King County Government

Greenhouse Gases & Traditional Pollutant Emissions Inventory–Year 2000

FULL REPORT

May 2002

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INTRODUCTION

Climate change is one of the most significant challenges of the 21st century – economically, socially, and ecologically. It results from significantly increased concentrations of heat-trapping, "greenhouse" gases, which are released when humans burn fossil fuels to generate electricity, power vehicles and dispose of waste. The predicted impacts of climate change in the Pacific Northwest are dramatic: reduced snow pack, winter flooding, modified ecosystems, increased air pollution, rising sea levels and increased potential for disease – all within a few decades. Though greenhouse gases are not currently regulated in the United States, policies that reduce their production often increase efficiency and save money in addition to reducing the human influence on climate.

Many of the activities that produce greenhouse gases (GHGs) are also sources of traditional pollutants. These pollutants are associated with decreased respiratory function – especially for children, the elderly and people with respiratory diseases such as asthma. In addition to being harmful to human health, traditional pollutants decrease visibility, impairing city views such as those of the Olympic and Cascade Mountains. Because of these impacts, traditional pollutants are a concern today, even when federal regulations are being met.

In recognition of these threats to human health and the environment, King County Executive Ron Sims, with the unanimous support of the King County Council[1], directed all County Departments to participate in an inventory of greenhouse gases and traditional pollutants that result from King County practices (hereafter referred to as the 2000 Inventory).[2] To that end, the *2000 Inventory,* prepared by the Department of Natural Resources and Parks, identifies sources of air emissions for which King County government is responsible.

This *2000 Inventory - Full Report* includes background material on climate change and air pollution, the inventory scope and purpose, descriptions of emission sources, a summary of the findings, recommendations for future inventories and an explanation of the next steps.

BACKGROUND

Climate Change and Greenhouse Gases

There is scientific agreement that humans have caused changes in the composition of the atmosphere. Human activities have increased the natural, background concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)—three important greenhouse gases—by roughly 31, 150, and 16 percent, respectively. According to the Intergovernmental Panel on Climate Change[3] (IPCC), the current concentrations for both CO_2 and CH_4 in the atmosphere have not been exceeded in at least the last 420,000 years—as far back as we can accurately measure their concentrations.

Human-induced changes in the atmosphere have already caused dramatic impacts to the world environment. For example, global sea level is rising, nearly all glaciers worldwide are shrinking, the ocean is warming significantly, Arctic sea ice is disappearing and a variety of plant and animal species are shifting from their accustomed habitats[4]. The scale and rate of these changes demonstrate the magnitude of the global experiment currently underway.

[1] King County Motion 11364

[2] Title: Clean Air Initiative Executive Policy and Procedure. Document Code No.: PHL 10-1(AEO).

[3] The Intergovernmental Panel on Climate Change(IPCC) was convened by the United Nations Environment Programme. The Panel is comprised of hundreds of scientists from dozens of countries. The information reflected here is summarized in their "Third Assessment" report, published in 2001.

[4] IPCC Third Assessment, Working Group I (Scientific Basis) and Working Group II (Impacts, Adaptation and Vulnerability).

Climate Change Impacts: What is Predicted Locally?

In the Pacific Northwest, a variety of impacts resulting from an altered climate are likely[5]. As mentioned above, sea level rise due to glacial melting and the warming of the ocean has been documented around the world and will continue to affect the shorelines of the Pacific Northwest for hundreds of years. A decrease in summer stream flow (due to reduced snow pack in the mountains during winter) is a very likely consequence and will put additional strain on water resources. There is a reasonable likelihood that significant water management issues will be raised due to a smaller amount of in-stream water. In contrast, flooding is expected to increase during winter because of warmer temperatures and more rapid snowmelt. Reduced snow pack during winter will also likely decrease the commercial viability of certain ski areas. Finally, air quality, fisheries, protection from infectious disease, ecosystem health and hydropower availability could all be significantly degraded.

King County, as one of the largest public service providers in the Pacific Northwest, will necessarily be affected by these changes. Local government activities such as solid waste handling, building construction and design, flood control and fisheries management will have to consider potential climate change impacts. When new structures are cited, for example, the County will need to consider a rising sea level and its effects on facility design and function.

Air Pollution – Ongoing Impacts

Traditional air pollutants, regulated under the federal Clean Air Act, are also a local concern. Though, in general, air quality has improved in recent decades, some pollutants continue to be a challenge as the Puget Sound faces population growth, urban sprawl and significant increases in vehicle travel. Traditional air pollutants are associated with decreased respiratory health – especially for children, the elderly and people with respiratory problems such as asthma, allergies, and emphysema. Because of these impacts, traditional pollutants are a concern today, even when federal standards are being met for the Puget Sound as a whole. In addition, the pollutants have at least three important relationships to GHGs:

1. **Many of the same human activities that contribute to climate change via increases in greenhouse gases also cause local air quality problems.**
2. **Higher summer temperatures resulting from climate change will likely increase ground-level ozone and smog.**
3. **Certain traditional pollutants modify or enhance the effective warming of greenhouse gases through chemical and physical interactions.**

INVENTORY PURPOSE

Why do an Air Emissions Inventory?

Inventories establish a baseline from which to measure progress. The purpose of most corporate or governmental inventories is to manage risk and for compliance with existing or anticipated regulation. In recent years, over 30 state governments, 100 local governments and several major corporations operating in the U.S. (e.g., LaFarge, DuPont, BP-Amoco, Ford, Boeing and Shell) have voluntarily inventoried their greenhouse gas emissions in order to:

- **Save money by highlighting opportunities for efficiency**
- **Participate in emission trading programs**
- **Identify "co-benefits," such as reducing regulated pollutants that form smog and harm human health**
- **Demonstrate environmental stewardship and social responsibility**

Local governments have been particularly active in conducting GHG emission inventories. In fact, one non-profit group, the International Council for Local Environmental Initiatives (ICLEI), has worked, worldwide, with 500 local governments to conduct inventories and set achievable reduction targets. More than 100 participants are from the United States, including New York, Los Angeles, Miami-Dade County, and Chicago as well as an active Northwest contingent of Seattle, Portland, Multnomah County, Spokane, Olympia and Burien.

[5] The local impacts listed in this section are found in the University of Washington Climate Impact Group's Regional Assessment: *An Integrated Assessment of the Impacts of Climate Variability and Climate Change on the U.S. Pacific Northwest.* http://tao.atmos.washington.edu/PNWimpacts/

King County joined ICLEI's "Cities for Climate Protection Campaign" in January 2002 via King County Council Motion 11364. All cities and counties participating in this Campaign commit to undertake and complete an emissions inventory, set a reduction target, develop an action plan, implement policies and measures to reduce those emissions, and monitor and verify results. The emissions inventory is the first milestone from which all subsequent actions are measured. The level of detail in scope and method vary depending on the resources of the participating government. King County's *2000 Inventory* represents a relatively detailed inventory because it considers both air pollutants and greenhouse gases and because it employs locally-derived data, when possible, to enhance accuracy. Using local, facility-specific information also allows for emission reduction targets and associated policies to be tied directly to the source.

ICLEI has placed emphasis on local government participation in inventories because cities and counties constitute a significant source of GHG emissions and thus, an important opportunity for emission reductions. Counties and cities also build roads, handle solid waste, and influence development patterns – all of which produce both GHGs and traditional air pollutants either directly or indirectly. At the same time, local governments provide transportation alternatives, energy efficiency programs, recycling opportunities, and other GHG *reduction* opportunities. ICLEI estimates that local governments participating in the U.S. campaign have an influence over about 17% of the nation's GHG emissions.

INVENTORY SCOPE

Time Interval and the 2000 Baseline

The 2000 Inventory considers emissions that occurred during calendar year 2000. The year 2000 was chosen based on the availability of data and the desire for as accurate a baseline as possible. Over time it will be useful to update this information in order to measure progress. Careful consideration should, however, be given to future comparisons against the 2000 baseline. For example, if the County were to sell a facility that is included in the 2000 data, the baseline would need to be appropriately adjusted for that change in order to avoid counting a divestiture as an actual emission reduction.

Methodology

Methods chosen for the 2000 Inventory are generally consistent with EPA and Intergovernmental Panel on Climate Change guidelines. DNRP staff worked with Puget Sound Clean Air Agency staff to identify appropriate methods, taking into consideration the nature and intent of the 2000 Inventory. For example, the 2000 Inventory applies locally specific data, where available, in the EPA/IPCC methods rather than using national or state averages. Please refer to the Technical Appendix for more detail on the methods for each emission source category.

Gases and Pollutants: What types of emissions are included?

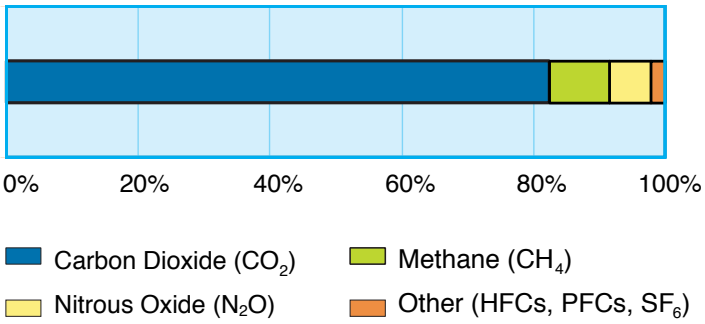
The *2000 Inventory* includes emission estimates for both greenhouse gases (GHGs) and traditional pollutants. Inventorying traditional pollutants and GHGs simultaneously ensures that reduction strategies provide "co-benefits" wherever possible to address both climate change and health-related impacts. The following gases and pollutants are included in the *2000 Inventory*[6].

Greenhouse Gases:

- Carbon Dioxide (CO_2) is released when fossil fuels (e.g., oil, coal and natural gas) or other organic materials are burned or are naturally degraded. It is not directly harmful to human health, but constitutes 82% (weighted for global warming potential, as defined below) of all human-caused U.S. GHG emissions, which contribute to climate change.
- Methane (CH_4) is produced through anaerobic (without oxygen) decomposition of organic waste in landfills and wastewater treatment plants, animal digestion, and natural gas, coal, and oil production. Methane accounts for 9% (weighted for global warming potential) of all human-caused U.S. GHG emissions.
- Nitrous Oxide (N_2O) occurs as a byproduct of fossil-fuel combustion and can also be released directly from soils. It is a potent, long-lived GHG that accounts for 6% (weighted for global warming potential) of U.S. GHG emissions.

[6] Statistics in this section and data for figure 1 were obtained from the U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gases and Sinks (1990-1999), 2001.

FIGURE 1: US Greenhouse Emissions by Gas
(weighted for "global warming potential")



The greenhouse gases (GHGs) listed above were selected for the *2000 Inventory* based on their relative abundance; together CO2, CH_4 and N_2O make up about 98%[7] of all GHGs emitted in the U.S.[8] in terms of their relative **global warming potential**. The global warming potential refers to the ability of a gas to absorb heat in the atmosphere relative to another gas over a particular time horizon[9]. For example, methane is 23 times more potent, by weight, than CO_2 in its ability to trap heat in the atmosphere. N_2O is roughly 300 times more potent than CO_2. Therefore, estimates of greenhouse gas emissions are most often presented in common units (metric tons of carbon equivalent) that take into consideration this warming potential in order to have an "apples to apples" comparison between different gases.

In contrast to traditional pollutants, the U.S. EPA does not currently regulate greenhouse gases. However, in 1998, the U.S. signed the Kyoto Protocol, which committed signatories to reducing greenhouse gas emissions according to country-specific targets. This international agreement calls for 38 industrialized nations to limit greenhouse gas emissions by an average of 7 percent below 1990 levels by 2012. In 1997, the U.S. Senate strongly opposed domestic emissions limitations associated with this agreement and, as of May 2002, the current administration has called for voluntary measures to meet GHG emission reduction targets. In the absence of federal leadership on greenhouse gas policy, many corporations as well as state and local governments have begun to actively limit their emissions, for the reasons previously described.

Traditional Pollutants:

Four traditional pollutants were selected for the 2000 Inventory specifically because of local health concerns or their potential to contribute to violations of federal air quality standards in the Puget Sound region.

- Nitrogen Oxides (NO_x) is a general term incorporating both nitric oxide (NO) and nitrogen dioxide (NO_2). Nitrogen oxides are typically created during combustion processes, and are major contributors to ozone formation and acid rain. NO_2 is a regulated air pollutant under the Clean Air Act and is formed from the oxidation of NO.
- Volatile Organic Compounds (VOCs) are evaporative, carbon-containing compounds, some of which are carcinogens. VOCs contribute to ozone formation and often have an odor. Sources include gasoline, alcohol, and the solvents used in paints.
- Particulate Matter (both $PM_{2.5}$ and PM_{10}) includes any material, except pure water, that exists in the solid or liquid state in the atmosphere. The size of particulate matter can vary from coarse, wind-blown dust particles (e.g., PM_{10}) to fine particles resulting from combustion (e.g., $PM_{2.5}$). All particulates contribute to reduced visibility, but fine particles have been shown to be more directly linked to respiratory problems.
- Sulfur Oxides (SOx) are pungent, colorless gases formed primarily by the combustion of sulfur-containing fossil fuels, especially coal and oil. SOx contribute to acid rain and may impact human health and vegetation. SO_2 is a regulated pollutant under the Clean Air Act.

[7] The few remaining GHGs (or those that make up 2% of total U.S. GHG emissions) are not included in this inventory because they are generated primarily through industrial activities that the County does not operate or control and because they are very difficult to inventory. Some example sources of these other GHGs include aluminum production, semiconductor manufacturing, electricity transmission and distribution and magnesium production and processing.

[8] For context, the U.S. has the highest total greenhouse gas emissions of any nation.

[9] A 100-year time horizon is typically used.

A total of six health-related primary pollutants are regulated under the 1970 Federal Clean Air Act and subsequent amendments. These "dirty six" (Lead, Particulate Matter, Ozone, Carbon Monoxide, Sulfur Dioxide and Nitrogen Dioxide) are caused by human activity and can injure health, harm the environment, cause property damage and reduce visibility. From these six, the *2000 Inventory* selected the four above based upon data availability and the relative contribution of King County government to regional emissions. The U.S. Environmental Protection Agency (EPA) has regulated these pollutants largely by developing health-based criteria as the basis for setting permissible levels. A geographic area that meets or does better than the standard is called an **attainment area**; areas that do not meet the standard are called **non-attainment** areas. The EPA, through state and local air agencies, has been very successful in limiting emissions from large point sources[10]. Smaller stationary sources and non-point sources, such as vehicles, continue to significantly impair local air quality because these sources are more difficult to quantify and regulate.

Currently, the Puget Sound Region is in attainment for all six regulated pollutants, though it is close to violating standards set for ozone. In July 1998, federal ozone standards were exceeded in the Puget Sound airshed. The Region would be in non-attainment under the Clean Air Act if it exceeded ozone standards regularly over three consecutive years. Consequences of non-attainment can include increased regulatory oversight and the loss of access to federal transportation funding.

NOx and VOCs play an essential role in the photochemical reactions that produce ground-level ozone, a regulated pollutant with health impacts and also a greenhouse gas. Because ozone is formed by other pollutants and not directly emitted, to reduce ozone is to reduce the ozone-forming pollutants NOx and VOCs. As shown schematically in Figure 2, to the right, NOx and VOCs (unburned hydrocarbons) undergo complex chemical reactions in the presence of sunlight to form ozone. Winds are able to shift ozone and other pollutants from urban areas and the highest concentrations are often found significantly downwind.

OZONE: GOOD OR BAD?

Readers may have heard of the "ozone hole." Generally speaking, ozone is beneficial in some parts of the atmosphere and harmful in others. In the upper atmosphere (stratosphere), ozone protects life on Earth from harmful UV rays. International programs, of which the US is part, have done a great deal to limit chemicals that remove stratospheric ozone. In the lower atmosphere, ozone is formed by other pollutants (NOx and VOCs) and causes numerous adverse health effects and is regulated under the Clean Air Act.

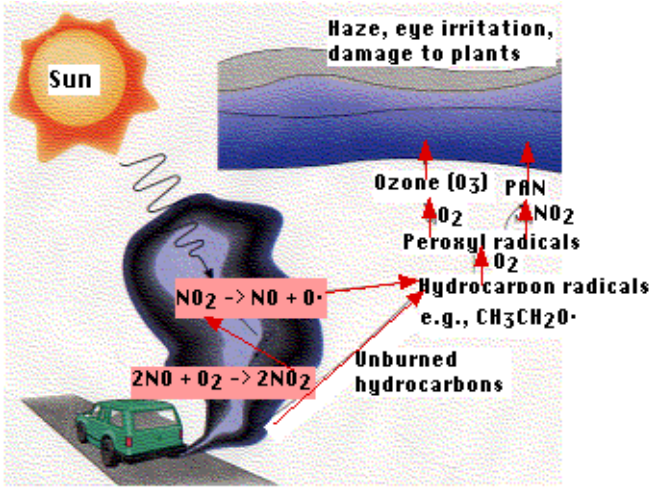


FIGURE 2: Schematic of Ozone Formation from NOx and VOCs[11]

[10] As a mechanism to enforce the Clean Air Act, Congress passed an amendment in 1990 that requires large sources (also called "point" sources) to obtain a permit for operations. King County currently submits point source reports to meet EPA requirements through the Puget Sound Clean Air Agency for three facilities: Cedar Hills Landfill, South Treatment Plant, and Westpoint Treatment Plant.

[11] See Dr. John Kimball's Biology web page at: http://www.ultranet.com/~jkimball/BiologyPages/A/AirPollution.html.

Coarse particulate matter (PM, with a diameter of less than or equal to 10 micrometers or about 1/8 the diameter of human hair) encompasses the majority of airborne particles that impair visibility and create harmful effects in the respiratory system. Research shows that fine particulates ($PM_{2.5,}$ or particles smaller than 2.5 micrometers) may be more directly linked to health concerns because these particles can penetrate deeper into the respiratory tract. The 2000 Inventory includes Particulate Matter along with VOCs as useful substitutes for a full toxics inventory (which would otherwise include dozens of pollutants) and as an indication of King County's relative impact on community health and the environment.

SOx are included in the *2000 Inventory* because the EPA regulates them and because data were readily available to estimate their emissions. Currently, however, SOx are not a primary concern in the Puget Sound region.

Defining the Boundaries: What emission sources are included?

The *2000 Inventory* focuses on sources that are under the control of King County *government* – operations, maintenance, and to the extent possible, purchases and contracts for all County departments[12]. This distinction is important in consideration of other inventories that are based on *geography*, such as Washington State's GHG Inventory or EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks. Geography or community-based inventories are "top-down" in their approach. In other words, they are reliant upon per capita averaging or statistics such as fuel imports, which do not present individual governments or corporations with specific information about their own practices. A "bottom-up" or "corporate" model allows an entity to make decisions about those emissions that result from its own operations.

In response to a growing interest on the part of companies to manage their GHG risk and participate in future emission-trading markets, the World Resources Institute developed the first edition of uniform accounting and reporting standards for GHG emission inventories, titled the "GHG Protocol". The standards aid corporations and government agencies in defining both *responsibility for* and relative *influence over* emission sources. The *2000 Inventory* takes advantage of this newly published and broadly accepted reporting standard and thus, considers the three categories of emissions for which the County is responsible, with special emphasis on the first and second:

- Scope 1: Direct emissions. **Direct** emissions include emissions from sources that are owned, operated or controlled by King County (e.g., Metro bus fleet, Cedar Hills landfill, wastewater treatment plants).
- Scope 2: Emissions from purchases of energy. These are **indirect** or "upstream" emissions that are the consequence of King County activities, but occur from sources controlled or owned by another entity, in this case an electric utility or other energy provider[13]. For example, though King County uses electricity to light office buildings, the resulting emissions do not occur on-site. Instead, they occur from processes inherent in the generation and transmission of electricity, controlled by the energy provider.
- Scope 3: Other indirect emissions. In addition to purchases of electricity, there are other **indirect** sources that are a consequence of County activities, such as emissions associated with employee commute and contracted work.

It is important to note that although the *2000 Inventory* focuses on King County "corporate" direct and indirect emissions, strategies and programs that the County undertakes to limit air emissions would likely have benefits beyond the corporate boundaries and, in fact, could significantly contribute to reducing *county-wide* emissions. For example, a County program to promote home composting not only reduces methane emissions at the County-owned landfill, but also avoids emissions from truck traffic needed to haul away yard debris and conserves energy needed to run large-scale compost processing equipment. Reduction strategies, such as these, are not included in the *2000 Inventory*, but will be developed as part of a County "action plan". For further details, please see "Next Steps" in the last section of this report.

[12] Though the 2000 Inventory focuses on County departments, there are some categories of emissions that also include Public Health – Seattle and King County. Where County departments are responsible for activities such as janitorial work or fleet maintenance, for example, emissions at Public Health facilities are included. The 2000 Inventory should not, however, be considered representative of all Public Health activities.

[13] The GHG Protocol notes that the emissions associated with the generation of imported energy are a special case of indirect emissions because, for many companies, electricity usage represents one of the most significant opportunities to reduce GHG emissions. Therefore, electricity (and other sources of purchased energy) is considered under a separate scope than other indirect emissions.

Double Counting and Indirect Emissions

A concern with including indirect emissions is that it leads to double counting – i.e. two different entities include the same emissions in their respective inventories. Take, for example, a case where a law firm includes the emissions that occur at a paper mill as its own direct emissions even though that firm only *purchases* paper products. Should the paper company also conduct its own emissions inventory, those manufacturing emissions would be double counted. To avoid this problem, some would suggest that strict boundaries be drawn around corporate and governmental entities to include only direct sources.

The limitation of this approach is that it does not begin to reflect the full scope of influence that an entity has. For example, purchasing policies alone can do a great deal to influence both greenhouse gas and traditional pollutant emissions. Further, reducing indirect emissions can represent the most significant money savings and environmental benefits. In the example of King County, if only direct emissions were included in the 2000 Inventory, millions of dollars in electricity purchases would be excluded and therefore the opportunity to identify and measure potential GHG reductions (and the potential for corresponding cost savings) would be lost.

Though double counting is not as important in voluntary reporting such as the 2000 Inventory, every attempt has been made to differentiate between direct and indirect emissions. In future years when GHG emissions are regulated and commonly traded in the marketplace, it is likely that this "corporate" model would be required – with careful delineation between direct and indirect sources – in order to attribute emissions to the responsible party and to avoid two companies claiming the same reduction. The 2000 Inventory begins to prepare King County for this type of accounting model, while helping decision makers understand the County's relative influence over emissions.

What is Excluded?

Due to lack of available data, some sources of emissions are not included in the *2000 Inventory*. Notable examples include:

- Employee air travel for County business;
- The wastewater collection system;
- Carbon sinks (forests) owned by the County;
- County roads (particulate matter emissions);
- Various contracted equipment;
- Various purchases (that contribute upstream, or indirect emissions);
- Other potential sources – particularly indirect sources, which are nearly infinite; and
- Activities that affect community-wide emissions, such as land-use planning

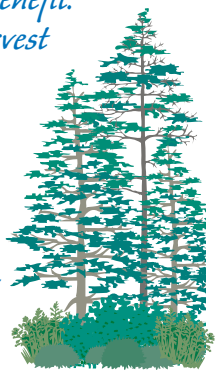
Therefore, the *2000 Inventory* must be considered an estimate and a "snapshot" in time that will likely need updating as new emission sources are discovered, new data become available or new questions relative to these emissions surface.

2000 Inventory in Context

In a few select cases, the *2000 Inventory* contains information about planned projects, called "Looking Ahead." These examples are intended to provide context to the emissions inventory and are not intended to project any actual emissions. Setting targets and revising the *2000 Inventory* are discussed in the "Next Steps" portion of the report.

WHAT ABOUT TREES?

Once emissions of greenhouse gases occur, the only way to "reverse" those releases is to increase absorption of carbon in terrestrial, oceanic, or freshwater ecosystems that store carbon. For example, trees are a carbon "sink," as they absorb carbon dioxide during photosynthesis and use it to construct roots, trunk, stems, and foliage. As trees age, they continue to accumulate carbon until they reach maturity, at which point they are relatively constant carbon stores. With sustainable forest management practices and reforestation, trees can provide a sizable carbon sequestration benefit. Conversely, deforestation, shortened harvest rotations, and unsound forest practices effectively increase GHGs. The 2000 Inventory focuses on emission sources and does not calculate the emission benefit of trees on County property. Further evaluation of carbon sequestration will be part of the County's "action plan" (see Next Steps).



SUMMARY OF FINDINGS

Explanation

The *2000 Inventory* does not include every direct and indirect source of emissions, nor does it quantify the benefits of many emission reduction efforts that the County has already made. Rather, the *2000 Inventory* is a "snapshot" for calendar year 2000, intended to provide general insight into the types of County activities that produce emissions, with sufficient detail to establish the needed baseline. A few examples of note-worthy efficiencies planned or taken in recent years are included in the accompanying sections. The reduction targets and subsequent action plan (discussed in the Next Steps section) will necessarily take into consideration these efforts and others when determining where the County can make the most significant improvements in the future.

TABLE 1: Summary of *2000 Inventory* – Direct Emissions

		Greenhouse Gases (MTCE) [a]	Traditional Pollutants (tons)				
			NOx	VOC	PM10	PM2.5	SOx
Direct Emissions	Municipal Solid Waste[b]						
	Cedar Hills Landfill	88,821	83.4	4.7	0.0	0.0	16.4
	Closed Landfills	13,371	1.2	0.0	0.0	0.0	0.2
	Mobile Sources						
	Metro Buses	26,310	802.1	55.0	31.0	27.6	20.4
	County Fleet - (gas and diesel)	7,560	107.4	49.7	3.3	2.8	4.0
	Lawn and Garden	included in Misc. Fuel	0.7	262.1	2.5	2.5	0.0
	Miscellaneous Fuel Use	625	13.3	6.2	0.4	0.4	0.5
	Employee Auto Use for County Business	236	2.5	3.3	0.1	0.0	0.2
	Municipal Wastewater Treatment						
	Renton Treatment Plant [c]	3,624	0.9	43.9	4.1	n/a	0.1
	Westpoint Treatment Plant	7,885	115.1	10.0	1.2	n/a	4.8
	Vashon Treatment Plant	52	0.0	0.5	0.0	0.0	0.0
	Biosolids[d]	872	0.0	0.0	0.0	0.0	0.0
	Area Sources (Evaporative Emissions)						
	Paint (Interior/Exterior)	0	0.0	48.1	0.0	0.0	0.0
	Traffic Paint	0	0.0	33.9	0.0	0.0	0.0
	Cleaners	0	0.0	11.9	0.0	0.0	0.0
	Auto Products and Misc. Solvents	0	0.0	2.0	0.0	0.0	0.0
	Road Paving/Repair materials	0	0.0	20.1	0.0	0.0	0.0
	Pesticides	0	0.0	0.3	0.0	0.0	0.0
	On-site Energy [e]						
	Propane	179	0.9	0.0	0.0	0.0	0.0
	Natural Gas	3,579	11.4	0.7	0.9	0.9	0.1
	Total - Direct Emissions	153,111	1,139.0	552.2	43.5	[f]	46.7

a. Metric Tons Carbon Equivalent is a common unit for expressing values of greenhouse gases. For reference to other emissions inventories, 1 MTCE is equivalent to 3.66 Metric Tons Carbon Dioxide Equivalent.

b. There are two different methods for calculating greenhouse gas emissions from landfills. The value reported in the table includes carbon dioxide and methane, whereas some methods only consider methane emissions. For this latter method the total greenhouse gas emissions from Cedar Hills and closed landfills are 31,570 and 11,545 respectively.

c. The South Plant does not burn digester gas on-site; rather it "scrubs" the waste gas and sells it to Puget Sound Energy. Conversely, the Westpoint Treatment Plant burns waste gas in an on-site co-generation unit for its energy needs. Therefore, the estimated *direct* greenhouse gas and NOx emissions appear much smaller for the South Plant, however, it should be noted that "downstream" emissions do occur from Puget Sound Energy's use of this gas for electricity generation. Please see the section on Municipal Wastewater Treatment in this report.

d. Expressed value does not include the potential of biosolids to contribute to sequestration of carbon dioxide (a greenhouse gas). A preliminary and conservative estimate by King County Inventory staff for the marginal sequestration benefit of biosolids application on forest lands is roughly 6,000 MTCE. As of May 2002, a study at the University of Washington is in progress to determine the actual emission reduction benefit.

e. These energy sources produce on-site emissions (direct) whereas the energy purchases through Puget Sound Energy, Seattle City Light and Seattle Steam produce indirect emissions. For emissions by electricity source (coal, natural gas, etc) please see Energy Purchases section of this report.

f. Methods for estimating $PM_{2.5}$ emissions from certain sources were not available at the time of the 2000 Inventory. Because of the missing data, it is inappropriate to total $PM_{2.5}$ emissions across all sources.

TABLE 2: Summary of *2000 Inventory* – Indirect Emissions

		Greenhouse Gases (MTCE)	Traditional Pollutants (tons)				
			NOx	VOC	PM10	PM2.5	SOx
Indirect Emissions	Energy Purchases						
	Electricity (Seattle City Light)	1,753	33.3	0.3	1.6	n/a	36.2
	Electricity (Puget Sound Energy)	10,685	74.1	1.7	5.7	n/a	93.8
	Steam (Seattle Steam)	945	3.0	0.2	0.2	0.2	0.0
	Total - Energy Purchases	13,383	110.4	2.2	7.5		130.0
	Mobile Sources						
	Employee Commute	6,164	105.1	105.2	2.6	n/a	5.6
	Lawn and Garden	n/a	0.4	14.0	0.1	0.1	0.0
	Heavy Equipment	396	16.9	1.5	0.6	0.5	0.4
	Municipal Solid Waste						
	Employee Waste [g]	153	0.2	0.0	0.0	0.0	0.0
	Area Sources						
	Road Paving/Repair materials	0	0.0	117.4	0.0	0.0	0.0
	Pesticides	0	0.0	0.1	0.0	0.0	0.0
	Cleaners	0	0.0	3.4	0.0	0.0	0.0
	Paint	0	(included in direct sources, listed above)				
	Total - Other Indirect Emissions	6,713	122.6	241.5	3.3	[h]	6.1

g. The estimate considers waste for the King Street Center and Transit Division, only. Please see the section on Employee Waste for more information about how emissions are avoided through work-site recycling and reduction efforts. For example, for King St. Center and Transit Division alone, it is calculated that approximately 1,074 metric tons carbon equivalent are avoided for the life-cycle of the recycled product.

h. As described in footnote f on the previous page, it is inappropriate to sum $PM_{2.5}$ emissions due to missing values for certain sources.

King County Government vs. Community-wide Emissions

As shown in Figures 3a and 3b, King County represents a small share of community-wide emissions. It is important to consider, however, that the total King County community-wide emissions consider *all* of the emissions from the 1.7 million citizens and the private entities within the county geographic boundaries (e.g., aircraft, automobiles, industry, etc.). Taking this perspective, King County, as a provider of major regional services, is very likely to be one of the largest single "corporate" entities contributing to emissions in the Puget Sound region.

FIGURE 3a: King County Government Relative Contribution of Traditional Pollutants to Community-wide Emissions

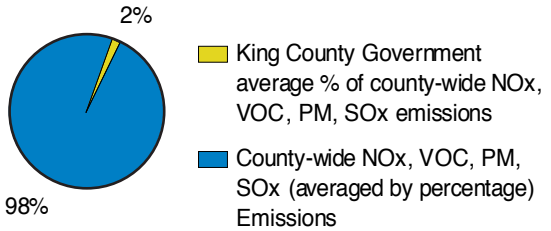
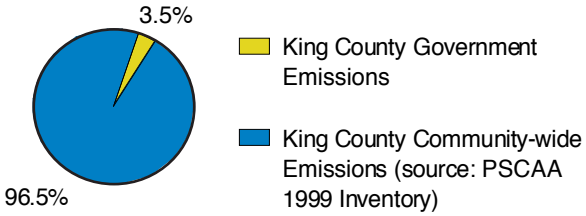


FIGURE 3b: King County Government Relative Contribution of Greenhouse Gases to Community-wide Emissions



DIRECT EMISSIONS – DESCRIPTION OF SOURCES

Municipal Solid Waste

Source Description: In landfills, methane (CH_4) and carbon dioxide (CO_2) are produced from decomposition of organic matter[14]. Methane occurs primarily during anaerobic (without oxygen) decomposition while CO_2 is usually a product of aerobic (with oxygen) decomposition. Nationwide, landfills constitute the largest source of anthropogenic (human-caused) emissions of methane[15]. Figure 4, below, reflects emissions in two distinct ways; total greenhouse gas (GHG) emissions (CO_2 and CH_4) versus CH_4 only. The two numbers reflect two different methodologies in deriving estimates from solid waste management[16]. Please see the *Technical Appendix* of this report for more information on this topic.

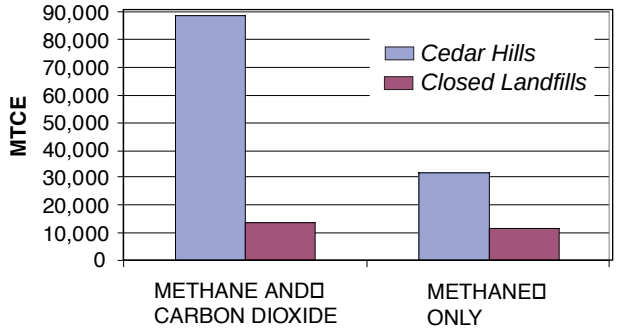
Nitrogen oxide (NOx), particulate matter (PM) and sulfur oxide (SOx) emissions result primarily from the combustion of landfill gas. Volatile organic compounds (VOC) are released from landfills due to decomposition and evaporation of particular compounds placed in the landfill.

Cedar Hills Landfill. In 2000, the Cedar Hills Landfill, owned and operated by King County, handled 100% of the mixed solid waste generated in the county, except that portion generated within Seattle. An estimated 90% of generated landfill gas[17] (comprised of roughly sixty percent methane and forty percent carbon dioxide) was captured and burned in a high-temperature flare. This gas collection system converted virtually all of the methane at the site to CO_2, a less potent GHG. This represents a significant avoidance of equivalent GHG emissions at Cedar Hills. Without this flaring, the GHG produced at Cedar Hills would be approximately 5 times as much.

LOOKING AHEAD: WASTE GAS-TO-ENERGY PROJECT

The Solid Waste Division has planned an additional improvement at Cedar Hills Landfill that would constitute a significant avoidance in community-wide emissions. Instead of flaring the waste gas, the project will capture the methane and burn it to produce energy. This gas-to-energy project will produce between 22 and 26 megawatts, making it one of the largest of its kind in the nation. The power produced by this project will displace other emissions associated with electricity generation to meet increased electrical demand. Using an average power output and assuming the plant is on-line 90% of the time, this project could produce roughly 190,000 MWh of electricity per year (83% of King County government's total 2000 electricity consumption). If the same amount of power is purchased from the grid, it results in roughly 34,000 MTCE of greenhouse gas emissions.

FIGURE 4: Two Methods for Estimating Greenhouse Gases at Cedar Hills Landfill



[14] See EPA's Emissions Inventory Improvement Program website for more complete description of this and all other source categories: http://www.epa.gov/ttn/chief/eiip/index.html.

[15] U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gases and Sinks (1990-1999), 2001.

[16] Both numbers are useful in context. The "methane and carbon dioxide" values shown in Figure 4 follow the "corporate model," in that all emissions that occur at the landfill site are considered. The "methane-only" method follows the example set by EPA and other geography-based models that do not consider CO_2. These models assert (correctly) that CO_2 in landfills results primarily from the decomposition of organic materials (e.g., food and yard waste). Because the growth and harvest of these materials in the U.S. is considered to be "carbon-neutral," it is assumed that the landfill emissions and growth uptake of carbon dioxide cancel out. That is – for a large geographic scale – photosynthesis (which removes CO_2 from the atmosphere) is equal to decomposition (which adds CO_2 to the atmosphere). The limitation of this latter approach, for King County, is that the photosynthesis that is assumed in the model is not within the County's direct control (e.g., the County is not in the forestry or agricultural industries) and so cannot claim this "removal credit" against the landfill source.

[17] Note that this value is a critical assumption for estimating emissions from landfill facilities. Obtaining a reliable, scientifically-based estimate of this parameter could be a dramatic improvement to the next inventory process. The 90% capture efficiency is based on a conservative estimate for the uncertainty associated with methane emissions, obtained from http://www.aeat.co.uk/netcen/airqual/naei/ipcc/uncertainty/.

Closed Landfills. In 2000, the Solid Waste Division maintained custodial responsibilities for 10 landfills located throughout King County. These landfills include the Hobart, Enumclaw, Cedar Falls, Duvall, Houghton, Puyallup/Kit Corner, Bow Lake, Corliss, Vashon, and South Park landfills. The closed landfills vary in age and in-place management systems. In 2000, some had sophisticated gas collection systems and some did not, while two (Enumclaw and Hobart) collected and flared the landfill gas.

TABLE 3: Greenhouse Gas Emissions from Closed Landfills

Closed Landfill	Methane & Carbon Dioxide (MTCE)	Methane Only (MTCE)	Year Closed (est.)
Bow Lake	158	144	1965
Cedar Falls	1,459	1,325	1985
Corliss	157	143	1965
Duvall	1,176	1,068	1978
Enumclaw	1,016	718	1993
Hobart	1,684	1,131	1993
Houghton	2,096	1,905	1965
Puyallup	694	630	1965
South Park	2,098	1,906	1988
Vashon	2,833	2,574	1999
TOTAL	**13,371**	**11,545**	

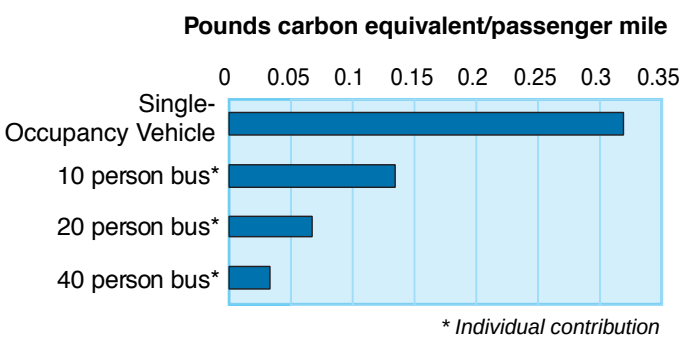
Mobile Sources

Source Description: EPA classifies planes, trains, automobiles, and other types of on and off-road equipment together as "mobile sources." Mobile sources are a major challenge in the Puget Sound Region – not only in terms of traffic, but also in protecting air quality and climate. In a typical year[18], they are responsible for over 60% of GHG emissions, over 40% of VOC and Particulate Matter (PM_{10}) emissions, 70% of SOx emissions and 85% of NOx emissions for the Puget Sound Region (King, Snohomish, Pierce, Kitsap). The GHGs and traditional pollutants result from the burning of fossil fuels (diesel and gasoline). Levels of traditional pollutant emissions vary depending on the age of the equipment or vehicle, with newer models generally employing improved emissions control technology. Greenhouse gas emissions depend on the fuel economy of the vehicle or equipment.

Metro Buses. In 2000, King County served an annual ridership of about 100 million within a 2,134 square mile area with a fleet of about 1,300 buses – including standard and articulated coaches, electric trolleys, vans and dual-powered (electric and diesel fuel) buses. With 8% of Metro miles traveled powered by electricity, GHG and traditional pollutants were less than what would be expected for a typical diesel bus fleet. For context, if all the electric buses and trolleys were heavy-duty diesel versus dual-powered or electric trolley buses, the GHG emissions would be about 2,300 MTCE higher. The bus fleet is a significant portion of the County's direct emissions, but it is necessary to consider the indirect, or *community-wide* emission *reductions* that are possible with reliable and frequent bus service. That is, emissions from the private vehicle sector are significantly reduced when citizens choose public transportation over single occupant vehicle trips, even more so if that mode of transportation uses renewable energy (e.g., hydropower-fueled electric trolley buses), cleaner fuels (e.g., ultra-low sulfur diesel) or hybrid engine technology. Figure 5, on the next page, shows the relative benefit from riding an average bus in the current fleet versus using a private vehicle for the same distance. The more passengers on the bus, the greater the greenhouse gas (and, by analogy, traditional pollutant) savings per passenger.

LOOKING AHEAD: CLEAN DIESEL PROGRAM. King County began purchasing ultra-low sulfur diesel fuel in 2001. This shift in fuel use, together with better emission control technologies will greatly reduce emissions of particulate matter. This reduction contributes to greater visibility and improved community health. Emission reductions will be realized as the cleaner fuel is phased in and will be included in a future update of the 2000 Inventory.

FIGURE 5: GHG Emissions: Bus vs. Car

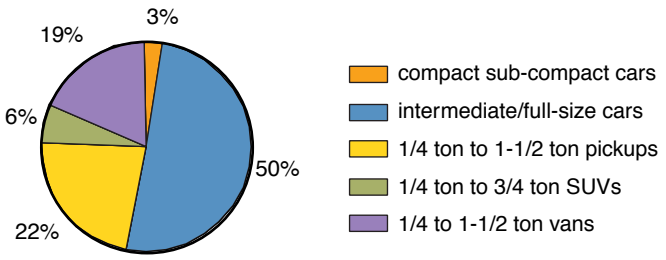


[18] Based on Puget Sound Clean Air Agency 1998 Traditional Pollutant Inventory and 1999 Summary of GHG Emissions.

LOOKING AHEAD: HYBRID BUS TESTING

In 2002, King County became the first in the nation to test an articulated electric hybrid bus. Two hundred aging buses will be considered for replacement by the hybrid model, which would decrease fuel consumption by 40% and drastically reduce traditional pollutant and GHG emissions.

FIGURE 6: King County DOT Vehicles
(total = 2,250)



LOOKING AHEAD: GREENING THE FLEET

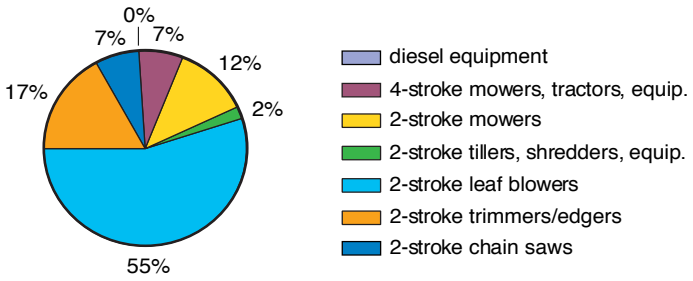
Beginning in 2001, King County has purchased 38 Toyota Prius Hybrid vehicles and will add 20 more in 2002 as part of its vehicle replacement program. Hybrid electric vehicles combine the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle – attaining more than twice the fuel economy of conventional vehicles and thus greatly reducing GHGs and traditional pollutant emissions per mile, relative to the average fleet vehicle.

County Fleet. In 2001, King County operated 2,725 vehicles and other pieces of equipment in the DOT Motor Pool (approximately 2,250 of which are cars, trucks, vans or SUV's). See Figure 6 for a description of these vehicles by type. There are approximately 460 pieces of equipment and vehicles related to Solid Waste operations (many of which are trailers or other non-emitting equipment). Trucks that transport biosolids and grit from the wastewater treatment plants traveled approximately 1.5 million miles in 2001. Some Public Health vehicles are maintained by King County Fleet Division and are included in the calculations and others are paid for and maintained within Public Health. The Sheriff's Department has a number of unmarked vehicles not maintained by the DOT. Over 2,000,000 miles were driven in compressed natural gas vehicles during 2000. These vehicles modestly reduce GHG emissions and drastically reduce traditional pollutant emissions compared to conventional-fueled fleet vehicles.

Lawn and Garden Equipment. Overall, King County-owned lawn and garden equipment, used to maintain facilities and parks, represents a relatively small source of greenhouse gases and most pollutants. However, each piece of equipment is a significant source of volatile organic compounds (VOCs), especially in comparison to an average fleet vehicle. For example, using one commercial chain saw—powered by a two-stroke engine—for two hours produces the same amount of VOC emissions as driving ten 1995 cars about 250 miles each[19]. The estimates for lawn and garden equipment consider the equipment owned and operated by various departments in the County in 2000, which includes mowers, edging equipment, tractors, shredders, blowers and chainsaws as well as other equipment.

At the time of the *2000 Inventory*, the most current emissions factors for this source category are derived from 1991 U.S. Environmental Protection Agency materials. As lawn and garden equipment has likely become cleaner and more efficient over time, it is likely that the emissions associated with this category are somewhat overestimated. Figure 7 gives a summary of the total emissions estimate for this King County equipment.

FIGURE 7: VOC Emissions from Lawn and Garden
(total = 262.1 tons)



[19] According to California Air Resources Board (CARB) outreach materials: http://www.arb.ca.gov/msprog/offroad/sm_en_fs.pdf

Miscellaneous Fuel Use. In 2000, King County purchased roughly 150,000 gallons of gasoline and 97,000 gallons of diesel for various on-site fueling needs at County facilities. The fuel was used in a variety of equipment including vehicles and mobile equipment such as lawn and garden tools, airport vehicles, generators, sheriff's department vehicles, public health vehicles and other on-site equipment.[20]

Employee Auto Use for County Business. In 2000, King County employees reported usage of over 1.6 million personal vehicle miles for County business. County-owned fleet vehicles traveled approximately 23.4 million miles. The estimates for this activity do not include airline trips for County business due to lack of available data.

Municipal Wastewater Treatment

Source Description: Disposal and treatment of municipal wastewater results in methane, carbon dioxide and traditional pollutant emissions[21]. As with solid waste, decomposition of organic material in anaerobic environments (without oxygen) results in primarily methane emissions while decomposition of organic material in aerobic environments (with oxygen) results primarily in CO_2 production. Depending on the technologies used to treat the waste, the amount of carbon dioxide and methane produced and emitted can be drastically influenced.

South Treatment Plant. The South Plant is part of King County's regional system that, together with the Westpoint Treatment Plant, treats wastewater for an estimated 1.3 million people in the Puget Sound region. In 2000, the South Plant captured digester gas, "scrubbed" it, and sold the treated gas (methane, the primary component of natural gas) to Puget Sound Energy. Because of this, direct emissions of greenhouse gases from digester gas – otherwise vented or flared – were practically eliminated. Traditional pollutants that result from flaring waste gas were also avoided. However, the South Plant had to purchase sizable amounts of electric power from Puget Sound Energy, which resulted in significant indirect emissions of both GHGs and traditional pollutants.

LOOKING AHEAD: FUEL CELL DEMONSTRATION
In March 2002, construction began on a fuel cell pilot project at the South Treatment Plant. The fuel cell system will use digester gas to generate power for the treatment plant. Ultimately, fuel cell systems at the South Treatment Plant could produce several megawatts of power—a large portion of the plant's electricity needs. This project will offset some energy purchases for King County, an indirect source of emissions. Fuel cells are also more efficient at converting fuel to energy than typical combustion sources and can dramatically reduce traditional pollutant emissions.

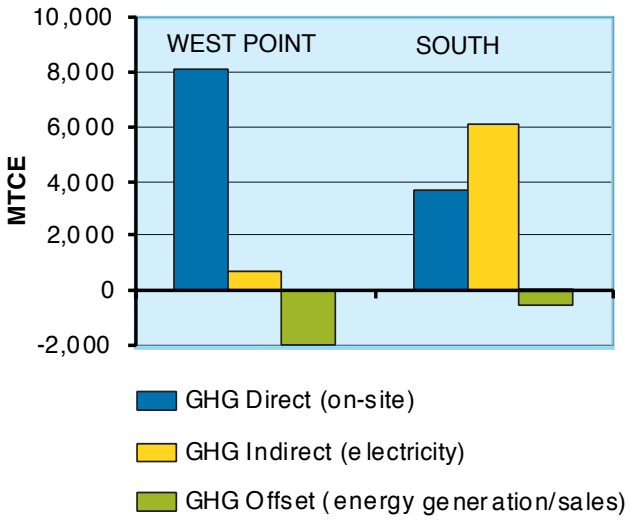
Westpoint Treatment Plant. The Westpoint plant is also part of King County's regional wastewater system. Like the South Treatment Plant, Westpoint captured digester gas (mostly methane) in 2000. At Westpoint, energy was produced on-site, employing a "co-generation" system that burned the methane to fuel turbines and boilers, producing electricity and heat that can both be used on-site. By using this process, Westpoint avoided indirect sources of emissions associated with energy purchases, but had on-site traditional pollutant and greenhouse gas emissions sources.

To consider the total impact of the treatment plants on emissions, it is sensible to consider not only the direct and indirect emissions, but also the offsets in emissions being realized due to the sales and generation of energy resources at the South and Westpoint Treatment Plants. Figure 8, on the next page, describes the emissions of greenhouse gases for the two plants considering all of these sources. It includes both the indirect emission *source* attributable to electricity purchases and the indirect *offsets* from the production or sale of on-site energy resources. The disparity in the indirect emissions from electricity purchases is explained by the fact that electricity purchased from Seattle City Light (e.g., Westpoint Treatment Plant) is much less "carbon intensive" than electricity purchased from Puget Sound Energy (e.g., South Treatment Plant).

[20] Because data were not always available on the precise end uses of bulk fuel, emissions were calculated assuming the fuel was used in average fleet vehicles.

[21] The *2000 Inventory* does not include emissions from the collection system, due to lack of available data. Other assumptions about fuel consumption relative to on-site generators are described in the Technical Appendix accompanying this report.

FIGURE 8: GHG's for West Point/South Plants (Direct, Indirect and Offsets)



Vashon Treatment Plant. In 1999, King County took responsibility for operation and maintenance of the Vashon Treatment Plant, which treats sewage from approximately 426 residential and commercial customers on Vashon Island.

Biosolids. Nitrous oxide (N_2O), a potent greenhouse gas, is produced naturally in soils through the linked microbial processes of nitrification and denitrification. The use of organic fertilizers, like biosolids, adds additional nitrogen to soils and results, via microbial and chemical pathways, in increased emissions of N_2O. King County's regional treatment plants produce biosolids that can be recycled as a fertilizer and soil amendment. In 2000, King County managed 134,000 wet tons of biosolids for application on forest and agricultural lands. It should also be noted, that as of May 2002, a study at the University of Washington is in progress to determine the carbon sequestration benefit of applying biosolids to forestlands. Biosolids application increases trees' growth rate, enhancing the sequestration of carbon. Updates to the *2000 Inventory* should include the increased sequestration benefit in order to conduct a complete analysis on emissions and offsets resulting from the application of this by-product of the wastewater treatment process.

Area Sources

Source Description: Area sources are typically small, numerous and, in most cases, not easily defined by location, in contrast with some of the large point sources previously described. Often, area sources are grouped in such a way that they can be estimated collectively using one methodology. In the *2000 Inventory*, the area sources included may also be described as "non-point" or "evaporative" sources. The primary concern with these sources is volatile organic compound (VOC) emissions, which contribute to ozone formation.

The following section is limited by available data and scale-appropriate methodology. Many methods currently available employ per capita averaging which is not applicable for a "corporate" inventory (i.e. typical consumer practices do not begin to reflect activity levels for a large local government). Given these limitations, it is important to consider the emission estimates for area sources as general guidelines and not certain quantities. The estimates in the Area Source category reflect activities that the County controls. However, there is some overlap in what would be considered direct and indirect, due to insufficient data.

Paint (Interior/Exterior). Volatile organic compounds (VOCs) are emitted during application of paints and other types of architectural surface coatings as the product dries. Using national emission factors and region-specific data when available, estimates were made based on the number of County employees. Calculations were also compared to actual purchasing records in order to determine applicability of the emission factors. Basing the estimates on this "top-down" approach means that the exterior/interior paint quantities are a gross estimate for all County facilities and do not differentiate between paint purchased by the County and quantities that would be applied via contract (e.g., a remodeling project).

Traffic Paint.[22] Traffic marking operations consist of marking highway center lines, edge stripes, and directional markings and painting on other paved and non-paved surfaces, such as markings in parking lots. VOC emissions result from the evaporation of organic solvents during and shortly after the application of the marking paint. The Transit and Roads Services divisions of the Department of Transportation both conduct traffic marking activities.

[22] The 2000 Inventory considers traffic paint separately from the rest of the paint and surface coating activities because precise data was available for this category, which allows for a more accurate estimate than if traffic paints were combined with the other sources. Traffic striping and marking is also a distinct function of the county and the associated emissions information may be more useful considered separately.

LOOKING AHEAD: ENVIRONMENTAL PURCHASING AND GREEN BUILDING PROGRAMS.
The Environmental Purchasing Program has helped dozens of County project managers purchase low-VOC products, among other "environmentally preferred" products, since 1995. Examples include low-VOC road patching materials, paints, and other solvent-containing products. The emissions reflected in the 2000 Inventory include those low-VOC purchases made during 2000. With the purchasing program continuing to grow and a new Green Building Initiative, it is expected that further emission reductions in the area sources category will be realized with updates to the 2000 Inventory. For example, the DOT Roads Division began using low-VOC cold patch for road repair projects beginning in 2001. In that same year, King County Executive Ron Sims also signed a Green Building Policy and Procedure that directs offices and departments to incorporate the use of LEED™ (Leadership in Energy and Environmental Design) methods and techniques into facility construction.

Cleaners (General and Auto-related). In cleaning agents, VOCs serve as propellants, aid in product drying (through evaporation), act as co-solvents and are emitted during product use. Emissions from cleaners are dispersed and though there are many points of origin, each application results in relatively small amounts of VOCs. Estimates for cleaners are based on purchasing data and scaled by square footage for all County facilities. It is assumed in the *2000 Inventory* that approximately half of the janitorial work is contracted out. Auto-related cleaners (windshield fluid, bus wash) have similar properties to general-purpose cleaners but are reported separately in the *2000 Inventory* because actual purchasing data was available for this activity.

Auto-Products and Miscellaneous Solvents. Automotive products include brake cleaners, engine degreasers, oil, de-icers, antifreeze and other maintenance-type products. Miscellaneous solvents are also included in this category as the majority of these, for King County, are used in vehicle maintenance and repair. The estimates also include a very small amount of solvents used at the County's Environmental Laboratory. All of these products are associated with emissions of volatile organic compounds (VOCs), with VOC content varying widely from relatively low (motor oil) to relatively high (de-icer). Due to the efforts of the Department of Transportation to keep thorough purchasing records, the *2000 Inventory* estimates emissions from automotive products based on actual purchases.

Road Paving and Repair Materials. Though a majority of road repair and paving activities were contracted out in 2000 (see "Scope 3: Other Indirect Emissions"), some work was done in-house by the Department of Transportation. The primary pollutants of concern from asphalt operations are volatile organic compounds (VOCs). Of the 3 types of asphalts, the major source of VOC is cutback – asphalt cement (thinned) or "cutback" with volatile petroleum distillates such as naptha or kerosene. Only minor amounts of VOCs are emitted from emulsified asphalts and asphalt cement. VOC emissions from cutback asphalts result from the evaporation of the petroleum distillate solvent, or diluent, used to liquify the asphalt cement. At the job site, VOCs are emitted as asphalt sits in the application equipment and from the road surface itself. Emissions from on-site equipment are included in the Fleet emissions, to the extent that equipment is County-owned and maintained.

Pesticides. Pesticides include substances used to control weeds (herbicides), insects (insecticides) and fungi (fungicides). Formulations of pesticides are made through the combination of the pest-killing material referred to as the active ingredient, and various solvents (which act as carriers for the pest-killing material) referred to as the inert ingredient. Both types of ingredients can contain volatile organic compounds (VOC) that can potentially be emitted to the air either during application or as a result of subsequent evaporation.

King County maintains landscapes at many of its facilities, including parks, median strips, and building grounds. In response to the listing of Chinook salmon under the Endangered Species Act (ESA), pesticide use on County property was severely limited in 2000 to protect water quality – overall, the **total use of pesticides decreased 50 percent** from 1999 to 2000. Though this effort is not included here as an emission "reduction," it is important context for the emission estimates portrayed in this report.

EMISSIONS FROM PURCHASES OF ENERGY – DESCRIPTION OF SOURCES

On-site Energy

Source Description: On-site energy refers to activities that require facilities or operations to generate energy at the point of use, typically through combustion of fossil fuels such as propane, natural gas, or other transportable fuel. Like gasoline or diesel, the combustion of these fuels results in both greenhouse gas and traditional pollutant emissions.

Propane. Like all fossil fuels, propane emits greenhouse gases during the combustion process; the carbon stored in the fuels is oxidized and emitted as CO_2 and smaller amounts of other gases and pollutants, including CH4 and VOCs. In 2000, propane was used to fire raw sewage engines and heat boilers at the wastewater treatment plants. Propane was also used in vehicles, however these emissions are included in the Fleet estimates under the Mobile Source category.

Natural Gas. Like other fossil fuels, such as coal and oil, natural gas can be used as a fuel in conventional steam boiler generators. The combustion of natural gas produces only a portion of the nitrogen oxide (NOx) and carbon dioxide (CO_2) emissions of oil and coal, and also results in less particulate matter (PM) and sulfur dioxide (SO_2) emissions per unit of energy. In 2000, King County used natural gas as a fuel to heat buildings and in wastewater treatment processes. Compressed natural gas was also used in vehicles, however these emissions are included in the Fleet estimates under the Mobile Source category.

FIGURE 9a: Electricity Usage by Source (total = 230,000 MWh)

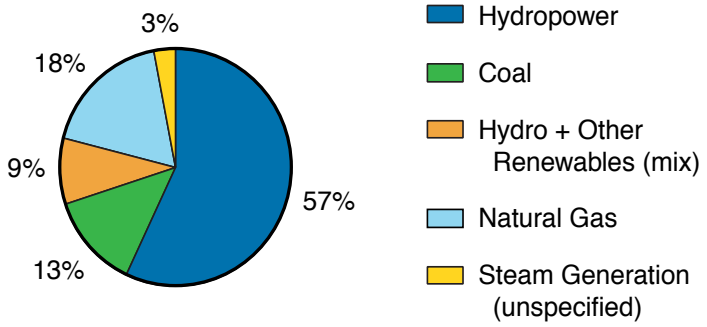
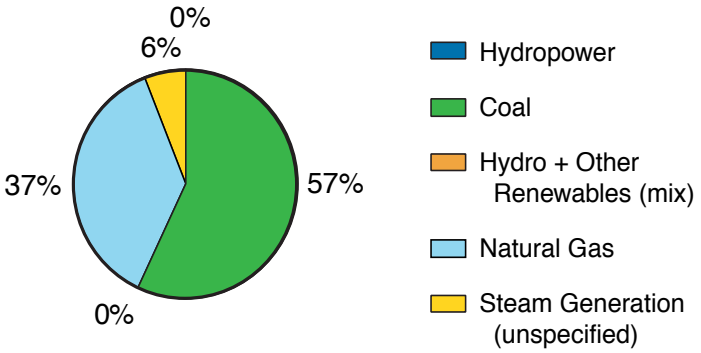


FIGURE 9b: GHG's by Electricity Source (total = 12,438 MTCE)



LOOKING AHEAD:
CHANGES IN ENERGY PURCHASES.
Seattle City Light has committed to no net greenhouse gases by 2020. City Light, though it continues to purchase from the grid to supplement its hydropower base, will mitigate the GHG emissions from those transactions. Should King County continue to purchase electricity from City Light, an update to the 2000 Inventory will demonstrate a reduction in indirect emissions caused by electricity generation. King County Department of Natural Resources and Parks, as the largest County user, has also set in motion, as of 2002, an energy strategy in which the County looks to become increasingly energy independent, with an emphasis on renewable energy projects.

Energy Purchases

Source description: In the U.S., electric power generation is dominated by fossil-fuel combustion (coal, oil, and natural gas), which is a significant source of greenhouse gases (GHGs) and other health-related pollutants. In fact, about 1/3 of total greenhouse gases (GHGs) in the U.S. are attributable to the generation, transmission and distribution of electricity[23]. Though the Northwest is known for its non-emitting, "climate-friendly" hydropower, in recent decades, Washington State has continued to grow in its dependence on fossil fuel-based electricity production[24]. This increase is due to a growing population and economy and associated increases in demand. Meanwhile, hydroelectricity competes with other water resources needs and necessarily fluctuates in accordance with changes to in-stream flows, such as those brought about by drought conditions and the maintenance of adequate flows for salmon migration.

In 2000, King County purchased electricity from two major utilities, Seattle City Light (SCL) and Puget Sound Energy (PSE). The indirect[25] emissions associated with purchases from City Light result in relatively low GHG emissions because the utility is heavily weighted toward hydropower electricity sources (and committed to renewable energy sources in general). Indirect emissions that result from PSE, on the other hand, are larger due to the utility's relatively higher (but still below the national average) fossil-fuel dependence. Figures 9a and 9b, on the previous page, describe the sources of electricity for the county and the associated indirect GHG emissions.

Steam is purchased from Seattle Steam to heat office and other buildings owned or operated by King County near the urban center of Seattle. Seattle Steam uses natural gas to heat the steam in boilers and the emissions associated with this combustion source are considered in this category. The values associated with 'Steam Generation' (unspecified) in Figures 9a and 9b refer to steam turbine-based electricity sources[26] and are separate from the emissions associated with purchases from Seattle Steam.

OTHER INDIRECT EMISSIONS– DESCRIPTION OF SOURCES

Mobile Sources

Employee Commute. In 2000, King County employed more than 13,000 employees who chose a variety of commute options for travel to and from their job sites. As part of the Commute Trip Reduction Act passed by the State legislature in 1991, and to meet broader traffic reduction and environmental objectives, King County aided its employees in finding alternatives to single-occupancy vehicle commutes. The numbers associated with the 2000 Inventory reflect the policies in place that encourage these transportation options – these include biking, telecommuting, busing, and others. Alternatives are further encouraged via free bus passes, "home-free-guarantees" and flex schedules. For comparison, if County employees all drove their own vehicles to work, the indirect emissions of greenhouse gases would be roughly 1,000 MTCE higher and traditional pollutants would be similarly increased.

Lawn and Garden Equipment. In 2000, King County contracted out some of its grounds maintenance activities, which include lawn and garden equipment operation. The figures for this category represent estimates for those sites that are contracted out via the Department of Construction and Facilities Maintenance[27].

Heavy Equipment. King County contracts out major construction projects such as asphalt paving, road construction and building construction. It is very difficult, without reporting requirements in contracts, to estimate the types of vehicles and their activity levels. In order to demonstrate the magnitude of this source of emissions, the 2000 Inventory estimates emissions that result from one of the County's largest contracted out construction activities—road paving.

[23] Inventory of *U.S. Greenhouse Gas Emissions and Sinks: 1990 – 1999*, EPA.

[24] *Washington State Energy Use Profile 1970-1993*, Washington State Community, Trade and Economic Development. Also see Washington State *2001 Biennial Energy Report*, Office of Trade and Economic Development, January 2001.

[25] Please see "Inventory Scope" section for more information on indirect sources of emissions. Emissions estimates for electricity purchased from Seattle City Light are based on estimates from the City of Seattle's greenhouse gas emissions inventory.

[26] Emissions estimates for this source are based on aggregate steam turbine electricity production from the grid provided by Seattle City Light.

[27] There may be other projects, besides the facilities maintained by DCFM, which contract out grounds maintenance.

Solid Waste

Office Waste. Although the 2000 Inventory accounts for all of the direct solid waste emissions at the County-owned regional landfill, it is worth considering the relative contribution of waste generated at dozens of County worksites. In addition to the emissions associated with waste generation, it is important to note the emission reductions that are gained because of County employee efforts to recycle and reduce waste. For over a decade, the Solid Waste Division has been promoting in-house recycling at County Facilities. In addition, beginning in 1998, King County DNR became an official "WasteWise" member, a program administered by EPA that helps organizations track recycling rates and relate those savings to greenhouse gas reductions. Data are not yet available for all departments and facilities which describe total waste generation and amounts recycled for specific materials in a consistent format. However, an estimated 1,074 MTCE were avoided, considering the life-cycle energy needs for manufacturing and distributing the recycled material, at the King Street Center and within the Transit Division alone. In the future, with all departments participating in the WasteWise program (as of 2001), data will become available to update the 2000 Inventory and reflect King County government-wide emissions and offsets from waste generation and recycling, respectively.

Area Sources

This category of emissions would typically include any type of product as outlined in the previous direct Area Sources section (paints, cleaners, etc). However, to date, there is no way to track quantities of products purchased via County contract. In a few select cases, where data were available, emissions were estimated for pesticide application, road paving and janitorial work (e.g., cleaners) by comparing maintenance contracts with County-maintenance requirements.

RECOMMENDATIONS FOR FUTURE INVENTORIES

1. Data Availability

The availability and quality of data are the most important determinants in publishing a credible emissions inventory. Some of the data used for the *2000 Inventory* were relatively easy to obtain and considered highly reliable while other sources were difficult to interpret or nonexistent. This is the first time that King County has undertaken such an effort, which explains much of this problem. In fact, many project managers expressed willingness to track this kind of information in future years if an update to the Inventory is planned and data collection requirements are implemented.

2. Purchasing Data

Some emission estimates will continue to be difficult to track without changes in the County's purchasing system. To date, the County's purchasing system is limited in its ability to track types of commodities (with the exception of some County Stores which keep up-to-date product inventories). If queries by type of product (gasoline or paint, for example) were possible, estimates would be simple. Without improved ability to catalog purchases, trends in emissions from purchasing practices in individual departments will be nearly impossible to track in future Inventory updates.

3. Contract Language

Language in contracts that requires reporting on purchases and other types of emission-relevant activities would allow for better estimates of indirect sources. For example, if contractors were required to estimate the number of hours and type of equipment operating on a particular project, estimates of emissions would be much easier. This type of information might also signal potential inefficiencies that County project managers would then be able to identify and correct.

4. Updating the 2002 Emissions Inventory

The technical appendices to this report document the inventory methodologies and identify the relevant data sources for future updates and analysis of changes in emissions over time. Some sources of emissions were not inventoried primarily due to a lack of resources. For example, additional resources or time would allow staff to run EPA models to estimate emissions from the wastewater collection system and to ask specific policy-relevant questions of the data. This work will require technical knowledge and expertise.

NEXT STEPS

The Emissions Target and Action Plan

Under direction of the King County Executive, the next step is to develop strategies to reduce emissions and identify where the County has already made progress. The Executive Policy and Procedure [PHL 10-1-1 (AEO); signed January 1, 2002] states:

> *6.4. Based on this inventory, by October 1, 2002, the Air Quality Steering Team shall develop an action plan to reduce King County emissions, working under direction of the Executive and in consultation with the Green Building Team and the Executive's Cabinet. The action plan shall set future targets for King County emissions included in the inventory. It shall propose strategies to achieve those targets, with estimates of the time and resources required for those strategies to be successful, and shall include a monitoring system to improve data quality and track results. It shall also recommend changes to King County policies and programs to reduce regional emissions of air pollutants and greenhouse gases and shall include recommendations for enhanced carbon sequestration from the county's biosolids, forestry and agriculture programs.*

DNRP is also directed to identify potential roles for King County in reducing *community-wide* emissions. King County has a significant role in helping the community reduce its emissions through our many services and programs. For example, we offer public transportation, promote Smart Growth, provide recycling services, protect forestlands, and conduct many other emissions-relevant activities. Updates to the Inventory may attempt to quantify these benefits should a broader, community-wide program emerge in partnership with other jurisdictions. The City of Seattle has already set targets for its electric utility and has inventoried greenhouse gases for all of its operations. In addition, the Puget Sound Clean Air Agency (PSCAA) is beginning to develop a region-wide greenhouse gas emission strategy in addition to their ongoing work in reducing traditional pollutants. Addressing emissions for the community at large requires partnership with these agencies as well as outreach to other local governments, schools, citizens, and businesses.

For more information on the Next Steps please see the Executive Policy and Procedure PHL 10-1-1 (AEO) http://www.metrokc.gov/recelec/archives/policies/phl101aeo.htm and County Motion 11364, attached to this Report.