GREENHOUSE GAS INVENTORY

OF SPRINGFIELD, OREGON

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I. INTRODUCTION

Purpose of Document

In September 2006 the Sustainable Business Initiative Task Force issued recommendations to the Eugene City Council and other public agencies, the private sector, non-profits and academic institutions in the Eugene-Springfield area for retaining and growing sustainable businesses and jobs. One of the recommendations (# D3) called for local governments to "Develop consortium and implement a metro area climate action plan." A climate action plan sets goals and identifies strategies for reducing greenhouse gas emissions. In addition to cleaning the local airshed, such a plan will also trigger innovation within the private sector to develop and market technologies and services to reduce emissions.

A starting point for the development of a metro area climate plan is baseline data on current and historical greenhouse gas emissions. The City of Eugene assessed baseline data for the community of Eugene's greenhouse gas emissions. The UO Climate Leadership Initiative decided to inventory the emissions produced within Springfield. This document describes the methodology and findings of the Springfield inventory. Our hope is that it can serve as a tool to begin a dialogue on how emissions can be cost effectively reduced in Springfield. We also hope that local governments in the metro area will refine and continue to update the inventory over time.

Background on Climate Change

Every year since 1997 has been in the Top 10 list of hottest years in recorded history, with 2005 deemed the warmest on record. Average global temperatures have risen by one degree Fahrenheit since the late 19th century. Globally, the warming in the 20th century is the largest of any century during the past thousand years and is roughly as warm as the Earth has been at any time in the last 420,000 years. A scientific consensus exists that natural processes cannot explain the increased temperature. The primary cause is the accumulation of human-produced greenhouse gasses such as carbon dioxide and methane (and other human activities such as deforestation). A growing number of scientists are also concerned that more than a 3-4^{o} degrees Fahrenheit temperature increase above pre-industrial levels may generate immense and possibly irreversible worldwide economic, social and ecological impacts, including here in the Pacific Northwest.

Although climate change is driven in large part by the global emission of greenhouse gasses, the impacts will be felt at the local level. Similarly, although action is required across the globe to resolve the problem, many solutions to climate change must begin with local communities. Local governments, therefore, are ground zero for responding to climate change.

Approach

Identifying the sources and amounts of greenhouse gas (GHG) emissions generated within a community (i.e., city, county, metropolitan area) is a crucial step toward reducing a community's climate change footprint. This analysis is commonly called a "greenhouse gas inventory". The purpose of an inventory is to create a clear picture of how a community uses fossil fuels and other forms of energy and generates pollutants and waste, and to pinpoint the activities and sectors contributing the most greenhouse gasses. A GHG inventory may also be required as a condition for participation in climate change registries and carbon cap and trade programs.

There is no one standard way to prepare a community-wide greenhouse gas inventory. In fact, the need to adapt to the goals of the inventory, local conditions and available data dictate that the specific methodology used be tailored to the local community. However, some standard practices have emerged that provide guidance for a community undertaking a GHG inventory. Overall, an inventory should be accurate (relative to its intended purpose), efficient, transparent, consistent over time and thoroughly documented.

This inventory was prepared using a relatively simple and straightforward methodology. The methodology may be readily used by jurisdictions that are preparing an inventory in-house, without the assistance of a consultant or access to a computer model. This approach is based on the methodology used by ICLEI's Cities for Climate Protection (CACP) Model, and on accepted national and international protocols.

II. METHODOLOGY

Overview

An inventory of greenhouse gas emissions for a community involves four main steps:

1. Define the goal and scope of the inventory.
2. Collect GHG emissions data.
3. Calculate GHG quantities and convert to CO2 equivalents.
4. Interpret inventory.

Step 1: Define the Goal and Scope of the Inventory.

Defining the goal and scope of the inventory at the outset helps ensure that the methodology used and the data gathered are appropriate for the ultimate use of the inventory. Some important issues to consider include the overall goal, target audience, geographic boundary, and timeframe.

The standard approach is to collect emissions data for a baseline year, an interim year, and a forecast year. Setting a baseline year allows a community to establish a reference point against which to measure changes in greenhouse gas emissions over time. For this inventory, 1990 is the baseline year and 2005 is the interim year. A forecast year is an estimate of emissions that would be produced in the future if no new reduction measures were taken. A forecasting component was not a part of this phase of the inventory.

The baseline indicates the “business as usual” situation for the community at the start of a GHG reduction program. Baselines are often mandatory for entities participating in a climate change registry or a carbon cap and trade program. The key issue in setting a baseline year is data availability. There must be sufficient and reliable data for each sector for the baseline year to calculate emissions. However, if a complete dataset is not available, it is possible to use historical trends and data from nearby years to estimate emissions for the baseline and interim years.

Step 2: Collect GHG Emissions Data.

The next step is to identify and record the quantities and activities associated with the release of GHGs. Community GHG inventories generally focus on three primary emission sources: energy consumption, vehicular transportation, and waste generation. Emissions from energy consumption are disaggregated into residential, commercial and industrial sectors, which are further broken down by fuel source. Emissions from the transportation sector are broken down by fuel source, generally limited to gasoline and diesel fuel (although some communities also document emissions from biodiesel, propane and other less prevalent fuel sources). Emissions from solid waste due to methane release from landfills are identified by types of waste (e.g., food, paper, plant debris, etc.). Instructions for each of these sectors are detailed in Appendix A.

Most community-level inventories focus on the predominant GHGs - carbon dioxide (CO_2) and methane (CH_4). They generally do not include the other GHGs covered in the Kyoto Protocol (NO_2, HFCs, PFCs, and SF_6). The rationale for omitting these other gases is that emissions from fossil fuel combustion (CO_2) and solid waste decay (CH_4) generally make up the vast majority of a community's climate change-inducing emissions, with the other GHGs contributing only marginally to the overall inventory.

Inventories generally do not cover GHGs and emission sources considered to be insignificant and/or not readily influenced by local government actions. A general rule that many communities follow is to exclude emissions sources that comprise a small component (generally 5% or less) of total emissions. Excluded emission sources often include aircraft and locomotive transportation, agricultural enteric and manure sources, solvent use, land use and forestry, and industrial emissions not associated with energy. Community-level inventories also tend to exclude the emissions related to the production of most goods bought or consumed in the community ("indirect" sources).

However, the exclusion of these "minor" emission sources (e.g., methane and nitrous oxides from agricultural activity) may not provide an accurate picture of local GHG emissions, as some greenhouses gases are much more potent than others (see discussion of *Global Warming Potential* below).

Some inventories account for carbon sinks such as sequestration, although that analysis is generally beyond the scope of a community-wide inventory. The rationale for excluding carbon sinks is that the appropriate data is often not available and the methodology for measuring carbon sinks can be complicated, data-intensive, and difficult to interpret.

There are two general approaches to collecting GHG data:

1. <u>Top-down</u>: uses more general information (e.g., energy use data from the county or state to estimate local energy consumption). This approach simplifies the calculation of GHG emissions and requires less time and effort. However, it is less accurate.

2. <u>Bottom-up</u>: summarizes detailed data consumption information from each local source (e.g., energy use data from each electric utility serving a community). This approach allows for a much more detailed and accurate analysis but requires significantly more time and effort.

To the extent that more accurate local information is available, a bottom-up approach is preferable. However, it may be necessary and desirable to use a combination of these approaches, depending on the availability of local data, resources and the desired specificity. Appendix A provides more information on these two approaches.

Step 3: Calculating Emissions.

The next step is to calculate quantities of greenhouse gases and convert them to CO2-equivalents (CO2e). Different GHGs have varying degrees of impact upon global climate change per unit of gas emitted. The degree of impact is described as the *Global Warming Potential (GWP).* GWP is a scale used to convert greenhouse gases to CO2 equivalents using CO2 as the reference point and base unit. For example, since methane is 21 times more potent a greenhouse gas than carbon dioxide, the relative global warming potential of carbon dioxide = 1, and methane = 21.

To calculate CO2e, all units of energy (e.g., kilowatt-hours, gallons, therms, etc.) must first be standardized by converting to million British Thermal Units (MMBTU). This is done by multiplying each consumption figure by the appropriate conversion factor to determine energy consumption in MMBTU. These conversion factors are listed in Appendix A. (Solid waste figures remain in tons).

Next, these energy units, now expressed as MMBTU, are multiplied by a CO2 emissions coefficient to calculate total metric tons CO2e. The coefficient for electricity varies depending on the year and the mix of power used to generate electricity. For waste, a CO2 emissions coefficient is multiplied by metric tons to calculate the total metric tons CO2 emissions equivalent, using a different coefficient for each type of waste.

Step 4: Interpret Results.

The results of the inventory identify aggregate GHG emissions and highlight which sources are the greatest contributors. A community can use these results to set a greenhouse gas reduction target, and develop a plan for meeting the target. The inventory can also be used as a baseline to track progress in meeting the plan’s goals. It is recommended that a community conduct inventories on a regular basis to evaluate the results of efforts to reduce GHG emissions. The results of GHG inventories may also used to establish compliance with carbon regulations and/or determine carbon credits for entities participating in cap and trade programs.

III. INVENTORY RESULTS

The methodology described in Section II was used to prepare the greenhouse gas inventory for Springfield. With a population of over 55,000, Springfield is the second largest city in Lane County.

In the base year 1990, the community of Springfield generated approximately 339,688 metric tons of CO_2 equivalent emissions. In 1990, transportation accounted for the largest percentage of emissions at 55 percent. Emissions from industrial energy use were second largest (25 percent). The residential (8 percent), commercial (7 percent) and solid waste (5 percent) sectors contributed significantly less emissions. Emissions from electricity were 38,003 metric tons CO_2e, compared to 95,480 tons from natural gas usage. The details of each sector's greenhouse gas generation are discussed in Appendix B.

Figure 1. Springfield Community Greenhouse Gas Emissions by Sector in 1990

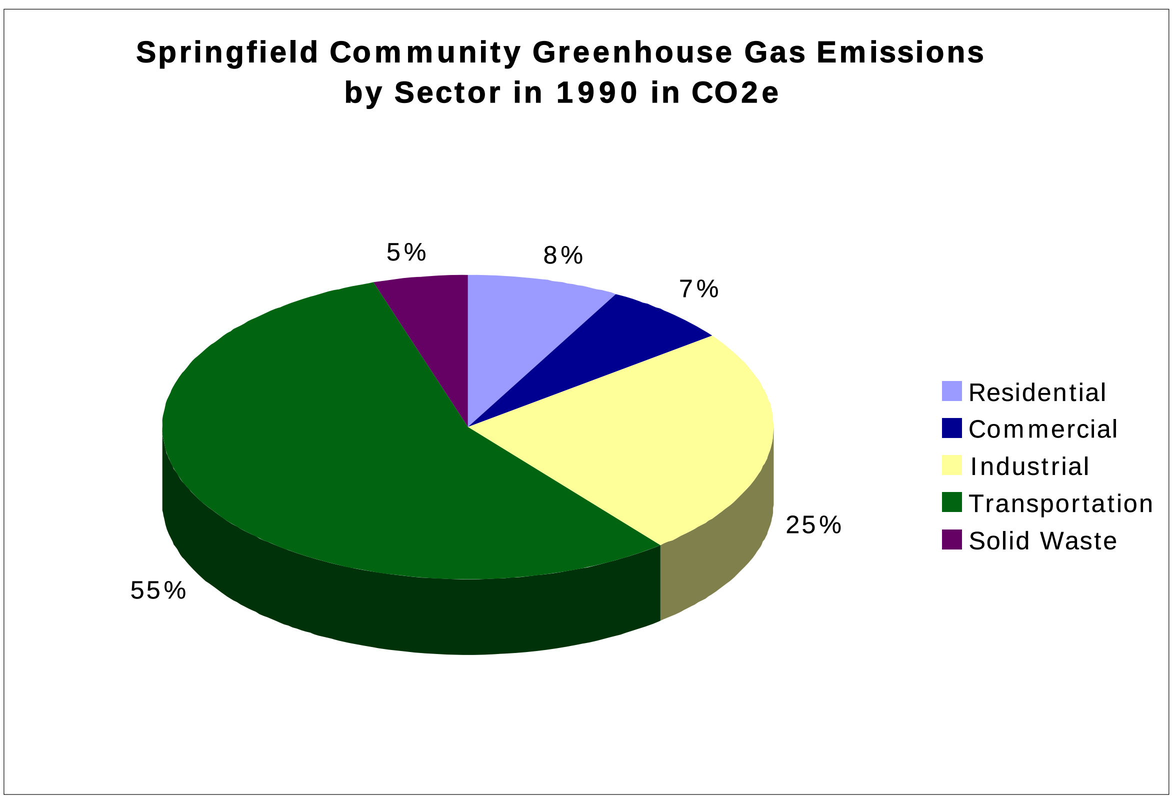
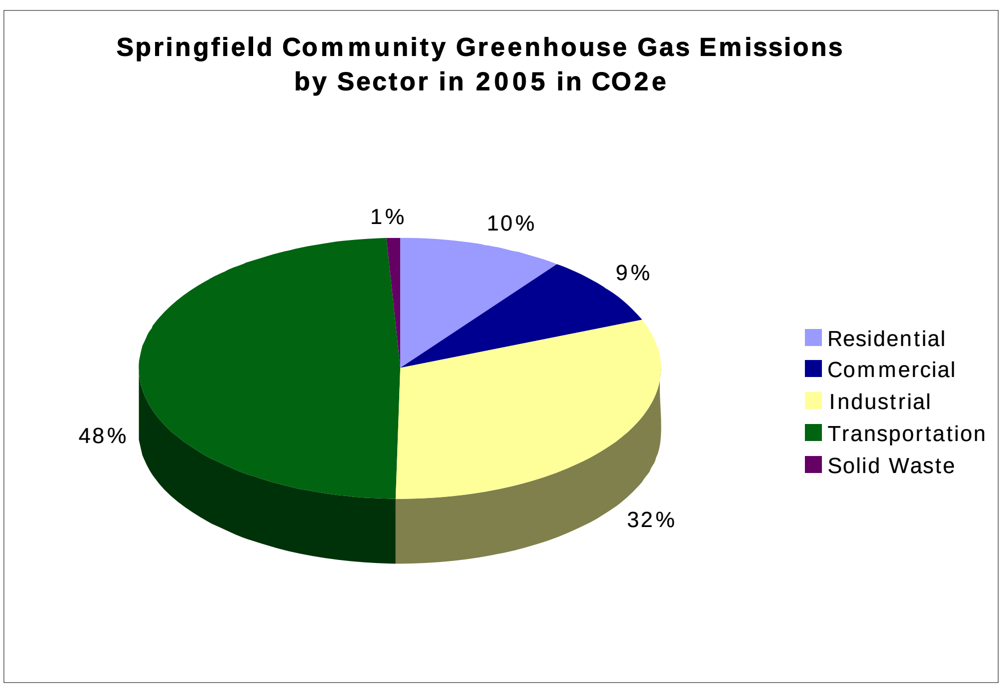


Table 1. Total CO2e Emissions for the Springfield Community in 1990 and 2005

Sector	CO2e Emissions (Metric tons) 1990	2005	% Change
Residential	27,725	44,554	61%
Commercial	22,357	37,246	67%
Industrial	83,400	137,015	64%
Transportation	188,927	211,714	12%
Solid Waste	17,279	3,869	(78%)
TOTAL	339,688	434,398	28%

In 2005, CO2e emissions were 434,398 metric tons. Similar to 1990, most of these emissions were from the transportation sector (48 percent), followed by industrial energy use (32 percent). From 1990 to 2005, the community of Springfield's GHG emissions increased overall by 28 percent. Emissions from energy use in the residential, commercial and industrial sectors use rose dramatically (each over 60%). Emissions from transportation rose 12 percent from 1990. The waste sector is usually a significant contributor of the greenhouse gas methane. CO2 emissions from landfilled solid waste were already the smallest contributor in 1990. Due to methane recovery equipment installed at Short Mountain Landfill around 1992, approximately 75 percent of the methane produced is captured before it is released. As a result, the waste sector now contributes only 1% of total emissions accounted for in this inventory.

Figure 2. Springfield Community Greenhouse Gas Emissions by Sector in 2005



IV. CONCLUSION

This inventory provides one piece of the baseline data needed for a metro area climate action plan. It should be linked with the GHG inventory for the community of Eugene to provide a complete picture of GHG emissions in the Eugene-Springfield metro area.

Once a full picture of metro area emissions is developed, a business-as-usual scenario should be developed to determine what GHG emissions in future years will look like if no changes are made. Targets should then be set for reducing locally generated greenhouse gas emissions within a specific time frame. Specific strategies and measures can then be identified to meet the target. A monitoring program should also be developed to measure progress toward the reduction goals.

A climate action plan may not only reduce greenhouse gas emissions. It may also help local households, businesses, and governments reduce their energy costs, clean the local airshed and thus help reduce Asthma and other airborne illnesses, and reduce dependence on imported fossil fuels.

APPENDIX A: DETAILED METHODOLOGY

ENERGY USE

Emissions from energy usage are based on annual consumption and are disaggregated into residential, commercial and industrial sectors, which are further broken down by fuel source. Potential sources of energy in a community include:

- Electricity
- Natural gas
- Propane
- Coal
- Fuel oil
- Steam
- Residential heating oil
- Wood

Electricity

Electricity comes from some other form of energy – oil, natural gas, moving water, wind, geothermal steam, nuclear, etc. Electricity from fossil fuels emits significantly more greenhouse gas than electricity from renewable resources (e.g., hydropower, wind, and biomass).

Each power plant has its own greenhouse gas emissions coefficient that is based on the type of fuel burned and the plant's thermal efficiency. Thermal efficiency is a function of the power plant's design, and indicates how much of the heat created during combustion becomes electricity.

Often, a community receives power from many locations and energy sources. The mix can vary from one hour to the next. The most accurate method (bottom-up approach) to determine the emissions coefficient for electricity use for a community is to identify the exact sources, coefficients, and mix for the electricity. The local utility may have already calculated this coefficient. If not, an alternative method (top-down approach) is to use the emissions coefficient calculated annually for each state by the U.S. Department of Energy based on the average amount of power supplied from various sources.

Emissions from electric power are "assigned" to the electricity's end-user, rather than the power generation facility itself. Accounting for these "indirect" emissions makes it possible to demonstrate how electricity-consuming activities occurring within the target area are directly responsible for GHG emissions, regardless of whether the physical emissions occur in the area or not. Making the connection between electricity-consuming activities and the resulting (off-site) emissions is an important step in emissions management.

Steps for calculating GHG emissions from electricity and natural gas:

1. Obtain electricity (kilowatt-hours), natural gas (therms), and other desired energy use data from local sources like utilities (bottom up approach) or the state energy commission (top down approach).

2. To calculate CO_2e, all units of energy (e.g., kilowatt-hours, gallons, therms, etc.) must first be standardized by converting to million British Thermal Units (MMBTU). This is done by multiplying each consumption figure by the appropriate conversion factor to determine energy consumption in MMBTU. These conversion factors are included below:

    - Electricity: kWh x 0.003412 = MMBTU
    - Natural gas: therms x 0.1 = MMBTU
    - Fuel Oil: gallons x 0.147 = MMBTU
    - Steam: klbs x 1.0 = MMBTU

3. Then multiply these figures (in MMBTUs) by the appropriate CO_2 emissions coefficient to calculate total metric tons CO_2. The U.S. Department of Energy annually determines each state's emissions coefficient based on the average amount of power supplied from various sources. The coefficients used for this analysis are provided below:

    - Electricity: MMBTU x specific energy source coefficient (based on mix of power sources) = Metric tons CO_2
    - Natural Gas: MMBTU x 0.053 = Metric tons CO_2
    - Steam: MMBTU x 0.053 = Metric tons CO_2 (uses the natural gas coefficient because natural gas is used to produce the steam)
    - Fuel Oil: MMBTU x 0.079 = Metric tons CO_2

How to calculate residential heating oil:

Heating oil and propane are not generally provided by one utility but by a variety of local distributors. One way to estimate heating oil consumption is to use information from the Energy Information Administration (EIA) of the Department of Energy (DOE) and data from the city or county Assessor's Office. Find the average annual consumption per square foot and multiply by the total square footage of residences in the area using oil heat obtained from the Assessor's office. A similar method can be used to calculate estimates for residential propane consumption by using propane consumption data from the EIA and the US Census Bureau.

The process for calculating emissions for commercial and industrial establishments is similar to that of the residential sector. Get commercial/ industrial electrical consumption for each year. Find the average commercial oil heating rate per square foot from the EIA of the Department of Energy. Get a current list of commercial, industrial, and tax-exempt (including municipal) properties that use oil heat and their square footage from the Assessor. Multiply the square footage by the average commercial oil heating rate according to the EIA.

Sources of info.

- Local utilities
- Public Utilities Commission website: www.puc.state.or.us - statistics for all electric utilities in Oregon
- Energy Information Administration: http://www.eia.doe.gov/environment.html
- E.P.A.: http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissions.html

TRANSPORTATION

Emissions from the transportation sector are generally broken down by fuel source and typically limited to gasoline and diesel fuel (although some communities also document emissions from biodiesel, propane and other less prevalent fuel sources). Air travel is not generally part of GHG emissions inventory protocol, despite being a major contributor to greenhouse gas emissions.

Steps for calculating emissions from transportation (top-down approach):
The ICLEI Model (Torrie-Smith software) and other transportation models use a top-down approach that includes built-in assumptions about VMT, including the number of vehicle trips, the length of the trips, the number of people in each vehicle. Default values are used for vehicle fuel efficiency and greenhouse gas emissions per unit of fuel based on number of people per vehicle, trip length, fuel consumption, and CO2 emissions per unit of fuel.

Steps for calculating emissions from transportation (bottom-up approach):

1. Find the total annual vehicle miles traveled (VMT) of different vehicles types within the geographic area from the local transportation planning or traffic management department. It may be easiest to use daily VMT. Many inventories multiply use a coefficient (e.g., 330) to account for traffic volume decreases on weekends and holidays. However, in some areas like the California Bay Area, driving increases on the weekend, so daily VMT is multiplied by 365.

2. Using state averages, break down VMT figures by vehicle type and size class.

3. Calculate the number of gallons of fuel used given average fuel efficiency of each type of vehicle. State averages include gasoline and diesel but not alternatives such as biodiesel. It is assumed that such alternatives represent an insignificant amount of overall transportation fuel. Note: State averages for fuel efficiency may not accurately reflect average fuel efficiency for local vehicles.

4. Convert estimated gallons of gasoline and diesel combusted by vehicles into GHG emissions.

Sources of info.:

- Local City or County
- Local Council of Governments
- State Department of Transportation
- Federal Highway Administration, Highway Statistics: http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm
- Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1993 (emissions coefficients for autos, light trucks and heavy trucks)

SOLID WASTE

Greenhouse gas inventories generally count only GHG emissions from waste disposed in landfills; emissions released when the materials were manufactured are not included. Landfilling can result in a positive or negative contribution to an area's GHG emissions, depending on the type of waste and on the management of the waste in the landfill. For example, when carbonaceous material such as paper is buried in a landfill, part of its carbon is sequestered. This means it can no longer enter the atmosphere as greenhouse gas. The remainder of the carbon decomposes to methane, a potent greenhouse gas, and carbon dioxide.

<u>Categories of waste for GHG Inventories:</u>

- Estimate of composition (percentage of different types of waste)
    - Paper and paper products
    - Food waste
    - Plant debris
    - Wood, furniture, textiles
    - All other waste

When methane is allowed to escape to the atmosphere, net GHG emissions from solid waste is substantial. However, sometimes methane is captured and used to generate electricity. The net effect of landfilling solid waste when using this accounting method is to reduce a community's overall GHG emissions. However, the amount of GHG sequestered when waste is landfilled offsets only a fraction of the amount of GHG produced when those same materials were manufactured. For instance, manufacturing a ton of office paper generates 3 tons of GHG. Landfilling that ton of office paper will only offset about 0.5 tons of the emissions from manufacture, depending on the landfill operation. To prevent double counting, manufacturing emissions are not part of a community's GHG inventory; instead they accrue to the manufacturer.

The following categories of solid waste are used by the CACP software, and therefore jurisdictions using the CACP methodology: Paper Products, Food, Plant Debris, Wood/Textiles, and All Other Waste.

<u>Steps to Calculate Emissions from Solid Waste:</u>

1. Determine how much waste is disposed in landfills in the target year by residential and commercial sectors. Focus on waste disposed at the landfill, not waste generated and collected by haulers (i.e., do not count recycled material).
2. Estimate, by percentages, the composition of waste (e.g., paper, food, etc.)
3. Determine if any methane is captured from landfills.
4. Convert solid waste tonnage into GHG emissions using standard coefficients (e.g., used by CACP software).

<u>Data Sources:</u>

- Local waste haulers
- Local landfill

- Local waste management agencies
- Statewide waste management agencies

APPENDIX B: DATA AND CALCULATIONS

ENERGY

Emissions from energy use are captured under the sector in which the energy is used: residential, commercial and industrial. Energy emissions accounted for in this inventory include electricity and natural gas sources; other sources of emissions from energy use such as propane, fuel oil and wood are not included.

Electricity

Springfield Utility Board:

The Springfield Utility Board (SUB) is the main electric utility serving the City of Springfield. SUB is a consumer-owned utility that purchases all of its energy from the Bonneville Power Administration (Data Source: Marc lePine, Utility Analyst, Springfield Utility Board; Ph: 541-744-3772).

Springfield Electricity Usage in KWh (Served by SUB)

Year	Commercial	Industrial	Residential	Public*	**Total (excluding Public)**
1990	**129,788,045**	**135,409,312**	**300,740,585**	**21,557,935**	**565,937,942**
1991	136,065,754	137,417,632	319,436,633	23,321,891	
1992	136,628,582	301,373,046	287,995,274	24,613,138	
1993	140,518,443	312,206,533	324,650,723	24,931,660	
1994	145,406,451	319,074,066	327,547,301	26,095,482	
1995	145,812,576	333,170,361	339,773,904	26,818,375	
1996	147,660,843	329,595,145	356,271,864	27,648,511	
1997	152,119,161	318,864,375	362,123,180	27,907,697	
1998	150,509,050	328,455,388	360,846,388	29,470,250	
1999	157,083,206	316,434,327	378,062,869	29,654,400	
2000	164,465,281	304,878,418	382,427,339	28,055,114	
2001	162,416,083	145,792,652	367,737,289	29,005,656	
2002	172,237,592	160,689,183	371,852,454	30,307,022	
2003	173,754,618	151,023,738	366,655,280	29,906,030	
2004	174,249,692	162,059,820	370,343,054	30,314,194	
2005	**178,592,666**	**161,915,433**	**382,323,153**	**30,335,074**	**722,831,252**
2006**	126,742,158	105,870,277	268,169,186	20,778,397	

*For the Public and SUB categories, the public account class includes parks and other non-profit buildings, and the SUB account class includes data from all utility owned buildings (offices, etc). Before September 1999, there was no "SUB" class; it was rolled into the Commercial class. Public data were not included in this inventory. These emissions would be accounted for in a municipal analysis (i.e., internal city operations).
** Jan-Aug 2006

1990 SUB CO_2 Emissions Coefficient for Electricity:

A calculated CO_2 emissions coefficient was not available for 1990. An estimate of 100 lbs CO_2/MWh (.045360 metric tons/MWh) was used. Source: Phil Carver; Oregon Department of Energy; 503-378-6874.

100 lbs CO_2/MWh * 1 metric ton/2204.6 lbs = .045360 metric tons CO_2/MWh

2005 SUB CO_2 Emissions Coefficient for Electricity:

122 lbs CO_2/MWh (.055339 tons CO_2/MWh). Source: Phil Carver, Oregon Department of Energy.

122 lbs CO_2/MWh * 1 metric ton/2204.6 lbs = .055339 metric tons CO_2/MWh

This CO_2 emissions coefficient is based on BPA's block power energy mix, shown below:

Springfield Utility Board's Energy Mix for 2005
(Based on BPA Block Power Mix)

Petrol & Other	0.05%
Hydro	82.54%
Nuclear	10.86%
Gas	1.58%
Coal	4.71%
Biomass	0.26%
	100.00%

1990 CO_2 Emissions from Electricity Use in Springfield (SUB)

ELECTRICITY	Energy consumption in KWh	Energy consumption in MMBTU	Conversion Factor To MWh	Energy Consumption in MWh	emissions coefficient (metric ton/MWh)	Metric tons of CO2
Residential	300,740,585	1,026,127	0.001	300,741	0.045360	13,642
Commercial	129,788,045	442,837	0.001	129,788	0.045360	5,887
Industrial	135,409,312	462,017	0.001	135,409	0.045360	6,142
Total	**565,937,942**	**1,930,980**		**565,938**		**25,671**

2005 CO_2 Emissions from Electricity Use in Springfield (SUB)

ELECTRICITY	Energy consumption in KWh	Energy consumption in MMBTU	Conversion Factor to MWh	Energy Consumption in MWh	Emissions coefficient (metric ton/MWh)	Metric tons of CO2
Residential	382,323,153	1,304,487	0.001	382,323	0.055339	21,157
Commercial	178,592,666	609,358	0.001	178,593	0.055339	9,883
Industrial	161,915,433	552,455	0.001	161,915	0.0555339	8,960
Total	**722,831,252**	**2,466,300**		**722,831**		**40,001**

<u>Eugene Water & Electric Board (EWEB)</u>

The Eugene Water and Electric Board (EWEB) serves the Weyerhaeuser facility in Springfield. Data was only available for the combined emissions from both the Weyerhaeuser facility and EWEB's upriver residential area. For the purposes of this Inventory, these emissions were included in the industrial emissions category, resulting in a slightly inflated figure for industrial emissions.

Emissions from Electricity Use for Weyerhaeuser and EWEB's Upriver Residential Area (EWEB)

	Energy consumption in KWh	Energy consumption in MMBTU	Conversion Factor To MWh	Energy Consumption in MWh	Emissions coefficient (metric ton/MWh)	Metric tons C02
1990	382907863	1306482	0.001	382,908	0.032205	12,332
2005	454192186	1549704	0.001	454,192	0.044453	20,190

1990 EWEB CO_2 Emissions Coefficient for Electricity:

1990 EWEB CO_2 coefficient: 71 lbs/MWh

71 lbs CO_2/MWh * 1 metric ton/2204.6 lbs = .032205 metric tons CO_2/MWh

2005 EWEB CO_2 Emissions Coefficient for Electricity:

2005 EWEB CO_2 coefficient: 98 lbs/MWh

98 lbs CO_2/MWh * 1 metric ton/2204.6 lbs = .044453 metric tons CO_2/MWh

Natural Gas

Springfield Natural Gas Usage (in therms)

Year	Residential	Commercial	Industrial	Total
1990	2,286,250	2,673,750	10,540,000	**15,500,000**
1991	2,370,014	2,771,711	10,926,166	16,067,891
1992	3,026,669	3,539,664	13,953,457	20,519,790
1993	3,406,880	3,984,317	15,706,294	23,097,491
1994	3,549,688	4,151,330	16,364,664	24,065,683
1995	3,799,259	4,443,201	17,515,227	25,757,687
1996	4,135,633	4,836,588	19,065,971	28,038,192
1997	4,175,882	4,883,658	19,251,522	28,311,062
1998	4,161,424	4,866,750	19,184,871	28,213,045
1999	4,600,116	5,379,796	21,207,314	31,187,226
2000	4,568,629	5,342,973	21,062,155	30,973,757
2001	4,425,000	5,175,000	20,400,000	30,000,000
2002	4,314,375	5,045,625	19,890,000	29,250,000
2003	4,203,750	4,916,250	19,380,000	28,500,000
2004	4,056,250	4,743,750	18,700,000	27,5000,00
2005	3,798,217	4,441,983	17,510,425	**25,750,625**
Total	**60,878,036**	**71,196,347**	**280,658,065**	**412,732,449**

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Totals for natural gas consumption were provided by Kip Much, District Manager, NW Natural in the Eugene office. The breakdown by residential, commercial, and industrial sectors provided below are estimates provided by Kip Much based on NW Natural’s monitoring systems.

Average usage for Lane County:

- Residential 14.75%
- Commercial 17.25%
- Industrial 68.0%

CO2 Emissions Coefficient for Natural Gas:

The CO2 Emissions coefficient for natural gas = .0616 tons/MMBTU. This is the national average used in the ICLEI CCAP software.

1990 CO2 Emissions from Natural Gas Use in Springfield

NATURAL GAS	Energy Consumption in therms	Conversion factor to million BTUs	Energy consumption in million BTUs	emissions coefficient	metric tons of C02
Residential	2286250	0.1	228,625	0.0616	14,083
Commercial	2673750	0.1	267,375	0.0616	16,470
Industrial	10540000	0.1	1,054,000	0.0616	64,926
Total	**15,500,000**		**1,550,000**		**95,480**

2005 CO2 Emissions from Natural Gas Use in Springfield

NATURAL GAS	Energy Consumption in therms	Conversion factor to million BTUs	Energy consumption in million BTUs	emissions coefficient	tons of C02
Residential	3798217	0.1	379,822	0.0616	23,397
Commercial	4441983	0.1	444,198	0.0616	27,363
Industrial	17510425	0.1	1,751,043	0.0616	107,864
Total	**25,750,625**		**2,575,063**		**158,624**

1990 Total CO2e Emissions from Energy Use in Springfield

Sector	Metric tons CO2e
Residential	27,725
Commercial	22,357
Industrial	83,400
TOTAL	**133,482**

2005 Total CO2e Emissions from Energy Use in Springfield

Sector	Metric tons CO2e
Residential	44,554
Commercial	37,246
Industrial	137,015
TOTAL	**218,815**

SOLID WASTE

For this study, per capita waste disposal rates were used, as this was the best available information. These per capita rates were then multiplied by the population of Springfield to determine total annual rates. Disposal data was not available for 1990 and 2005; the per capita rate for 1993 was used for 1990, and the rate for 2004 was used for 2005. Statewide waste composition data from 1994-95 was used for 1990, and waste composition data for 2002 was used for 2005. Wastes disposal and composition data were obtained from the Oregon Department of Environmental Quality. Municipal solid waste coefficients are from ICLEI.

Data

Lane Wasteshed Per Capita Waste Disposed

Year	Per Capita Waste Disposed in Lbs.
1993	**1782**
1995	1569
1997	1650
1998	1644
1999	1640
2000	1582
2001	1479
2002	1575
2003	1556
2004	**1565**

Oregon Statewide Waste Composition 1994-1995

Type of Waste	Percent of Total	
Paper & paper products	28.95%	
Food waste	14.65%	
Plant debris	5.8%	
Wood, furniture, textiles	11.62%	
Subtotal		(61.02%)
All other waste	38.98%	
Total	**100.00%**	

Oregon Statewide Waste Composition 2002

Type of Waste	Percent of Total	
Paper & paper products	20.62%	
Food waste	15.60%	
Plant debris	6.58%	
Wood, furniture, textiles	11.75%	
Subtotal		(54.55%)
All other waste	45.45%	
Total	**100.00%**	

1990 Emissions from Waste Disposal for Springfield

	% of total waste stream	tons MSW	coeff	tons CO2e
Paper & paper products	28.95%	10,456	1.21035	12,656
Food waste	14.65%	5,291	1.12964	5,977
Plant debris	5.80%	2,095	(0.16136)	-338
Wood, furniture, textiles	11.62%	4,197	(0.24207)	-1,016
All other waste	38.98%	14,079	-	
Total	**100.00%**	**36,118**		**17,279**

Springfield MSW to landfill	36,118	tons MSW
	17,279	**tons CO2e**

2005 Emissions from Waste Disposal for Springfield

	% of total waste stream	tons MSW	coeff	tons CO2e
Paper & paper products	20.62%	8,251	1.21035	9987
Food waste	15.60%	6,242	1.12964	7052
Plant debris	6.58%	2,633	(0.16136)	-425
Wood, furniture, textiles	11.75%	4,702	(0.24207)	-1138
All other waste	45.45%	18,187	-	
Total	**100.00%**	**40,016**		**15,476**

Springfield MSW to landfill	40,016	tons MSW	
	15,476	tons CO2e	
Methane Recovery in 2005 = 75%	**3,869**	Tons CO2e (methane generated minus methane recovered)	**3,869**

<u>Calculations:</u>

1990 (Used 1993 data):

Springfield population in 1990 = 44,683. Per capita waste disposal rate in 1993 was 1782 lbs/year.

1782 lbs X 44,683 people = 79,625,106 lbs/year = 36,117.711 metric tons.

2005 (used 2004 data):

Springfield population in 2005 = 56,370 people. Per capita waste disposal rate in 2004 was 1565 lbs/year.

1565 lbs X 56,370 people = 88,219,050 lbs/year = 40,015.898 metric tons.

Methane Recovery

Short Mountain landfill started methane recovery in 2001/2002. Methane recovery for Short Mountain Landfill = 75% (Source: Dan Hurley, Lane County Waste Management; 682-3811).

TRANSPORTATION

Methodology

Two different methodologies were used to calculate CO2 emissions from transportation.

MOBILE6 Air Emissions Model Methodology:

A locally-derived, bottom-up methodology was initially used to calculate emissions from vehicular transportation. Susan Payne of Lane Council of Governments (LCOG) provided the data and performed these calculations.

Vehicle Miles Traveled (VMT)

The number of Vehicle Miles Traveled (VMT) was initially calculated for 2002 by Susan Payne of LCOG. To determine VMT for 1990 and 2005, traffic data for the Eugene-Springfield area from the latest Urban Mobility Report (from Texas Transportation Institute) was used to deduce the rate of change over time. This rate of change for VMT was used to extrapolate the 2002 VMT calculations to 1990 and 2005.

The number of Vehicle Miles Traveled (VMT) was calculated for 2002 using the regional transportation model that is used for regional planning efforts in the Central Lane Metropolitan Planning Organization (MPO) area, which consists of Eugene, Springfield, Coburg and parts of Lane Co. (map downloadable from http://www.centrallanempo.org). The various parts of the road network that lie within Eugene, Springfield, and then Lane Co. (including Coburg) were separated out. VMT from Interstate 5 was not included in either Eugene or Springfield; it was lumped into the Lane County portion for two reasons: traffic on I-5 has a high percentage of inter-regional traffic which doesn't respond to any local policy or intervention, and the facility actually splits Eugene and Springfield.

CO2 Emissions

The EPA air emissions model, MOBILE6, was used to compute the emissions rate for the Lane Co. fleet mix which was provided by Oregon's Department of Environmental Quality (DEQ). The vehicle mix gives the distribution of vehicles by class, including light duty gasoline vehicles, light duty gasoline trucks of various weights, heavy duty gas and diesel trucks etc. and is derived from 2004 DMV records. Not all vehicle classes needed by MOBILE6 are tracked by DMV and so the fleet mix is the best approximation that DEQ has for the input into the emissions model.

MOBILE6 model also has a built in default assumption as to the distribution of the miles driven by each class of vehicle that is modeled. Since more accurate information than the default is not available, the default distribution was used. At the end of the model run, a CO2 emissions rate in grams per mile (gm/mile) is produced. The emissions rate for the Lane Co. fleet is estimated as 543.66 gm/mile. The fleet is estimated by MOBILE6 to have an average mile per gallon (MPG) of 16.8 mpg. The details as to the emissions rate for major vehicle classes, the distribution of VMT assumed for the fleet mix, and the MPG for each vehicle class, plus the composite emission factors are in the table below.

Vehicle Type:	**LDGV**	**LDGT12**	**LDGT34**	**LDGT**	**HDGV**	**LDDV**	**LDDT**	**HDDV**	**MC**	**All Veh**
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.4655	0.2907	0.1111		0.0417	0.0015	0.0020	0.0823	0.0052	1.0000
Fuel Economy (mpg):	23.4	18.7	14.3	17.3	9.5	27.3	18.3	7.0	50.0	16.8
Composite CO2:	379.2	473.9	618.4	513.8	933.5	372.8	557.1	1447.1	177.4	543.66

LDGV = Light-Duty Gasoline Vehicles
LDGT12 = Light-Duty Gasoline Truck
LDGT34 = Light-Duty Gasoline Truck
LDGT = Light-Duty Gasoline Truck
HDVG = Heavy-Duty Gasoline Vehicle
LDDV = Light-Duty Diesel Vehicle
LDDT = Light-Duty Diesel Truck
HDDV = Heavy-Duty Diesel Vehicle
MC = Motorcycle

The emission rate in gm/mile is then reduced by 1%. This is because the CO2 rate reported by MOBILE6 is "atmospheric" CO2 as determined by a carbon mass balance equation. This includes not only the emissions of CO2 formed during combustion (tailpipe CO2) but also the CO2 formed later in the atmosphere by the natural oxidation of the vehicle's hydrocarbon and carbon monoxide emissions. One percent is never oxidized, and so current guidelines advise reducing MOBILE6 estimates by 1%.

Data

2002:

VMT in Springfield is estimated at 970,000 vehicle-miles per day.

Emissions rate for the Lane Co. fleet is estimated as 543.66 gm/mile. The fleet is estimated by MOBILE6 to have an average mpg of 16.8 mpg.

To compute tons/day of CO2 in Springfield:
970,000 VMT * 543.66 gm/mile * 1/453.5924 lbs/gram * 1/2204.6 ton/lbs= 527 metric tons/day

Reduced by 1% = **522 metric tons/day * 365 days = 195,530 metric tons CO2e**

The MOBILE6 CO2 model was re-ran for 1990 and 2005, assuming that the Lane Co. fleet mix was and will be the same as it is today. For 1990, the CO2 emissions rate was computed at 589.5 gm/mile (15.4 mpg average fleet mileage). For 2005, the emissions rate was 545.46 gm/mile (16.7 mpg fleet average).

<u>1990:</u>
VMT in Springfield is estimated at 893,680 vehicle-miles per day (based on average rate of increase of 8.54% from 1990-2002)

To compute tons/day of CO2 in Springfield:
893,680 * 589.5 * 1/453.5924 * 1/2204.6 = 527 metric tons/day. Reduced by 1% = **522 metric tons/day** = **190,530 metric tons/year.**

<u>2005:</u>
VMT in Springfield is estimated at 1,001,471 vehicle-miles per day (based on average rate of increase of 1.07% from 1999-2003)

To compute tons/day of CO2 in Springfield:
1,001,471 * 545.46 * 1/453.5924 * 1/2204.6 = 602.2 metric tons/day. Reduced by 1% = **546 metric tons/day = 199,290 metric tons/year**

ICLEI Methodology:

This approach used the methodology and assumptions employed by the ICLEI CACP model.

The data for daily VMT (source described above) was multiplied by 330 (to account for traffic volume changes on weekends and holidays).

<u>1990:</u>

1990 VMT = 893,680/ day * 330 day/yr = 294,914,400 annual VMT.

<u>2005:</u>

2005 VMT = 1,001,471/ day * 330 day/yr = 330,485,430 annual VMT.

These numbers were then multiplied by the model's default values for vehicle fuel efficiency and greenhouse gas emissions per unit of fuel.

1990 CO2e Emissions from Vehicular Transportation in Springfield

	annual VMT	average MPG	total gallons	conversion factor	enrgy cnsmptn in million BTUs	Emiss Coeff	Tons CO2e
Annual VMT:	**294,914,400**						
Gasoline/gasohol		CCP ESTIMATES					
Car	187,565,558	19.70	9,521,094	0.125	1,190,137	0.0790	94,021
Lt trck/psngr van	85,230,262	14.30	5,960,158	0.125	745,020	0.0790	58,857
Other truck(hdgv)	6,783,031.20	8.00	847,879	0.125	105,985	0.0790	8,373
Bus/other				0.125			
Subtotal	279,578,851		16,329,131		2,041,141	0	161,250
Diesel fuel							
Car	2,654,230	30.00	88,474	0.139	12,298	0.081	996
Lt trck/psngr van	1,179,658	17.00	69,392	0.139	9,645	0.081	781
Other truck(HDDV)	11,501,662	5.00	2,300,332	0.139	319,746	0.081	25,899
Bus/other		4.90	-	0.139	-		-
Subtotal	15,335,549		2,458,198		341,690		27,677
Total	**294,914,400**	**15.70**	**18,787,330**	**0.127**	**2,382,831**	**1**	**188,927**

2005 CO2e Emissions from Vehicular Transportation in Springfield

	annual VMT	average MPG	total gallons	conversion factor	energy cnsmptn in million BTUs	Emiss Coeff	Tons CO2e
Annual VMT:	**330,485,430**						
Gasoline/gasohol		CCP ESTIMATES					
Car	210,188,733	19.70	10,669,479	0.125	1,333,685	0.0790	105,361
Lt trck/psngr van	95,510,289	14.30	6,679,041	0.125	834,880	0.0790	65,956
Other truck(hdgv)	7,601,164.89	8.00	950,146	0.125	118,768	0.0790	9,383
Bus/other				0.125			
Subtotal	313,300,188		18,298,666		2,287,333	0	180,699
Diesel fuel							

Car	2,974,369	30.00	99,146	0.139	13,781	0.081	1,116
Lt trck/psngr van	1,321,942	17.00	77,761	0.139	10,809	0.081	876
Other truck(HDDV)	12,888,932	5.00	2,577,786	0.139	358,312	0.081	29,023
Bus/other		4.90	-	0.139	-		-
Subtotal	17,185,242		2,754,693		382,902		31,015
Total	**330,485,430**	**15.70**	**21,053,359**	**0.127**	**2,670,236**	**1**	**211,714**

Vehicle Type	VMT %	Ave MPG	Conversion Factor	Conversion Factor
Gasoline car	63.3	19.7	0.125 MMBtu/gallon	0.079 tons Co2/MMBtu
Gasoline light truck	28.9	14.3	0.125 MMBtu/gallon	0.079 tons Co2/MMBtu
Gasoline other truck	2.3	8.0	0.125 MMBtu/gallon	0.079 tons Co2/MMBtu
Diesel car	0.9	30.0	0.139 MMBtu/gallon	0.081 tons Co2/MMBtu
Diesel light truck	0.4	17.0	0.139 MMBtu/gallon	0.081 tons Co2/MMBtu
Diesel heavy duty	3.9	5.0	0.139 MMBtu/gallon	0.081 tons Co2/MMBtu

This approach resulted in a figure of 188,927 metric tons CO2e for 1990 and for 211,714 metric tons CO2e for 2005.

In comparison, the Mobile6 Air Emissions Model approach described above calculated 190,530 metric tons CO2e for 1990, and 199,290 metric tons/year for 2005. For the purposes of this inventory the ICLEI numbers were used.