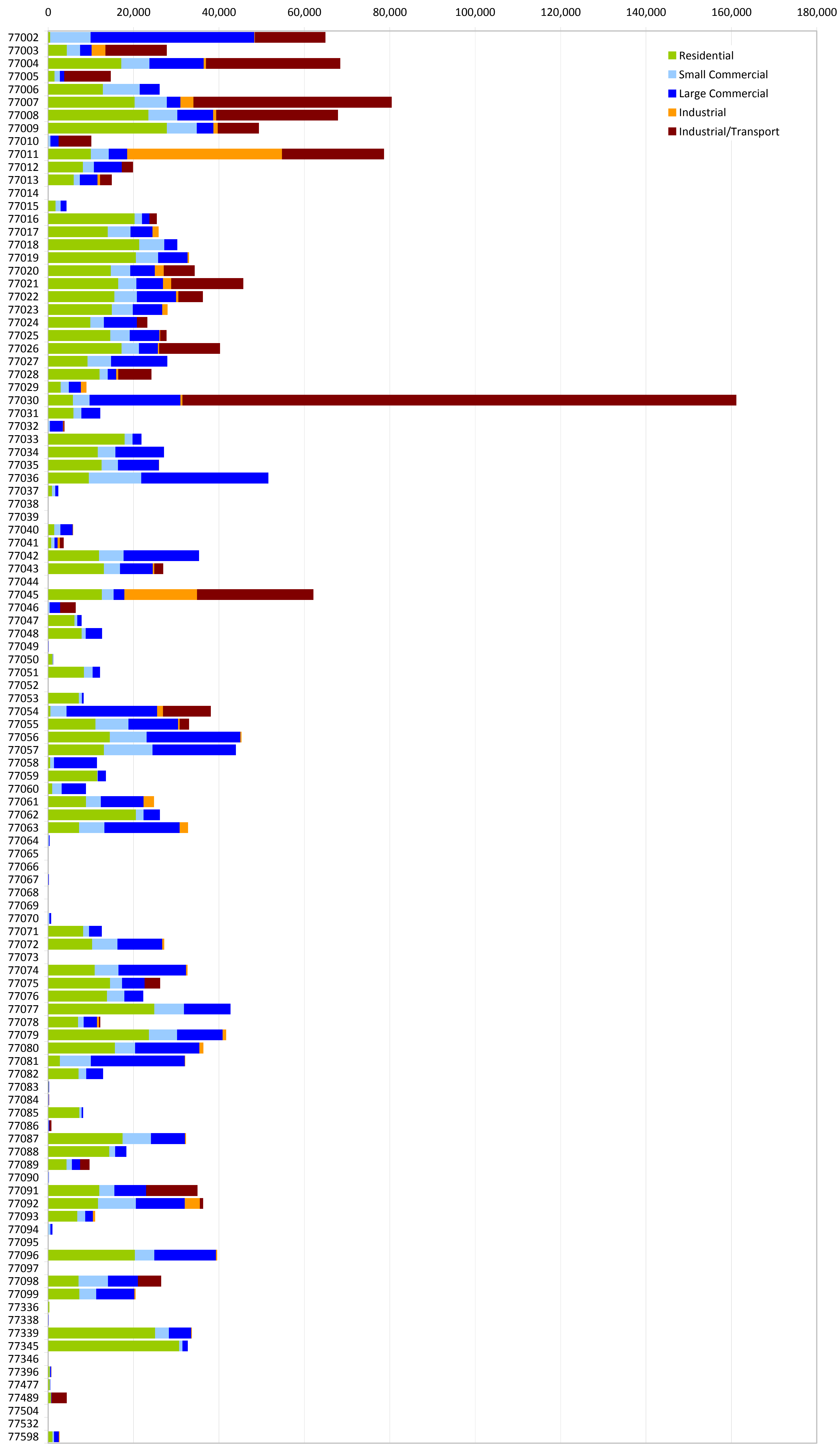


	Emissions (tons CO2E)	Percent of Total
TOTAL	2,318,491	100%
Industrial/Transport	457,218	20%
Industrial	88,755	4%
Large Commercial	599,114	26%
Small Commercial	306,815	13%
Residential	866,589	37%

As the figure shows, total residential natural gas use comprises 37% of total natural gas emissions, whereas, the second largest source, large commercial is 26% of total emissions. This analysis illustrates that great strides can be made in energy efficiency efforts targeted at residents (or residential builders) and large commercial businesses.

Zip Code. The analysis by zip code is presented below. This analysis shows that there are a few select zip codes that

Figure 67: Natural Gas Emissions Analysis by Zip Code and Sector, in tons of CO2E, 2007



See Appendix H for all zip code maps by usage (electricity or natural gas) and totals.

Recommendations, Next Steps, & Conclusions,

Given this inventory and preceding analysis, there are four major recommendations for the next steps of this 2007 inventory.

Improvements to the P2D Software.

As a beta-tester city of the P2D software and a member of the P2D Advisory Council, the City of Houston has provided substantial feedback, comments, and suggestions to the P2D team in San Francisco. Appendix G provides these issues in a question and answer format. However, before continuing to use the P2D software, it is recommended that several of these issues be addressed and updated in the software package. One significant drawback to using the P2D software is that the emissions coefficients are not yet up-to-date with the 2008 Local Governmental Operations Protocol; therefore, it is recommended that inventory updates in the P2D software also be accompanied by an inventory update in the CACP2009 software (to be released by ICLEI in April 2009). Ability to compare across cities?

Calculation of Other Criteria Pollutants and Use of CACP Software.

One significant shortcoming of the P2D software is the lack of criteria air pollutants; however, the CACP2003 software and forthcoming CACP2009 software contains the calculation of these pollutants. Although P2D was released to a limited number of cities in 2008, the software currently only has the ability to calculate greenhouse gas (GHG) emissions; therefore, it is recommended CACP be used to supplement the inventory by estimating the other criteria air pollutants—NOx, SOx, CO, VOCs, and PM10 using the same categorical breakdowns - energy use (electricity and natural gas), transportation, and waste.

CACP was developed by Torrie Smith Associates for ICLEI (International Council for Local Environmental Initiatives), STAPPA (State and Territorial Air Pollution Program Administrators), and ALAPCO (Association of Local Air Pollution Control Officials). The development of the software has been supported by the U.S. Environmental Protection Agency (U.S. EPA). For additional information regarding CACP2003 and CACP2009, see the CACP users' guide located at http://www.icleiusa.org/cacp.

The pollutants measured in this software were NOx (nitrogen oxides), SOx (sulfur oxides), CO (carbon monoxide), VOCs (volatile organic compounds), and PM10 (particulate matter -10 microns or less in diameter). Under "Community Analysis", the three categories to be estimated are energy use (electricity and natural gas) for the residential, commercial, and industrial sectors, transportation, and waste.

Using a combination of the two software programs, six criteria air pollutants can be estimated—GHGs in CO2e, NOx, SOx, CO, VOCs, and PM10. These six pollutants were identified as important to estimate by the Mayor's Task Force on the Health Effects of Air Pollution (2006), the criteria pollutants from the EPA, and the pollutants on the Air Pollutant Watch List (APWL) from the TCEQ. It is important to note that the gases and global warming potentials for each of these pollutants are from the IPCC's 1995 Second Assessment Report (SAR) and consistent with international practices (California, 2008)[24].

The five other criteria air pollutants are described next. NOx incorporates all those highly reactive gases that contain nitrogen and oxygen. In most cases these gases are colorless and odorless and are formed when fuel is burned at high temperatures (EPA, May 2007). NOx is emitted from motor vehicles, power plants and other sources of inefficient or incomplete combustion (EPA, April 2007). Reducing NOx emissions is essential to reducing ground level ozone and helping to curb global warming.

Sulfur oxides are colorless gases that are the result of burning sulfur (EPA, March 2007, SO2). All fuels used by man (oil, coal, natural gas, wood, etc.) contain some sulfur; during the combustion process, sulfur reacts with oxygen to form sulfur oxides (SOx). SOx is detrimental to the respiratory health of vulnerable populations, such as youth and elderly (EPA, March 2007, SO2).

Carbon monoxide is a colorless, odorless, and poisonous gas produced by the incomplete burning of carbon in fuels (EPA, April 2007). The largest emissions contribution comes from highway motor vehicles. Thus, the focus of CO reduction has been on traffic oriented sites in urban areas where the main source of CO is motor vehicle exhaust. CO in cities is usually 85-95% from on-road vehicles. Other major CO sources are wood-burning stoves, incinerators and industrial sources (EPA, April 2007).

VOCs are emitted from sources as diverse as autos, chemical manufacturing, dry cleaners, paint shops and other sources using solvents (EPA, April 2007). VOCs, in combination with NOx, is also a chief contributor to ground-level ozone. Thus, VOCs are an indoor and outdoor air pollutant that is detrimental to the health of the residents of the city of Houston.

Coarse particulate matter is from construction sites, unpaved roads, fields, smokestacks, fires, power plants, industry, autos, etc. This air pollutant contains solid particles and liquid droplets found in air. Particles formed in the atmosphere by condensation or the transformation of emitted gases such as SO2 and VOCs are also considered particulate matter (EPA, April 2007). PM10, measured in tons per year (tpy), can cause health problems in the lungs and bloodstream.

Ultimately, it is recommended that the CACP2009 software be used to estimate emissions from these five pollutants. The CACP2009 software contains the standard emissions factors required by the 2008 Local Government Operations Protocol, unlike the CACP2003 and P2D.

<u>Streamlining the Data Collection System.</u>

Another important recommendation is the streamlining of the data collection system. The data collection process for this 2007 GHG emissions inventory took 3 months. It is recommended that a regular, transparent data collection system be implemented across the city, state, or country to facilitate this data collection process. If the data values were required to be reported by each entity, especially the electricity companies, this process would be made significantly more efficient.

[24] The Second Assessment Report values are the default values in CACPS and P2D.

Formulation of Reduction Measures.
The final recommendation and next step is to formulate feasible emission reduction measures.

These four recommendations and next steps are essential to establishing a more complete emissions inventory and establishing a transparent, systematic emissions inventory process.

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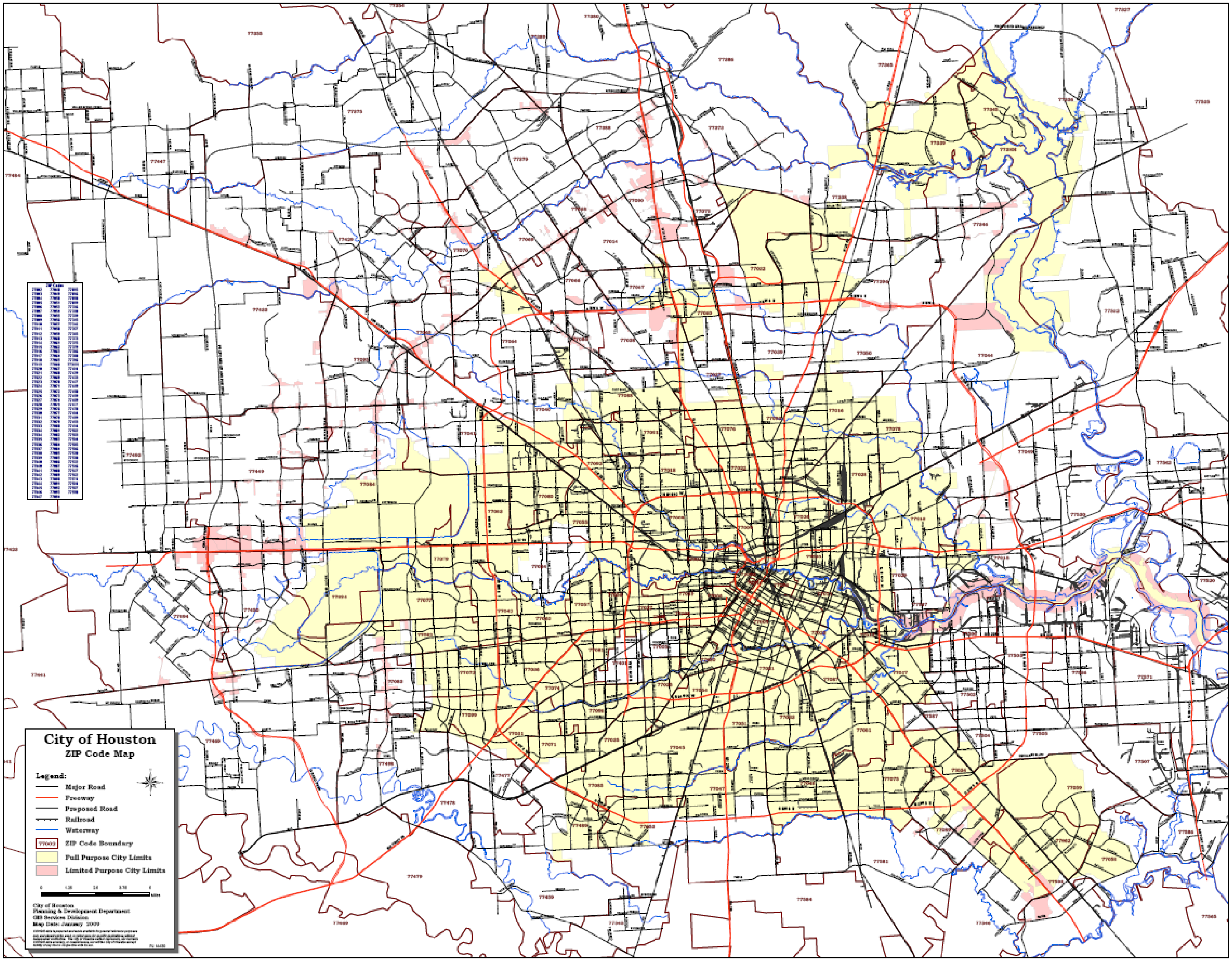
APPENDIX A: MAP OF HOUSTON CITY LIMITS



APPENDIX B: CENTERPOINT ENERGY RATE CLASS DESCRIPTIONS AS OF 2003

TDSP Rate Codes	TDSP Rate Class -- TxSET	Rate Description
	NON-IDR	
111	Residential	Residential
191	Residential 01	Residential / SCUD
350	Commercial Under 10 kVA	Secondary Service 0 to 10 KVA
351	Commercial Under 10 kVA 01	Secondary Service 0 to 10 KVA / SCUD
352	Commercial Under 10 kVA 02	Secondary Service 0 to 10 KVA / Sea. Agg.
353	Commercial Under 10 kVA 03	Secondary Service 0 to 10 KVA / TL
348	Commercial Under 10 kVA 04	Secondary Service 0 to 10 KVA / Metro Bus Shelters
349	Commercial Under 10 kVA 05	Secondary Service 0 to 10 KVA / Metricom
360	Commercial Over 10 kVA	Secondary Service 51 KVA or Greater / LF > 10%
370	Commercial Over 10 kVA 01	Secondary Service 11 to 50 KVA
371	Commercial Over 10 kVA 02	Secondary Service 11 to 50 KVA / SCUD
372	Commercial Over 10 kVA 03	Secondary Service 11 to 50 KVA / Sea. Agg.
380	Commercial Over 10 kVA 04	Secondary Service 51 to 400 KVA / LF < 10%
381	Commercial Over 10 kVA 05	Secondary Service 51 to 400 KVA / SCUD / LF <10%
361	Commercial Over 10 kVA 06	Secondary Service 51 KVA or Greater / SCUD / LF > 10%
362	Commercial Over 10 kVA 07	Secondary Service 51 KVA or Greater / Sea. Agg. / LF > 10%
382	Commercial Over 10 kVA 08	Secondary Service 51 to 400 KVA / Sea Agg. / LF < 10%)
363	Commercial Over 10 kVA 09	Secondary Service 51 KVA or Greater / TL / LF > 10%
373	Commercial Over 10 kVA 10	Secondary Service 11 to 50 KVA / TL
383	Commercial Over 10 kVA 11	Secondary Service 51 to 400 KVA / TL / LF < 10%
390	Primary Over 10 KVA	Primary Service 51 KVA or Greater / LF >10%
391	Primary Over 10 KVA 01	Primary Service 11 to 50 KVA
392	Primary Over 10 KVA 02	Primary Service 51 to 400 KVA / LF < 10%
366	Primary Over 10 KVA 03	Primary Service 51 KVA or Greater / SCUD / LF >10%
376	Primary Over 10 KVA 04	Primary Service 11 to 50 KVA / SCUD
364	Primary Over 10 KVA 05	Primary Service 51 KVA or Greater / TL / LF > 10%
374	Primary Over 10 KVA 06	Primary Service 11 to 50 KVA / TL
384	Primary Over 10 KVA 07	Primary Service 51 to 400 KVA / TL / LF < 10%
	IDR	
990	SVS	Secondary Voltage Service 0 to 10 KVA
991	SVL	Secondary Voltage Service > 10KVA
992	PVS	Primary Voltage Service
993	TVS	Transmission Voltage Service
994	SVSD	Secondary Voltage Service 0 to 10 KVA / SCUD
995	SVLD	Secondary Voltage Service > 10 KVA / SCUD
996	PVSD	Primary Voltage Service / SCUD
997	TVSD	Transmission Voltage Service / SCUD
970	SVS_SA	Secondary Voltage Service 0 to 10 KVA / Seasonal Agg
971	SVL_SA	Secondary Voltage Service > 10 KVA / Seasonal Agg
972	PVS_SA	Primary Voltage Service / Seasonal Agg
	STREETLIGHT	
941	SLB_Municipality	Street Light Services for Municipalities
961	SLB_Non_Municipality	Street Light Services for Non-Municipalities
	MISCELLANEOUS LIGHTING	
680	MISC GL Lighting Service	Guard Light Service
681	MISC GL Lighting Service 01	Guard Light Service / SCUD
682	CUST Owned GL Lighting Ser	Customer Owned Guard Light Service
683	CUST Owned GL Lighting Ser 01	Customer Owned Guard Light Service / SCUD
690	Misc Security Lighting Service	Security Light Service
691	Misc Security Lighting Ser 01	Security Light Service / SCUD
692	CUST Owned SL Lighting Ser	Customer Owned Security Lighting Service
693	CUST Owned SL Lighting Ser 01	Customer Owned Security Lighting Service / SCUD

LF = Load Factor
TL = Transformer Losses
kVA = Kilovolt Amperes
HVC = High Voltage Credit (applicable to Primary Rates only)
SCUD = 20% State College / University Discount
Sea Agg = Seasonal Agricultural

Appendix C: The 11 Source Activity Definitions[25]

Agriculture, Forestry and Other Land Use
Activities directly related to land use, such as farming, ranching, dairy and other food-producing activity; forestry and energy crop production; greenbelts, afforestation, and wetland restoration.

Electricity, Steam, and District Energy Consumption
Activities related to fuel consumed in heating and cooling government-owned or -operated buildings and facilities, by electricity and utility delivered heating/cooling, end-user efficiency programs, fuel switching, and renewable energy.

Fugitive Emissions from Fuels
The release of GHGs during the extraction, processing, and transportation of fossil fuels to the final point of use, and procedures to reduce such emissions.

Mobile Fuel Combustion – Road
Activity from on-road vehicles such as cars, buses, motorcycles and trucks; traffic management; fuel switching; and transportation mode switching.

Mobile Fuel Combustion – Non-road
Activity from off-road vehicles, such as boats, trains, aircraft, tractors, earthmovers, and similar equipment.

Other
Activity from any process, technique or technology not accurately represented by any other Source or Source Type.

Process Emissions
Industrial or commercial activity, including changes to reduce raw material consumption or increase process efficiency.

NOTE: Refer to Section 1.2.5 of the IPCC Guidelines for Greenhouse Gas Inventories, Volume 3 for a comprehensive list of emissions that should be tracked in this sector.

Stationary Fuel Combustion
Activity related to utility power generation using fossil fuels, including backup or other small-scale power generation.

Use of Greenhouse Gases in Products
The industrial or commercial use of fossil fuels as feedstocks, or otherwise incorporating them into products.

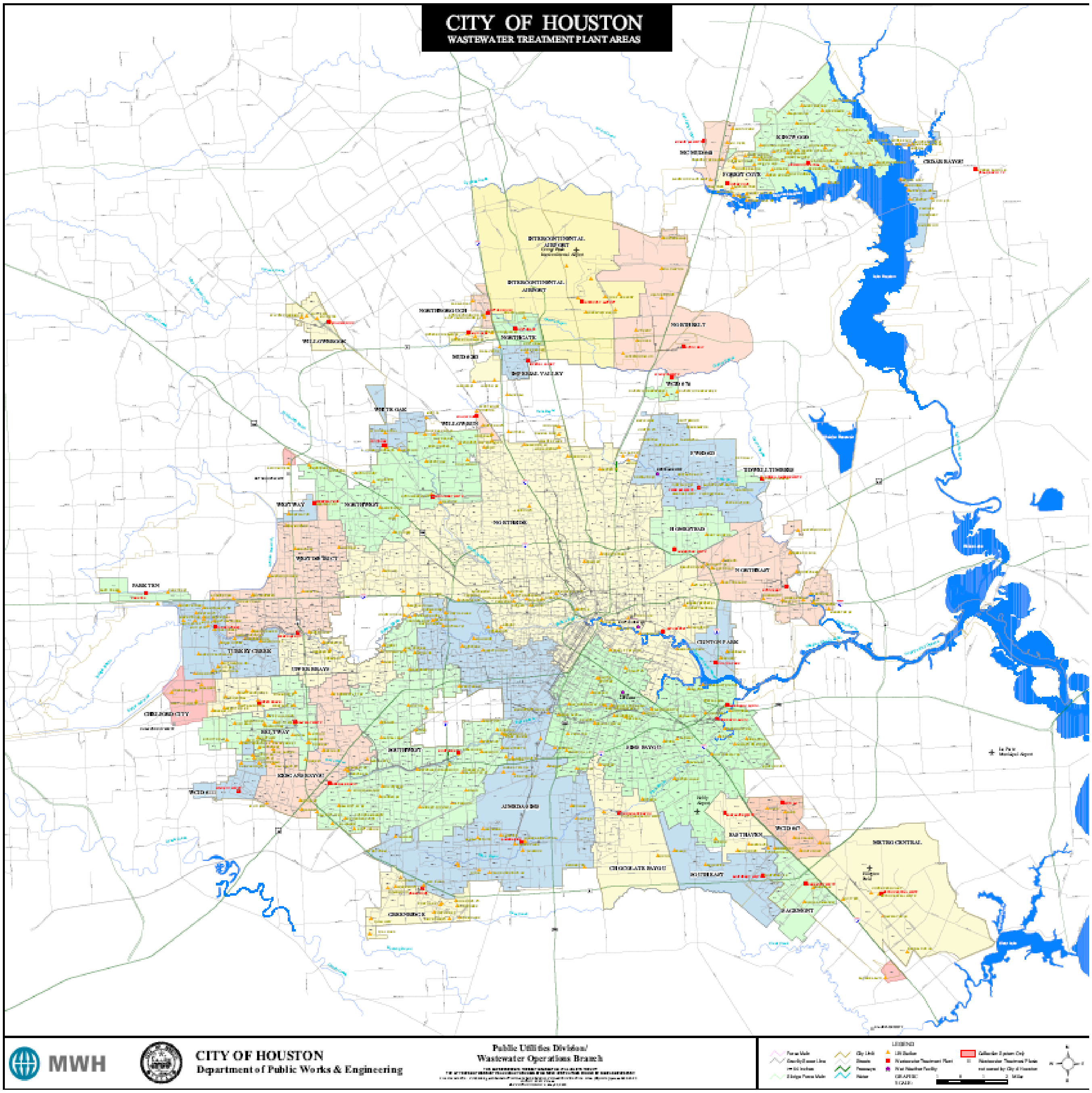
[25] (P2D, 2008)

NOTE: Refer to Section 1.2.5 of the IPCC Guidelines for Greenhouse Gas Inventories, Volume 3 for a comprehensive list of emissions that should be tracked in this sector.

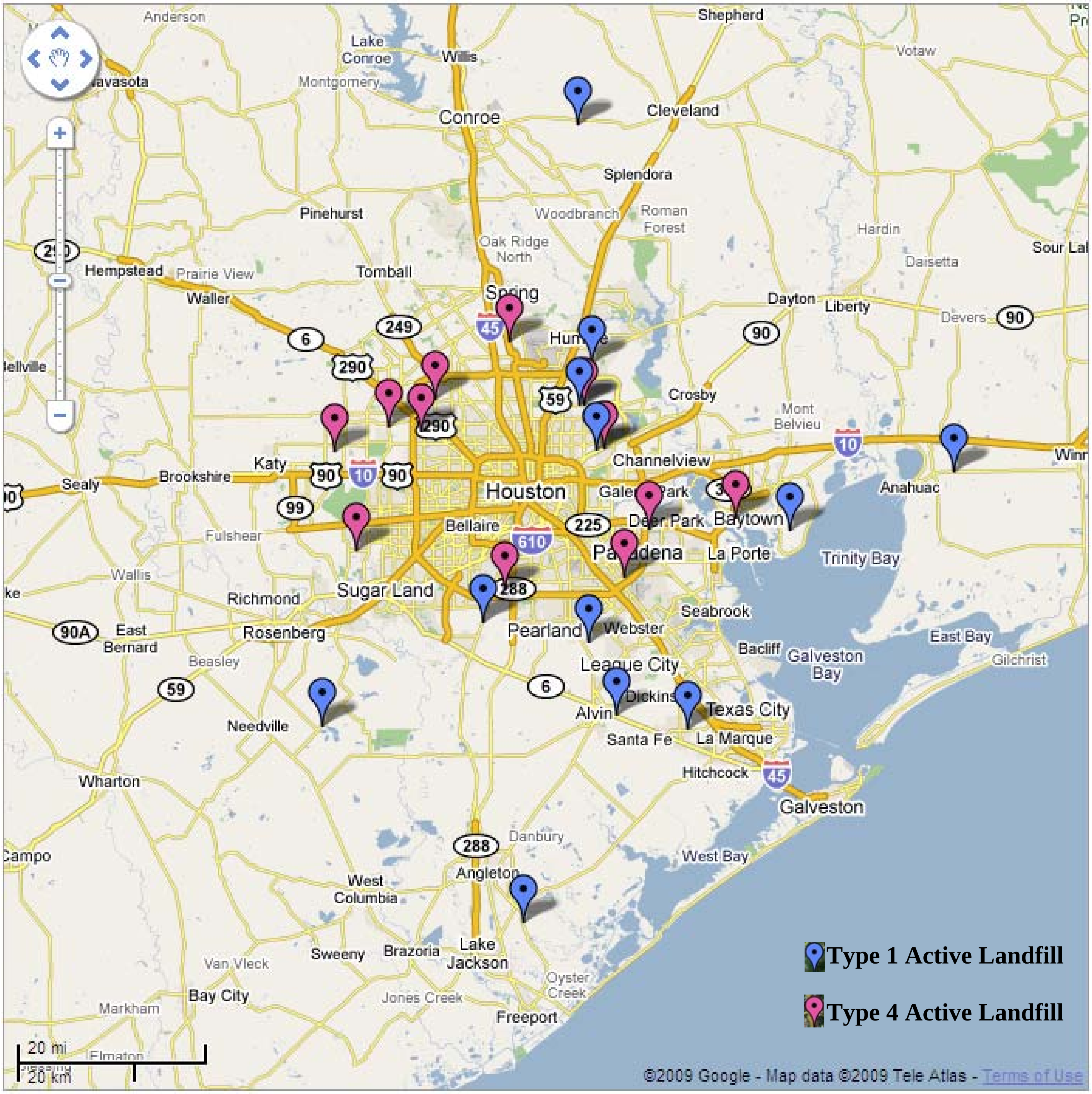
Waste – Wastewater
Activity related to the treatment and processing of wastewater (sewage), from domestic or industrial sources.

Waste - Solid Waste
Activity related to the landfilling, incineration or recycling of municipal solid waste (garbage), industrial waste, or waste from other streams.

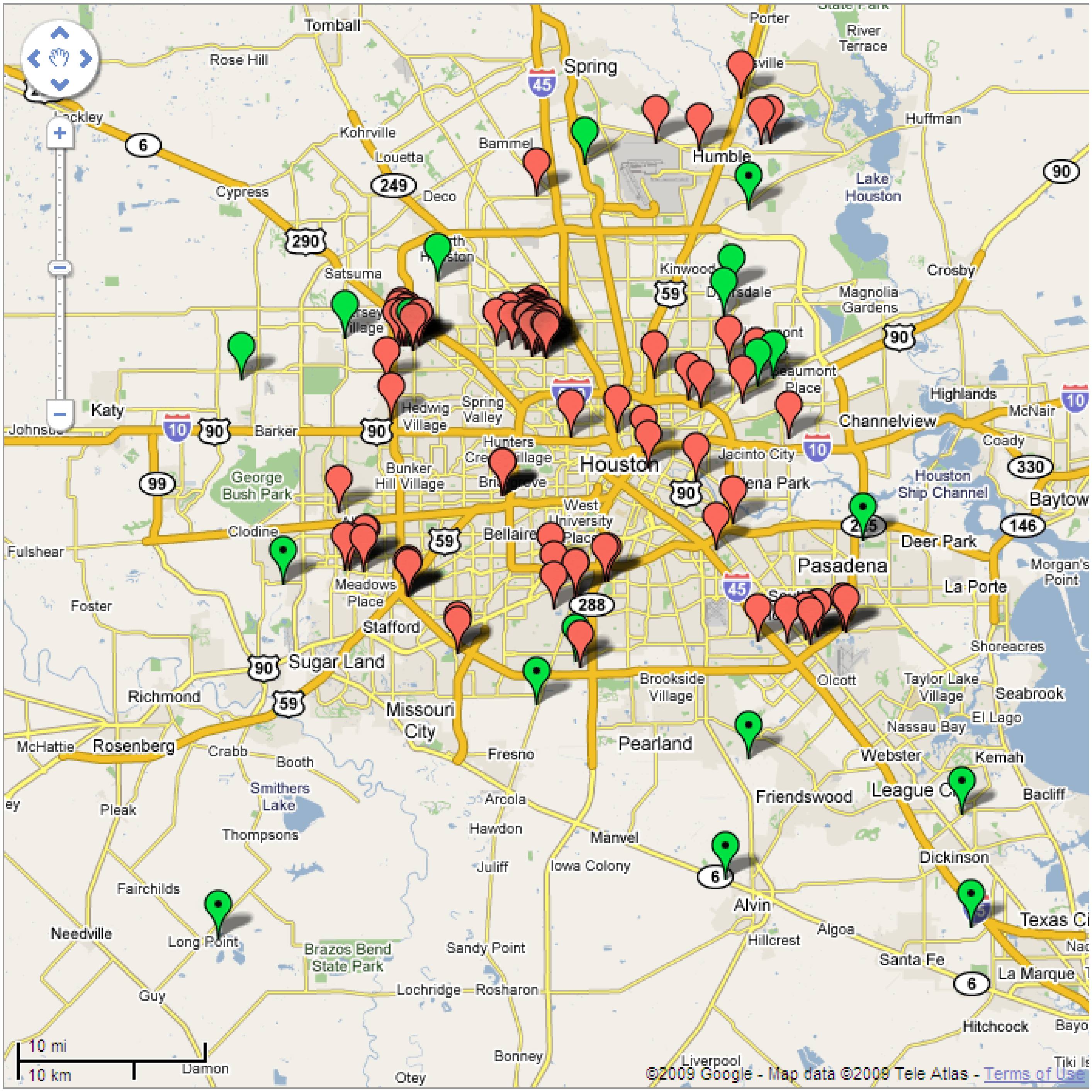
APPENDIX D: CITY OF HOUSTON WWTP MAP



APPENDIX E: 23 ACTIVE LANDFILL MAP BY TYPE OF LANDFILL



Appendix F: 127 Active and Inactive Landfills



Inactive Landfill

Scope 1 Active Landfill

Scope 3 Active Landfill

APPENDIX G: CITY OF HOUSTON P2D CORRESPONDENCE[26]

Questions/suggestions - black
Jim Yienger & Sarah Weingarden's comments (ICLEI)- blue
Jen Tsuda (COH - me) comments/responses/follow-ups - red
Jen McGraw & Scott Johnson (P2D help team in SF) comments – burgundy
Brian Yeoman and others at CCI - green

Energy

Overall data update – we will be getting electricity data and natural gas data within 2 weeks (by changing base year to 2007, the request was expedited from months to weeks)

1) **Electricity/Natural Gas Question:** Our community natural gas data by zip code will take longer than expected to retrieve; however the electricity data by zip code will be retrieved in a more timely fashion. Therefore, would it be possible/logical to use the electricity usage rate by zip code as a proxy for natural gas usage by zip code?

   Jim: I don't think your proposal would work. I am not certain that electricity and natural gas usage would be proportional.

   Jen T: We may have avoided this issue by changing our base year to 2007 (where data is more easily retrievable for our natural gas provider). If I have additional questions re this, I'll contact you.

   Jen T: Follow-up – we have zip codes that cross City boundaries, would we use a proxy like # households, population, # of meters, etc. to determine how much of the energy use in that zip code is actually within City/community boundaries? What have other cities done?

2) **Coefficients (in the Administration section):** How do I know that these are the best coefficients we could possibly use? I've set the Electricity Region to ERCOT and the Sub-region to All. Can we go anymore specific? Would it beneficial to retrieve the "blend" of energy from our energy providers and input this in?

3) For the government inventory, by entering the natural gas data as Scope 1 (instead of Scope 2, as I've read in the "Local Govt Ops Protocol"), does this imply that a City produces their own natural gas and does not purchase the natural gas from another provider? Scope 1 for natural gas means that you are burning the natural gas you buy on site. For any boilers and furnaces using natural gas, this is all scope 1. Scope 2 is for electricity consumption only because your use of electricity cause emissions at a plant owned by someone else.

[26] As of 04/01/2009. This document is constantly updated as correspondence between P2D, ICLEI, COH, and CCI progresses. Please email jennifer.tsuda@cityofhouston.net for the most up-to-date document.

Jim: I looked through your data and it looks great. I have a couple of suggestions. I would suggest that for all your records in Buildings and Facilities, Wastewater, and streetlights and traffic signals that you make all the "natural gas" sources set to "Scope 1", instead of "Scope 2".That would be consistent with the Local Government Operations Protocol, if you are following this. You can find and download the protocol under the "resources" link.

Scope 1 for natural gas means that you are burning the natural gas you buy on site. For any boilers and furnaces using natural gas, this is all scope 1. Scope 2 is for electricity consumption only because your use of electricity cause emissions at a plant owned by someone else.

4) After clicking on the following:
Sector – "Energy"
Record – "Natural Gas"
GHG Emission name – "Test"
Source – "Stationary Fuel Combustion"
Scope – "1"
Method – "Stationary Fuel Combustion"
Fuel – "Natural Gas"
Activity Area – "Commercial", "Residential", Industrial", "Electric Power"
Energy Combusted – "____ "
Units – "Btus"
I wanted to find out what commercial, residential, industrial, and electric power mean. If I have natural gas data from the residential sector that is used to produce electricity, do I categorize the activity area as "residential" or "electric power"? What does electric power mean? Thanks!

Jen M: While CO2 Emissions Factors are generally directly related to the quantity and carbon content of the fuel burned, CH4 and N2O emission vary with the technology used to burn the fuel. US EPA provides average emission factors for Natural Gas for CH4 and N2O for the four activity areas listed (see attached spreadsheet). The CH4 value for the electric power industry is lower than the others--I believe that is because the average power plant is much more efficient and has more controls on it than the average home furnace. Different data sources use different activity areas, so you may encounter that in the application--the software just shows whichever ones were in the source data.

To your question...I would pick residential.

Geography	Data Type	Activity Area	Fuel	Start Year	End Year	Original Va	Original U	Gross or N	Reference	Value	Numerato	Denominat
US	CH4 Emission Factor	Commercial	Natural Gas	1990	2004	5	kg per TJ	GCV	EPA Invent	5	kg	TJ
US	CH4 Emission Factor	Electric Power	Natural Gas	1990	2004	1	kg per TJ	GCV	EPA Invent	1	kg	TJ
US	CH4 Emission Factor	Industrial	Natural Gas	1990	2004	5	kg per TJ	GCV	EPA Invent	5	kg	TJ
US	CH4 Emission Factor	Residential	Natural Gas	1990	2004	5	kg per TJ	GCV	EPA Invent	5	kg	TJ
US	N2O Emission Factor	Commercial	Natural Gas	1990	2004	0.1	kg per TJ	GCV	EPA Invent	0.1	kg	TJ
US	N2O Emission Factor	Electric Power	Natural Gas	1990	2004	0.1	kg per TJ	GCV	EPA Invent	0.1	kg	TJ
US	N2O Emission Factor	Industrial	Natural Gas	1990	2004	0.1	kg per TJ	GCV	EPA Invent	0.1	kg	TJ
US	N2O Emission Factor	Residential	Natural Gas	1990	2004	0.1	kg per TJ	GCV	EPA Invent	0.1	kg	TJ

5) Also, I have another question regarding the electricity sector. We have already put ERCOT as our electricity region and ALL as our sub-region in the coefficients section. However, I wanted to find out what blend of energy (i.e. the coal to natural gas to water to wind to nuclear to other energy mix) the software assumes, and how we are able to refine this blend if we are able to retrieve more city-specific information (i.e. where in the software we can change this and/or who to contact to program this change for us). I attached the 2008 PUC report that on page 26 provides the actual blend of energy used for 2007 (which we'd want to make sure was updated in our software). This report shows that in 2007, the ERCOT blend was: If/when we get more specific info from our energy provider, we'd likely want that blend to be input instead.

Type of Fuel	**2007 ERCOT %**
Natural Gas	45.5%
Coal	37.4%
Water	0.4%
Wind	2.9%
Nuclear	13.4%
Other	0.4%
Total	**100.0%**

6) I am looking for the emission factors in P2D for the fuel that makes up electricity generation. I've found the grid average electricity emissions factors in the administration section for CO2, CH4, and N2O. However, I cannot seem to find the fuel that makes up this electricity consumption (see attached workbook for the EFs I am looking for in P2D that I was able to locate in CACP, specifically the ones in blue). I am thinking that the Fuel tab in the Coefficients section is where I need to look, but when I select Electric Utility and/or Electric Power I only get a few entries and only for Residual Fuel Oil and Coal, respectively. Can you point me in the right direction on where to look, or let me know if we are not able to view these in P2D and where I may find the assumptions used to calculate the grid average electricity EFs?

7)

Transportation

Overall data update – we have cars, buses, trains, non-road and planes data. We are waiting on boats (from TCEQ).

1) **Coefficients (in the Administration section):** How do I know that these are the best coefficients we could possibly use?

2) **Fleet Average Transportation Calculator:** How do we change the % allocation of fuel and type of vehicle in this calculator? Do we change the coefficients in the administration section, or is there a way we can just change the percentages?

3) In the community inventory's transportation category, how are the emissions calculated for Scopes 1, 2, and 3? Specifically, hypothetically speaking, if a trip from Houston to Frankfurt is recorded in the inventory, as a Scope 3 activity, how are the emissions allocated to Houston's inventory?

   Jim: The community protocol is not yet finalized but some issues are pretty clear. Emissions in different "scopes" do not add up technically speaking. An "inventory" will not be a single number but rather a matrix of sources in scope 1,2,and 3 that do not add up. Many cities want to report a single GHG number. To do that ICLEI's appendix in the LGOP gives guidance on that by creating a roll up number by selecting sources from your matrix.

4) We have all the data we need for Non-Road equipment (as pasted below); however, P2D does not offer an LPG or CNG fuel option for off-road equipment/machinery. After looking through the coefficients section, I have not been able to find these fuel types for the vehicle types listed below. I've also looked at the IPCC's 2006 guidelines for mobile combustion/non-road and LPG and CNG as fuel types for non-road are not offered as coefficients (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf). After looking at the 2009 US EPA's GHG Emissions Draft (http://epa.gov/climatechange/emissions/downloads09/07Energy.pdf), I was unable to find these coefficients. Do you know where I can find this information and, if not, can ICLEI or P2D provide us with some guidance on what to do?

Vehicle Type	Fuel Type	Gallons Used
Agricultural Equipment	CNG	63,868
Agricultural Equipment	Diesel	31,139
Agricultural Equipment	Gasoline	2,705
Agricultural Equipment	LPG	9
Commercial Equipment	CNG	149,643,838
Commercial Equipment	Diesel	597,628
Commercial Equipment	Gasoline	457,100
Commercial Equipment	LPG	1,004,930
Construction and Mining Equipment	CNG	346,068
Construction and Mining Equipment	Diesel	1,622,958
Construction and Mining Equipment	Gasoline	167,367
Construction and Mining Equipment	LPG	138,426
Industrial Equipment	CNG	387,887,040
Industrial Equipment	Diesel	37,907
Industrial Equipment	Gasoline	403,725
Industrial Equipment	LPG	17,469,757
Lawn and Garden Equipment (Com)	Diesel	46,280
Lawn and Garden Equipment (Com)	Gasoline	155,194
Logging Equipment	Diesel	0
Logging Equipment	Gasoline	2
Pleasure Craft	Diesel	10,111
Pleasure Craft	Gasoline	338,824
Railroad Equipment	Diesel	5,275
Railroad Equipment	Gasoline	1
Railroad Equipment	LPG	73
Recreational Equipment	Diesel	4,497
Recreational Equipment	Gasoline	632,251
Recreational Equipment	LPG	2,008
	TOTAL	561,068,978

Jim: ICLEI recommends you adhere to the LGOP for your inventory. You can find emission factors for CO2 for these in Table G.9. For the CH4 and N2O emissions, look at table G.12- this has your off road categories for gasoline and diesel. LGOP does not have explicit CH4 and N2O off road coefficients for CNG and LPG. For those you might have to use table G.3 values as a proxy and document it.

Phone call with Jim (3/10/09, 4pm): Tried to add our own CH4, N2O, and CO2 coefficients using the LGOP (September 2008), Table G3 (for CH4 and N2O), Petroleum Products-Commercial/Institutional (LPG) and Natural Gas-Commercial/Institutional (CNG) as a proxy for our LPG and CNG off-road vehicles (pp.172) and Table G9 for CO2 under LPG and CNG (pp. 177). We could add the coefficient, but we could not pull it up in the calculator. Direct entry was the recommendation, but Jim and Jen M will get back to me.

Jim: Houston has nonroad agriculture equipment running CNG and LPG in the community. P2D has default EFs for CH4 and N2O for non road only have gasoline and diesel in this vehicle category.
We have LGP and CNG emission factors for CH4 and N2O for agricultural vehicles from the LGOP

In admin for Ch4 and N2O coefficients in mobile combustion, using "new" P2D allows you to create and combination of fuel and vehicle in the mobile combustion tab of admin. We created it. However because the default list for the mobile non-road calculator for agricultural vehicles only has gasoline and diesel, there is no way to use the new value created in admin.

I thought of two work-arounds that don't work:
Use a stationary combustion EF set for LGP and CNG, but there is no way to access the stationary calculators in the community (we did not allow this in community)
Use a proxy vehicle – fuel combo that is default in the mobile category that uses LPG and CNG, like CNG Bus, and edit those factors. However there are very few for on road types and we do not want to change the default of those as they may be needed.

Anyone have other ideas?

Unless there is an answer I am recommending that Houston calculate the emissions offline for these types using a spreadsheet, use direct entry to enter the results, and then upload the reference calculation and spreadsheet to the record.

Jen M: Yes, if we don't have an emissions factor in all likelihood it wasn't in our source materials (IPCC, National Government Inventories, etc.). Because the primary published sources of emissions factors are related to national inventories they often don't include some combinations of fuels and vehicle types that are not common at a national scale. Adding new, user generated fuel/vehicle combinations is on our todo list, but we haven't built that feature yet. So, I agree with Jim's suggestion that you calculate this in a spreadsheet using the emissions factors you want, directly enter those values and upload the spreadsheet to the record.

5) We have a question in regards to the diesel bus emission factors (and the rest of the vehicle emission factors as well). I looked at the emission factors for the diesel buses under mobile combustion and only the CH4 and N2O EFs show up. So my question is, how are the CO2 emissions calculated if there isn't an emission factor for it in the administration section? Is there another calculation that takes place? If so, how does this calculation happen?

Jen M: All fuel CO_2 emissions factors are in the Fuel tab of the coefficients tables in the administration section. Because CO_2 is based on the carbon content of fuel and the amount of fuel used, CO_2 emissions factors for fuels are the same whether the fuel is consumed in a stationary source (like a generator) or a mobile source (like a car or boat). So we only have one table in the coefficient section for fuel CO_2 emissions factors.

The mobile fuel combustion calculation happens in two parts. The CO_2 is calculated as Emissions Factor per Unit of Fuel * CH_4 and N_2O emissions Fuel Used. The fuel used value is either entered by you or calculated based on the distance traveled data you enter and the fuel efficiency.

CH_4 and N_2O emissions rates are tied to the technology burning the fuel. And in the on-road transport sector emissions factors are expressed as CH_4 or N_2O per distance traveled. Whereas, in stationary combustion the CH_4 and N_2O are calculated on a per unit of fuel basis like CO_2 is. This is why we have separate tables for Stationary and Mobile Combustion CH_4 and N_2O emissions factors. If you want more detail on the algorithms involved, we have them all described in the help document.

By the way, Id like to make the coefficient admin section more intuitive. Weve thought about organizing it by the calculator the coefficients are used in, but that would end up with a lot of duplication since many are used in more than one calculator, and the duplication could make customization tricky.

Waste

Overall data update – we have all the data we need for active landfills and COH owned/operated WWTP. We must extrapolate/estimate inactive landfills (have all the data that is available). We must determine if we want industrial pre-treatment WWTP and industrial WWTP too.

1) Is it best to enter solid waste data by landfill? The City of Houston does not own any of their landfills, but contracts this work out. So, in the CACPS software, the City entered the data as a lump-sum of the tonnage of solid waste landfilled in 2005 and entered their own percent breakdown of this waste. How would you suggest the City of Houston's government solid waste emissions inventory in P2D be entered? By landfill? As an aggregate number?

Jim: For your government inventory, anything you count here will be "Scope 3". You have options since scope 3 is optional to report.

Do you contract out operations of the landfill? In this case you could count all emissions from it as Scope 3. Is your contract not related to operating the

landfill, rather only for landfilling your government operations waste? In this case you'd only count the waste actually created by government operations.

When you say the city entered a lump sum of waste landfilled, was this waste generated by the city government, and or community, or both?

2) **Question**: According to the Project 2 Degrees help manual, to determine Houston's climate for the waste inventory, as defined by the software, the following criteria (from According to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories) apply:
   Temperate = Mean Annual Temperature (MAT) is less than or equal to 20°C. Applies to Boreal as well.
   Tropical = Mean Annual Temperature (MAT) is greater than 20°C.
   Dry = Ratio between Mean Annual Precipitation and Potential Evapotranspiration (MAP/PET) is less than or equal to 1.
   Wet = Ratio between Mean Annual Precipitation and Potential Evapotranspiration (MAP/PET) is greater than 1.
   Houston's 2005 numbers are:
   MAT = 21.1°C; so, Tropical (from http://www.srh.noaa.gov/hgx/climate/iah/normals/iah_summary.htm#2005)
   MAP/PET = (28.64 inches/48.7inches) = 0.59; so, Dry (from http://etweather.tamu.edu/rainhistory.htm and http://etweather.tamu.edu/2005pet.htm)
   However, this Dry Tropical climate is not what I would expect Houston to be classified as. I expected Houston to be a Wet Tropical climate**. Are these the correct numbers and if so, how can I explain the Dry Tropical climate conclusion?**

3) **Inactive/closed landfills:** Houston has 105 inactive landfills (all within city limits) and 30 active landfills (11 inside city limits and 14 outside city limits) as mapped here. The data available for the active landfills is complete enough to plug into the software; however, there is incomplete data on the inactive landfills (most only have rough acreage estimates w/o depth and only a rough idea of what is inside, i.e. "junk" or "rubbish"). These inactive landfills certainly do not have accurate waste composition data, methane information, or tonnage data. Also, a majority of these landfills were closed in the 1970s and 1980s and were active in pre-subtitle D regulation time (so many of these landfills were not regulated at the time they were active). The range of years these landfills were active was from less than a year to 36 years. The range of time these landfills have been closed for is from 17 years to 37 years. I checked the TCEQ's (Texas Commission on Environmental Quality's) online database of permits to see if I could dig up any more information about the inactive landfills; however, much of the information available only verifies the data I have already collected (from H-GAC or Houston-Galveston Area Council). Given these data limitations, I will have to make some educated/researched assumptions to be able to plug in reasonable

numbers for the inactive landfills I have enough information for. However, I wanted to find out:

a. Have any other cities run into this issue in doing their inventories? If so, how have they dealt with it? Could I contact them to discuss this?
b. Does ICLEI have a protocol in dealing with inactive landfills?

Jim: In general closed should be accounted for. Are any of them collecting methane? (Jen T: No, none are collecting methane for use, from the data I have) For those you can derive emissions from collection measurements.

From the sounds of it, given they've been closed a long time, it sounds like they may not by significant and might be excluded as deminimis. If there are no real mitigation possibilities available then it does not make sense to start making a detailed analysis of all of them. You might start by creating a single "closed landfill' record in P2D, open for say 15 years say from 1965 to 1980, that received "x" tons of waste per year while it was open. Run the model and see what kind of emissions you get. Is it close to being significant? If it is small you could cite this method in your inventory and leave it at that, and just use the same estimate every year for reinventorying. If you find a huge emissions it might be worth studying it further.

The questions is how to get the X tons that it received. If there is no data, extrapolate it based on what you know. Take current rates you know and extrapolate back by population to years 1965 to 1980. Subtract off the waste from the landfills you can account for specifically in different records and that will give you your X value to put in P2D. Finally, you could disaggregate this between scope 1 and 3 by roughly allocating the emissions based on number of closed landfills in and out of the city.

Unfortunately there is no exact method for dealing with situations where there is no data. I just made up the methods above thinking about it. My feeling is to start simple and then go from there. I think if you could actually do mitigation work at some sites it makes sense to do better analysis at that site.

Jen T: This helps and I will use this methodology as well and look at the IPCC's manual for inactive landfills. I will let you know when/if I have additional questions.

Jen M: I know this is a common problem. IPCC 2006 Tier 1 methods for national government inventories allow countries to estimate historical waste data based on current waste mass and population growth assuming default waste composition. The NGO I work with, CNT ran into this when preparing Chicago's community inventory and ended up doing an estimate of solid waste emissions based on current year generation data. ICLEI likely has other examples of how this has been handled in other cities.

4) **Waste scopes:** From the October 2008 Version 1 of the P2D Guidance Manual for the Waste Sector (pp. 19-20): Scope 1 - emissions from solid waste and water treatment facilities in the community and Scope 3 - decomposition of solid waste which was generated within the community at a landfill site outside of the community. For my own understanding/information, I wanted to find out the logic/thought process behind these scope distinctions. As I was determining which landfills go into which scope, I realized that putting landfills that are outside of the defined "community" (in Houston's case the Houston Full Purpose City Limits) into Scope 3 is not truly taking ownership of one's community's trash (although it is accounting for solely the methane emissions from the landfill within the community). For Houston, 14 of the 25 active landfills are outside of the "community" yet for the most part all of this waste originates from within the community. Thus, this is certainly something that the community can control (i.e. recycle more, reduce the amount of trash produced, etc), but is being accounted for in Scope 3 not Scope 1 because of the location of the landfill. For the landfills outside of the "community", is there any way to account for the amount of waste produced as Scope 1 (since this is something we can control). I can see where double counting can be an issue, but it seems that by accounting for the Houston community's waste as Scope 3 (for those landfills outside city limits) is not as comprehensive as it could be (nor as responsible as we should be). I may be missing a piece of the logic and I am completely open to the thought process that went into this and any suggestions you may have for me. As a larger question, what is the difference between the coefficients that calculate Scope 1 and Scope 3 emissions (are there any differences)?

Jim: The protocol just helps you define Scope 1 vs 3. It doesn't define what you as Houston take credit for. If you look at the ICLEI appendix of the protocol in the "rolling up emissions" you can define scope 3 emissions in your roll up as long as you clearly explain that this is what you want to do. If you want to report emission against the total waste stream created by the city regardless of landfill location this is what you'd do.

Jen T: Thank you. This answers my question.

Jen M: The idea behind the scopes, as they were first created by WRI/WBCSD in the GHG Protocol is that Scope 2 and 3 allow you to track emissions that may not "belong" to you but for which you are claiming some responsiblity or want to track. This concept has been brought into the International Local Government GHG Emissions Analysis Protocol as well.

Thus, if you in Community A are sending your waste to a landfill in another Community B, that Community B would count the resulting landfill emissions as Scope 1, direct emissions. And you in Community A would count those same emissions as Scope 3, indirect emissions. That way if anyone ever tried to add the emissions of your two communities together

those emissions wouldn't be counted.

Just because something is a Scope 3 emission doesn't mean that you should ignore it or not include it as part of your inventory--different organizations will have different rules and guidelines on this. Scope 3 emissions from waste disposed of outside the community is required under the ICLEI International Protocol (see the section I've pasted at the bottom of this email). CCI recommends being as complete as possible and counting as many Scope 3 emissions as you can.

ICLEI International Protocol
Page 43
http://www.iclei.org/fileadmin/user_upload/documents/Global/Progams/GHG/LGGHGEmissionsProtocol.pdf
In summary, base year methane emissions that occur at landfills within the geopolitical boundary of the community must be counted and should be classified as Scope 1 regardless of where the waste was generated or when the waste was disposed (in cases where waste generated by another community is present in a landfill within the analysis community's geopolitical boundary, emissions from that waste shall be included in the analysis community's Scope 1 emissions). Additionally, all methane emissions that result from the waste generated within the geopolitical boundary of the community must be counted regardless of where those emissions occur or when the waste was disposed, and these emissions should be classified as Scope 3.

5) **Wastewater type coefficient:** The COH owned/operated WWTPs take a combination of pre-treated industrial water and domestic water. From what the P2D manual says, we can create a new coefficient for this type of water (and I know how to in the technical sense, but I am uncertain as to how to come up with the number). Should I take a percentage of industrial to domestic and use the percentage of each coefficient (on average these WWTPs take 84% domestic and 16% pre-treated industrial)? What is considered industrial (contents of wastewater)? This may help me determine what # to use for the coefficient.

   Jen T: I wanted to follow up with you regarding any additional information you need from us regarding our WWTPs to determine what coefficient we should use for our mix of domestic and pre-treated industrial wastewater?

   Jen T: For our community inventory, we have 39 WWTPs that treat wastewater that is a mix of 84% domestic and 16% pre-treated industrial wastewater. What would ICLEI/P2D suggest we do in classifying this wastewater? Should we determine a new "mixed" coefficient, use the "domestic" category and note the discrepancy, or another solution

   Jen M: My current suggestion is that your TOW waste value should reflect the actual wastewater mix. And as I mentioned, USEPA uses a 1.25

multiplier to capture industrial waste that is comingled with domestic wastewater as is described in the US Inventory

Jen M: I just wanted to follow up on your question about pre-treated industrial wastewater comingled with domestic wastewater. The 1.25 multiplier is used in the formula for TOW below. USEPA uses this formula to estimate TOW with an assumed BOD of 90 grams per person per day (EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2005 p 8-9).

I did a little research on it and the issue here is that we are trying to determine the proper amount of degradable waste in the wastewater and that varies greatly among industries (a food processing plant has a different wastewater profile than an electronics manufacturer) and I believe there are additional impacts to this value from the pre-treatment. So, my expert judgement would be that unless you can get a more specific TOW value for your wastewater from your local wastewater engineers you should just use the equation below to come up with your TOW value and include the 1.25 multiplier, as crude as that is.

From IPCC 2006 Guidelines
6.2.2.3 CHOICE OF ACTIVITY DATA
The activity data for this source category is the total amount of organically degradable material in the wastewater
(TOW). This parameter is a function of human population and BOD generation per person. It is expressed in
terms of biochemical oxygen demand (kg BOD/year). The equation for TOW is:
EQUATION 6.3
TOTAL ORGANICALLY DEGRADABLE MATERIAL IN DOMESTIC WASTEWATER
TOW = P • BOD • 0.001 • I • 365
Where:
TOW = total organics in wastewater in inventory year, kg BOD/yr
P = country population in inventory year, (person)
BOD = country-specific per capita BOD in inventory year, g/person/day, See Table 6.4.
0.001 = conversion from grams BOD to kg BOD
I = correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00.)

The factor I values in Equation 6.3 are based on expert judgment by the authors. It expresses the BOD from
industries and establishments (e.g., restaurants, butchers or grocery stores) that is co-discharged with domestic
wastewater. In some countries, information from industrial discharge

permits may be available to improve I.
Otherwise, expert judgment is recommended.

Jen T: Thank you! This is helpful and provides another source that we can cite. It also is good for us to better understand what type of information (and the granularity of the information) that is required so we can keep improving on our inventories.

6) **What is assumed in the WWTP process?** Most cities have a step called "primary sedimentation"; however, COH WWTPs do not. Is this assumed in the waste coefficients? If so, how can we determine what alternative coefficient # to use?

   Jen T: What are the assumptions behind the coefficients in the wastewater calculator for the aerobic process, well-managed? Does it take into account the emissions from the wastewater treatment plant as a whole or just the process of the bacteria eating the wastewater?

7) **Industrial Pre-Treatment Plants**: For the community inventory, so far, we have the 39 COH owned/operated WWTPs. There are 68 industrial pre-treatment plants (COH permitted) and hundreds of other individual private industrial treatment plants (TCEQ permitted). However, these plants use a chemical process (add chemicals to industrial wastewater) to take out the metals in the water so they can either (a) go to the COH system or (b) be dumped in another way. This water, according to the COH engineers, does not have organic matter in it; therefore, do these WWTPs constitute the assumptions behind the WWTP category? Is this more of a policy question that I should ask Karl about?

   Jen T: We have about 80 industrial pre-treatment facilities that produce BOD and emit methane during the wastewater treatment process. One of the requirements to calculate the emissions emitted from these plants is "Population Served" (the number of people served by each of the WWTP). However, since these 80 WWTPs are businesses, this doesn't apply. What kind of number should I put in here? I was thinking that if there was a default value used for amount of wastewater/person, then I could use the gallons of wastewater processed and back calculate a "population served" number? Does such a default value exist in P2D, or do you have any suggestions on how to deal with this, or do you foresee any problems with this back calculation?

8) Is industrial wastewater (that does not contain BOD) a de minimus source?

9) How do I figure out population served if it is a business?

   Jim: Some of this is interpretation of the protocol… Lets see. I am also putting sarah and Xico, from my tech team on this thread to see if they

uncover ideas. Regarding industrial and residential waste I take this from the protocol:

"Please note that in Equation 10.7 and Equation 10.8, the population served needs to be modified to include contributions from industry if significant industrial contributions of nitrogen are discharged to your municipal treatment system. The equivalent population from industry is calculated based on the total nitrogen discharged by industry to the municipal treatment system, expressed in kg of total nitrogen per day divided by the nitrogen population equivalent of 0.026 kg N/person/day. This industrial equivalent population is added to the domestic populations served by the centralized wastewater treatment system and the total population (domestic plus industrial equivalent) is the value you should use in Equation 10.7 and Equation 10.8, as appropriate."

It seems to me that this is saying you need to know the total nitrogen discharged to the station by industry. I don't think trying to calculate it based on volume of discharge and a waste/water per person metric because the nitrogen levels in industrial effluent are different than in residential. Once you know the actually industrial N levels you would convert that value to "people-equivalent" using .026 and use that number, since there are no real people served by the stations.

Regarding the coefficients from aerobic processes I they are for the biological processes at the plant- they do not include energy used by the plant for example.

For other Q's lets see what my colleagues come up with,

Jen T: I have contacted our local City of Houston WWTP experts as well as officials at the TCEQ and EPA. Our 80 industrial WWTPs and 79 industrial pre-treatment plants are not required to report nitrogen levels to the local, state, or federal levels of government. When we contacted approximately 20% of each of these types of facilities, they do not test for nitrogen in their water because it is not a requirement. Also, in looking up the 80 industrial WWTPs in the EPA's PCS (Permit Compliance System http://www.epa.gov/enviro/html/pcs/adhoc.html) database, none of these have BOD or CBOD coming from the plants. Thus, my questions are:

1. **Is there another way to estimate "population served" other than nitrogen levels? If so, what is it?**
2. **If WWTPs (both industrial and industrial pre-treatment) do not have BOD, does that mean they do not have GHG emissions?**
3. **If WWTPs (both industrial and industrial pre-treatment) do not have nitrogen in their wastewater, does that mean they do not have GHG emissions?**

Jen T: Thank you for these answers. We are in the process of collecting the nitrogen per day (kg) discharged from each of the 80 industrial pre-treatment plants and each of the 79 industrial WWTPs in Houston. Also, I wanted to follow up with you regarding the City's industrial pre-treated and domestic wastewater mix. Do we need to provide you or Xico with any additional information in order to get a refined coefficient for our mix of domestic and pre-treated industrial wastewater?

Jim: I'm adding another ICLEI staffer, Jamie O'Connell to this thread. She can read through the LGOP and add her opinion. Here's my take.

The protocol indicates that N2O emissions are based on N levels in the waste water, so it seems to me there would be no N2O emissions. The population served metric is simply to calculate N values. Also it looks like the N2O formulas are for long term emissions after effluent has been discharged into the environment, an so I don't think you'd apply it to pre-treatment if that water is going to regular treatment station.

Jen M: I just wanted to add that there is no IPCC methodology for estimating N2O from industrial wastewater treatment. The top-down methods used by IPCC/EPA include a 1.25 multiplier to domestic wastewater N2O to accommodate industrial protein releases that are not accommodated elsewhere. I'm happy to talk about this more if you haven't resolved it yet.

By the way, the places I go for more understanding of this area are the IPCC guidelines, the USEPA national inventory and the LGO protocol.

10) What the percentage breakdown for Houston is for the remaining (highlighted) categories of waste (see attached spreadsheet).Also, if the remaining categories of waste cannot be categorized into one of the 7 P2D categories then please find out what coefficients we must add and what the coefficient numbers should be.

Sarah W:
February 25, 2009

City of Houston – Community Inventory
RE: Research Summary on Waste Categories

Per the request of Jennifer Tsuda with the City of Houston, I conducted research to identify whether certain waste types as categorized by Texas Council on Environmental Quality (TCEQ) generated significant quantities of GHG emissions and should thus be included in the city's community GHG emissions inventory. (See table below for the list.)

		P2D Categories						
TCEQ Categories		Food	Garden/ Park	Paper/ Cardboard	Wood	Textiles	Nappies (disposable diapers)	Plastics/ Other Inert
	Commercial	19%	8%	27%	8%	2%	0%	37%
	Commercial							
	Institutional							
	Residential	17%	22%	22%	4%	4%	0%	31%
	Residential							
	Recreational							
	Litter							
	Brush	0%	100%	0%	0%	0%	0%	0%
	C&D	0%	0%	0%	40%	10%	0%	50%
	Hazardous Waste							
	NHIW Class 1							
	NHIW Class 1-A							
	NHIW Classes 2/3							
	Incinerator Ash							
	Medical Waste							
	Asbestos							
	Dead Animals							
	Sludge							
	Grease							
	Grit							
	Septage							
	Contaminated Soil							
	Tires							
	Rejects/Spoils							
	Other							

I first reviewed Volume 5 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories to determine whether the highlighted waste types are significant sources of emissions. Chapter 2 Section 2.4 ("Other Waste") states that in most countries GHG emissions from medical waste appear to be insignificant. In addition, emissions from hazardous wastes disposed of in solid waste landfills are also likely to be small. Please see page 2.10 for more information.

For confirmation purposes, I reviewed the TCEQ report "Municipal Solid Waste in Texas: A Year in Review – 2007 Data Summary and Analysis,"

published in September 2008. This is the latest report available. The table below shows the typical waste composition of landfills in Texas in 2007.

Waste Type	% of Total Tons Disposed
Non-Hazardous Industrial Waste	
Class 1 (asbestos)	0.15%
Class 1 (other)	0.34%
Class 2 & 3	4.71%
Special Non-Industrial Waste	
Incinerator ash	0.01%
Treated medical waste	0.14%
Asbestos	0.34%
Dead animals	0.03%
Sludge	4.48%
Grease trap waste	0.07%
Grit trap waste	0.06%
Septage	0.06%
Contaminated soil	1.71%
Tire pieces	0.06%
Rejected materials	0.04%
Other	0.70%

My research concludes that GHG emissions from these waste types are considered de minimis[27] and should be labeled as such in the notes section of the waste sector in the P2D Emissions Tracker software. Additionally, these waste types are not used by P2D Emissions Tracker to calculate GHG emissions from solid waste.

Overall Technical Questions

1) **General Technical Software Question:** I am curious to see if other cities have had the same problem or if other cities have asked this question. I worked on the initial government inventory for Houston during the summer of 2007 in the Clean Air and Climate Protection Software (CACPS); this inventory was finalized and published online in August 2008 found here. After plugging in the final, published numbers from the CACPS software into the P2D software, the GHG emissions output is quite different. The difference is mostly attributed to the waste sector (which has been greatly refined in the P2D software). In the CACPS software, the data was input as a lump sum tonnage of waste with a percent breakdown of the waste composition. In the P2D software, the breakdown

27 According to the Local Government Operations Protocol Version 1.0, De minimis emissions can be from one or more sources, for one or more gases which, when summed, equal less than 5% of an organization's total emissions. (See Glossary for details)

requires landfill by landfill data (due to the assumptions that need to be made). For this comparison I used the lump sum number and used assumptions that were in line with a majority of the landfills, which was that the management type is anaerobic with the site coverage as methane oxidizing material and 75% of methane is flared. The remaining data input was the same as the CACPS software (waste composition percentages). Yet the differences in emissions output is strikingly different - 856,310 vs. 15,586 tons CO2e (see below).

TOTALS		
	Emissions	
	GHG (CACPS)	GHG (P2D)
Buildings	405,772	468,569
Vehicle Fleet	212,197	178,224
Streetlights	108,038	99,622
Water/Sewage	510,207	628,064
Waste	856,310	15,586
Other	0	0
TOTAL	2,092,524	1,390,065

I know there will be differences since the emission factors have been updated, but these waste differences seem to be too large. Given these differences in waste and the erratic nature of the other categories (they are not all skewed in one direction - up or down), have other cities had this same problem? How have they dealt with it? How can one explain these differences? Where would you go to determine why this is happening? Any suggestions on how to (a) solve this problem and (b) explain the differences so that we can move forward confidently using CACPS, P2D, or both (which Houston will likely be doing since P2D only measures GHGs and not the other criteria pollutants we are interested in, which CACPS does measure-NOx, SOx, PM10, VOCs, CO)?

Jim: I'll have to look at how you did your waste numbers in CACPS to comment on this. Let's hold on this until we can talk.

Jen T: I've attached the most recent back-up file (and you have reader access to our P2D account).

Jen M: You are further ahead than most cities in getting your inventory into the 2 Degrees Emissions Tracker, so I don't have comparisons for you, however I will say that the recommended solid waste accounting methods have change pretty dramatically from CACPS. The waste model in 2 Degrees is the IPCC first order decay model. This is also recommended by the ICLEI International Protocol. ICLEI is better suited to answer detailed questions about CACPS, but as I understand it there are two waste models in CACPS and if you used the methane committment method you were actually accounting for the lifecycle emissions of waste, rather than the emissions from the landfill alone.

So, I would recommend the following: 1) I or one of the ICLEI staff can look at your waste data and make sure that this is truly a metholology issue rather than some other calculation error. 2) Assuming it is just the metholodgy issue, Houston should make the decision whether they want to change methods. If so, the Project 2 Degrees calculations are compliant with most major protocols and programs. If not, you can record your previously calculated waste emissions in the Emissions Tracker as kgs of CH4 and N2O rather than using the solid waste calculators in the tool.

It is useful for us to know you are interested in the critera pollutants calculations as well...that helps us plan the for software development purposes. Other feedback you have about wants, needs, complaints is greatly appreciated.

Jen T: I wanted to follow up with you regarding the City of Houston's government inventory comparison between CACP and P2D. I've re-pasted the question below (in blue). I know we've already addressed the waste differences (due to the "waste in place" model), but the skewing of the numbers in both the positive and negative directions still needs to be addressed. Has ICLEI made any progress in figuring out the difference? Any suggestions as to the reason behind the numbers skewing up and down or what type of footnote is needed if using both types of software?

Jim: Are you referring to all the other sectors? Its easy to characterize the differences. They are due to having slightly different emission factors . There is natural variability in ways to compute emission factors so the answer is not which one is more right or more accurate, the question is which one is the standard.

The answer, in terms of which software defines the standard, the answer is actually neither at the moment. Old CACPS emission factors are no longer standard, as the LGOP superseded those numbers. P2D was developed in parallel with the protocol, but due to timing (LGOP was finished after P2D emission factors needed to be finalized) not all of its emission factors have been incorporated into P2D. Most are.

I would advise you to, using the admin feature of P2D, go through each of the emission factors you are using as defined by P2D (eg. For electricity, natural gas, etc) and compare them to the LGOP. For those that differ, define a custom factor for that fuel and use the LGOP number. This way you can ensure you are using today's standard.

For other pollutants you can use the EFs from CACPS to make the calculation. If you have data in CACPS just pull the CAP numbers directly from CACPS and use those in your report.

Jen T: Yes and thank you, I will add this as a footnote to our report. I will be going through the emission factors at the end of this week/beginning of next week and will contact you or Sarah if I have questions about which EFs to use from the LGOP.

Should I also go through the EFs in CACP to update these as well and be sure we are following LGOP protocol on both fronts?

Jen M: I'll leave this question to ICLEI.

And, will the standard LGOP emissions factors be put into P2D (and CACP) in the next update(s) so as to limit the data intensity of going through each one for other cities?

Jen M: We will do our best to harmonize these. I haven't finished a complete comparison, but to date, most Emissions factors I've looked at have matched.

Jen M: In regard to your calculation results in CACP vs 2 Degrees, ICLEI can speak with far more expertise about their CACP software, but to try to understand your issue I looked at an old copy I have. A source of variance between CACP and the LGO Protocol and 2 Degrees is in the electricity emissions factors. CACPS uses the NEMS emissions factors which include the emissions associated with electricity lost during transmission and distribution (T&D). The LGO Protocol and others recommend instead using the EGrid Emissions Factors which are net of T&D losses. These EGrid values are the emissions factors in 2 Degrees. Under the LGO protocol T&D emissions are Scope 3 for an end user of electricity and should be calculated separately if you want to include them. A rule of thumb value I often see for T&D losses is 7%-10% . Your 9% difference on streetlight emissions is within that range.

As with waste, it is up to Houston whether you want to adjust your methods to use the EGrid values that the LGO Protocol recommends or to stick with the old values to be consistent with your previous inventories. An in-between option that would update your inventory to be in line with the LGO Protocol would be to use the EGrid values but calculate T&D losses as Scope 3. You can estimate T&D losses as a share of electricity use in your region by asking your utility or comparing electricity generation and electricity sales data in your region.

I am not certain what other fuels are in your inventory, but the attached spreadsheet shows you a comparison of CO_2 emissions factors between my version of CACP, 2 Degrees, and the LGO Protocol for Electricity in the Texas Grid Region, Natural Gas, Motor Gasoline. You can see there that 2

Degrees and LGO match almost exactly in terms of emissions factors, but there is some variance with CACP. I've explained the electricity issue above. For other fuels this mainly just reflects that the coefficients used by the US EPA and DOE have evolved since my version CACP was published (the source on some of them is the 2000 US EPA Inventory, whereas we've used 2007 and 2008 in Project 2 Degrees).

I've also noticed that there is some discrepancy (5 % on average) between the LGO protocol and 2 Degrees on the Heat Content of coal. This matters only if you are recording coal by weight instead of energy units and is because USEPA has published different values in their Climate Leaders documents and their national inventory documents. We'll keep tracking down these issues.

Comparison between 2 Degrees, CACP and LGO Protocol					
	2 Degrees	CACP	Difference from Degrees	LGO Protocol	Difference from Degrees
Electricity					
CO_2 lbs per MWh ERCOT Year 2000	1408	1485.5	5%		
CO_2 lbs per MWh ERCOT Year 2004	1421	1460.5	3%	1,421	0%
Natural Gas					
CO_2 kg per MMBTU	53.06	55.90	5%	53.06	0%
Gasoline					
CO_2 kg per gallon	8.80	9.393	6%	8.81	0%

2) **Emissions Coefficients Question:** Generally, how will Houston know when to change its coefficients and when to use the defaults in the P2D software?

3) **IPCC Assessment Report Question:** How will Houston know which IPCC Assessment Report (2nd, 3rd, 4th) is best to use for GWP values? Since, the default is the IPCC 2nd Assessment Report, is this the best choice?

4) **Categories:** I played around with the categories last night and I was unable to connect the category I created to the GHG Emissions Activity that I created. For instance, we want to input all 110 COH zips codes that are within the COH city limits as categories available to all sectors (which I know how to do). But how do I connect the residential, commercial, industrial electricity use to each zip code

separately? Do we have to flip it around so the categories are commercial, residential, industrial?

General Suggestions/Questions

1) I would like to learn how to calculate the other criteria air pollutants in the Project 2 Degrees software , if that is possible. In addition to the GHGs in Project 2 Degrees, the City of Houston is also interested in calculating the following emissions for both the government and community inventories: CO, NOx, PM10, SOx, and VOCs. We used the CACPS software to calculate all 6 pollutants for the 2005 baseline government inventory and would like to calculate all 6 pollutants for the 2005 baseline community inventory (using the new P2D software).

   Jim: Project 2 Degrees does not have this functionality at present, unfortunately. You would need to use CACPS for this, or use its emission factors separately to make the calculation. We can assist you with this. If you simply used the same energy data etc from CACPS and put that into P2D, you can just keep and report the CAPS as output from CACPS is you make a report offline.

2) Just realized that P2D and CACPS have something in common. You have to change the units first before you input the value otherwise it converts for you. EX. Fuel Efficiency: You have to change to MPG first before you enter the value. Same with Miles. Can this be changed to be more clear about which to change first?

3) **Comment/Suggestion:** Not urgent, just a convenience comment. It may be helpful to new users of the software, if it included click-able definitions along the way so a user does not have to stop and open the help file to find a definition or concept explanation. For instance, when using the waste inventory, I encountered many unknown terms to me (nappies, how the climate type is defined, the definitions of each of the waste management types, etc) and although not difficult to open the help file, it might help those that "learn-by-doing" if the help manual was incorporated into the interface.

4) **Comment/Suggestion**: Also, not urgent, but a convenience suggestion. Since this software was made for a global audience, the source of the data may differ depending on the city, state, nation, etc. (especially for waste data). However, it would be helpful as a user goes along, if the software offered a click-able/pop-up option for each piece of data required that included suggestions about where the data may be located (by level of government, geographic location, etc.). For instance, in the waste inventory under waste management type, "For many localities, one may contact the local landfill". Of course this suggestion may not be necessary if the audience is assumed to be those who are experts in each

category/field; however, if one person is managing the inventory and is not an expert in all of these categories, this may be a helpful option for them in the future.

5) I am working on adding "categories" in P2D (all zip codes in COH city limits), but after reading the help file (pp.24,44,59,71-72) and user guide (pp.16-17), I am still uncertain of how to connect the "categories" I've created to the "GHG Emission Activity". Ideally, I want to be able to enter all 110 COH zip codes as "categories" available to all sectors (which I know how to do). Then, using the energy use sector as an example, I want to have the Record names be "Electricity" and "Natural Gas" (which I also know how to do). After this I want to enter the "GHG Emission Activities" as "Residential", "Industrial", and "Commercial" (which I also know how to do). My question is: how do I connect the "GHG Emission Activity" to the "Categories", so that I can further sub-categorize from electricity to zip code 77002 to residential electricity use in zip code 77002?

   Jen M: Right now categories can only be applied to records, not activities within records. FYI, we're looking carefully right now at this model, so it is helpful to know how you are trying to use this feature.

6) Would it be possible to form a virtual discussion group among P2D city users so that cities using P2D are able to discuss relevant issues/questions/problems directly with those that have had to deal with similar questions? Would it also be possible to make other P2D cities'/administrators' contact info available to each other? As an iterative process, I think this type of discussion and openness in working with the software will also benefit the programmers and developers of the software in continuing to develop a product that is user friendly/useful to cities.

   Jen M: Thanks for the suggestions. We are looking into some options for this right now. We definately want to enable this kind of discussion. In the mean time your comments, questions, and suggestions are hugely helpful and definately influence the software development.

7) Since many cities will have inactive landfills, maybe have a screen/question before the data input that selects active or inactive landfill and the data input screen would be tailored to the inactive (or active) landfill data needed (depending on selection on previous screen).

8) User Functionality
   a. In "Review Coefficients" section when I search once and then search again, the second search will search my first search instead of searching the entire database (even when "reset" is clicked in between).
   b. The software errors out when I spend too long in one section (even if I am actively clicking around).

9) We've entered about 330 GHG emissions activity entries into one record. It would be nice to have a "+ New GHG Emission Activity" button at the top of the page as well as on the bottom so a user doesn't have to scroll to the bottom each time to add a new entry.

Jen M: Ive made note of this suggestion.

10) I wanted to find out if there is a way to speed up the loading process of each screen when entering a new activity. It takes approximately 15 seconds for each screen to load and there are about 5 screens one must go through to enter one entry. To enter 224 entries took about 5 hours, is there a trick to speed up the loading of each page, or a way to enter all the data into one screen? This could significantly cut down on the labor intensive nature of the process. To explain a little more in depth: It takes about 15 seconds for each screen to load. One must go through, on average, 5 screens to enter one entry. So to enter one entry takes approximately 75 seconds. In the transportation section we have 448 entries, which amounts to 33,600 seconds or 560 minutes or 9 hours and 20 minutes to enter all the data. Since the actual entry itself only takes at most 15 seconds to type in, subtracting 15 from 75 equals 60 seconds of waiting time per entry. For the transportation section, this amounts to 26,880 seconds or 448 minutes or 7 hours and 28 minutes of waiting time.

Jen M: We're shortening the load times for screens with some back end magic, and you should start to see improvement on that in the next couple of weeks. Also, you can use the import tool to bulk import data from a spreadsheet (which, as I said I'll send more complete instructions on in another mail).

On the website, the reason we make you go through the wizard boxes when entering data instead of just having a simple entry table is that we need you to make the selections to get you to the correct calculator screens with the correct default coefficients. If you pick "Stationary Fuel Combustion" as you are entering data you will get different choices for calculation tools than if you pick "Electricity, Steam, and District Energy Consumption."

Kathryn M: Thanks Brian, I know we've been getting good feedback from Houston and we're listening. We've already put into place some performance enhancers to get loading time between 2-4 seconds. We're also looking at how to decrease the number of screens but this is more complex. We probably listened to ICLEI a little too much in the initial building of this and we have a new proposed data model that will work better but it will not come into play until release 3.

11) I know I already mentioned this, but I wanted to suggest it again. We would like to categorize by 5 levels of specificity and analyze data across and between these 5 levels, but the software only allows us to use 3 levels and the analysis section

(in reporting) does not get the specificity we'd like. For instance, currently for our cars/buses we have "Transportation" – "On-Road" – "Type of Vehicle_Day of Week_Time of Day". But we'd like to do "Transportation" – "On Road" – "Day of the Week" – "Time of Day" – "Type of Vehicle". And we'd like to analyze our data down to the most granular data possible, so policies can be made based on this granular analysis; however, currently the analysis is only at the sector level.

Jen M: Thanks for this detail. We are looking at a longer-term improvement to the system that would let you create more flexible hierarchies like this.

Right now, as Ive said there are several ways to do this. The way youre doing it is fine. You could also create categories like Monday Tuesday Wednesday Morning Afternoon etc in the Administration section and apply those to the appropriate records, which would let you use the filter by category feature on the mange inventory page. For example, in my test account I have the following

Sector: Energy Use
Records:
01-Residential Electricity Use
03-Small Commercial & Industrial Electricity Us
05-Large Commercial & Industrial Electricity Use
06-Street and Highway Lighting Electricity Use
Commercial Energy Use (which has both electricity and natural gas activity data)

When I choose to filter those by the category I created called Commercial in the Manage Inventory screen I just get the following records which have been categorized as commercial:
03-Small Commercial & Industrial Electricity Us
05-Large Commercial & Industrial Electricity Use
Commercial Energy Use (which has both electricity and natural gas data)

12) I entered about 16 entries into P2D last night around 9PM CST from my home computer (in Firefox); however, these 16 entries are not showing up this morning on my work computer (in IE). Is there a compatibility issue with Firefox & P2D? Do you know where these entries might be? My phone number is 832-393-0988.

    Jen T: (15 minutes later) The entries just showed up as I was working in the program. But I am still curious as to what may have caused it to not show up first thing this morning? Thank you for your help.

Jen M: Im sorry you had this trouble, Im glad it resolved itself, but I have the development team looking into the issue and will let you know if they get to the cause.

In regard to your missing data the other day, the technical team looked at it and gave me this response:

I have not heard of any issues with the hosting environment today, so there are several potential explanations:

1. She was the first person to hit the site this morning and just didn't wait long enough for the site to spin up and then display the records; or

2. She had the wrong sector selected and didn't realize it; or

3. She had a filter enabled, and the filter was hiding the records she expected to see. Maybe she filtered for Scope 3, and all of the emissions she entered were for Scope 1; or

4. She was in the wrong inventory type (community instead of govt) and/or inventory year.

13) Sorry about the multiple emails. I wanted to delete our Community Inventory for 2005 (this was the year we were going to initially enter, but changed it to 2007). I've gone through the help file and clicked around in the program, but I still can't find the delete button for it. Can I do this or is this something that has to be done from the programming side?

Jen M: We dont have the ability to delete an entire inventory right now, you would have to go in and delete each record in the inventory separately. (But Ive made note of this issue). Let me know if that really doesnt work for you and I will talk to the team about options for them to do something on the database side.

Jen T: About deleting the 2005 year from our Community Inventory side, I've deleted all the entries, but it is still confusing for those entering data when 2005 and 2007 appear on the opening screen. Is there a way that either the database side can delete this for us or the programming side can enable a delete button for inventory years so we may delete ourselves?

14) Also, in the help file pp. 126-143, the XML file format is described. I want to be able to import and export in this file format (so we don't have to type in each entry), is there a specific format we have to use to do this? Can we export the emissions of each individual GHG emission activity to XML then to Excel? Can you point me in the right direction as to where I can find detailed steps on how to do this in P2D?

Jen M: Yes, we have what is called an XML schema that allows the software to recognize the data you are trying to import. Excel can generate and read XML data and we have a template that lets you enter data in Excel. I realize the instructions on how to do this are incomplete, and have the team writing up a more detailed step-by-step process, which I will forward to you.

Jen T: I can't wait to get the XML instructions and spreadsheets!

Jen M: I'm still waiting on the step-by-step import directions, but in the mean time you may want to look a the import template on the import page in the Administration section. Any questions or comments on that are welcome.

15) A "Save and Close" button at the top of the emissions entry box (in addition to or instead of a "Save and Close" button at just the bottom).

    Jen M: Thanks. Ive made note of this.

16) The drop down menu for the fuels when you select "Heavy-Duty Vehicles" is not in alphabetical order. The other drop downs are alphabetical. I wonder if this would be a quick correction?

17) When you change the units in the calculator first, the units stay the same after you choose the vehicle type but change back to km/L when you select the fuel type. Can this be changed to remain in mpg or can we default ours to be "miles per gallon" and "miles" somehow?

18) Also, P2D is running much slower than the last time I used it, is it because the number of entries we've entered has increased dramatically? Is it because of increased traffic on the website? Or something else?

19) When entering the waste composition percent breakdowns, is there a way to put in our own defaults based on type of waste. For example, we have different waste compositions based on whether it is residential, commercial, C&D, etc. It may speed up the entry process if we are able to enter all this data in one screen and vary it year by year more easily.

20) It takes about 5 minutes to enter one solid waste entry because of the number of screens and the inability to cut-and-paste from excel the weight of waste. So, we are very interested in getting that excel spreadsheet to import and export to excel as soon as possible.

21) Do you know when the next software update will be and if/when our comments/suggestions will be incorporated?

Jen M: Following up on your questions and suggestions this week. I've filed your comments with the team. We're doing new deployments of the site every few weeks. Most of our updates right now have to do with additional languages. I don't have the exact schedule of the updates, but your suggestions that are quick bug fixes will show up faster than those that require us tho think through redesign options for the site.

22) The ability to click on the “Help” button from inside an entry screen would be helpful, especially for those just getting started with P2D.

Jen M: Good suggestion.

23) In the coefficients section of the administration section, it would be helpful if we could select multiple filters in each box and also deselect filters with the “Control” and “Click” used in most Microsoft products.

Jen M: I’ve passed this along to the technical team.

24) Would it be possible to add the Local Government Operations Protocol (September 2008) bookmarked document to the bottom of all screens and menus (as well as the regular help menu)? I think having these two documents readily, easily available (and accessible) through each P2D screen may help others.

Jen M: I agree the LGO Protocol is very useful, but it is a US/North American-centric document, so it doesn’t apply to all users of the site. I’ll add it to the list of documents once we have more country or region-specific resources sections on the site, though.

25) Allow us to choose default units in all data entry screens before entering data. For instance, when entering the natural gas data the default unit in the dropdown is “MJ”; it would be helpful if the user could set the programs defaults (in all screens) from one administration screen.

Jen M: Thanks for the suggestion. The development team is working right now to improve the persistence of unit selections across the site, so that if you select to view your data in tonnes youll see it that way until you change it. Hopefully that will address this issue.

26) It would be helpful if the software allowed blank/placeholder entries to be made so that as we wait for data to come in, we can have all the pre-data entry screens complete. For instance, for our electricity data, we are still waiting on getting actual numbers, but we know the GHG emission name and the answers to all the questions before the final screen. So it would be helpful if we could make placeholders with this information but kept the data at 0.

Jen M: Thats an interesting suggestion. It hadnt occurred to us that youd want to work that way.

27) I am attempting to use the P2D import template; however, when I try to import the xml sheet, there is an error message that says:

> Website Error
> Emissions Tracker has encountered an error. If you had unsaved data when the error occurred, your data may have been discarded. You can attempt to return to Emissions Tracker or logout.

I wanted to find out, if I am using Office 2003 and Windows XP, is this compatible with the import worksheet and P2D? Do you have any suggestions as to what the problem may be?

Jen M: I just wanted to let you know I got your message on this. I've escalated it up to Scott and his team at Ascentium and they should be in touch shortly to help you out. This is just to follow up on Ryan's phonecall, I called him back but he wasn't in. Ascentium has investigated your import problem and has identified the problem on the server that is causing it. They are waiting for the hosting team to fix it and we will let you know as soon as that happens. Once it is fixed you should be able to proceed with your import. Please let me know if you have any questions on this.

Jen M: Here's the latest update from Ascentium on the import template. Please let me know if you have questions. -Jen McGraw

We've applied the hotfix for import to the Project2Degrees site. Jenifer should be able to import now.

However, there are a few caveats:
If she is attempting to import a large amount of data she may see the following error - "Error: import service failed. The request channel timed out while waiting for a reply after 00:01:00…" The import did not fail, but the import log was too big to be displayed.

If she has defined any Domestic Waste Water activities that use the "Aerobic treatment plant – not well managed" or "Aerobic treatment plant –well managed" treatment methods, those activities will not import. There was an error in the Excel Import template that was also fixed during the hotfix. To import those records she will need to download the new template.

Let me know if you have any questions.

28) I noticed that a user can add duplicate GHG emission activities names. I think this may become a problem in the future, especially with the ability of multiple users being able to input data. It might be useful to limit this field to unique names.

Jen M: We haven't enforced unique activity names on the theory that the activity and record name combined would give you the flexibility to identify your data however you have it, so that if you have a record "city hall" with an activity "lighting electricity use" and another record "convention center" with an activity "lighting electricity use" it may be useful to you to to be able to reuse those activity names. But if you think that flexibility might actually be a problem for you rather than a feature, that is useful to know.

29) Ryan (ICLEI) had a couple of great suggestions/problems in regards to the contact field in the Records screen. First, there is no way to delete a contact after one is created. Second, an error screen pops up when the contact number is entered in the wrong format. Is there a way to allow multiple formats to be entered or to specify the format required so that the error screen does not pop up?

Jen M: These are good points, we agree that the way contacts works could stand to be cleaned up a little and will add it to our list of todo items. Thanks.

30) I noticed in exporting the emissions data that I can open the xml format in excel (but not in access). And in working with large volumes of data in excel, I've discovered that excel is limited to 65536 rows. The City of Houston does not have more than 65536 rows; however, in thinking about the future (additional years of data) and about cities with even more granular data than us, this may become an issue for other users. I would suggest being able to export to access or creating a P2D analysis tool that allows the user to analyze the data within the software program directly (i.e. charts, bar graphs and pie charts for any array of data as we can do in excel). Let me know if I need to clarify further.

Jen M: Thanks for this comment we'll keep an eye on this as we continue to improve the export functions.

31) We are encountering the same 'Website Error' we encountered before when trying to access only our:
2007 Waste – Active Landfills data
We are able to access the rest of our data; however this record is inaccessible. Do you know what the problem may be and how we may be able to fix it and/or who would be the best contact for these website problems?

Jen M: The team needs the following information to diagnose your problem with the landfill data. Can you please give us a bit more information?

1. Is it an emission record, emission activity, measure record, or measure activity that Jennifer cannot open?
2. If it is an emission record and/or emission activity, how was it created (via import or created by using the emission tracker website)?
a. If it was an imported emission record and/or activity, can we get an import template with that record's info (cleaned of actual numbers)?
b. If it is an activity, what calculator was used to create the activity? Did the calculation use any custom inputs (coefficients, fuels, etc.)?
3. What sector and source were used?
4. What browser is she using, and what operating system is she using?

Jen T: I just checked again and it is still coming up with a website error. Here is the info:

(1) Emission record
(2) Created using emission tracker website
(3) Waste sector, Active Landfill Source
(4) Internet Explorer 7; Windows XP

Jen M & Scott J: Hrm, we have never seen this before, and unfortunately we cannot reproduce the issue without some additional information:

1. Does the record contain a single activity, or many?
2. Which calculator(s) were used to create those activities?
3. Were categories applied to the record?
4. Were any notes created for the record?
5. Did the record contain any attachments?
6. Did the record contain any contacts?
7. Were the record status flags modified away from the defaults (Incomplete and Unofficial)?

Also, if Jennifer really needs a solution to this problem quickly, we may want to suggest that she re-create the record in question and, if it works as expected, delete the other record.

Jen T: Since the data input into this record was both time consuming (approximately 5-10 minutes per activity) and tedious and since the import tool does not yet have a sheet for the solid waste multi year calculator, we would prefer to retrieve the data that is in there (rather than re-input these). Also, we would like to figure out what the issue might be so we and others don't run into this problem in the future. The answers to the questions are below:

(1) Many activities, approximately 50-60
(2) Solid Waste Multi Year calculator
(3) Categories were not applied
(4) No notes were created
(5) No attachments

(6) No contacts

(7) Record status flags were not modified

In the meantime, I will begin to re-input this data in another record, but please do let us know when you figure out/fix the issue so we don't use too much time doing unnecessary data entry. I can be contacted at 510-332-3965 after 3pm Pacific time or by email if you need further detail. We appreciate your attention and help on this issue!

Scott J: Jennifer, please do not re-create the record; if you do, I suspect that you will run into the same issue.
I believe that we now have enough information to reproduce this issue internally. While we investigate this, I have a few questions about how you are documenting waste in Houston:
1. In general, how are you using Emissions Tracker to model your waste inventory?
a. Do each of the 50-60 activities represent a unique waste site?
b. If not, how did you break down your waste stream and/or sites?
2. Have you thought yet about how you will map measures to the waste inventory structure you have created?
It would help us to better understand how you planned to track waste in Houston so that we can account for scenarios such as yours as the Emissions Tracker software evolves. Thanks.

Jen T: Thanks for the quick response; I haven't yet and won't recreate the record. Here is some more information regarding Houston's waste documentation. Attached is our detailed methodology in the word document and the attached spreadsheet contains the data and organization that went into the activity entries. Also, brief answers to your questions are below:

(1) We are tracking (created activities) by landfill and type of waste. (So the activities would be "XYZ Landfill_Residential" or "XYZ Landfill_Commerical" etc etc, see the methodology word doc for full explanation and key decisions we made.) The table below is also in the word doc and contains the P2D inputs for active landfills.

Active Landfills	
Sector	Waste
Record	Active Landfills
GHG Emission Name	"Permit #_Name of Landfill_Type of Waste"
Source	Waste - Solid Waste
Scope	1 or 3
Method	Solid Waste Multi-year
Waste Management Type	Managed/Managed, semi-aerobic
Climate Type	Wet Tropical
Site Coverage	Managed and covered with CH4 oxidizing material
Recovered Methane (%)	See input section
Flared Methane (%)	See input section
Complete Historical Data	Yes/No
Waste Generated (Tons)	See input section
Waste Fraction by Disposal Type (%)	100% SWDS
Composition (%)	See input section

(2) We are thinking of mapping measures by location and waste type (i.e. targeting residential waste reduction or C&D waste diversion, etc); this is the reason for our activity structure. Also, the data available in Texas for landfills is by year, landfill, and waste type – this survey is released on an annual basis and is easily accessible/added to in Access each year (in thinking ahead to future inventories).

Please do let us know if you need further info or would like to discuss our structure/plans/etc. Thanks for the help and have a great weekend.

Jen M & Scott J: FYI, we have reproduced Jennifer's issue and know what the source of the problem is. The application is crashing because too much data is coming back when she tries to open the inventory record containing a really large number of waste activities.

We know how to fix the issue, but the code has to be written and we have to run a test pass to make sure we do not break existing functionality. We should be able to get this out as a hotfix, but until the code has been written and tested I provide an exact date when a fix will go live.

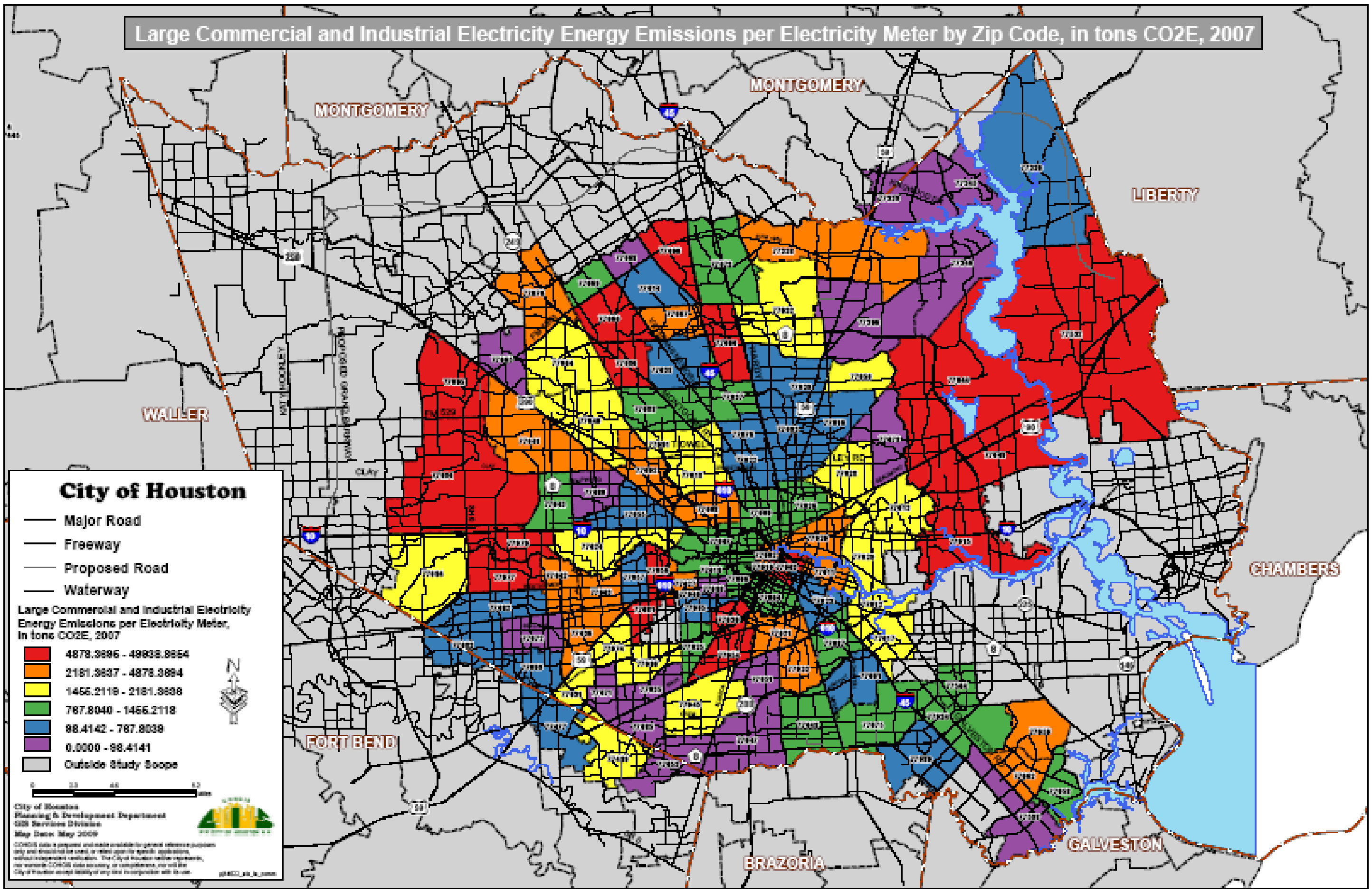
Jennifer has two options for how to proceed:

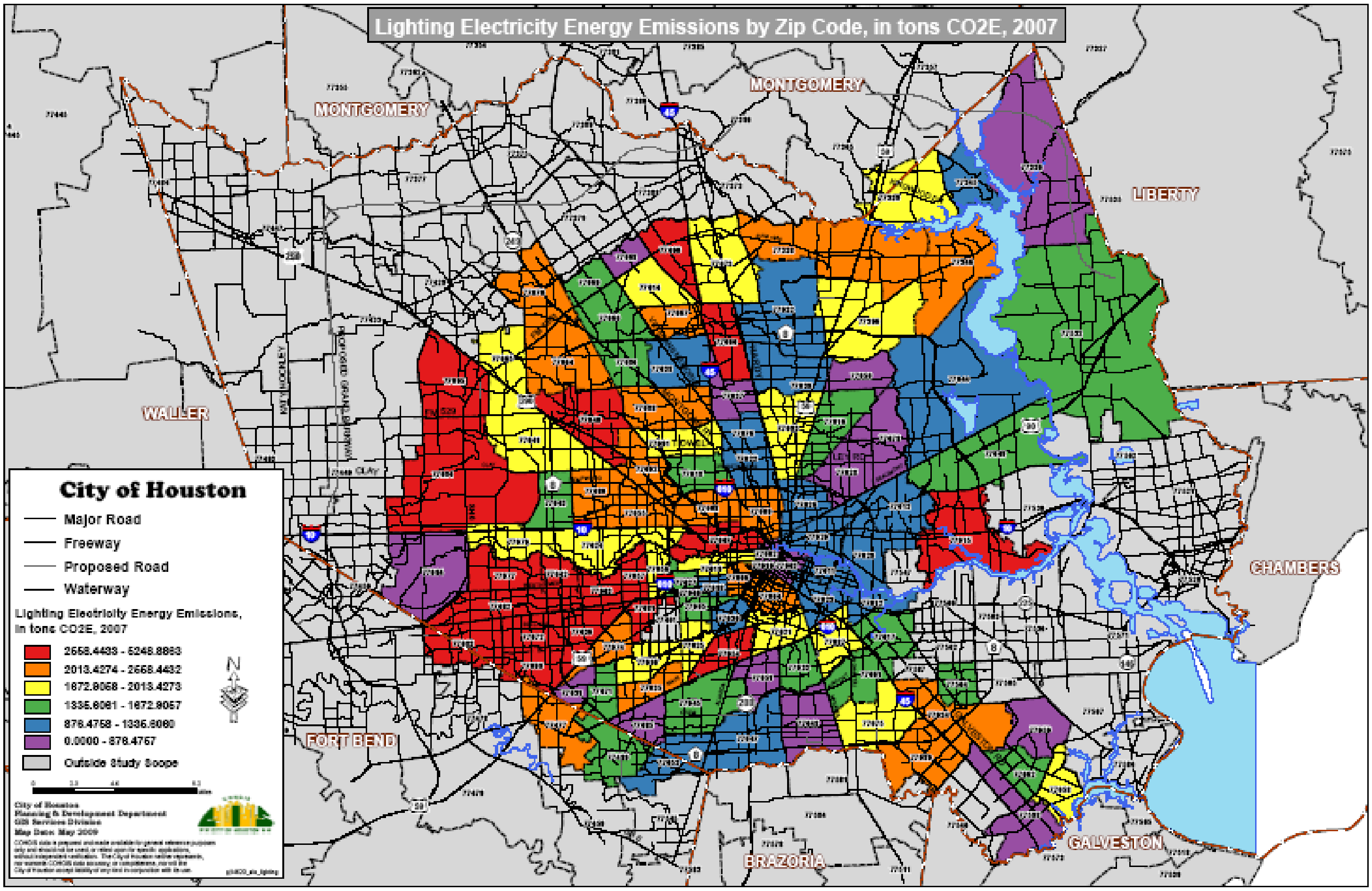
1. Wait for the hotfix to go live; or
2. Re-create her waste records, but split the content up into more than one record (perhaps splitting it out by commercial, residential and industrial).

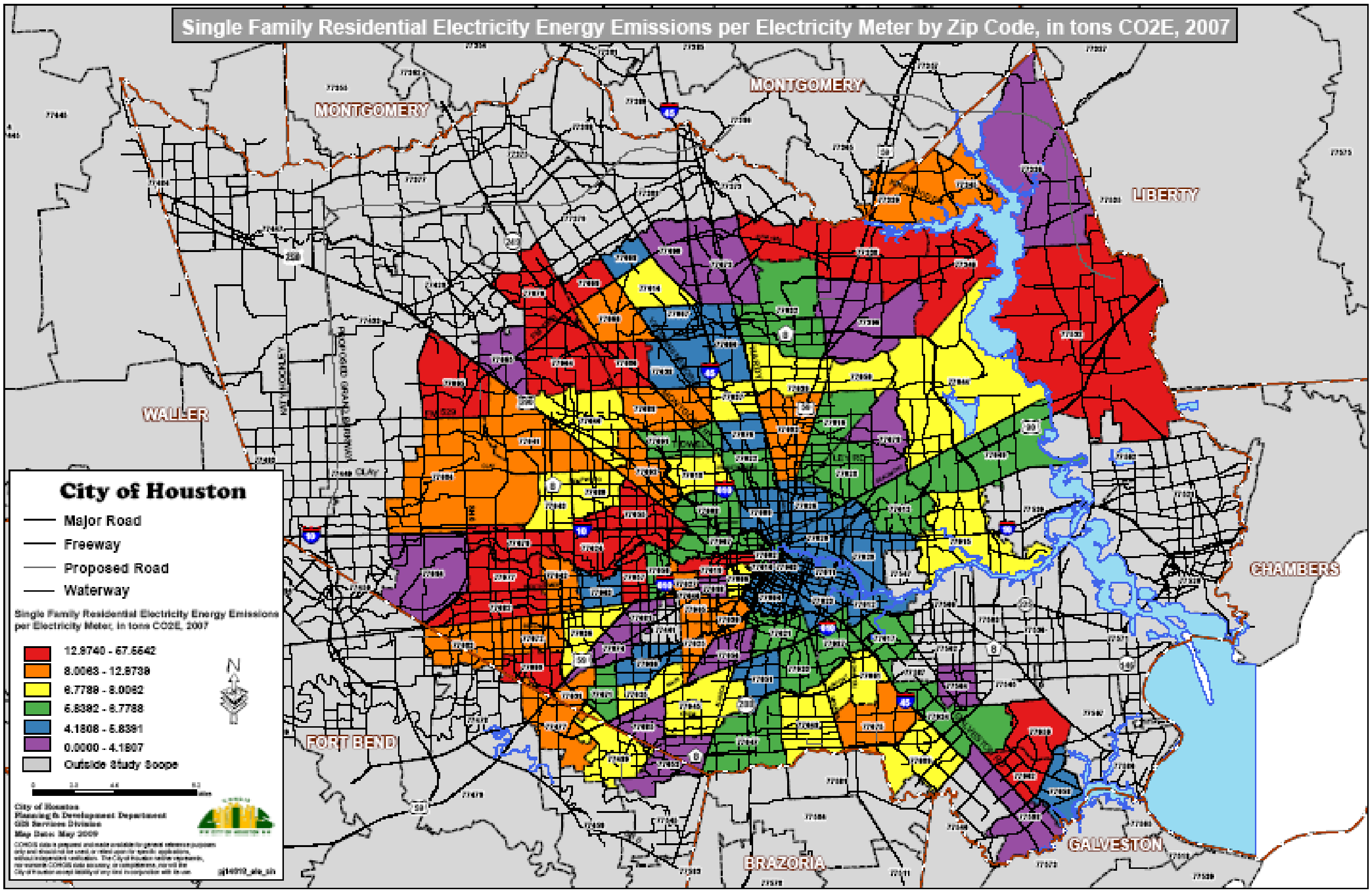
Let me know if you have any questions about this. Thx.

Jen T: Thank you for working on this problem. I think we will wait for the hotfix. However, when P2D figures out a "go live" date, please let us know, so we can anticipate this and/or plan to re-enter in smaller parts.

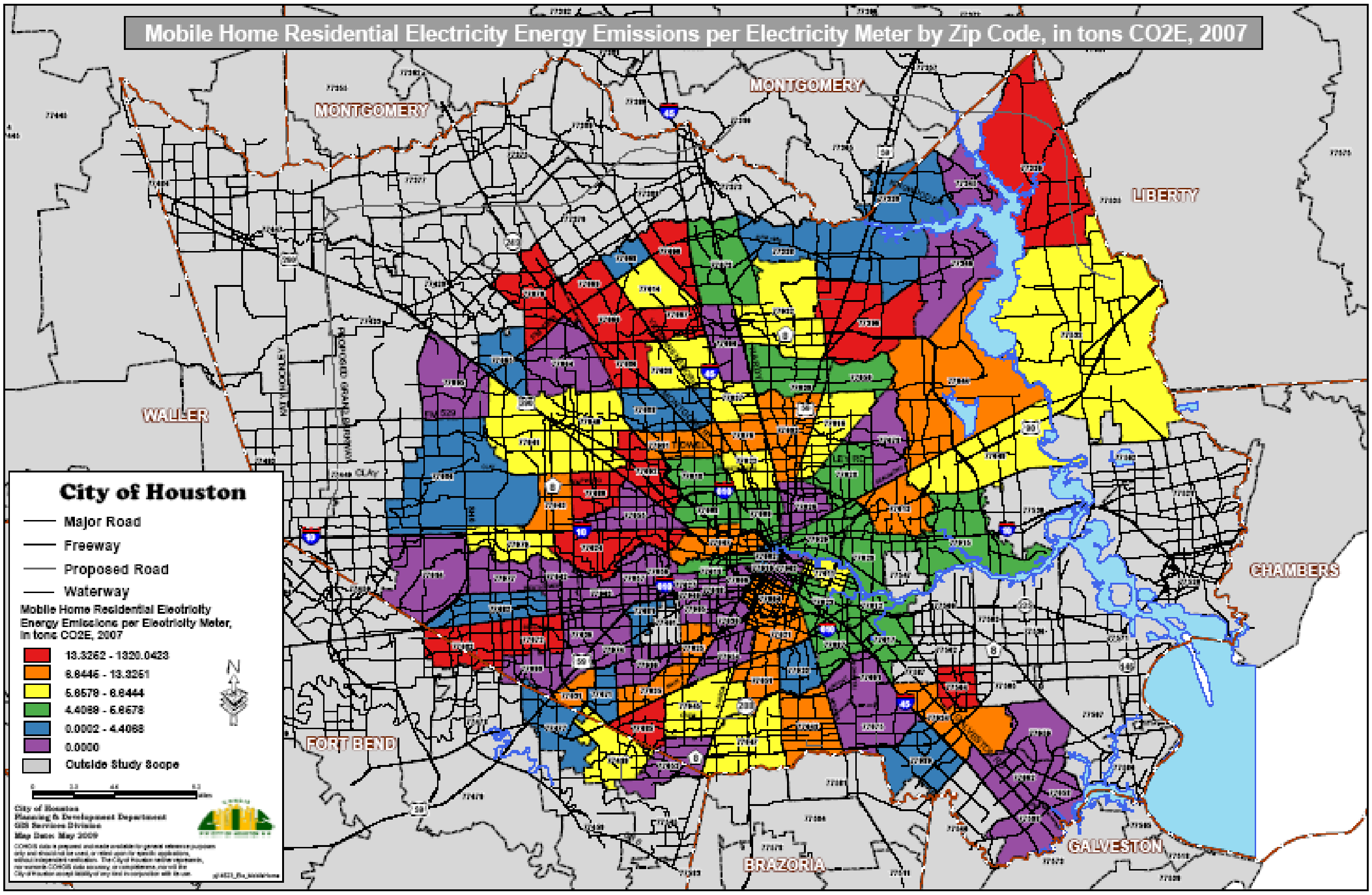
Appendix H: Energy Emissions Zip Code Maps (Electricity, Natural Gas, and Totals Maps)

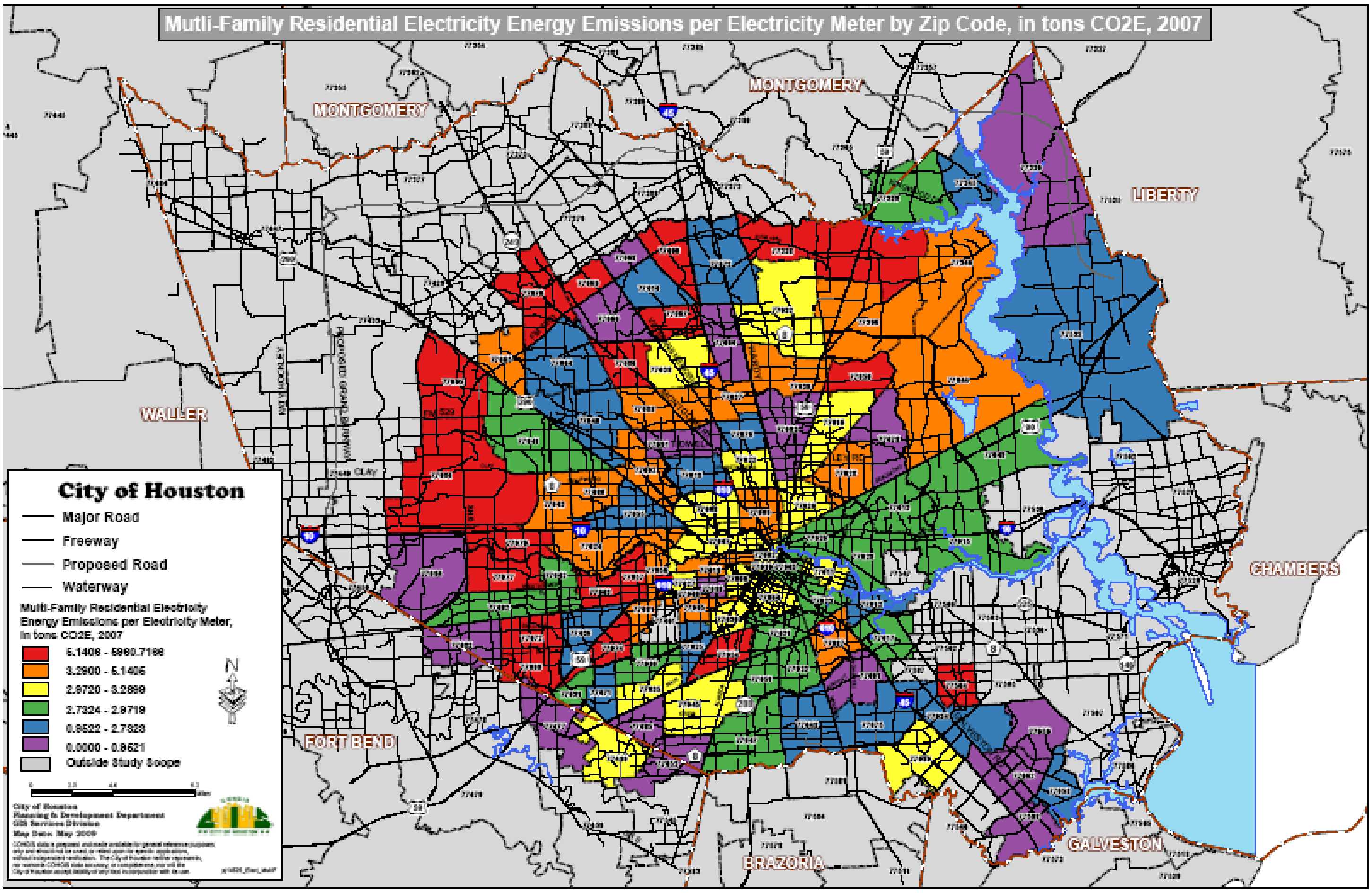



Lighting Electricity Energy Emissions by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Lighting Electricity Energy Emissions, in tons CO2E, 2007
2658.4433 - 5248.8863
2013.4274 - 2658.4432
1672.8068 - 2013.4273
1336.6061 - 1672.8067
876.4758 - 1336.6060
0.0000 - 876.4757
Outside Study Scope
N

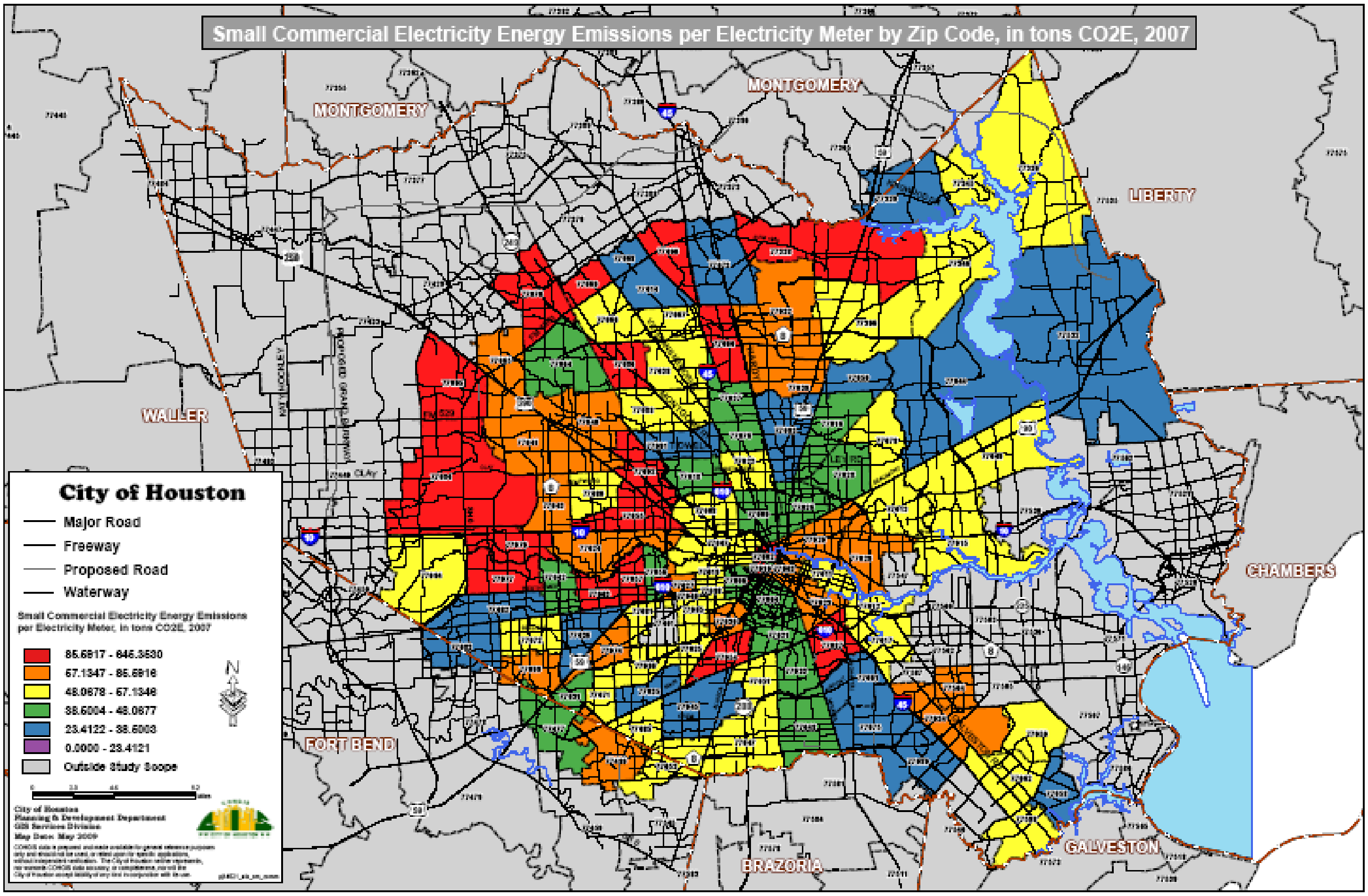


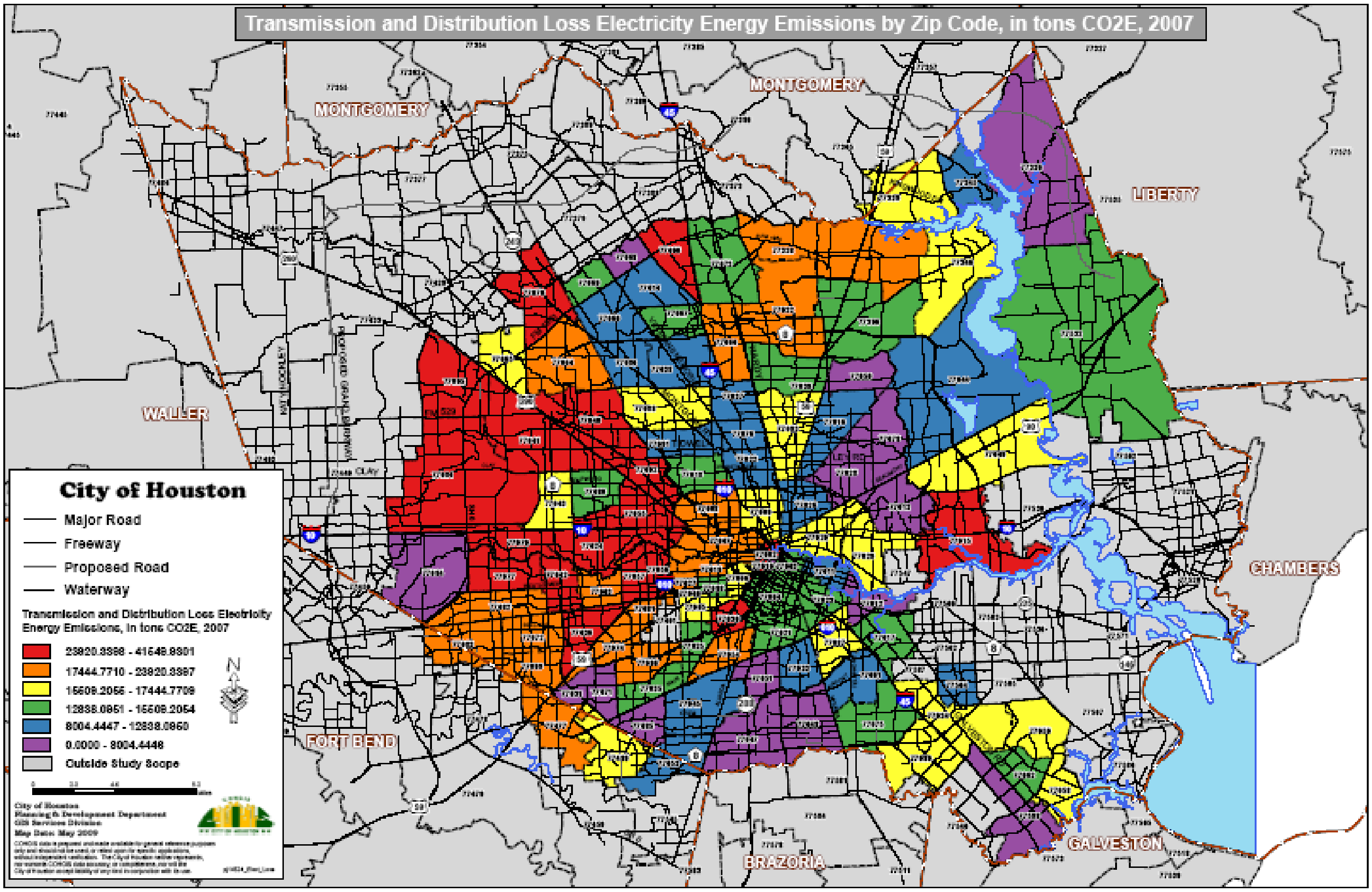
Single Family Residential Electricity Energy Emissions per Electricity Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Single Family Residential Electricity Energy Emissions per Electricity Meter, in tons CO2E, 2007
12.8740 - 67.5642
8.0063 - 12.8739
6.7789 - 8.0062
5.8392 - 6.7788
4.1808 - 5.8391
0.0000 - 4.1807
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009


Mobile Home Residential Electricity Energy Emissions per Electricity Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Mobile Home Residential Electricity Energy Emissions per Electricity Meter, in tons CO2E, 2007
13.3262 - 1320.0423
6.8446 - 13.3261
5.6579 - 6.8444
4.4069 - 5.6578
0.0002 - 4.4068
0.0000
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009

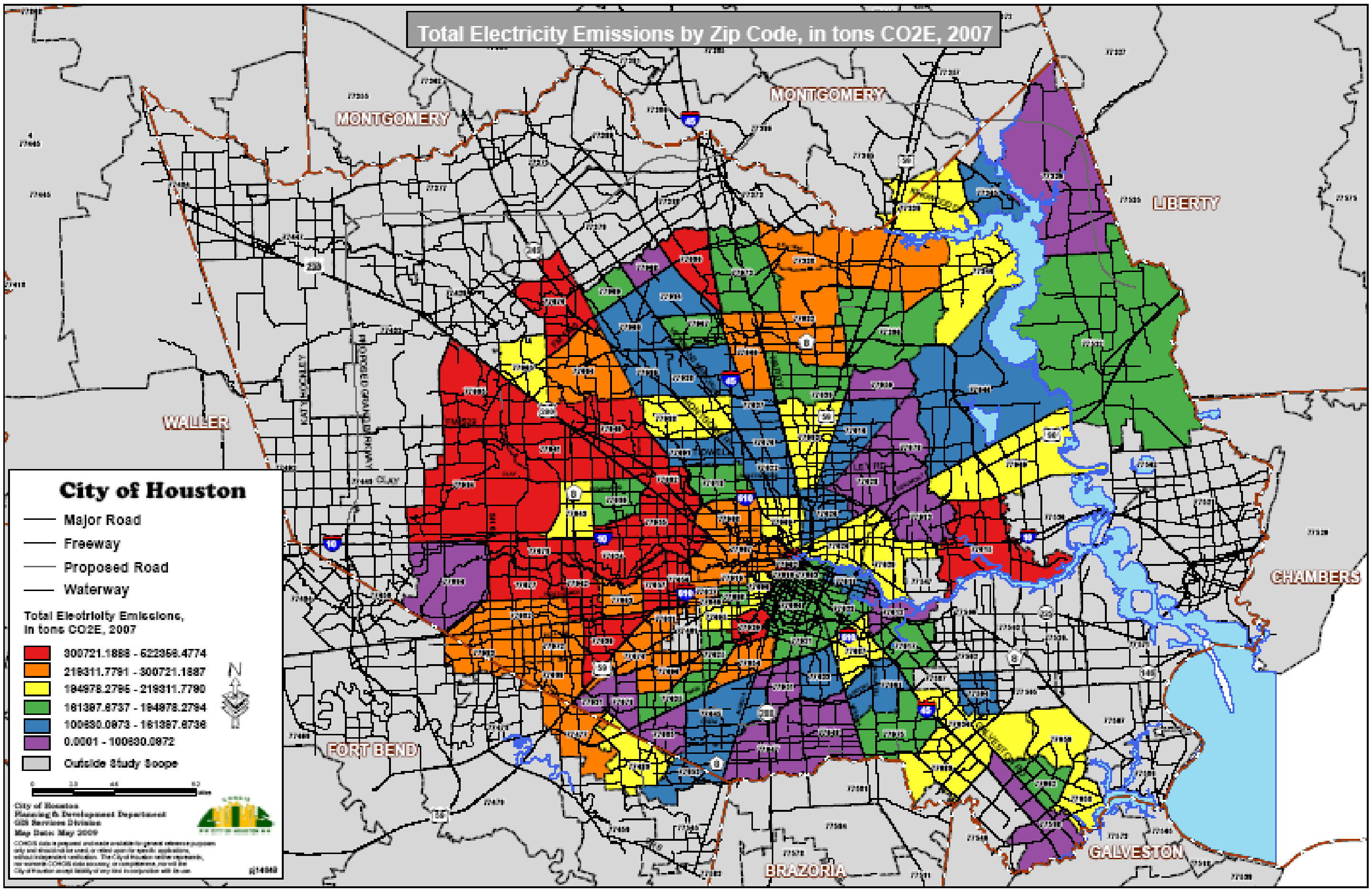


Mutli-Family Residential Electricity Energy Emissions per Electricity Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Mutli-Family Residential Electricity Energy Emissions per Electricity Meter, in tons CO2E, 2007
5.1406 - 5960.7168
3.2900 - 5.1406
2.9720 - 3.2899
2.7324 - 2.9719
0.8622 - 2.7323
0.0000 - 0.8621
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009

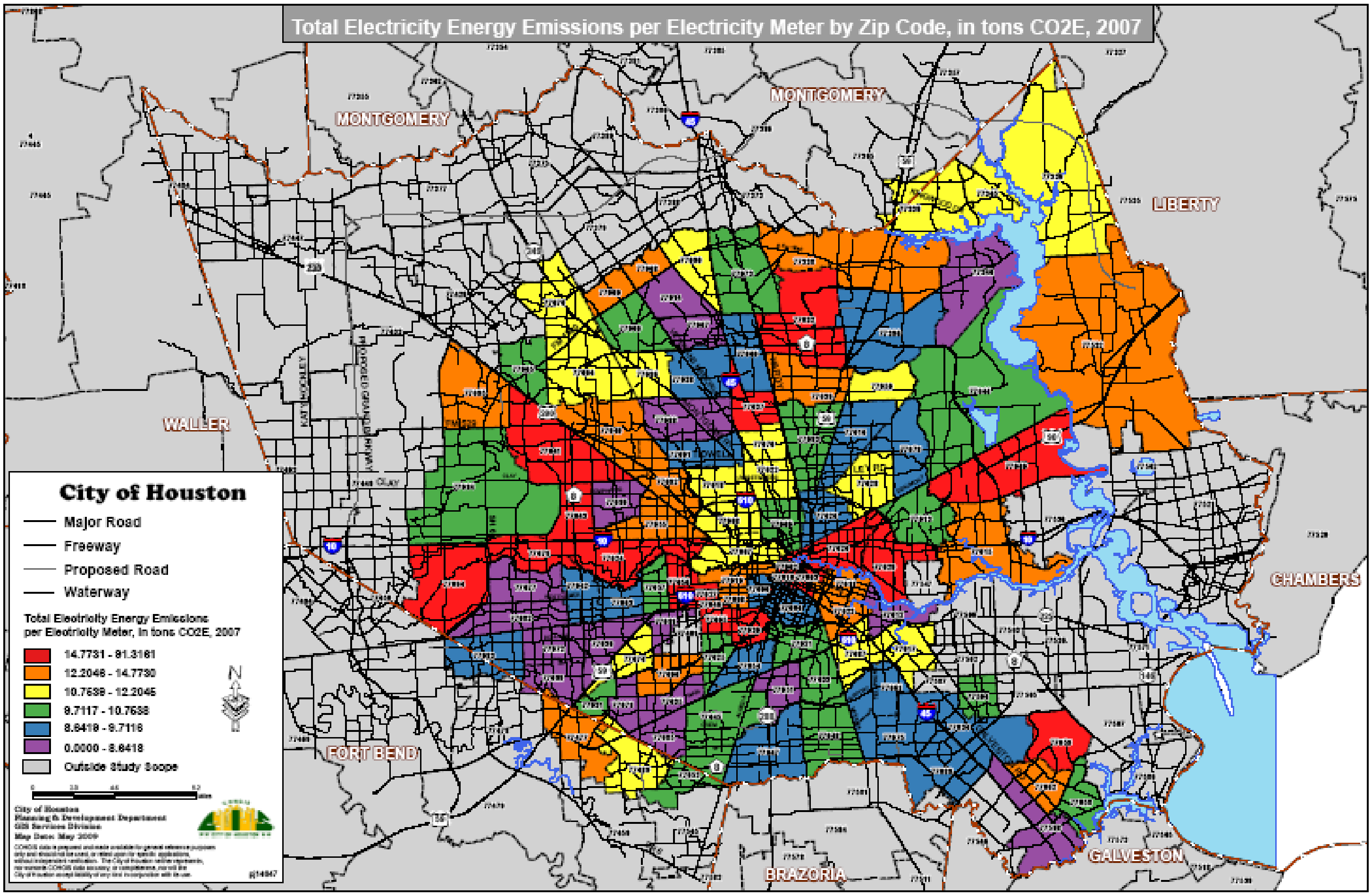

Small Commercial Electricity Energy Emissions per Electricity Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Small Commercial Electricity Energy Emissions per Electricity Meter, in tons CO2E, 2007
85.6917 - 646.3530
67.1347 - 85.6916
48.0678 - 67.1346
38.6004 - 48.0677
23.4122 - 38.6003
0.0000 - 23.4121
Outside Study Scope
N



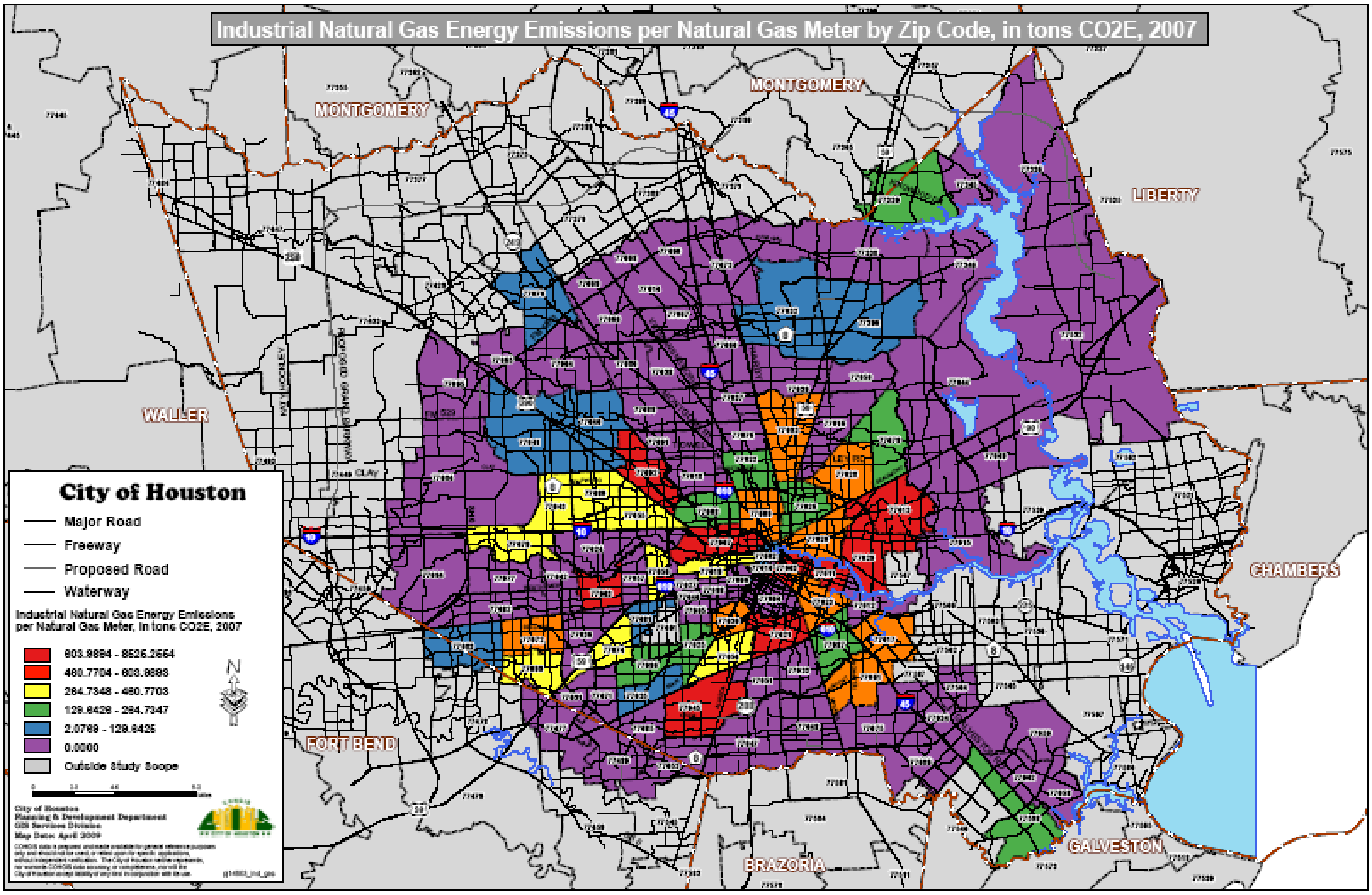
Transmission and Distribution Loss Electricity Energy Emissions by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Transmission and Distribution Loss Electricity Energy Emissions, in tons CO2E, 2007
23920.3398 - 41649.9301
17444.7710 - 23920.3397
15609.2055 - 17444.7709
12838.0851 - 15609.2054
8004.4447 - 12838.0850
0.0000 - 8004.4446
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009

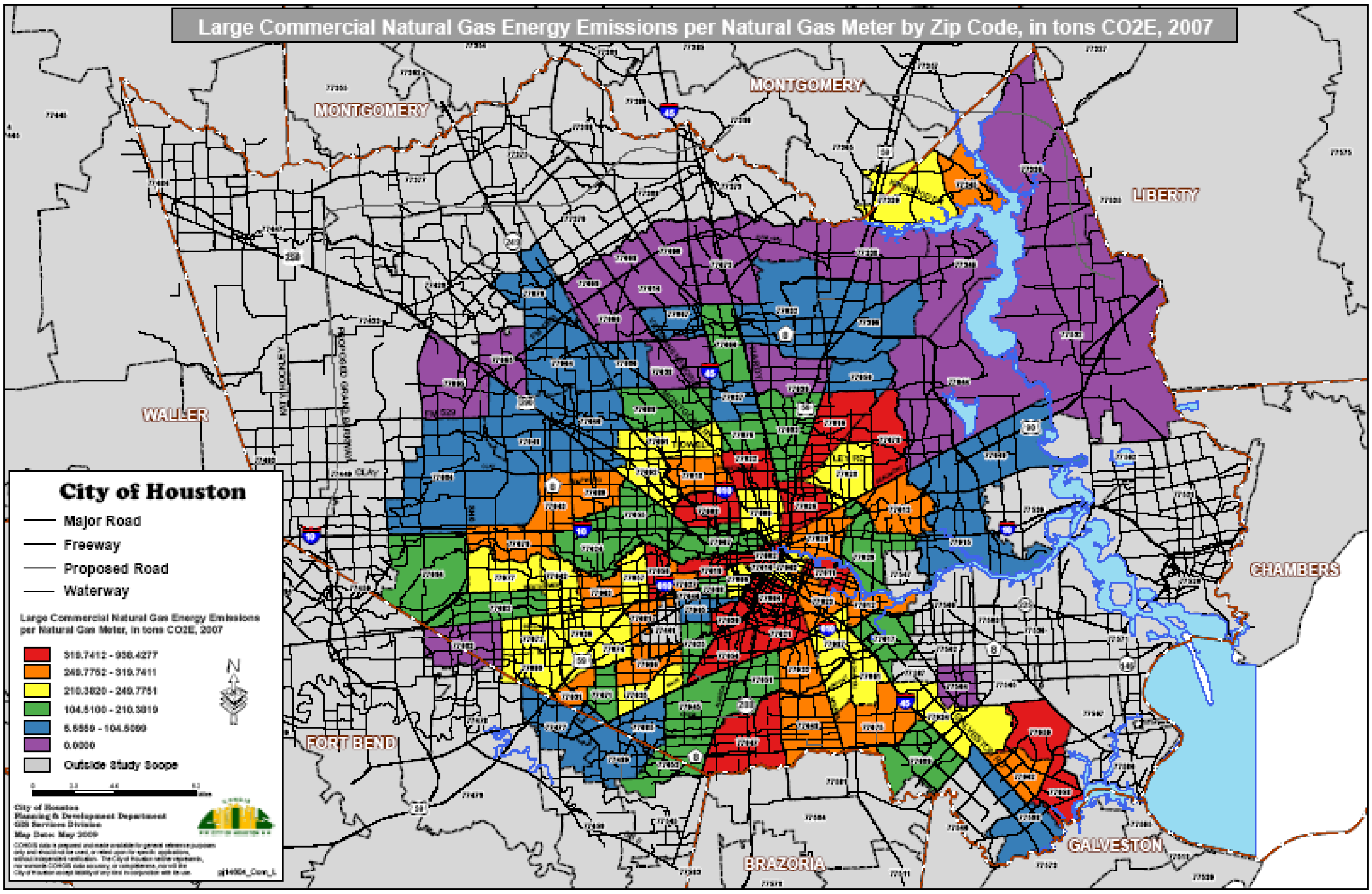


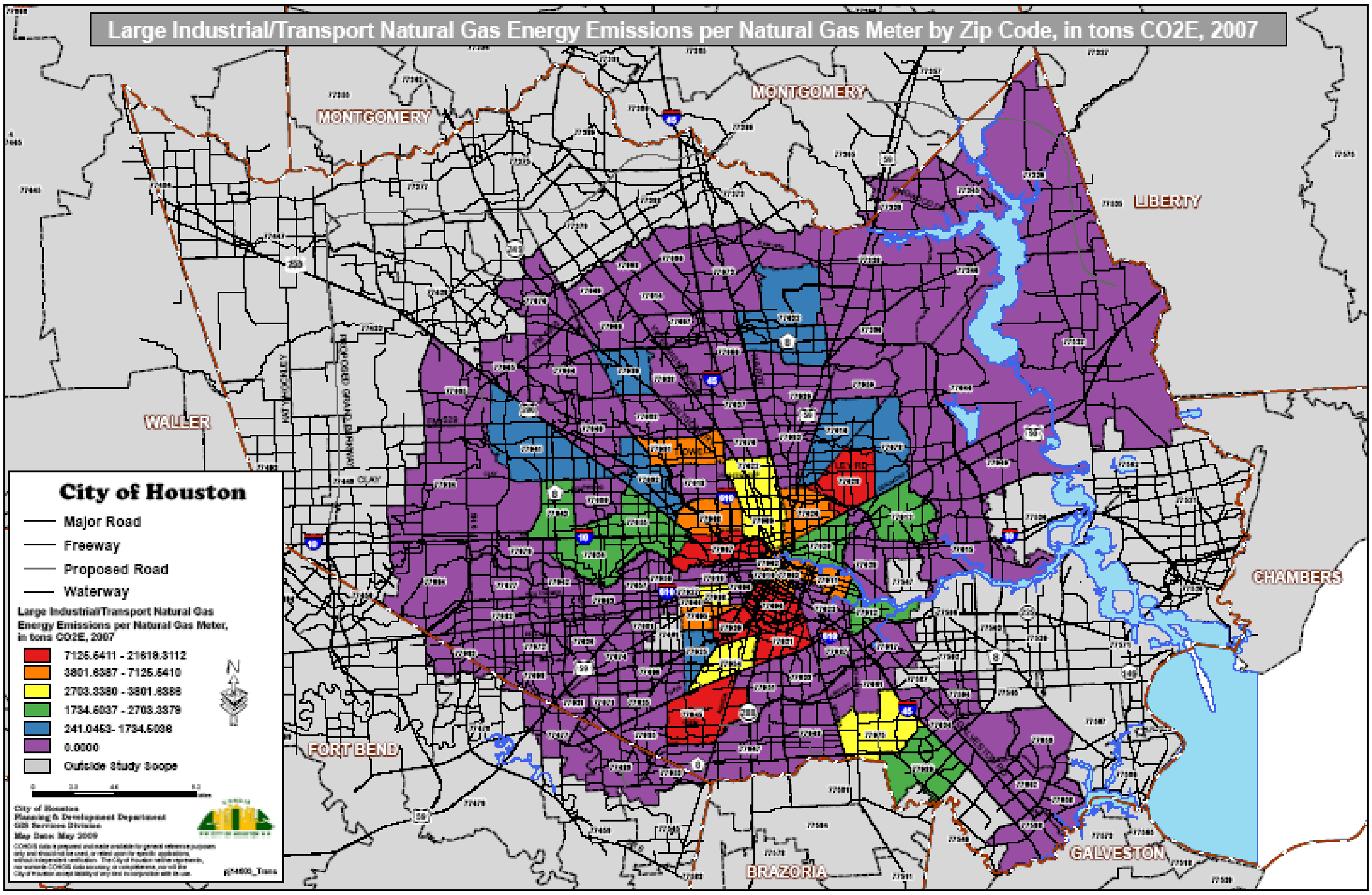
Total Electricity Emissions by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Electricity Emissions, in tons CO2E, 2007
300721.1888 - 622356.4774
219311.7791 - 300721.1887
194978.2795 - 219311.7790
181397.8737 - 194978.2794
100630.0873 - 181397.8736
0.0001 - 100630.0872
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009

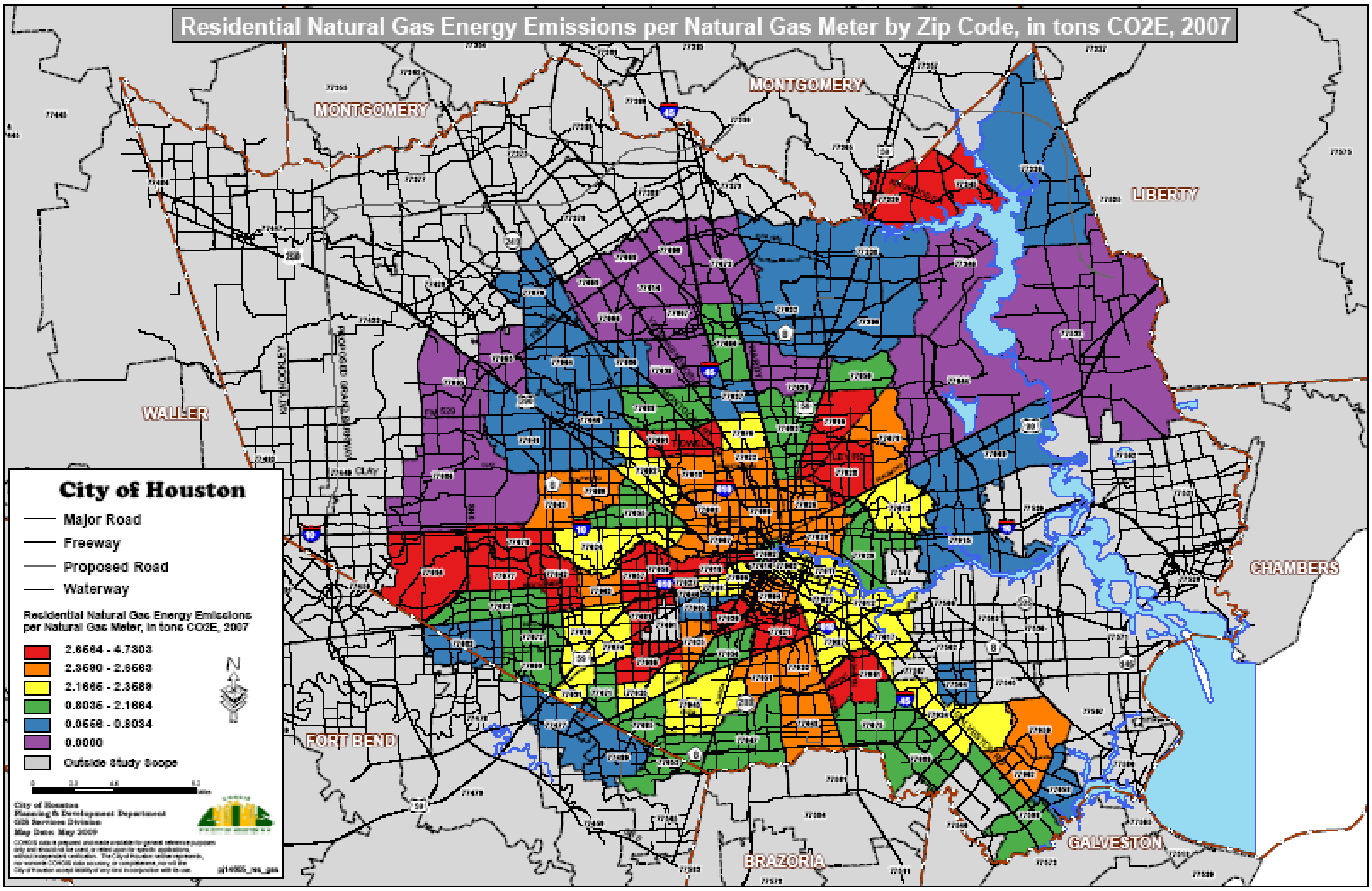


Total Electricity Energy Emissions per Electricity Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Electricity Energy Emissions per Electricity Meter, in tons CO2E, 2007
14.7731 - 81.3161
12.2046 - 14.7730
10.7639 - 12.2045
9.7117 - 10.7638
8.6419 - 9.7116
0.0000 - 8.6418
Outside Study Scope

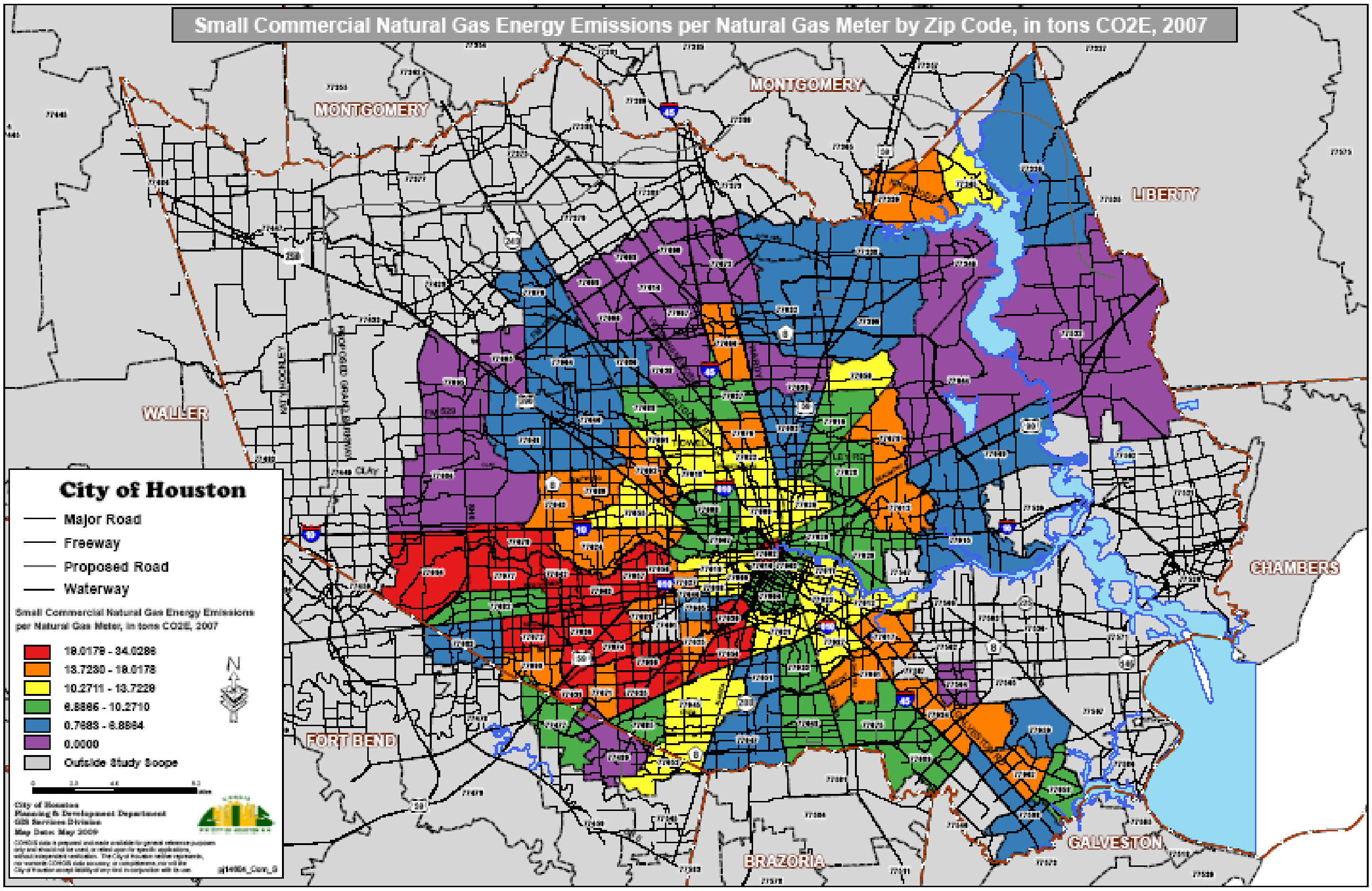

Industrial Natural Gas Energy Emissions per Natural Gas Meter by Zip Code, in tons CO2E, 2007
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Industrial Natural Gas Energy Emissions per Natural Gas Meter, in tons CO2E, 2007
0.0000
Outside Study Scope
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON

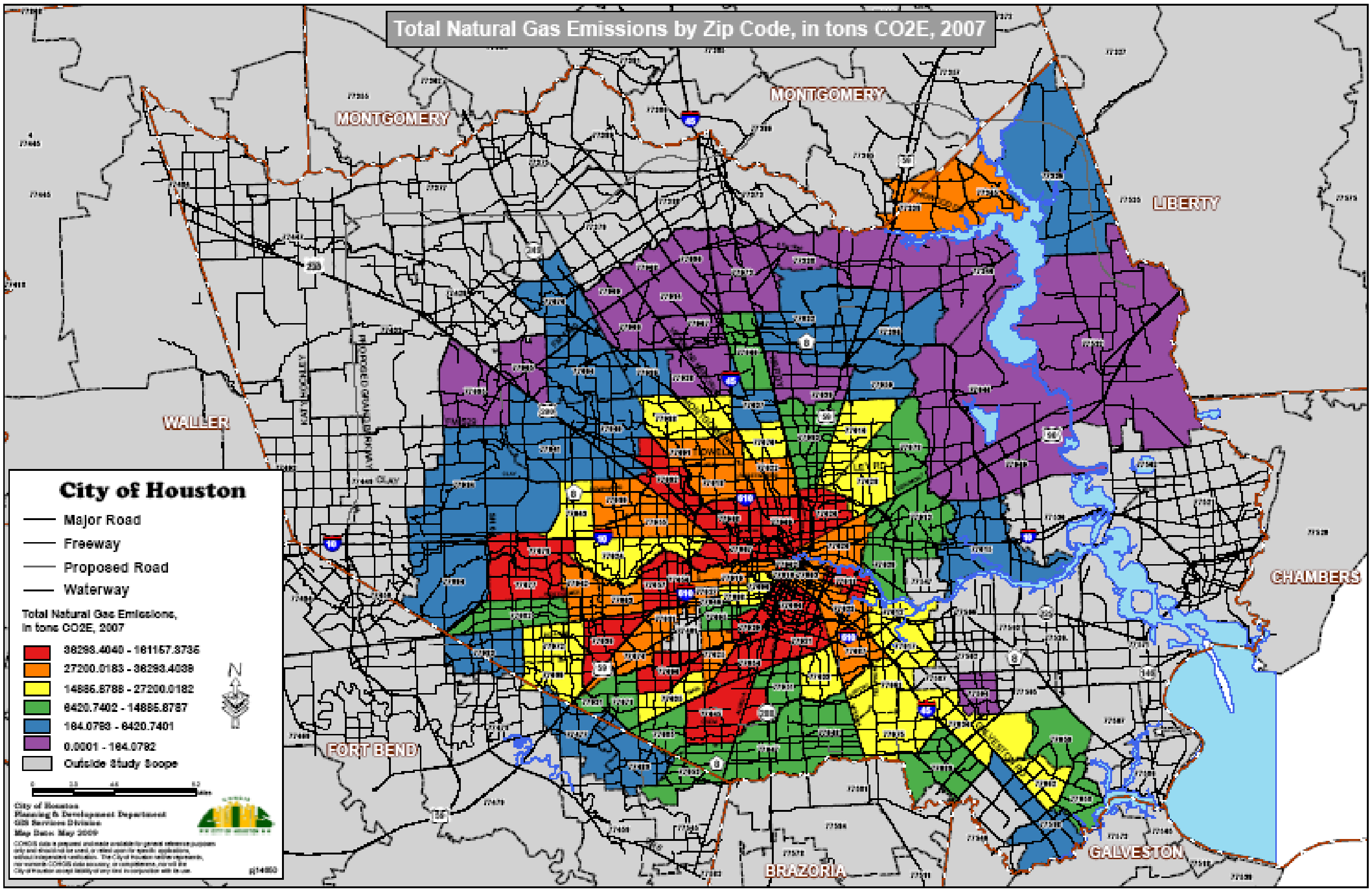

Large Commercial Natural Gas Energy Emissions per Natural Gas Meter by Zip Code, in tons CO2E, 2007
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Large Commercial Natural Gas Energy Emissions per Natural Gas Meter, in tons CO2E, 2007
319.7412 - 938.4277
249.7752 - 319.7411
210.3820 - 249.7751
104.5100 - 210.3819
5.5559 - 104.5099
0.0000
Outside Study Scope
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON

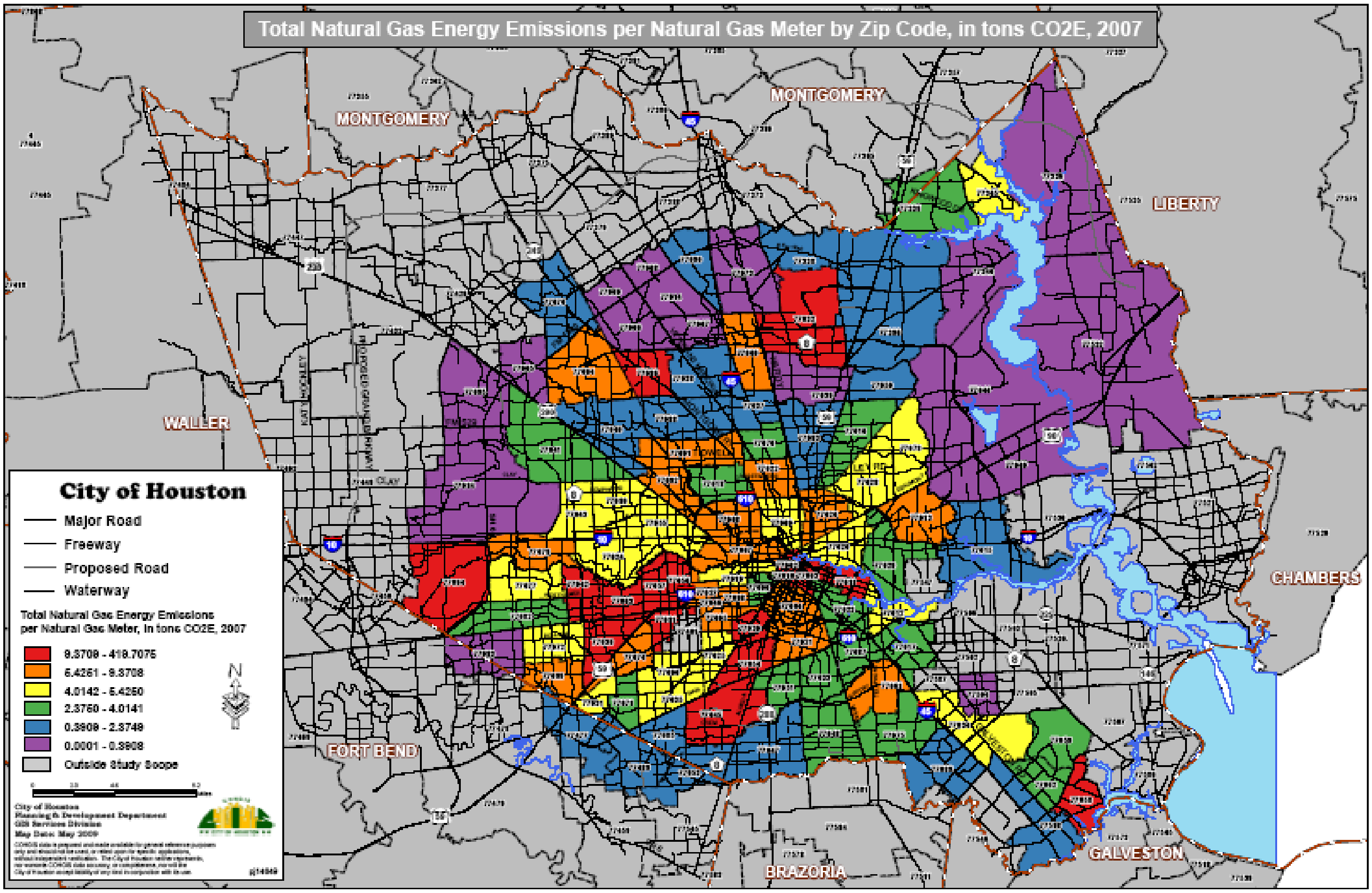

Large Industrial/Transport Natural Gas Energy Emissions per Natural Gas Meter by Zip Code, in tons CO2E, 2007
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Large Industrial/Transport Natural Gas Energy Emissions per Natural Gas Meter, in tons CO2E, 2007
7125.6411 - 21618.3112
3801.6387 - 7125.6410
2703.3380 - 3801.6386
1734.6037 - 2703.3379
241.0453- 1734.6036
0.0000
Outside Study Scope
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON

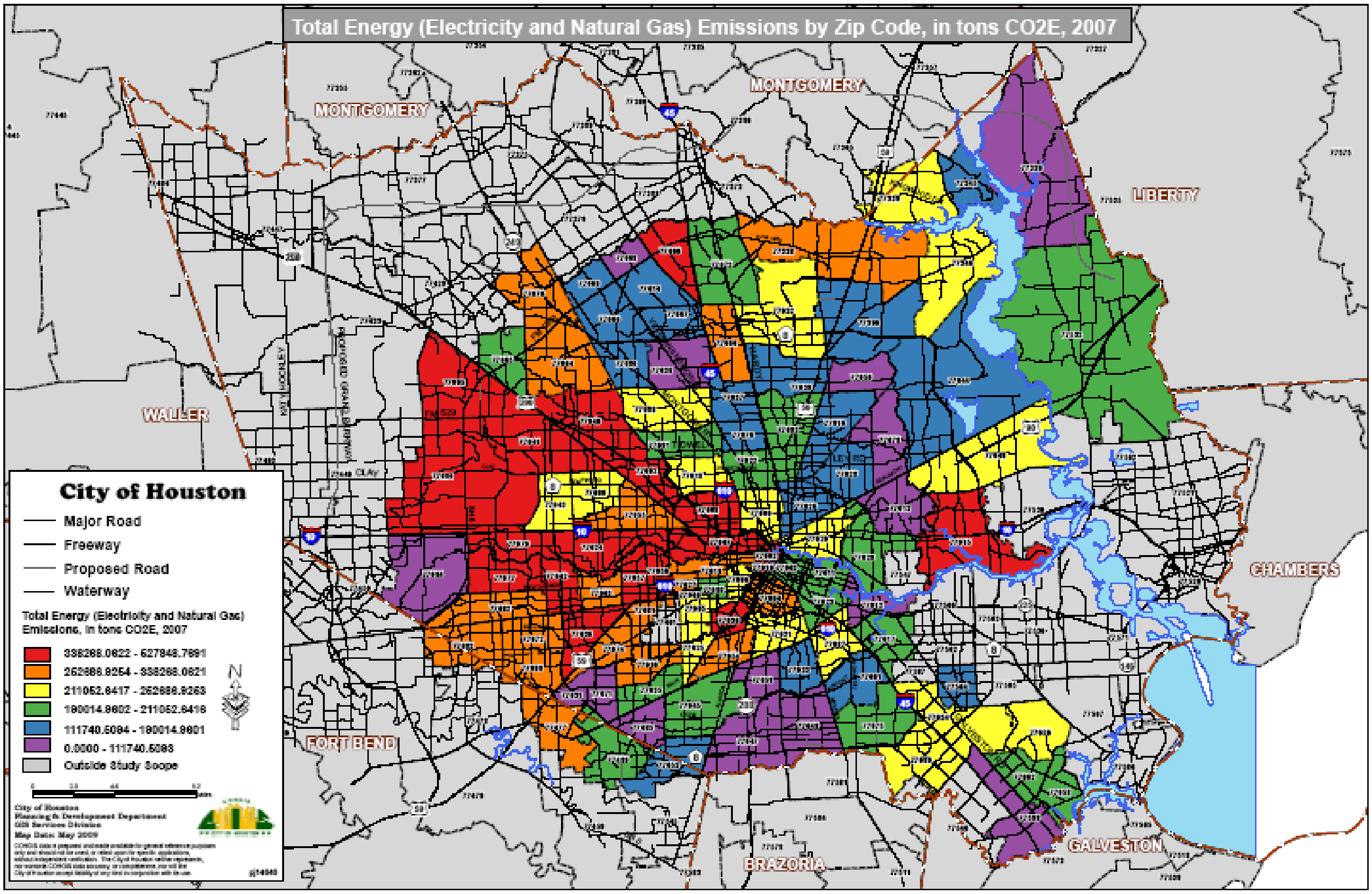


Residential Natural Gas Energy Emissions per Natural Gas Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
GALVESTON
BRAZORIA
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Residential Natural Gas Energy Emissions per Natural Gas Meter, in tons CO2E, 2007
2.8684 - 4.7303
2.3690 - 2.8683
2.1866 - 2.3689
0.8036 - 2.1864
0.0668 - 0.8034
0.0000
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009

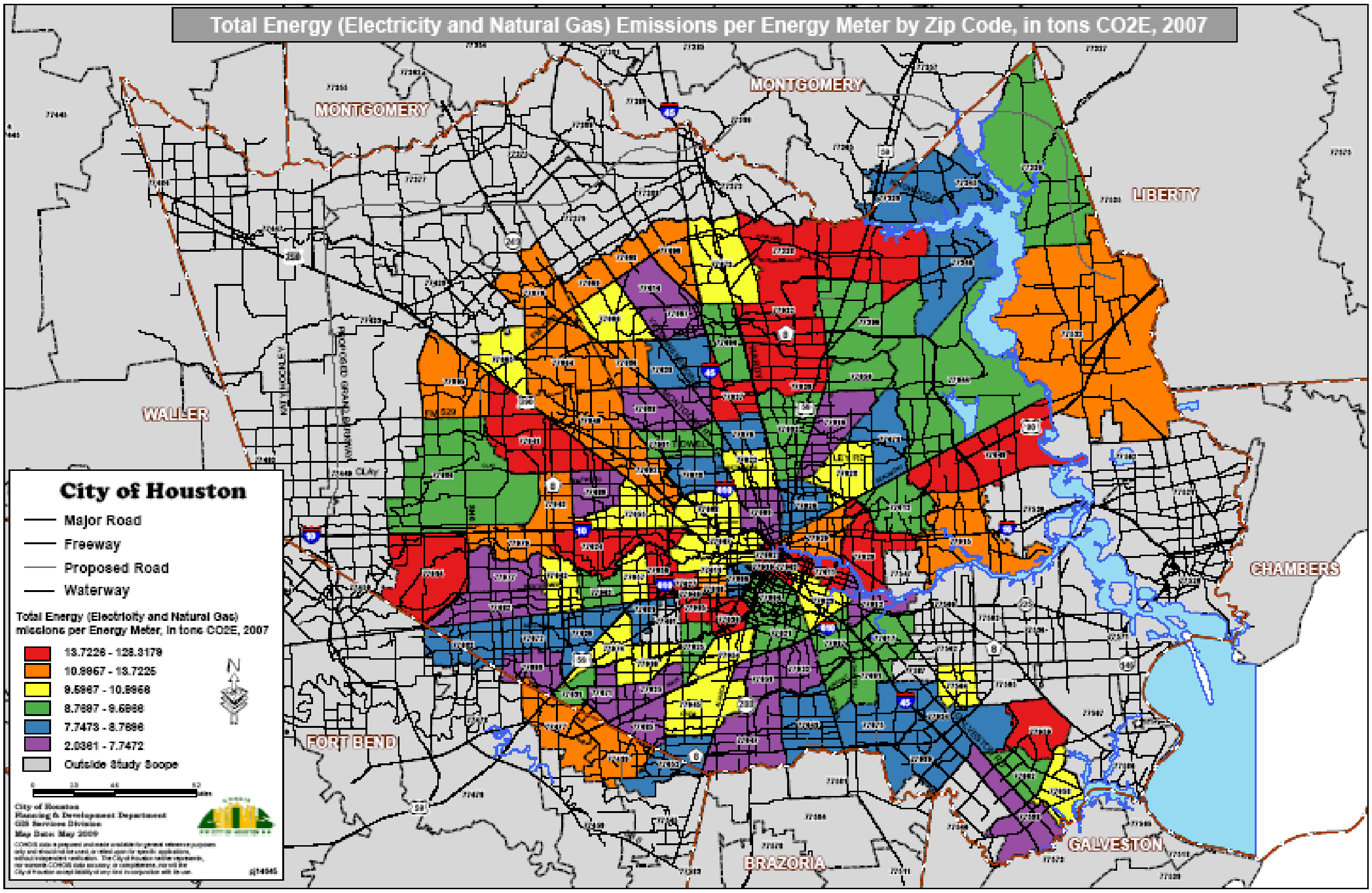

Small Commercial Natural Gas Energy Emissions per Natural Gas Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Small Commercial Natural Gas Energy Emissions per Natural Gas Meter, in tons CO2E, 2007
18.0179 - 34.0288
13.7230 - 18.0178
10.2711 - 13.7229
6.8886 - 10.2710
0.7683 - 6.8884
0.0000
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009


Total Natural Gas Emissions by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Natural Gas Emissions, in tons CO2E, 2007
36293.4040 - 161157.3736
27200.0183 - 36293.4039
14886.8788 - 27200.0182
6420.7402 - 14886.8787
164.0793 - 6420.7401
0.0001 - 164.0792
Outside Study Scope

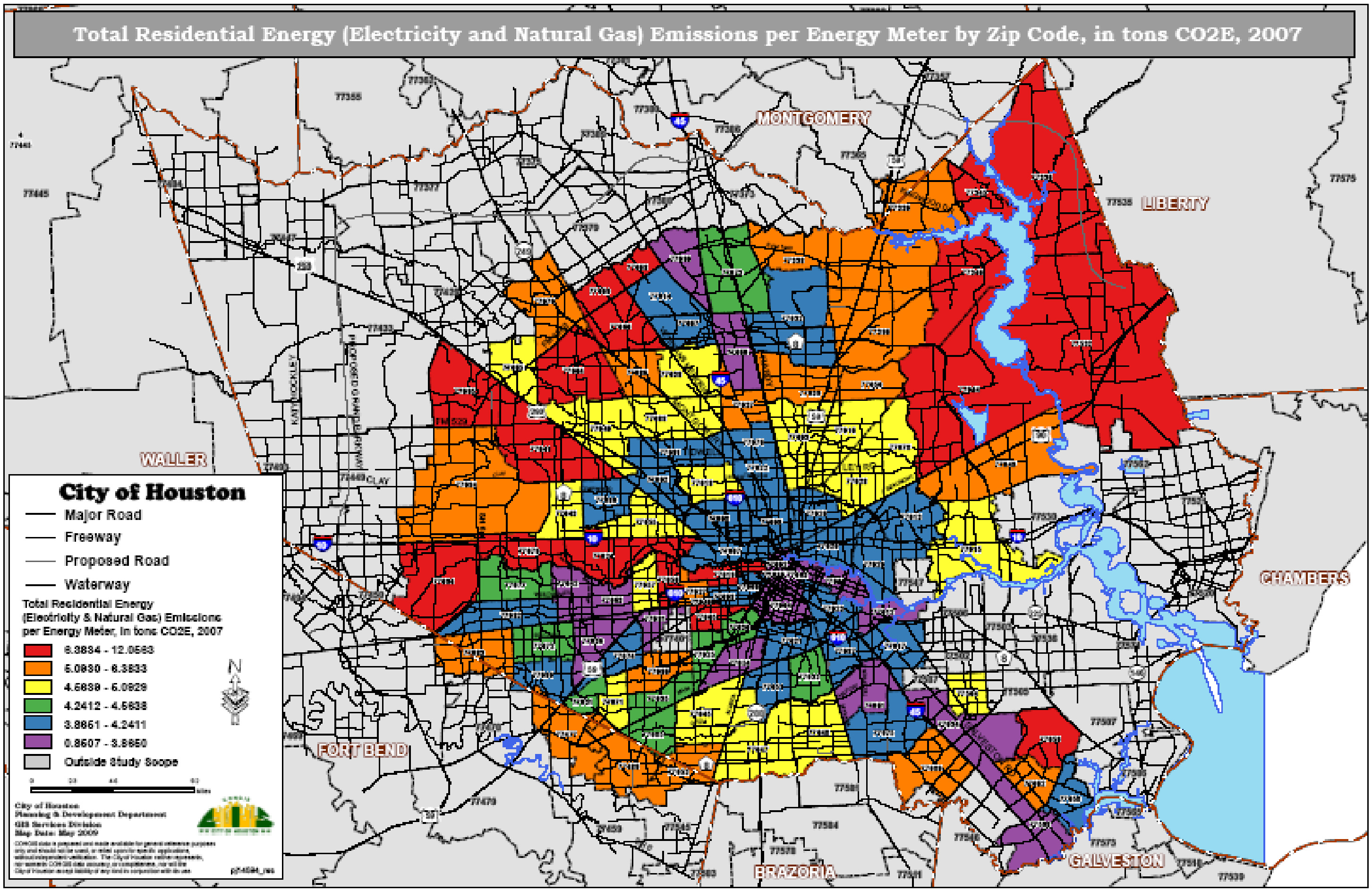

Total Natural Gas Energy Emissions per Natural Gas Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Natural Gas Energy Emissions
per Natural Gas Meter, in tons CO2E, 2007
9.3709 - 419.7075
6.4261 - 9.3708
4.0142 - 6.4260
2.3760 - 4.0141
0.3909 - 2.3749
0.0001 - 0.3908
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009



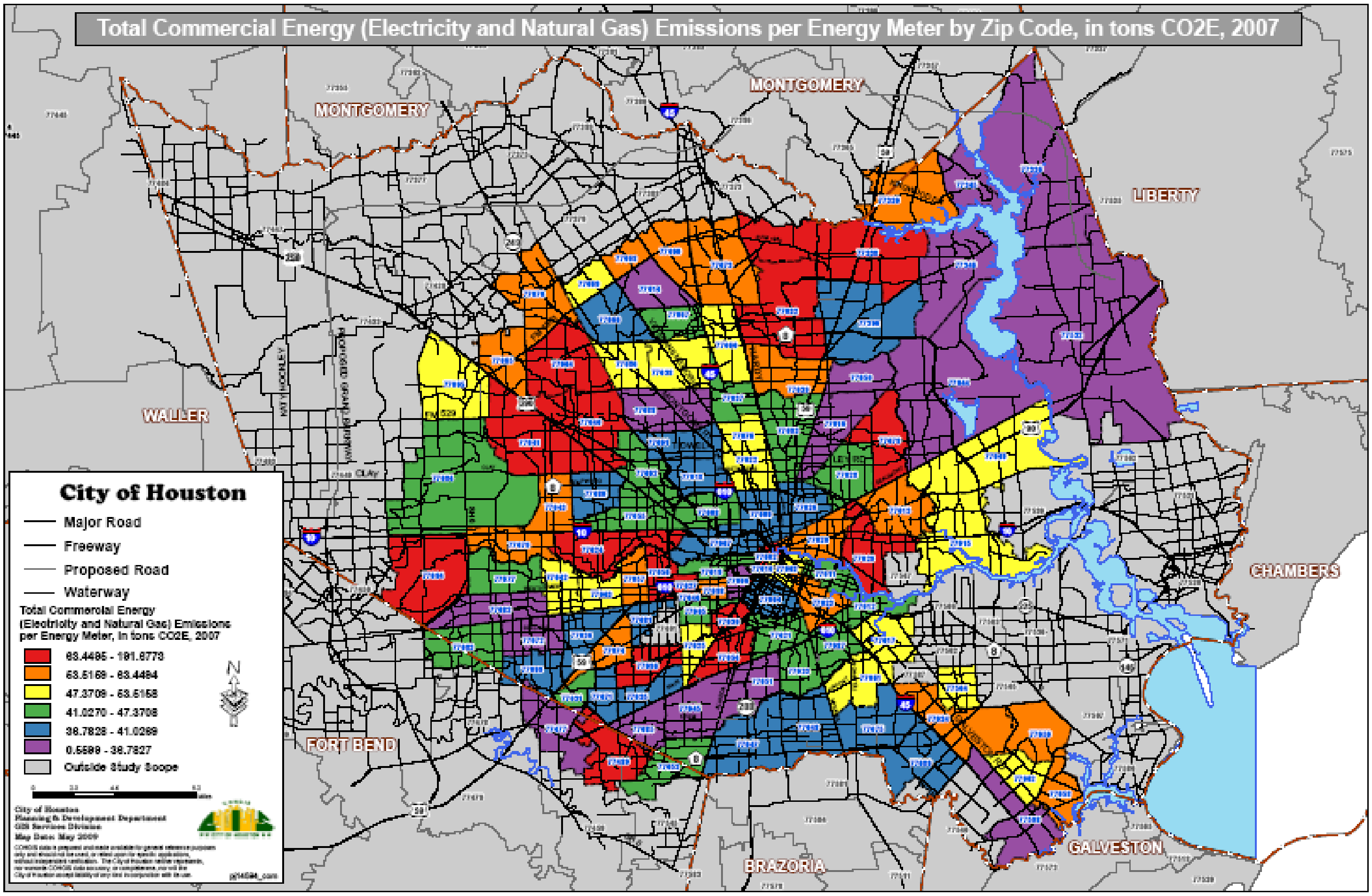
Total Energy (Electricity and Natural Gas) Emissions by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Energy (Electricity and Natural Gas) Emissions, in tons CO2E, 2007
338268.0622 - 627848.7691
262688.9254 - 338268.0621
211052.6417 - 262688.9263
180014.9602 - 211052.6416
111740.5084 - 180014.9601
0.0000 - 111740.5083
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009

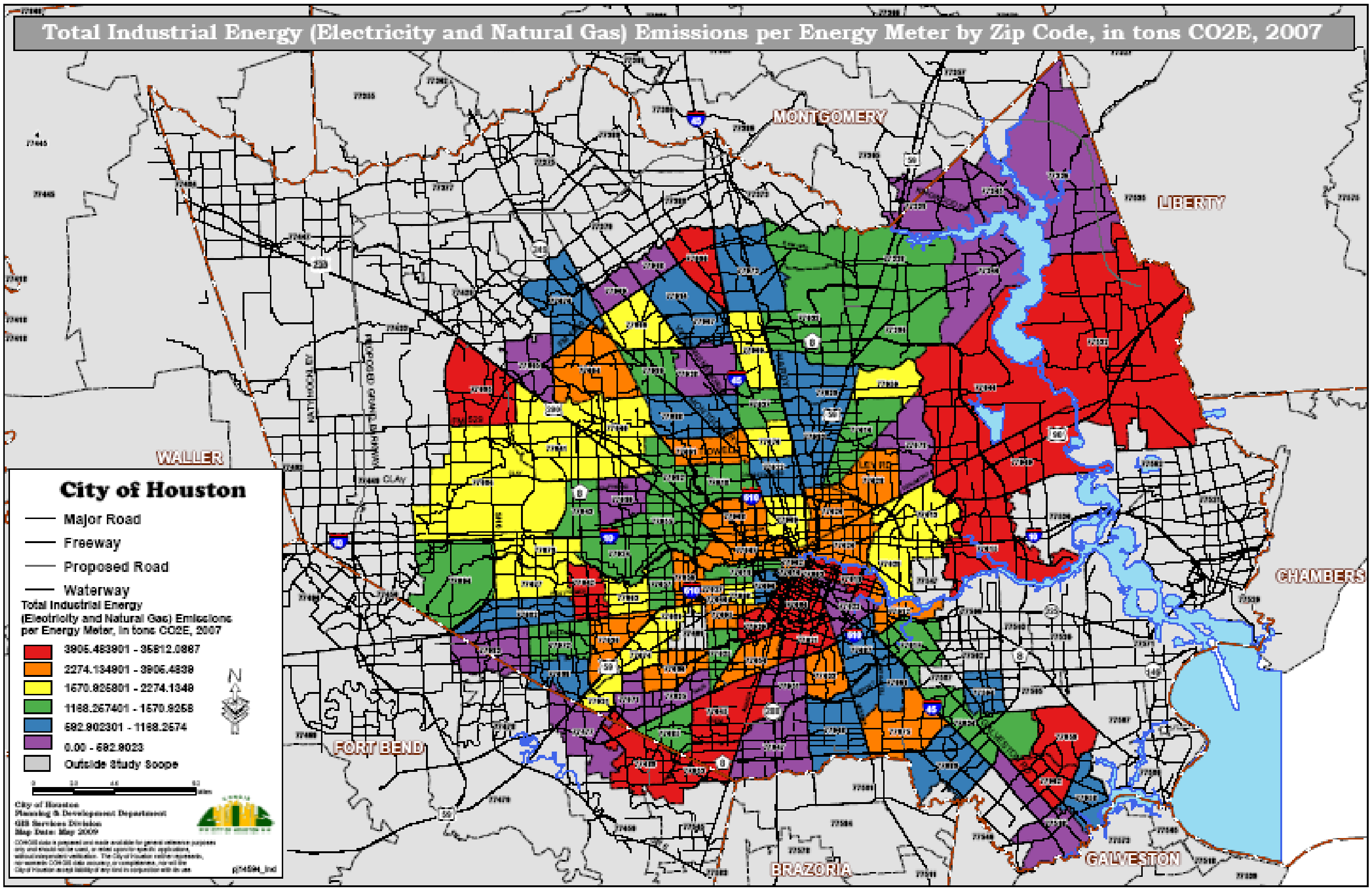


Total Energy (Electricity and Natural Gas) Emissions per Energy Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Energy (Electricity and Natural Gas) missions per Energy Meter, in tons CO2E, 2007
13.7226 - 128.3179
10.9967 - 13.7225
9.6967 - 10.9966
8.7697 - 9.6966
7.7473 - 8.7696
2.0361 - 7.7472
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009



Total Residential Energy (Electricity and Natural Gas) Emissions per Energy Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Residential Energy (Electricity & Natural Gas) Emissions per Energy Meter, in tons CO2E, 2007
6.3834 - 12.0563
5.0930 - 6.3833
4.5639 - 5.0929
4.2412 - 4.5638
3.8651 - 4.2411
0.8607 - 3.8650
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009


Total Commercial Energy (Electricity and Natural Gas) Emissions per Energy Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Commercial Energy (Electricity and Natural Gas) Emissions per Energy Meter, in tons CO2E, 2007
83.4485 - 191.8773
63.5159 - 83.4484
47.3709 - 63.5158
41.0270 - 47.3708
38.7828 - 41.0269
0.5599 - 38.7827
Outside Study Scope
N
City of Houston
Planning & Development Department
GIS Services Division
Map Date: May 2009



Total Industrial Energy (Electricity and Natural Gas) Emissions per Energy Meter by Zip Code, in tons CO2E, 2007
MONTGOMERY
LIBERTY
WALLER
CHAMBERS
FORT BEND
BRAZORIA
GALVESTON
City of Houston
Major Road
Freeway
Proposed Road
Waterway
Total Industrial Energy (Electricity and Natural Gas) Emissions per Energy Meter, in tons CO2E, 2007
3905.483901 - 35812.0867
2274.134901 - 3905.4839
1670.925801 - 2274.1349
1168.267401 - 1670.9258
582.902301 - 1168.2574
0.00 - 582.9023
Outside Study Scope
N