King County International Airport

Greenhouse Gas Emissions Inventory:

1990, 2007 & 2020

Prepared for:

Martin Luther King Jr. County, Washington

Prepared by:

KPFF Consulting Engineers
Synergy Consultants, Inc.
BridgeNet International

King County
International Airport
Boeing Field

June 24, 2011

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King County International Airport

Greenhouse Gas Emissions Inventory

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EXECUTIVE SUMMARY

King County has voluntarily prepared a greenhouse gas emissions inventory associated with its Transportation Division -- Airport. The purpose of the inventory is to establish a baseline for emissions in 2007, and then forecast (backcast) emissions that occurred in 1990 and identify a future forecast of emissions for 2020 without further emission reduction (business as usual). This will form the basis for evaluating future emission reduction actions.

In the case of the Airport, the organization boundaries were limited for this review to the County's Transportation Department - Airport Division activities and associated emissions. Operational boundaries reflect Scope 1, 2, and 3 emissions also known as *direct, indirect, and optional emissions*. For the Airport, Scope 1 and 2 emissions are from sources that are owned and controlled by the Airport Division (terminal buildings, mobile sources, and the power required to operate these resources). Scope 3 emissions are a consequence of the activities of the Airport Division, but occur at sources owned by another party. Scope 3 emissions are associated with the airlines and aircraft operators, tenants, and general public that use that airport. Separately noted are activities of Scope 3 sources that are under the control of the County.

Based on these boundaries, approximately 263,414 metric tons of CO_{2e} in 2007 were identified associated with activity at Boeing Field (Scope 1, 2, and 3). In contrast, about 187,472 metric tons of CO_{2e} were emitted in 1990, and 304,132 metrics tons are anticipated to occur in 2020 if emission further reduction actions are not undertaken.

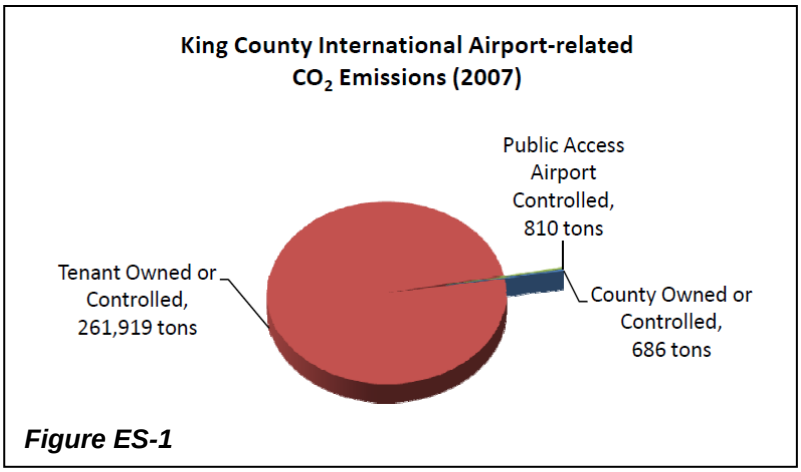


Figure ES-1

Of total airport-related emissions, King County owned or controlled less than 1% of the emissions in 2007 (686 metric tons of CO_{2e}). Over 98% of the emissions associated with the Airport were generated with aircraft operations, which the County does not own or have the authority to control. The chart below shows the distribution of emissions by the sources owned or controlled by the County.

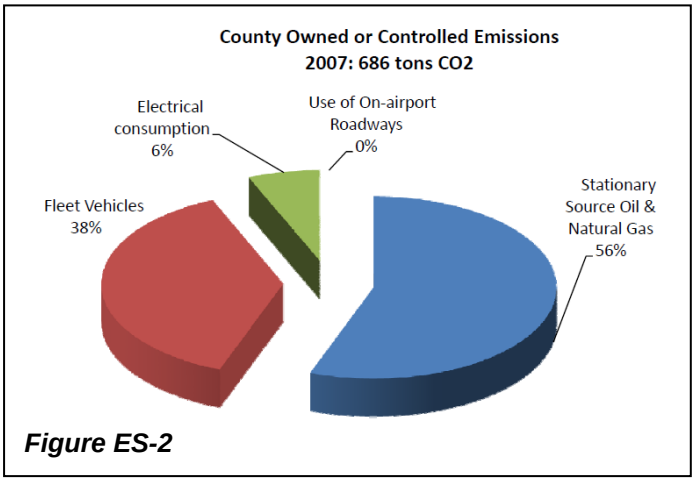


Figure ES-2

The largest portion of greenhouse gas emissions that the County either owns or has substantial control at the Airport is due to natural gas consumption at airport facilities, while 38% of emissions were caused by gas/diesel fuel use in airport fleet vehicles in 2007. While the County does not own the ground vehicles from users accessing their aircraft in tie-down locations (on airfield), they do control that activity, which represents less than 1 metric ton.

Airline, aircraft operator, and tenant-owned and controlled emissions represent 261,919 metric tons of CO_2 in 2007 or 99.4% of total airport-related emissions. As would be expected, aircraft represent the single largest source of CO_2 emissions at 259,528 metric tons of CO_2 with most of the aircraft emissions occurring above an altitude of 3,000 feet (referred to as residual/cruise/APU).

About 12% of emissions from aircraft occur while the aircraft are on the ground (in the taxi-idle or takeoff modes) and 80% of the emissions occur when the aircraft is at cruise.

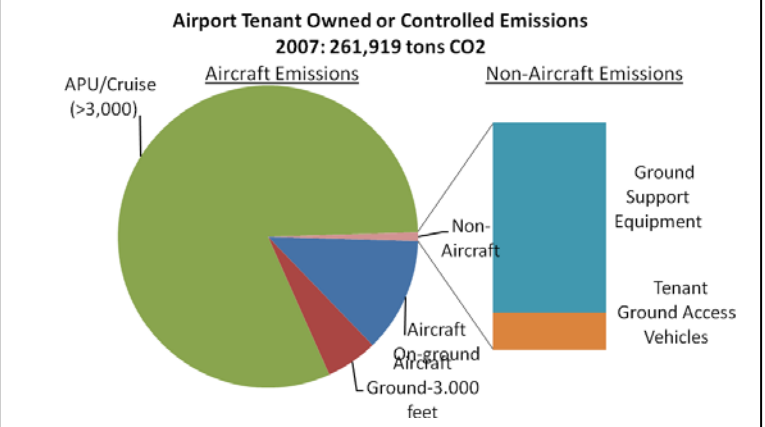


Figure ES-3

All of the public-owned and controlled emissions reflect on-road travel associated with airport activity: either through vehicular access by passengers and airport employee work commute. Of the airport-related emissions, public owned/controlled emissions represent 810 metric tons of CO_2 in 2007.

Based on emissions for 2007, emissions for 1990 and 2020 were estimated relative to the differences in activity:

- 1990: 331,643 operations
- 2007: 300,184 operations
- 2020: 308,242 operations

Aircraft emissions below 3,000 feet were evaluated using forecast fleet mixes from the Master Plan. Based on the 2007 relationship between fuel consumption below 3,000 feet and fuel dispensed at the Airport, the fuel dispensed in 1990 and 2020 were estimated. All other sources of emissions were estimated in proportion to 2007 activity.

Total airport-related emissions in 1990 were estimated to be 187,472 metric tons, with 737 tons being associated with sources owned or controlled by the County. By 2020, total airport-related emissions could increase to 304,132 metric tons, with 809 tons being from sources owned or controlled. The chart below shows this trend, assuming continued business as usual.

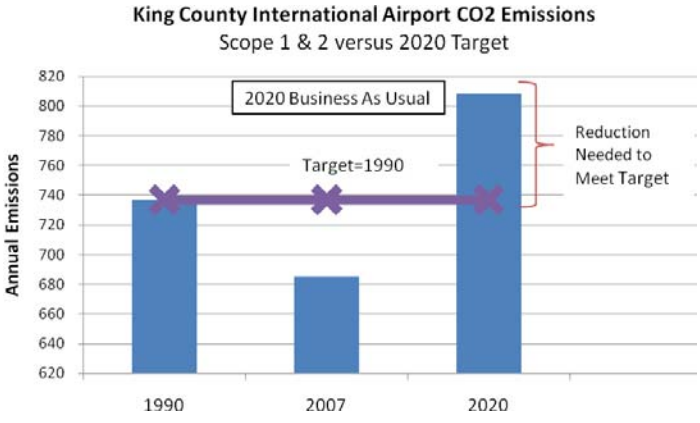


Figure ES-4

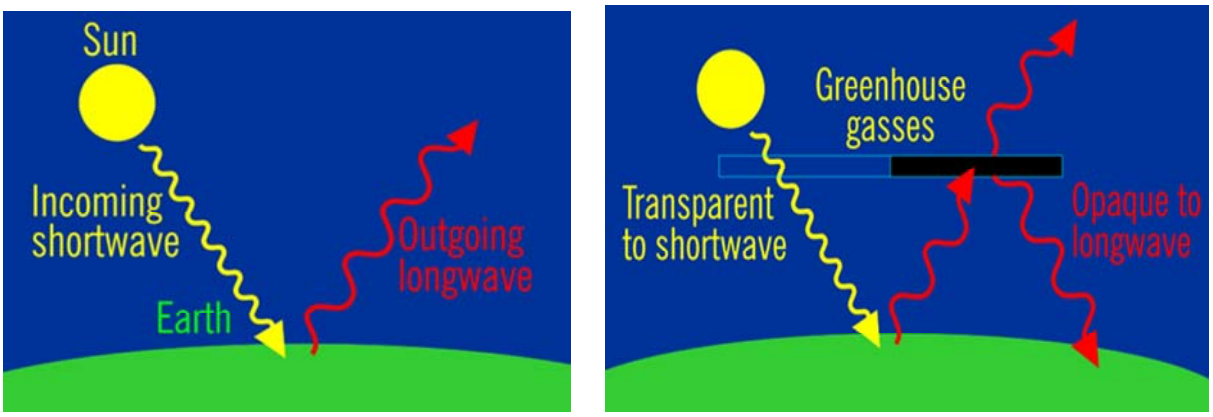
I. BACKGROUND

I.1 WHAT ARE GREENHOUSE GASES (GHG)?

Greenhouse gases are those that trap heat in the earth's atmosphere. Both naturally occurring and anthropogenic (man-made) greenhouse gases include water vapor (H_2O), carbon dioxide (CO_2),[1] methane (CH_4), nitrous oxide (N_2O), and ozone (O_3).[2] Because different greenhouse gases absorb and re-radiate different wavelengths of infrared light, and because they remain in the atmosphere at different lengths levels and lengths of time, each type of greenhouse gas traps a different amount of heat. Thus in an inventory, emissions of greenhouse gases often focus on CO_2, and if they include other greenhouse gases, are reported as "carbon dioxide equivalent" or CO_{2e}.

There are also gases that do not have a direct global warming effect but indirectly affect land and/or solar radiation absorption by influencing the formation or destruction of other greenhouse gases. These gases include carbon monoxide (CO), oxides of nitrogen (NOx), and non-methane volatile organic compounds (NMVOCs). Aerosols, which are extremely small particles or liquid droplets, such as those produced by sulfur dioxide (SO_2) or elemental carbon emissions, can also affect the ability of the atmosphere to absorb or shed heat.

FIGURE I-1
ATMOSPHERE WITHOUT GREENHOUSE GASES AND WITH GREENHOUSE GASES



[1] All greenhouse gas inventories measure carbon dioxide emissions, but beyond carbon dioxide different inventories include different greenhouse gasses (GHGs).

[2] Several classes of halogenated substances that contain fluorine, chlorine, or bromine are also greenhouse gases, but they are, for the most part, solely a product of industrial activities. For example, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) are halocarbons that contain chlorine, while halocarbons that contain bromine are referred to as bromofluorocarbons (i.e., halons) or sulfur (sulfur hexafluoride: SF_6).

Although the direct greenhouse gases CO_2, CH_4, and N_2O occur naturally in the atmosphere, human activities have changed their atmospheric concentrations. Since the pre-industrial era, concentrations of these greenhouse gases have increased substantially (according to IPCC Intergovernmental Panel on Climate Change – see Section I.2 of this report).

CO_2 has increased 31%, methane increased 150%, and nitrous oxides by 16%. Beginning in the 1950s, the use of CFCs and other stratospheric ozone depleting substances (ODSs) increased by nearly 10% per year until the mid-1980s, when international concern about ozone depletion led to phased reductions in ODSs.[3] In recent years, use of ODS substitutes such as hydrofluorocarbons (HFCs)[4] and perfluorocarbons (PFCs)[5] has grown as they begin to be phased-in as replacements for CFCs and hydrochlorofluorocarbons (HCFCs).

Gases in the atmosphere can contribute to the greenhouse effect both directly and indirectly. Direct effects occur when the gas itself absorbs radiation. Indirect radiative forcing occurs: 1) when chemical transformations produce other greenhouse gases; 2) when a gas influences the atmospheric lifetimes of other gases and/or; 3) when a gas affects atmospheric processes that alter the radiative balance of the earth (e.g., affect cloud formation, etc.). The IPCC developed the Global Warming Potential (GWP) concept to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to another gas.

[3] Known as the Montreal Protocol.

[4] HFCs are used in many applications, such as solvents, domestic and commercial refrigerants, firefighting agents, propellants for pharmaceutical and industrial aerosols, foam-blowing agents, and in blends for air conditioning refrigerants

[5] PFCs are emitted as by-products of industrial processes and are also used in manufacturing.

I.2 WHO ADDRESSES GREENHOUSE GASSES

The following section discusses greenhouse gases from the perspective of an airport operator, such as the King County.

In the U.S., recent national regulations do not directly control aviation-related greenhouse gas emissions, but in certain instances require reporting of emissions. Concentrations of a few gasses that also represent greenhouse gases, such as nitrogen oxides, ozone, and carbon monoxide, are regulated by the Clean Air Act for visibility and human health implications rather than for climate change effects. The primary players currently addressing greenhouse gases and climate change are:

- **Kyoto Protocol**- The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is an amendment to the international treaty on climate change, assigning mandatory targets for the reduction of greenhouse gas emissions to signatory nations. Countries that ratify the Kyoto Protocol commit to reduce their emissions of CO_2 and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases. As of August 2007, a total of 171 countries[6] and other governmental entities have ratified the agreement. Notable exceptions include the United States and Australia. Other developing countries, such as India and China, which have ratified the protocol, are not required to reduce carbon emissions under the present agreement despite their relatively large populations.

  Although a signatory to the protocol, the United States has neither ratified nor withdrawn from the protocol. In late 1998, then Vice President Gore signed the protocol; however, both Gore and Senator Joseph Lieberman indicated that the protocol would not be acted upon in the Senate until there was participation by the developing nations. The Clinton

[6] http://maindb.unfccc.int/public/country.pl?group=kyoto

Administration never submitted the protocol to the Senate for ratification due to estimates of large declines in the Gross Domestic Product associated with compliance. No subsequent U.S. administration has ratified the protocol.

- **Intergovernmental Panel on Climate Change (IPCC)** - Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The role of the IPCC is to understand the risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation. It does not carry out research nor does it monitor climate-related data or other relevant parameters. It bases its assessment mainly on peer reviewed and published scientific/technical literature. The IPCC has completed four assessment reports, developed methodology guidelines for national greenhouse gas inventories, special reports, and technical papers.
- **State and Local Actions**: The Kyoto Protocol became law for nearly 200 countries. Even though the US has failed to ratify Kyoto, local action has taken place. In 2005, then Seattle Mayor Greg Nickels launched the US Mayors Climate Protection Agreement to advance the goals of the Kyoto Protocol through leadership and action. Two years later, when participation reached over 500 cities, the US Conference of Mayors launched its own Climate Protection Center to administer and track the Agreement. Under the Climate Protection Agreement, participants commit to:
  - Strive to meet or beat the Kyoto Protocol targets in their own communities;
  - Urge their state governments, and the federal government, to enact policies and programs to meet or beat the greenhouse gas emission reduction target suggested for the United States in the Kyoto Protocol -- 7% reduction from 1990 levels by 2012; and
  - Urge the U.S. Congress to pass the bipartisan greenhouse gas reduction legislation, which would establish a national emission trading system

In addition, the following specific actions have occurred at the State and local level:

- **King County Climate Plan** - In 2006, then King County Executive Ron Sims issued Executive Orders on Global Warming Preparedness which directed the County to reduce greenhouse gas emissions and to prepare for anticipated climate change impacts. These Executive Orders mandated that County departments take climate change actions with regard to land use, transportation, environmental management and clean energy use. In late 2006, all County environmental reviews conducted under the State Environmental Policy Act (SEPA) were required to include a greenhouse gas inventory.
- In October 2006 the King County Council mandated that the County submit a Global Warming Mitigation and Preparedness Plan (the "Climate Plan"), as well as an annual report in each subsequent year. Consistent with the Executive Orders, the Council required specific actions to be taken relative to: emissions inventories, greenhouse gas reduction targets, land use, environmental management, emergency preparedness, energy use and transportation.
- In May 2011, the County Council adopted Resolution 2011-0208.1 which rescinded an earlier climate action plan and endorsed continuation, expansion, or initiation of a number of initiatives, including:
  - Collaboration with several parties on greenhouse gas emissions
  - Participation in The Climate Registry (TCR)
  - Establishing a 2020 goal for reducing energy and greenhouse gas emissions
  - Undertake specific actions designed to reduce emissions and increase sustainability.
- The **City of Seattle** has prepared the *Seattle Climate Action Plan*. The Ac-

tion Plan addressed the recommendations of Mayor Nickels' *Green Ribbon Commission on Climate Protection.*

- In August 2006, the State of California, which is ranked as one of the largest greenhouse gas emitter in the world, agreed to reduce the state's greenhouse-gas emissions by 25% by the year 2020. This resulted in the ***California Global Warming Solutions Act*** (also known as AB32) which could put California in line with the Kyoto initiative.
- The **governors of Washington**, Oregon, Arizona, New Mexico, and California have joined together in a regional strategy addressing global warming. Several parties, including Utah, the Providence of British Columbia, and portions of Mexico have joined as observers. *The west coast governors' regional strategy and* the Western Climate Initiative (WCI) includes the following actions:
  - Purchase of state vehicles that are fuel-efficient vehicles for motor pool fleets.
  - Reduce diesel emissions by:
    - reducing diesel generators used by ships in west coast ports; and
    - creating an emission-free truck stop system along the I-5 corridor from Mexico to Canada.
  - Remove barriers to and encourage the development of renewable electricity generation resources and technologies.
  - Develop uniform efficiency standards for items such as appliances that can potentially reduce greenhouse gas emissions.
  - Develop better ways to collect data on greenhouse gas emissions and their sources.
  - Updating state energy codes for new construction and promoting state-funded weatherization assistance for energy-efficient homes.
  - Providing tax incentives to companies for developing renewable and alternative energy projects.
  - Creating a biodiesel use pilot program to substitute biodiesel for fossil fuels in school buses.
  - Develop and implement a CO_2 market-based cap and trade mechanism.

Started in late 2003, the **Chicago Climate Exchange** (CCX) was originally formed as North America's only voluntary, legally binding greenhouse gas reduction and trading system for emission sources and offset projects in North America and Brazil. CCX employed independent verification, included six greenhouse gases, and traded greenhouse gas emission allowances from 2003 to 2010. The companies joining the exchange committed to reducing their aggregate emissions by 6% by 2010. In November 2010 due to inaction in the US to regulate greenhouse gases and the reduced value of carbon offsets, the Climate Exchange stated that it would cease trading carbon credits at the end of 2010, although carbon exchanges will still be facilitated.

I.3 SOURCES OF GREENHOUSE GASES AT AN AIRPORT

Research has shown that there is a direct link between fuel consumption and greenhouse gas emissions. Therefore, sources that require power/fuel at an airport typically are reflected in a pollutant emissions inventory. Given the experience with emission inventories prepared for criteria pollutants, it is expected that the same sources would generate greenhouse gases. Airport sources of greenhouse gas emissions would include:

1. **Aircraft including auxiliary power units** (APU): APU refers to the onboard engine that is used to support the aircraft while parked on the ground;

2. **Ground support equipment** (GSE) **and Fleet Vehicles**: A variety of ground equipment service commercial aircraft while they unload and load passengers and freight at an airport. GSE primarily consist of vehicles that do not leave the airfield, such as aircraft tugs, air start units, loaders, tractors, cargo-moving equipment, service vehicles, etc. In general GSE are off-road vehicles and include fleet vehicles of the airport operator that maintain airport facilities (such as snow removal, fire fighting, etc).
3. **Ground access vehicles** (GAV): GAV encompass all on-road or highway vehicle trips generated by the users of the airport. GAV include all vehicles traveling to and from, as well as within the airport public roadway system (excluding GSE) or fleet vehicles.
4. **Airport infrastructure and stationary sources** such as for lighting, cooling, etc.
5. **Airport and airline maintenance industrial activities**.
6. **Airport construction activities.**

As the inventory documented in this report is the first in depth greenhouse gas inventory for King County International Airport, it is scoped to only consider emissions from the first four sources (aircraft/APU, GSE, GAV, and airport infrastructure) based on inventories prepared for other airports, as they are expected to be the dominant (key) sources of greenhouse gases.

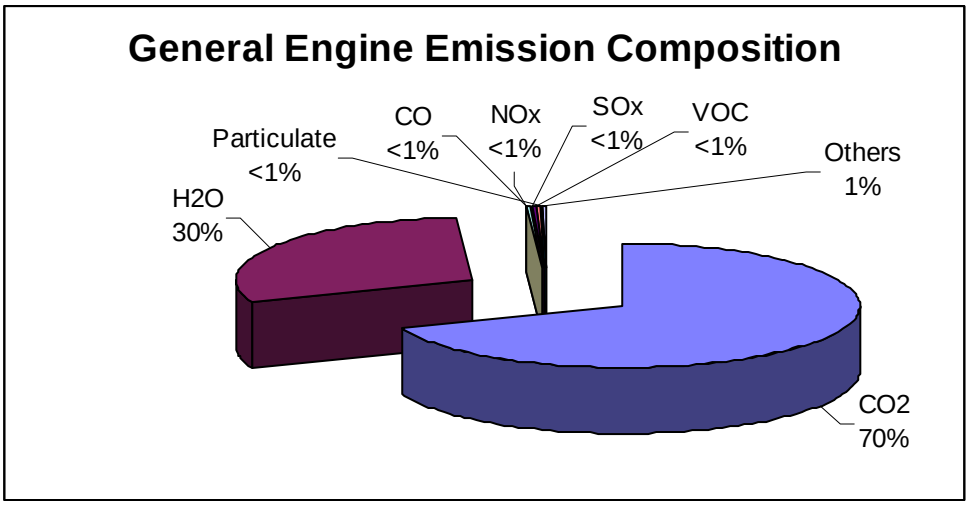
Aircraft are probably the most often cited air pollutant source, but as is noted in FAA materials, in general, they produce the same types of emissions as cars. Aircraft jet engines, like many other vehicle engines, produce carbon dioxide (CO_2), water vapor (H_2O), nitrogen oxides (NO_x), carbon monoxide (CO), oxides of sulfur (SO_x), unburned or partially combusted hydrocarbons (also known as volatile organic compounds (VOCs)), particulates, and other trace compounds. FAA data shows that aircraft engine emissions are roughly composed of emissions are reflected in **Figure I-2.**

The *FAA's Emissions Primer* further notes that "About 10 percent of aircraft emissions of all types, except hydrocarbons (i.e., VOC) and CO, are produced during airport ground level operations and during landing and takeoff. The bulk of aircraft emissions (90 percent) occur at higher altitudes. For hydrocarbons and CO, the split is closer to 30 percent ground level emissions and 70 percent at higher altitudes."

According to most international reviews, aviation emissions comprise a potentially important and growing percentage of anthropogenic greenhouse gases and other emissions that contribute to global warming. The IPCC estimated that global aircraft emissions accounted for about 3.5% of the total quantity of greenhouse gas from human activities. However, the scientific community has identified areas that need further study to enable them to more precisely estimate aviation's effects on the global atmosphere. As for the contributions of U.S. aviation relative to other U.S. industrial sources, data from the USEPA show that aviation accounted for about 3% of U.S. greenhouse gas emissions. As the US General Accounting Office (GAO) in 2000[7] noted, "global aviation emissions of carbon dioxide (measured in million metric tons of carbon) are a small percentage of carbon emissions worldwide; however, they are roughly equivalent to the carbon emissions of certain industrialized countries."

[7] US General Accounting Office (GAO) *Environment: Aviation's Effects on the Global Atmosphere Are Potentially Significant and Expected to Grow*; GAO/RCED-00-57, February 2000.

FIGURE I-2



The GAO report noted the importance of aircraft emissions in greenhouse gases for the following reasons:

- Jet aircraft are the primary source of human emissions deposited directly into the upper atmosphere. The IPCC noted that some of these emissions have a greater warming effect than they would have if they were released in equal amounts at the surface.
- CO_2 is relatively well understood and is the main focus of international concern, as it survives in the atmosphere for about 100 years and contributes to warming the earth. Moreover, as noted, global aviation's carbon dioxide emissions (measured in million metric tons of carbon) are roughly equivalent to the carbon emissions of certain industrialized countries.
- CO_2 emissions combined with other gases and particles emitted by jet aircraft - including water vapor, nitrogen oxide and nitrogen dioxide (collectively termed NOx), and soot and sulfate — could have two to four times as great an effect on the atmosphere as carbon dioxide alone.
- The IPCC concluded that the increase in aviation emissions attributable to a growing demand for air travel would not be fully offset by reductions in emissions achieved through technological improvements alone. Experts agree that the aviation industry will continue to grow globally and contribute increasingly to human-generated emissions. The experts differ, however, in the rates of growth they project and the effects they anticipate.

I.4 AIRPORT AND AVIATION EMISSIONS INVENTORIES

The following summarize various inventories prepared that include some or all of airport-related emissions:

I.4.1 USEPA Greenhouse Gas Emissions Inventory

In 2008, total U.S. greenhouse gas emissions were approximately 6,956.8 Tg $CO_{2\text{-eq}}$ (teragrams of CO_2 equivalent emissions – teragrams are 10^{12}). Emissions declined from 2007 to 2008, decreasing by slightly fewer than 3% due to a decrease in demand for transportation fuels associated with the record high costs of these fuels that occurred in 2008.[8]

Of total U.S. emissions, electricity generation accounted for the largest portion (35%), with transportation activities accounting for the second largest portion

[8] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2008*, April 2010.

(27%). Aviation is included in the transportation category.

The IPCC's 2000 *Good Practice Guidance* defines a key category as a "[source or sink category] that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both." By definition, a key category is one that has a notable contribution to the absolute overall level of national emissions. In the 2008 national level emissions inventory, 19 source categories were identified ranging from "CO2 emissions from stationary combustion sources- coal" (the largest source), to "Non-CO2 Emissions from Stationary Combustion" (the lowest source). The second largest emissions source was "CO_2 Emissions from Mobile Combustion: Road & Other" while "CO_2 Emissions from Mobile Combustion: Aviation" was the sixth largest source.

The methodology used by EPA in defining transportation activity, and specifically the "CO_2 Emissions from Mobile Combustion: Aviation" employed the following steps:

- Determine total fuel consumption. The source of this data was FAA's *Fuel Cost and Consumption*. While the report notes "fuel consumed", few mobile sources actually identify fuel consumed, but rather rely on fuel dispensed, assuming that all fuel dispensed is consumed in travel.
- Emissions factors for fuel consumption were derived from the IPCC *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.*

I.4.2 IPCC Methodologies

As noted above, the USEPA uses the IPCC methodologies for aviation greenhouse gas emission inventories. However, IPCC documentation notes that there are three tiers to their evaluation methodology: Tier 1, Tier 2, and Tier 3 go from the most simple to the most complicated/data intensive, respectively.

Relative to aircraft activity, the methods differ by:

- Tier 1 – reflect total fuel consumed in the country;
- Tier 2 – requires a knowledge of aircraft Landing and Takeoff Cycles (LTOs)[9] and dispensed fuel to account for cruise level energy consumption;
- Tier 3 – uses method/model developed by the European Environment Agency (Denmark) which requires knowledge of origin/destination of flights. In the US, the FAA's SAGE model (System for Assessing Aviation's Global Emissions) is used, which is not available at the airport operator level at this time. While FAA has indicated that they may make SAGE data available for all US Airports, at this time the data is not available.

There may be significant discrepancies between the results of a bottom-up approach and a top-down fuel-based approach for aircraft and the choice of methodology usually depends on the type of fuel, the data available, and the relative importance of aircraft emissions. **Figure I-3** shows the LTO cycle as well as cruise level.

[9] The LTO – landing and takeoff cycles – refers to the number of aircraft that land and then takeoff. LTOs are typically equal to the number of total aircraft operations (the sum of all arrivals and departures) divided by 2.

FIGURE I-3
LANDING AND TAKEOFF CYCLE

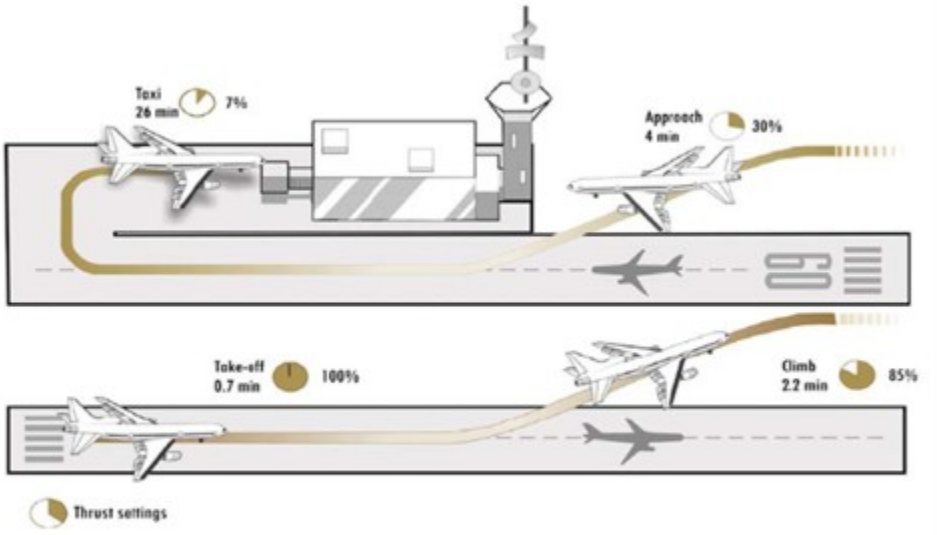


Figure 1 - Illustration of ICAO Emissions Certification Procedure LTO Cycle.
Source: ICAO.

Four LTO Modes: approach, taxi-in/taxi-out, takeoff, and climbout.

I.4.3 Other Inventories

Based on the internet search, State-level emission inventories have been prepared by numerous states. Cities have prepared inventories for city-owned resources as well as overall emission sources. This section briefly provides examples of a few of these inventories.

Airport Inventories

Depending on the purpose of the inventory, the approach to preparing that inventory can differ as well as the methodologies. In 2009, the Transportation Research Board's Airport Cooperative Research Program (ACRP) released Report 11 titled *Guidebook on Preparing Airport Greenhouse Gas Inventories*. That report notes that based on the inventories prepared to date, the purposes of the inventories could be categorized as: 1) climate change initiatives—GHG reduction goals (climate action plan), 2) environmental management and sustainability programs, 3) disclosure of project/ action effects, and 4) future regulations. Depending on the purpose of the inventory, the source boundaries would likely differ. This inventory, prepared for King County, used guidance in Report 11 concerning climate change initiatives, and thus represents all sources associated with the Airport.

ACRP Report 11 then identifies methodologies to be used in preparing inventory to enable a comparison amongst airports. Similar to climate action registries, the recommended approach for airports identifies Scope 1, 2, and 3 source emissions, but then also stratifies the emissions based on the airport operator's ownership and/or control of the source.

State emissions inventories. In 1999, the USEPA issued guidance concerning the preparation of emission inventories for purposes of developing a consistent framework for the state inventories. The EPA methodology is

based on the IPCC method discussed previously.

The State of Washington prepared a greenhouse gas emissions inventory representing emissions within the state. **Table I-1** shows that inventory in comparison to the county and city inventories. Each inventory was prepared using differing methods and is formatted to facilitate the consideration of emissions and their mitigation by each party.

The State of Washington greenhouse gas inventory[10] indicates that in 2005, state-wide emissions were approximately 95 million tons of CO_{2e}. The inventory was prepared by the State Dept. of Community, Trade & Economic Development. That report indicated that emissions were "… calculated based on methodology outlined in the *State Tool for Greenhouse Gas Inventory Development*, a series of worksheets developed by the U.S. Environmental Protection Agency." The Ecology documentation available on the web does not indicate the source of the aviation portion of transportation emissions. As noted in the **Table I-1,** transportation-related emissions statewide reflect nearly half of all emissions.

King County inventory:[11] King County has assembled an emissions inventory for County owned resources, as well as community-wide emissions. **Table I-1** lists the 2004 county-wide emissions. King County is a participant in the ICLEI Cities for Climate Protection program (CCP). CCP recognizes two GHG inventory types: government and geographic. The government inventory accounts all emissions that can be attributed to the actions of King County government in the course of normal business activity. For its government inventory, King County follows a hierarchy of four guidance documents: WRI, ICLEI, US EPA, and IPCC. The county obtained its geographic community inventory from the Puget Sound Clean Air Agency (PSCAA).

TABLE I-1
US, STATE, COUNTY AND CITY GREENHOUSE GAS EMISSIONS (CO2e)

Source	United States (2008)	State of Washington (2005)	King County (2005)	City of Seattle & Community (2000)
Total Tons CO_{2e}	6,956.8 million	94.8 million	21.9 million	7.0 million
Source Distribution				
Transport	27%	47%	58%	54%
Industrial	19%	3%	na%	36%
Electricity	35%	20%	na%	6%
Other	19%	30%	na%	5%
Aviation (if identified)	2.4%	8%	na	15%

Source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010*, USEPA, March 2010; State Inventory published in 2007, King County Plan, and City of Seattle (includes community and city emissions). na=not available.

[10] Washington Department of Ecology, *Greenhouse Gas Inventory and Reference Case Projections, 1990-2020*, December 2007.

[11] http://your.kingcounty.gov/dnrp/measures/indicators/at-ghg-emissions.aspx

City emissions inventories. An exhaustive list of cities have begun or completed preparation of greenhouse gas emission inventories. In 2002, the City of Seattle completed an emissions inventory.[12] The City inventory anticipated that transportation (including aviation) currently represents about 56% of citywide emissions. A category "airports" represented 14.8% of the total and was expected to increase to 16.3% of the citywide total by 2010.

[12] *Inventory and Report: Seattle's Greenhouse Gas Emissions,* City of Seattle, April 2002.

II. INVENTORY PROTOCOL

This chapter documents the methodologies used to prepare the greenhouse gas emissions inventories for King County International Airport. Discussed are:

- Airport organization and operational boundaries
- Methods to quantify airport-related sources
- Uncertainties and Data Cautions

II.1 AIRPORT ORGANIZATION AND OPERATIONAL BOUNDARIES

The following protocols were consulted in preparing this inventory for King County International Airport:

- **Intergovernmental Panel on Climate Change** (IPCC) - focused on inventories for nations, but provide guidance for other parties on various sources, including aviation.
- **US EPA** - has prepared guidance for states to prepare inventories, but has also prepared a protocol through the Climate Leaders effort to assist other entities, particular corporations with consistent greenhouse gas inventories.
- **World Resource Institute (WRI)** an environmental think tank, in collaboration with the World Business Council for Sustainable Development, has developed comprehensive guidance to assist corporations prepare emission inventories, both representing the corporate entity as well as corporate projects.
- **ICLEI**[13] - is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. ICLEI has implemented a program titled, the Cities for Climate Protection (CCP) to assists cities with adopting policies and programs to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. According to their web site, more than 800 local governments participate in the CCP.
- **Airport Cooperative Research Project (ACRP) Report 11** – which documented various ways airport operators could prepare and present their emissions inventories. See Section I.4 discussion.

The inventories discussed in the preceding section all rely on one or more of the above protocols or methodologies for quantifying greenhouse gases. As noted by these protocols, for a greenhouse gas inventory to be of use, it must be transparent, and be prepared in a way that lets the users understand the sources of emissions and those that the entity has authority to control. In most cases, the preparation of an inventory enables the identification of notable sources of greenhouse gases and the identification of measures to reduce those emissions. To be useful requires consid-eration of an appropriate inventory boundary that reflects "the substance and economic reality of the entities activities" and responsibilities. For corporate entities, this often relates to the legal form of the business. For governmental parties, this can become less clear, but typically focuses on emissions directly from the governmental activities, as well as those within its control. Thus, the choice of the inventory boundary is typically dependent on the characteristics of the entity, the intended purpose of the information, and the needs of the information users.

EPA and WRI guidance suggest that the following be considered when establishing the boundaries:

[13] The organization International Council for Local Environmental Initiatives is now identified as ICLEI

- **Organizational structure**: as reflected by control through ownership, legal agreements, joint ventures, etc. In the case of the Airport, the organization boundaries were limited for this review to the County's Airport Division activities and associated emissions. This approach will enable the County to combine, if it desires, the emissions associated with the airport organizational structure, with those of other elements of the County.

- **Operational boundaries**: Once an entity has determined its organizational boundaries in terms of the operations that it owns or controls, it then sets its operational boundaries. This involves identifying the emissions associated with its operations and categorizing them as *direct, indirect, and optional emissions.*

  - **Direct/Scope 1** emissions are from sources that are owned and controlled by the party. For example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.

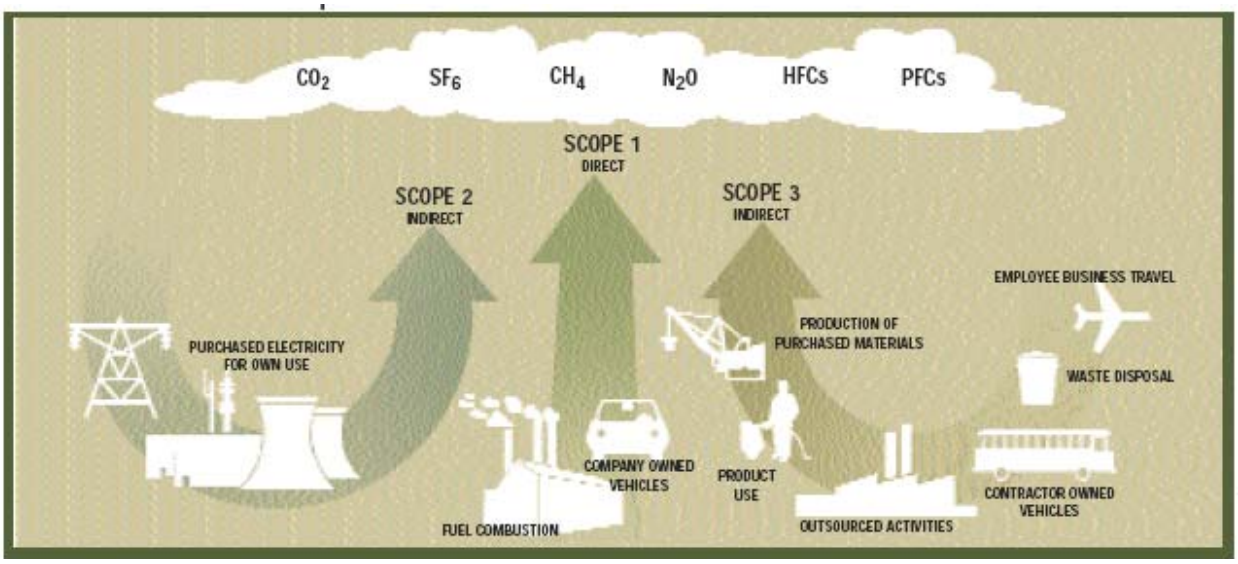
  - **Indirect/Scope 2**: Refers to the consumption of purchased electricity, where the generation of that power occurs by another party.

  - **Indirect and Optional** emissions are a consequence of the activities of the entity, but occur at sources owned or controlled by another party. An example of indirect emissions is the emissions from the generation of purchased electricity consumed by a company. The WRI method identified two forms of indirect emissions: Scope 2 and Scope 3. Scope 2 emissions are those from the generation of purchased electricity consumed by the entity. Scope 3 is an optional reporting category that allows for the identification of all other emissions that are a consequence of the activities of the entity, but occur from sources not owned or controlled by the entity.

Indirect and direct emissions as advocated by USEPA are similar to the Scope 1 and 2 emissions noted by WRI, whereas WRI Scope 3 emissions are the emissions that EPA considers optional.

Note that ACRP Report 11 encourages airports to identify emissions by Scope, but to then also note where the airport may own a facility and can control its use, but may not be able to dictate full use (such as the use of on- airport roadways). Therefore, the Airport reports note both the Scope 1, 2, and 3, but also ownership or control.

FIGURE II-1
WRI BOUNDARIES - SCOPE 1, 2, AND 3



Various parties are now developing guidance for the inclusion of an emissions life cycle assessment of activities that generate greenhouse gases. A life cycle evaluation would, for instance, capture the emissions associated with producing and delivering fuels for their use. As a specific methodology for airport-related activities has not been developed for the life cycle assessment, this inventory only addresses the downstream use of fuels by airport activity.

Given the organization boundaries for King County's activities at the Airport, the operational boundary for the Airport Division was defined as the County owned and controlled resources. Because of the visibility of aircraft and their emissions within the physical boundaries of the Airport, as well as other activities by tenants, attempts were made to capture the emissions with those activities and note that they are owned and or controlled by airlines/tenants. However, the one exception to this evaluation is the exclusion of emissions associated with The Boeing Company ground activities. In addition, because of the high amount of on-road vehicular travel associated with passengers using the Airport, emissions from these sources were also quantified based on the information available, but noted as associated with public (private) activities. The inclusion of these emissions provides further information about airport-related activities and their emissions.

An important element of the inventory protocol is the use of proper boundaries that avoid the double counting of emissions. As noted in the IPCC 2006 guidance[14] "National inventories include greenhouse gas emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction. … For example, emissions from fuel used in road transport are included in the emissions of the country where the fuel is sold and not where the vehicle is driven, as fuel sale statistics are widely available and usually much more accurate."

In an airport setting, the issue of ownership is clear, as ownership is related to the party that has title to the asset (i.e., the aircraft is owned or leased by an airline, most buildings and facilities are owned by the County, but may be the subject of a long-term lease by a tenant). However, control can be more difficult to identify, as many parties contribute to the control of various sources. Therefore, the King County Airport Division inventory identifies sources of emissions and attempts to focus first on ownership and then control.

II.2 METHODS USED TO QUANITY GREENHOUSE GASES AT BOEING FIELD

Based on the types of sources at Boeing Field, emissions from the following were quantified:

II.2.1. Aircraft Emissions

Aircraft greenhouse gas emissions would be expected to be the largest sources of greenhouse gases at an airport due to the fuel requirements of air travel. To quantify aircraft-related greenhouse gases, the following steps were used:

- The quantity of fuel dispensed at Boeing Field to aircraft (jet fuel and aviation gas) was obtained by King County. Jet-A and AvGas fuel is dispensed to aircraft. In 2007, a total of 26,453,952 gallons of JetA was dispensed and 768,998 gallons of AvGas were dispensed.[15] Fuel dispensed represents the amount of fuel that aircraft operators purchased at Boeing Field in order for departures to achieve their desired travel. It does not reflect the fuel ac-

[14] *2006 IPCC Guidelines for Preparing National Greenhouse Gas Inventories , Volume I - General Guidance and Reporting*, IPCC, 2006, Page 1.4

[15] King County reports.

quired in origin cities that is necessary to enable travel to Boeing Field (arrival-based fuel). While the arrival-based fuel consumption is not reflected in fuel dispensed, as it would be attributed to that flight origination city, a subsequent step accounts for fuel consumption in the local setting and considers fuel consumed in the LTO approach mode. Fuel dispensed can be translated into CO_2 emissions based on the US Energy Information Administrations estimate that about 21.095 pounds of CO_2 is generated by burning one gallon of Jet A fuel and 18.355 pounds of CO2 for one gallon of AvGas**.** Thus, aircraft fuel consumption in 2007 generated about 212,775 metric tons of CO_2.

- In accord with the IPCC protocol, the Tier 2 method was used to quantify aircraft greenhouse gas. In Tier 2, the second step of the evaluation process requires the calculation of fuel burn in the LTO cycle (approach, taxi-in, taxi-out, takeoff, and climbout). To quantify emissions in the LTO cycle, the FAA's Emissions Dispersion Modeling System (EDMS) Version 7.1 was used. Appendix A provides a listing of the numbers of LTOs by aircraft type at Boeing Field.

  Data necessary to run the EDMS includes:

  – Types and numbers of aircraft operating: FAA ASDi data was obtained for 2007 to identify all flights at Boeing Field and the types of aircraft being operated. Based on knowledge of the airline operating each flight, the specific aircraft type and engine combinations could be identified, using industry publications, such as *Jane's Information Group* - Airline Fleet and *JP Airline Fleets International*.

  – Time-in-mode: Default time-in-mode data was then used for all of the operating modes at Boeing Field in lieu of airport specific information.

Fuel burn was then converted to emissions for each mode using the same factor as noted above. Emissions from the EDMS were then reported according to: 1) approach, 2) taxi-in/taxi-out, 3) takeoff, and 4) climbout. In accord with the IPCC Tier 2 method, emissions associated with flight in the cruise mode were identified based on subtracting the LTO based emissions from the fuel dispensed. ACRP Report suggests streamlining the emissions by: a) on the ground, b) flight from the ground to 3,000 feet, and c) flight above 3,000 ft (cruise). Ground would represent the LTO cycles (taxi/idle/delay and takeoff), whereas ground to 3,000 would encompass approach and climbout. Cruise is not represented in the LTO cycle.

In preparing the inventory, fuel consumption specifically associated with the Auxiliary Power Unit (APU) on aircraft could be identified. However, similar to departure operations, such fuel use is reflected in the fuel dispensed. Therefore, unlike an emissions inventory for criteria pollutants, the greenhouse gas inventory for aircraft (cruise-related emissions) reflects fuel burn associated with the APU.

As King County does not operate aircraft, the emissions associated with these sources are identified as Airline/ Aircraft Operator/ Tenant-owned/ controlled emissions.

LTO Emissions for year 1990 and 2020 were prepared based on activity levels for those years taken from the FAA's Terminal Area Forecast, showing actual activity in 1990 and a forecast for 2020, as prepared by FAA 2009 (recognizing that the FAA updates the TAF annually). Based on a review of TAF data for the year 2007, the FAA's official TAF contains inaccurate data, and thus information from the County was used. Thus, the activity levels evaluated in this inventory represent:

- 1990: 331,643 operations
- 2007: 300,184 operations
- 2020: 308,242 operations

Fuel dispensed was available for year 2007. To estimate fuel dispensed in 1990 and 2020, the fuel estimated by EDMS in

LTO cycle was calculated and then cruise fuel was estimated in proportion to the 2007 levels for both JetA and Avgas.

Because CO_2 is the largest total quantity directly emitted, and because consistent factors are not available for all pollutants, a CO_2 equivalent (CO_{2e}) is not evaluated in this report at this time.

II.2.2 Fleet Vehicles and Ground Support Equipment (GSE)

This category refers to all of the vehicles that support aircraft and airport activity. The method used to quantify GSE emissions was:

King County Fleet Vehicles

Separate from tenant GSE, the County operates service equipment that includes: firefighting equipment, snow removal, airport administrative ground travel, and airport maintenance vehicles. In 2007, the County purchased 22,256 gallons of gasoline, and nearly 6,198 gallons of diesel to serve its fleet vehicles. CO_2 emissions associated with the consumption of these fuels were computed based on standard CO_2 factors (i.e., 19.564 lbs of CO_2 per gallon of gasoline, and 22.384 lbs of CO_2 per gallon of diesel).

In lieu of the availability of 1990 and 2020 fuel use by these vehicles, County fleet vehicle fuel use and emissions were estimated in occur in proportion to the change in total airport operations relative to 2007.

Tenant GSE

- At this time, a publicly available source of greenhouse gas emission factors could not be identified for airport GSE. EPA's NONROAD2005 model was run for the national fleet of non-road vehicles to identify the range of emission factors associated with various horse-power ranges (i.e., 175<hp<=300) non-road equipment in 2007. An average emission factor for each range of horse-power was calculated from the NONROAD2005 data and used as a surrogate rate for GSE. Given the relative consistent emission factors across various engine sizes, this approach appears reasonable. The NONROAD2005 emission factor represents the emissions in grams per break-horse-power hour of CO_2.
- For criteria pollutant emissions, the FAA EDMS is used by the airport community to prepare an emissions inventory. Unfortunately, at this time, the FAA's EDMS does not generate greenhouse gas emissions associated with GSE. Therefore to estimate tenant GSE associated with aircraft for each year (1990, 2007, and 2020), default GSE information was obtained from EDMS (vehicle type/class and time of use) and then emission factors for these vehicles were obtained from NONROAD2005.
- Emissions associated with each vehicle type were computed as the product of the total hours of use, horsepower rating, load factor, and the emission rate.

II.2.3 Ground Access Vehicles (GAV)

GAV generally are all of the street-licensed vehicles that operate to and from the Airport or that operate on the airfield to the tie-down areas. GAV vehicles at Boeing Field are primarily associated with passengers, employees, aircraft owners, and cargo travel. It is not possible to capture in an inventory all GAV emissions with the data that is presently available, but rather this emissions inventory focused on capturing GAV emissions from passengers, and other surface movements for which data is readily available. Thus, greenhouse gas emissions GAV were quantified using the following steps:

- In 2007, Boeing Field accommodated 27,352 passengers. No information exists to identify passenger ground travel mode. Passengers were assumed to access the Airport using the following modes: 47% by private vehicle, 10% by rental car, 26% by taxi/limo, 7% by other, and 10% by Kenmore vans to/from Sea-Tac Airport. All vehicles are assumed to be gas except for Kenmore Air vans, which are assumed to be gas and diesel.

Travel distance was also estimated. Private vehicles were estimated to travel nearly 50 miles round trip, whereas taxi's and van's were estimate to travel 7 miles round trip.

With the exception of Kenmore Air vans to/from Sea-Tac, fuel consumption associated with these vehicular trips was then calculated using a national fuel economy average for 2007 of 22.5 miles per gallon.

Kenmore Air provided information concerning fuel purchases associated with their vans (1,772 gallons gas and 2,648 gallons of diesel in 2009, which was assumed also applicable to 2007).

- County employee commute travel was included. In 2007, 53 full time County employees were employed at Boeing Field as well as 12 part-time interns. Employees are estimated to travel about 30 miles round trip and have the same vehicle fuel economy as passengers.
- Based on county security badge records, the number of on-airport vehicles traveling to tenant locations or to access aircraft tie-downs were estimated. Employee travel in 2007 was identified based on County survey of the tenants. Tenant reported that their GAVs consumed 16,683 gallons of gas, 17,752 gallons of diesel, and 88 equivalent gallons of propane in 2007. Emissions in 2007 were directly calculated based on earlier described emission factor for CO_2. Emissions in 1990 and 2020 were estimated to be in proportion to the difference in the level of activity between 1990 or 2020 and actual levels in 2007. The on-airport portion travel of the users accessing their tie-down stalls, while representing a Scope 3 emission, the activity is controlled by the County due to the security requirements of these users. Thus, in some tables these Scope 3 emissions are noted in the category of owned or controlled emissions.
- Tenant employee travel was estimated in two ways. Responses to a County survey indicate that 8,494 gallons of gas were consumed by employee work commute and 574 gallons of diesel fuel in 2007. For other vehicles, based on survey data, nearly 348 vehicle trips occurred on the airfield with an estimated average travel distance of 2 miles (on airport travel). Emissions were then calculated based on national average fuel economy, as noted for passengers.
- The portion of on-airport travel that the County could control was then estimated to be 0.5 mile roundtrip for those accessing the terminal or other non-secure parking lots at the airport. Vehicles entering the Air Operations Area were then estimated to travel 2 miles round trip.
- GAV travel in 1990 and 2020 were estimated in proportion to the level of airport operations difference in each year relative to 2007 levels.

II.2.4. Facility/Stationary Source Emissions

Stationary fossil fuel burning equipment primarily include heating and cooling, power supplies for building (i.e., electrical consumption) activities. The following data was collected in order to quantify emissions from these sources:

- A substantial quantity of electricity is consumed at an airport to power lighting in the terminal, support facilities, and airfield. King County records indicate that about 5,376,028 kilowatt hours (kWh) of electricity was purchased by the County at the Airport from City Light in 2007. Using the Seattle Climate Partnership CO_{2e} generation rate for electrical power from City Light of 0.018 pounds of CO_{2e} per kWh (2007), County controlled Airport facilities generate about 20 metric tons of electricity based CO_{2e} in 2007.

  It is important to note that the emission factor for City Light electrical consumption has declined over the years due to the reliance on cleaner power and the commitment to offset electrical generation. Thus in estimating emissions that would have occurred in 1990, several approaches

were considered. First, electrical consumption for 1990 was estimated in proportion to the difference in the level of airport activity in 1990 relative to 2007 levels. That indicates that in 1990 approximately 6,448,110 kWh was consumed. Then consideration was given to the emission factor for 1990. Three approaches were considered – using the 2007 factor for City Light (0.018 lbs/kWh), using the 2005 City Light factor (0.57 lbs/kWh) or using the factor from Puget Sound Energy in 2007 (0.8517 lb/kWh). A 1990 City Light emission factor could not be identified.

As evidenced, these numbers are substantially different and have a heavy influence on the resulting electricity-related inventory. Because of that influence, the 2005 City Light emission factor (0.057) was used.

- While the County invoices some of its tenants for the electricity and natural gas that they consume, because the County owns the facilities and receives the invoices from utility providers, the emissions are noted as Scope 2 emissions.
- In addition to electricity, the County purchases natural gas for purposes of heating various airport-related facilities. In 2007, County records indicate that 71,884 therms of natural gas were purchased, which generated about 381 metric tons of CO_{2e}.
- The County also consumes diesel fuel to power stationary sources, such as generators. Because the fuel consumed by the generators is not separately reported, the emissions from those sources are reflected in the County-owned fleet vehicles noted earlier.
- Facility-related greenhouse gas emissions in 1990 and 2020 were estimated in proportion to a blended rate comparing 2007 conditions for operations and passengers to activity levels in 1990 and 2020. This blended rate was used as some base energy is required to support facilities regardless of the level of activity accommodated.

II.2.5. Other Source Emissions

Three other categories of emissions are often accounted for in airport inventories: construction emissions, use of refrigerants, and recycling. These emissions were not quantified for this inventory, as they are not expected to be significant on an annual basis or data was not available.

II.3 UNCERTAINTIES AND DATA CAUTIONS

The inventories for Boeing Field documented in Section III were prepared using the ACRP 11 Report guidance, which reflects guidance to airport operators for preparation of greenhouse gas emissions inventories. That guidance notes, and this report acknowledges, that there are limitations associated with some of methodologies,

Most notably, few airports have data concerning all of the airport-related sources or do not have the data at an appropriate level of detail necessary to prepare inventories separating Scope 1, 2, or 3 emissions. As a result, most airport operators preparing inventories are required to make data assumptions.

The inventories prepared for this evaluation rely on known data, where data is available. The following bullets note limits associated with the various source assumptions:

- Aircraft: the aircraft emissions inventory is of high quality. Fuel dispensed at the Airport is a reliable source and the conversion of fuel burn to CO_2 emissions is relatively well understood. Given the current format of fuel data, it is not possible to separate out the emissions associated with Auxiliary Power Unit (APU). For most airports, aircraft-related CO_2 emissions represent 80 to 90% or more of the airport-wide emissions.
- Ground Support Equipment (GSE): No greenhouse gas emission factor data is currently available for GSE, and thus this evaluation relied on average emis-

sion factors associated with other non-road vehicles. Also, no fleet specific data is available concerning GSE at Boeing Field. Therefore, the County may wish to consider a more comprehensive evaluation of tenant GSE, noting either fuel dispensed to these vehicles, as well as vehicle type, energy type, and annual use.

- Ground Access Vehicles (GAV): Estimates of GAV emissions were prepared for Boeing Field based on information about passenger levels and employees. Future surveys of passenger and employee ground travel and vehicle/fuel types would improve the accuracy of the GAV evaluation.
- Facilities/Stationary Sources: The County retains data concerning fuel use by airport facilities and stationary sources. This enables a clear identification of CO_2 emissions. Fuel consumption of tenant activities was not pursued as few airports are able to obtain such information without extensive data collection processes.

As noted, a City Light electrical generation emission factor for 1990 could not be located. In lieu of a 1990 factor, the 2005 factor was used which is nearly 6 times greater than the 2007 factor, but substantially less than the PSE factor. These differences are associated with the commitment by City Light to offset emissions associated with its electrical generation.

- No information was available concerning the use of refrigerants at the airport. The chemical composition of some refrigerants is known to have high global warming potential values (such as R-134a containing 1,1,1,2 Tetrafluoroethane with a global warming potential of 1,300). Future survey work should include the identification of any refrigerants in use.

It is not possible to quantify the degree of uncertainty associated with this inventory. Rather, the quality of the investigation is likely to be equal or greater than that for other local inventories because of the emissions associated with aircraft activity and the use of actual fuel dispensed data for 2007.

III. EMISSIONS INVENTORY

This chapter presents the results of the inventory. First is the inventory for 2007, as it is based on actual fuel consumption data or estimates. A backcast of emissions in 1990 and a forecast of emissions for 2020 were prepared. In lieu of fuel consumption information, the backcast and forecast, as noted in Chapter II, were estimated in proportion to activity differences between 1990 and 2007 for all sources with the exception of aircraft LTO emissions. Aircraft LTO fuel was quantified using the FAA's EDMS model based on the FAA's 2010 Terminal Area Forecast. Cruise emissions for 1990 and 2020 were then estimated in the same LTO/Cruise proportion as occurred in 2007. The chapter then concludes with a brief summary of possible County next steps.

As this chapter shows, CO_2 emissions associated with King County International Airport have increased between 1990 and 2007, and would continue to increase through 2020 if no further fuel conservation mechanisms are put in place.

- 1990 CO_2 emissions: 187,472 metric tons
- 2007 CO_2 emissions: 263,414 metric tons (41% increase over 1990)
- 2020 forecast business as usual CO_2 emissions: 304,132 metric tons (nearly 16% over 2007)

III.1 EXISTING (2007) GREENHOUSE GAS EMISSIONS

Table III-1 provides a summary of the 2007 greenhouse gas inventory. As the table notes, activity due to the Airport generated 263,414 metric tons of CO_2 in 2007, not including the non-CO_2 greenhouse gases and the emissions associated with The Boeing Company ground activities. Relative to this total, 0.3% of the emissions are associated with King County's Airport Division activities, 99.4% of the emissions are associated with tenant activities, and 0.3% by public access activities.

III.1.2 KING COUNTY OWNED OR CONTROLLED EMISSIONS

As noted in **Table III-1**, the sources of emissions that King County either owns or has authority to control at King County International Airport represent 686 metric tons of CO_2 in 2007. **Figure ES-1** shows the proportion of emissions associated with the King County's Airport Division.

As this table on the next page notes, the largest portion of greenhouse gas emissions that the County either owns or has substantial control, were natural gas use at these Airport facilities (381 tons), and then fuel consumption from county fleet vehicles (260 tons). Due to the carbon offsetting activities of City Light, which supplies electricity to the Airport, electrical-related emissions represent 6.4% of the County's emissions. This is graphically shown in **Exhibit ES-2**.

Nearly 62% of the County's owned and controlled emissions are from two sources: electrical and natural gas consumption at airport facilities.

About 72% of natural gas consumption at Airport facilities occurs at two locations: Airport Maintenance Shop (48%) and the Main Terminal (25%).

TABLE III-1
SUMMARY OF GREENHOUSE GAS EMISSIONS ASSOCIATED WITH BOEING FIELD ACTIVITY (2007 AND BACKCAST 1990 AND FORECAST 2020)

User/Source Category	WRI Scope	2007 CO2 (tons/ year)	2007 Percent of User	2007 % of Total	CO2 Emissions 1990 Backcast	CO2 Emissions 2020 Forecast
King County-owned/controlled						
Facilities/Stationary Sources						
Electrical	2	44	6.4%	0.0%	127	53
Other (oil, gas)	1	381	55.6%	0.1%	323	487
Facilities Total	½	425	62.0%	0.2%	449	541
County Fleet Vehicles (on- and off-road)	1	260	38.0%	0.1%	288	267
Ground Access Vehicles (on-airport travel)	3	0.3	0.0%	0.0%	0	0
King County-owned/controlled Total		**686**	**100.0%**	**0.3%**	**737**	**809**
Airlines/Aircraft Op/Tenants-owned/controlled**						
Aircraft						
Approach	3	8,628	3.3%	3.3%	6,694	10,006
Taxi/Idle/Delay	3	21,837	8.3%	8.3%	15,557	25,102
Takeoff	3	10,343	3.9%	3.9%	7,318	12,077
Climbout	3	5,945	2.3%	2.3%	4,592	6,733
Subtotal LTO	3	46,752	17.8%	17.7%	34,161	53,918
Residual/Cruise/APU	3	212,776	81.2%	80.8%	149,333	245,628
Aircraft Total	3	**259,528**	**99.1%**	**98.5%**	**183,494**	**299,547**
Ground Support Equipment	3	**2,001**	**0.8%**	**0.8%**	**2,211**	**2,055**
Ground Access Vehicles (on-airport and off-airport)	3					
Tenant Ground Access Vehicles	3	**308**	**0.1%**	0.1%	**340**	**316**
Tenant Employee Commute	3	**82**	**0.0%**	0.0%	**91**	**84**
Ground Access Vehicles Total	3	**390**	**0.1%**	**0.1%**	**431**	**401**
Stationary Sources	3	**-**	**0.0%**	**0.0%**	-	-
Airline/Tenant-owned/controlled Total		**261,919**	**100.0%**	**99.4%**	**186,136**	**302,002**
Public-owned/controlled**						
Passengers (on and off airport)	3	378	46.7%	0.1%	122	651
County Employee Commute (on and off airport)	3	327	0.1%	0.1%	362	563
Tiedown users (off airport)	3	104	12.8%	0.0%	115	106
Public-owned-controlled Total		**810**	**100.0%**	**0.3%**	**599**	**1,321**
Total Metric Tons		**263,414**		**100%**	**187,472**	**304,132**
Operations		**300,184**			**331,643**	**308,242**
Enplanements		**27,352**			**8,837**	**47,060**

Source: Synergy Consultants, January 2011. Activity: FAA Terminal Area Forecast November 2010.

Note the difference between **Table III-1 and III-2** relates to the inclusion of the tie-down users on-airport roadway-related emissions. While these are Scope 3 emissions, there is some degree of control that the County can exert over these emissions.

Of electrical consumption at King County International Airport facilities, 85% is associated with the following buildings:

AOC Building	nearly 26%
Arrivals Building	19%
Main Terminal	16%
South Pump House	9%
7300 Building	8%
FAA Air Traffic Tower	7%

Of these seven (7) buildings, consumption at each ranged from over 1 million kilowatt hours to a low of 300,000 kilowatt hours per year. As noted in Section II, while the County invoices some if its tenants for electrical consumption, because the facilities are owned by the County and the County receives the invoice from the utility provider for the utility use, these emissions are considered Scope 2.

III.1.2 AIRCRAFT OPERATOR/TENANT OWNED/CONTROLLED EMISSIONS

Aircraft Operator/tenant-owned and controlled emissions represent 99% of airport-related emissions are noted in **Table III-1** or nearly 262,000 metric tons of CO_2 in 2007. As would be expected, aircraft represented the single largest source of CO_2 emissions associated with the Airport at nearly 99% (259,528 metric tons of CO_2).

GSE represent the second largest source of airline/tenant emissions at nearly 1%.

No tenant information was pursued concerning facility of stationary source emissions. It is likely that some facility-based power is expended by tenants, and tenant maintenance and industrial activities are conducted with some leaseholds which are not reflected in this inventory.

Most notably, while The Boeing Company flight activity was considered in the LTO based emissions, an evaluation of The Boeing Company (a large tenant at the airport), was beyond the scope of this inventory.

III.1.3 PUBLIC-OWNED/CONTROLLED EMISSIONS

Within this inventory, all of the public-owned and controlled emissions reflect on-road travel associated with airport activity: vehicular access by passengers and aircraft owners accessing their tiedowns.

Of airport-related emissions public-owned and controlled represent the vehicular travel off airport. This represents the smallest group of Airport-related emissions at 0.3% of total Airport emissions or 810 metric tons of CO2 in 2007. Within this category, passenger ground travel to/from the airport represents nearly 47% and aircraft owners accessing the Airport represent about 13%.

III.2 BACKCAST (1990) AND FORECAST (2020) GREENHOUSE GAS EMISSIONS

As noted in Section III.3, Washington State and King County have adopted greenhouse gas emission reduction goals. At this time, a reasonable aviation activity forecast for 2050 does not exist, that would enable a comparison of emissions at the Airport to the County goal. However, using the FAA's Terminal Area Forecast, the anticipated activity/emissions in 2020 can be compared with the state goal of reducing emissions to 1990 levels. However, to do so requires an estimate of emissions that occurred in 1990 and then how those emissions would compare to those anticipated for 2020.

Based on activity that occurred in 1990, the fuel use/CO_2 emissions that occurred in 1990 was estimated in proportion to activity/emissions in 2007 with the exception of

aircraft. Aircraft emissions were first modeled for the LTO cycle emissions based on the level of activity and fleet mix occurring in the respective year. Then Cruise/APU emissions were estimated in proportion to LTO/Cruise that existed in 2007.

Table III-1 lists the emissions for 1990 and 2020 by source category and enables a comparison relative to 2007 levels. As noted, in 1990, King County International Airport processed 331,643 annual aircraft operations and 8,837 enplaned passengers (passengers boarding commercial flights). FAA's 2010 TAF forecasts that total aircraft operations in 2020 are expected to remain lower than the 1990 levels, and only slightly larger than 2007 operations. Projected to be 308,242 operations and 47,060 enplanements in 2020, the enplaned passenger level in 2020 would be 72% greater than 2007 levels of 433% greater than 1990 levels. The activity projections then have a large effect on predicting future emissions.

Figure ES-4 shows the trend in Scope 1 and 2 emissions between 1990, 2007, and 2020.

III.2.1 1990 Emissions (Backcast)

About 187,472 metric tons of CO_2 are estimated to have been emitted in 1990 due to activity at King County International Airport.

Slightly less than 1% of emissions were associated with sources owned or controlled by the County at about 737 metric tons.

Aircraft emissions, a Scope 3 emissions from the County inventory perspective, represented 183,494 metric tons. The second largest source of airport emissions in 1990 were due to aircraft GSE vehicles at 2,211 tons (also Scope 3), and then airport passenger surface travel-related emissions at 599 metric tons (Scope3).

III.2.2 2020 Emissions (Forecast)

The forecast for 2020 represents a business as usual condition relative to actions that the County has taken through the 2007 timeframe. Thus, this forecast is often referred to as a business as usual (BAU) case, as it is expected that the County will enact further energy conservation measures designed to reduce energy use and greenhouse gas emissions. Thus the 2020 BAU condition provides a sort of benchmark for comparing emission reduction actions.

Total airport-related emissions are expected to increase to 304,132 metric tons of CO_2 in 2020. Whereas emissions increased nearly 41% between 1990 and 2007, the rate of increase of total airport-related emissions is expected to slow to 15.5% between 2007 and 2020. Scope 1 and 2 emissions are expected to increase by about 18% between 2007 and 2020 under Business as Usual, whereas they increased 10% between 1990 and 2007. The change between 1990 and 2007 is largely a function of a large assumed decrease in electrical-related CO_2 emissions at the same time with an increase in fleet vehicle fuel consumption.

In 2020, aircraft emissions are expected to continue to remain the single largest source of airport-related emissions under the BAU scenario.

As a BAU scenario, this analysis does not reflect the following anticipated actions, as it is not possible at this time to precisely identify how they will affect the emissions associated with the Airport:

- Continued technological improvements associated with aircraft engine design and operation. Several industry associations anticipate a 1-3% per year fuel consumption reduction through 2020.
- Ground support activities in the area are transitioning to cleaner burning vehicles.
- The County, like many governmental agencies and airport operators are ex-

amining airport facilities to reduce energy consumption.

- National fuel consumption standards for GAV are expected to further reduce fuel consumption from on-road travel.

III.3 NEXT STEPS

Now that the first full airport inventory has been prepared, the County will likely begin to further refine how it will comply with the many local emission reduction commitments that have been discussed. These include:

2008 King County Comprehensive Plan

- Collaborate with other local governments, businesses, and residents in the region to reduce greenhouse gas emissions throughout the region to 80 percent below 2007 levels by 2050

Washington emission reduction objectives (ESSB 2815):

- By 2020, reduce overall emissions of GHGs in the state to 1990 levels
- By 2035, reduce emissions to 25% below 1990 levels
- By 2050, reduce emissions to 50% below 1990 levels

At present, an aviation forecast has not been prepared for periods beyond 2030. Therefore, the following paragraphs identify how the 2020 forecast of business as usual (BAU) compares to the 2020 State of Washington goal of reducing 2020 emissions to the 1990 level. This commitment is expected to be applicable to emissions referred to as Scope 1 and 2 (as defined in Chapter 2).

Table ES-4 translates the inventory presented in earlier into the WRI Scope 1, 2, 3 format. As the table notes, 1990 emissions of Scope 1 and 2 totaled 737 metric tons. By 2020, with continued business as usual, the emissions are expected to reach to 808 tons (Scope 1 and 2). Thus to achieve the desired goal of 1990 emissions of reducing emissions from owned and controlled sources, the County would need to reduce emissions by 71 metric tons of CO_2 (nearly 9% over projected BAU levels).

Registries and Emissions Reporting

The emissions inventory prepared for this document relied on ACRP Report 11 in terms of presenting the emissions. This format was used to be of assistance to the Airport in future evaluations and decisions on mitigation. The County may also wish to submit its emissions inventory to The Climate Registry or another reporting entity, and thus, a formal presentation based on Scope 1, 2, and 3 is often desired. **Table III-2** provides that listing.

Mitigation:

The County will likely need to investigate various options to reducing emissions to achieve the targeted emissions by 2020. Given the dominance of facility-related power consumption relative to the County's emissions, a review of possible energy conservation measures should be conducted. An Energy Audit and facility assessment has been completed by the County. Recommendations of this assessment should be given high priority and could substantially assist the County with meeting its greenhouse gas emission reduction targets for airport-related sources. Both local utility providers (City Light and Puget Sound Energy) provide incentive programs for upgrading facility systems for energy efficiency.

In addition, the County owns a number of obsolete buildings at the airport. Upgrade of the energy efficiency and/or demolition should be considered. New construction should follow the guidance provided in the County's 2008 Green Building and Sustainable Infrastructure Ordinance. To assist the

County with considering various actions, Scorecard has been prepared that identifies nine categories, including a set of prerequisites, seven sets of credits (optional items) organized by key topics of sustainability. This online scorecard[16] provides information for achieving each prerequisite and credit which could be applied to future airport development.

The County should also consider the purchase of sustainable electrical service from City Light. While the City has committed to offsetting electrical power generation, in today's financial climate, their ability to continue to do so is predicated on their major customers' purchasing sustainable power. This could help the County also meet its Energy Plan objectives for clean energy use.

The County should also continue coordination with its tenants about energy efficiency and greenhouse gas emission reduction actions. Included in this coordination should be the consideration of renewable power projects, such as solar power. Guidance concerning these activities is provided in ACRP Report 21 *Airport Energy Efficiency and Cost Reduction.* as well as FAA's *Technical Guidance For Evaluating Selected Solar Technologies on Airports.*

In 2001, with the passage of the FAA Reauthorization (Vision 100 – Century of Aviation), congress required FAA to create a program to fund airport voluntary emission reduction action. While this program is designed to reduce criteria pollutants (carbon monoxide, ozone precursors, etc), the reduction of criteria pollutants has the potential to also reduce greenhouse gases. This program, referred to as the Voluntary Airport Low Emission (VALE) program, is available to fund between 75%-95% of the cost of airport infrastructure or the differential cost of replacing vehicles with cleaner energy vehicles. King County International Airport is identified as an airport that is eligible for VALE funding, because the Airport is a commercial service airport located in a area designated by US EPA as non-attainment or maintenance for a criteria pollutant; Boeing Field is located in the Central Puget Sound maintenance area for carbon monoxide and course particulate matter (PM10 - 10 microns or smaller).[17]

To date, FAA VALE funding has been provided for the following types of projects:

- Installation of preconditioned air/and ground power to reduce aircraft APU use;
- Central heating and cooling plant improvements with emissions controls;
- Renewable Energy Projects: Geothermal HVAC system and solar power
- Conversion of fleet vehicles to cleaner fuel vehicles

Additional funding sources may also be available to assist with various programs. While the grant application period has closed the US EPA's National Clean Diesel Funding Assistance Program recently solicited proposals nationwide for projects that achieve significant reductions in diesel emissions in terms of tons of pollution produced and diesel emissions exposure, particularly from fleets operating in areas designated by the Administrator as poor air quality areas. Eligible diesel emission reduction solutions included vehicle engine retrofit devices, cleaner fuels, and engine upgrades, and/or vehicle or equipment replacement.

[16] http://your.kingcounty.gov/solidwaste/greenbuilding/scorecard.asp

[17] http://www.faa.gov/airports/environmental/vale/

TABLE III-2
Emissions Presented by Scope 1, 2, and 3 (tons per year)

	1990 Back-cast	2007	2020 Forecast
Scope 1 Emissions			
Stationary Source Power	323	381	487
Fleet Vehicles	288	260	267
Subtotal	610	642	755
% of total	0.33%	0.24%	0.25%
Scope 2 Emissions			
Purchased Electricity	127	44	53
% of total	0.07%	0.02%	0.02%
Scope 3 Emissions			
Aircraft	183,494	259,528	299,547
GSE	2,211	2,001	2,055
On Airport GAV	0	0	0
Off Airport GAV	577	790	1,074
Employee Commute	453	410	648
Subtotal	186,735	262,729	303,323
% of total	99.6%	99.7%	99.7%
Total Scope 1, 2 and 3	187,472	263,414	304,132

Source: Synergy Consultants, January 2011.
Note the difference between **Table III-1 and III-2** relates to the inclusion of the on-airport roadway-related emissions. While these are Scope 3 emissions, there is some degree of control that the County can exert over these emissions.

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Appendices

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Appendix A - Abbreviations, Glossary, and References

Abbreviations

ACRP - Airport Cooperative Research Program of the Transportation Research Board
APU - Auxiliary Power Unit
AVI - Automatic Vehicle Identification

BFI - King County International Airport (Boeing Field), three letter designator
BTU - British Thermal Units

CCP - Climate Protection Program of ICLEI
CEQA - California Environmental Quality Act
CNG - Compressed Natural Gas
CO_2 - Carbon Dioxide
CO_{2e} -Carbon Dioxide equivalent

EDMS - Emissions Dispersion Modeling System
EIA - Energy Information Administration of the Department of Energy
EPA - US Environmental Protection Agency

FAA - Federal Aviation Administration

GAV - Ground Access Vehicle
GHG - Greenhouse Gases
GSE - Ground Support Equipment
g-bhp-hr: Grams per brake horsepower hour

ICLEI - Organization once known as International Council for Local Environmental Initiatives
IPCC - Intergovernmental Panel on Climate Change

KCIA - King County International Airport
kWh - Kilowatt hour

LTO - Landing and Takeoff Cycle

NEPA - National Environmental Policy Act

SCP - Seattle Climate Partnership
SEA - Sea-Tac Airport
SEPA - Washington State Environmental Policy Act

WRI - World Resource Institute

USEPA - US Environmental Protection Agency

Glossary

AIR CARRIER: An operator (e.g., airline) in the commercial system of air transportation consisting of aircraft that hold certificates of Public Convenience and Necessity issued by the Department of Transportation to conduct scheduled or non-scheduled flights within the country or abroad.

AIR POLLUTION: One or more chemicals or substances in high enough concentrations in the air to harm humans, other animals, vegetation, or materials. Such chemicals or physical conditions (such as excess heat or noise) are called air pollutants.

ALTERNATIVE ENERGY: Energy derived from nontraditional sources (e.g., compressed natural gas, solar, hydroelectric, wind).

ANTHROPOGENIC: Human made. In the context of greenhouse gases, anthropogenic emissions are produced as the result of human activities.

ATMOSPHERE: The mixture of gases surrounding the Earth. The Earth's atmosphere consists of about 79.1 percent nitrogen (by volume), 20.9 percent oxygen, 0.036 percent carbon dioxide and trace amounts of other gases. The atmosphere can be divided into a number of layers according to its mixing or chemical characteristics, generally determined by its thermal properties (temperature). The layer nearest the Earth is the troposphere, which reaches up to an altitude of about 8 kilometers (about 5 miles) in the polar regions and up to 17 kilometers (nearly 11 miles) above the equator. The stratosphere, which reaches to an altitude of about 50 kilometers (31miles) lies atop the troposphere. The mesosphere, which extends from 80 to 90 kilometers atop the stratosphere, and finally, the thermosphere, or ionosphere, gradually diminishes and forms a fuzzy border with outer space. There is relatively little mixing of gases between layers.

AVIATION GASOLINE: All special grades of gasoline for use in aviation reciprocating engines, as cited in the American Society for Testing and Materials (ASTM) specification D 910. Includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further processing (any refinery operation except mechanical blending). Also included are finished components in the gasoline range, which will be used for blending or compounding into aviation gasoline.

BIOFUEL: Gas or liquid fuel made from plant material (biomass). Includes wood, wood waste, wood liquors, peat, railroad ties, wood sludge, spent sulfite liquors, agricultural waste, straw, tires, fish oils, tall oil, sludge waste, waste alcohol, municipal solid waste, landfill gases, other waste, and ethanol blended into motor gasoline.

BRITISH THERMAL UNIT (Btu): The quantity of heat required to raise the temperature of one pound of water one degree of Fahrenheit at or near 39.2 degrees Fahrenheit.

BUNKER FUEL: Fuel supplied to ships and aircraft for international transportation, irrespective of the flag of the carrier, consisting primarily of residual and distillate fuel oil for ships and jet fuel for aircraft.

CARBON CYCLE: All carbon reservoirs and exchanges of carbon from reservoir to reservoir by various chemical, physical, geological, and biological processes. Usually thought of as a series of the four main reservoirs of carbon interconnected by pathways of exchange. The four reservoirs, regions of the Earth in which carbon behaves in a systematic manner, are the atmosphere, terrestrial biosphere (usually includes freshwater systems), oceans, and sediments (includes fossil

fuels). Each of these global reservoirs may be subdivided into smaller pools, ranging in size from individual communities or ecosystems to the total of all living organisms (biota).

CARBON DIOXIDE: A colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Carbon dioxide is a product of fossil fuel combustion. Although carbon dioxide does not directly impair human health, it is a greenhouse gas that traps terrestrial (i.e., infrared) radiation and contributes to the potential for global warming.

CARBON EQUIVALENT (CE) or CARBON DIOXIDE EQUIVALENT: A metric measure used to compare the emissions of the different greenhouse gases based upon their global warming potential (GWP). Greenhouse gas emissions in the United States are most commonly expressed as "million metric tons of carbon equivalents" (MMTCE). Global warming potentials are used to convert greenhouse gases to carbon dioxide equivalents (CO_{2e}).

CARBON SEQUESTRATION: The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Fossil fuels were at one time biomass and continue to store the carbon until burned.

CLIMATE: The average weather, usually taken over a 30 year time period, for a particular region and time period. Climate is not the same as weather, but rather, it is the average pattern of weather for a particular region. Weather describes the short-term state of the atmosphere. Climatic elements include precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hailstorms, and other measures of the weather.

CLIMATE CHANGE: The term "climate change" is sometimes used to refer to all forms of climatic inconsistency, but because the Earth's climate is never static, the term is more properly used to imply a significant change from one climatic condition to another. In some cases, "climate change" has been used synonymously with the term, "global warming"; scientists however, tend to use the term in the wider sense to also include natural changes in climate.

COMBUSTION: Chemical oxidation accompanied by the generation of light and heat.

COMMERCIAL SECTOR: An area consisting of non-housing units such as non-manufacturing business establishments (e.g., wholesale and retail businesses), health and educational institutions, and government offices.

CONCENTRATION: Amount of a chemical in a particular volume or weight of air, water, soil, or other medium.

CONTRAIL: Contrails are line-shaped clouds or "condensation trails," composed of ice particles that are visible behind jet aircraft engines, typically at cruise altitudes in the upper atmosphere. Aircraft engines emit water vapor, carbon dioxide (CO_2), small amounts of nitrogen oxides (NOx), hydrocarbons, carbon monoxide, sulfur gases, and soot and metal particles formed by the high-temperature combustion of jet fuel during flight.

CRITERIA POLLUTANT: A pollutant determined to be hazardous to human health and regulated under EPA's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act require EPA to describe the health and welfare impacts of a pollutant as the "criteria" for inclusion in the regulatory regime. In this report, emissions of the criteria pollutants are carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), and sulfur oxides (SOx).

EMISSION FACTOR: The rate at which pollutants are emitted into the atmosphere by one source or a combination of sources.

EMISSION INVENTORY: A list of air pollutants emitted into a community's, state's, nation's, or the Earth's atmosphere in amounts per some unit time (e.g. day or year) by type of source. An emission inventory has both political and scientific applications.

EMISSIONS COEFFICIENT/FACTOR: A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of carbon dioxide emitted per barrel of fossil fuel consumed).

EMISSIONS: Releases of gases to the atmosphere (e.g., the release of carbon dioxide during fuel combustion). Emissions can be either intended or unintended releases.

ENERGY CONSERVATION: Reduction or elimination of unnecessary energy use and waste.

ENERGY INTENSITY: Ratio between the consumption of energy to a given quantity of output; usually refers to the amount of primary or final energy consumed per unit of gross domestic product.

ENERGY: The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. In the United States, electrical energy is often measured in kilowatt-hours (kWh), while heat energy is often measured in British thermal units (Btu).

ENERGY-EFFICIENCY: The ratio of the useful output of services from an article of industrial equipment to the energy use by such an article; for example, vehicle miles traveled per gallon of fuel (mpg).

ENHANCED GREENHOUSE EFFECT: The concept that the natural greenhouse effect has been enhanced by anthropogenic emissions of greenhouse gases. Increased concentrations of carbon dioxide, methane, and nitrous oxide, CFCs, HFCs, PFCs, SF6, NF3, and other photochemically important gases caused by human activities such as fossil fuel consumption, trap more infra-red radiation, thereby exerting a warming influence on the climate.

ENPLANEMENTS: The number of passengers on departing aircraft.

ETHANOL (C_2H_5OH): Otherwise known as ethyl alcohol, alcohol, or grain spirit. A clear, colorless, flammable oxygenated hydrocarbon with a boiling point of 78.5 degrees Celsius in the anhydrous state. In transportation, ethanol is used as a vehicle fuel by itself (E100), blended with gasoline (E85), or as a gasoline octane enhancer and oxygenate (10 percent concentration).

FAA ASDi (Aircraft Situation Display to Industry): This represents data collected by the FAA that tracks the minute-by-minute progress of their aircraft in real-time. The ASDI information includes the location, altitude, airspeed, destination, estimated time of arrival and tail number or designated identifier of air carrier and general aviation aircraft operating on IFR flight plans within U.S. airspace.

FAA T-1 DATA: This data base refers to information collected by the FAA and reported by the Bureau of Transportation Statistics concerning on-time arrival data for non-stop domestic flights by major air carriers, and provides such additional items as departure and arrival delays, origin and destination airports, flight numbers, scheduled and actual departure and arrival times, cancelled or diverted flights, taxi-out and taxi-in times, air time, and non-stop distance.

FIXED BASED OPERATOR (FBO): A private operator that may conduct refueling, aircraft or ground support equipment services for others at the airport.

FLUOROCARBONS: Carbon-fluorine compounds that often contain other elements such as hydrogen, chlorine, or bromine. Common fluorocarbons include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

FOSSIL FUEL: A general term for buried combustible geologic deposits of organic materials, formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the Earth's crust over hundreds of millions of years.

FOSSIL FUEL COMBUSTION: Burning of coal, oil (including gasoline), or natural gas. The burning needed to generate energy release carbon dioxide by-products that can include unburned hydrocarbons, methane, and carbon monoxide. Carbon monoxide, methane, and many of the unburned hydrocarbons
slowly oxidize into carbon dioxide in the atmosphere. Common sources of fossil fuel combustion include cars and electric utilities.

FREON: See chlorofluorocarbon.

FUGITIVE EMISSIONS: Unintended gas leaks from the processing, transmission, and/or transportation of fossil fuels, CFCs from refrigeration leaks, SF6 from electrical power distributor, etc.

GENERAL AVIATION: That portion of civil aviation, which encompasses all facets of aviation except air carriers. It includes any air taxis, commuter air carriers, and air travel clubs, which do not hold Certificates of Public Convenience and Necessity.

GLOBAL WARMING POTENTIAL (GWP): The index used to translate the level of emissions of various gases into a common measure in order to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of one kilogram of a greenhouse gas to that from the emission of one kilogram of carbon dioxide over a period of time (usually 100 years). Gases involved in complex atmospheric chemical processes have not been assigned GWPs.

GLOBAL WARMING: The progressive gradual rise of the Earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns.

GREENHOUSE EFFECT: Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

GREENHOUSE GAS (GHG): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrochlorofluorocarbons (HCFCs), ozone (O3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).

HEAT CONTENT: The amount of heat per unit mass released upon complete combustion.

HEAT: Form of kinetic energy that flows from one body to another when there is a temperature difference between the two bodies. Heat always flows spontaneously from a hot sample of matter to a colder sample of matter. This is one way to state the second law of thermodynamics.

HYDROCARBONS: Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons.

HYDROCHLOROFLUOROCARBONS (HCFCs): Compounds containing hydrogen, fluorine, chlorine, and carbon atoms. Although ozone depleting substances, they are less potent at destroying stratospheric ozone than chlorofluorocarbons (CFCs). They have been introduced as temporary replacements for CFCs and are also greenhouse gases.

HYDROFLUOROCARBONS (HFCS): Compounds containing only hydrogen, fluorine, and carbon atoms. They were introduced as alternatives to ozone depleting substances in serving many industrial, commercial, and personal needs. HFCs are emitted as by-products of industrial processes and are also used in manufacturing. They do not significantly deplete the stratospheric ozone layer, but they are powerful greenhouse gases with global warming potentials ranging from 140 (HFC-152a) to 11,700 (HFC-23).

HYDROPOWER: Electrical energy produced by falling or flowing water.

HYDROSPHERE: All the Earth's liquid water (oceans, smaller bodies of fresh water, and underground aquifers), frozen water (polar ice caps, floating ice, and frozen upper layer of soil known as permafrost), and small amounts of water vapor in the atmosphere.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC): The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

INTERNATIONAL COUNCIL FOR LOCAL ENVIRONMENTAL INITIATIVES (ICLEI): (www.iclei.org) is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. More than 630 cities, towns, counties, and their associations worldwide comprise ICLEI's growing membership. ICLEI works with these and hundreds of other local governments through international performance-based, results-oriented campaigns and programs. The ICLEI Cities for Climate Protection (CCP) Campaign assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban li-

vability and sustainability. More than 800 local governments participate in the CCP, integrating climate change mitigation into their decision-making processes.

JET FUEL: Includes both naphtha-type and kerosene-type fuels meeting standards for use in aircraft turbine engines. Although most jet fuel is used in aircraft, some is used for other purposes such as generating electricity.

JOULE: The energy required to push with a force of one Newton for one meter.

KEROSENE: A petroleum distillate that has a maximum distillation temperature of 401 degrees Fahrenheit at the 10 percent recovery point, a final boiling point of 572 degrees Fahrenheit, and a minimum flash point of 100 degrees Fahrenheit. Used in space heaters, cookstoves, and water heaters, and suitable for use as an illuminant when burned in wick lamps.

KYOTO PROTOCOL: An international agreement struck by nations attending the Third Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (held in December of 1997 in Kyoto, Japan) to reduce worldwide emissions of greenhouse gases. If ratified and put into force, individual countries have committed to reduce their greenhouse gas emissions by a specified amount.

LANDING AND TAKEOFF CYCLE (LTO): LTO refers to an aircraft's landing and takeoff (LTO) cycle. One aircraft LTO is equivalent to two aircraft operations (one landing and one takeoff). The standard LTO cycle begins when the aircraft crosses into the mixing zone as it approaches the airport on its descent from cruising altitude, lands and taxis to the gate. The cycle continues as the aircraft taxis back out to the runway for takeoff and climbout as its heads out of the mixing zone and back up to cruising altitude. The five specific operating modes in a standard LTO are: approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. Most aircraft go through this sequence during a complete standard operating cycle.

LIFETIME (ATMOSPHERIC): The lifetime of a greenhouse gas refers to the approximate amount of time it would take for the anthropogenic increment to an atmospheric pollutant concentration to return to its natural level (assuming emissions cease) as a result of either being converted to another chemical compound or being taken out of the atmosphere via a sink. This time depends on the pollutant's sources and sinks as well as its reactivity. The lifetime of a pollutant is often considered in conjunction with the mixing of pollutants in the atmosphere; a long lifetime will allow the pollutant to mix throughout the atmosphere. Average lifetimes can vary from about a week (e.g., sulfate aerosols) to more than a century (e.g., CFCs, carbon dioxide).

LIGHT-DUTY VEHICLES: Automobiles and light trucks combined.

LIQUEFIED NATURAL GAS (LNG): Natural gas converted to liquid form by cooling to a very low temperature.

LIQUEFIED PETROLEUM GAS (LPG): Ethane, ethylene, propane, propylene, normal butane, butylene, and isobutane produced at refineries or natural gas processing plants, including plants that fractionate new natural gas plant liquids.

LOW EMISSION VEHICLE (LEV): A vehicle meeting the low-emission vehicle standards.

METHANE (CH_4): A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 21. Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The atmospheric concentration of methane has been shown to be increasing at a rate of

about 0.6 percent per year and the concentration of about 1.7 per million by volume (ppmv) is more than twice its pre-industrial value. However, the rate of increase of methane in the atmosphere may be stabilizing.

METRIC TON: Common international measurement for the quantity of greenhouse gas emissions. A metric ton is equal to 1,000 kilograms, 2,204.6 pounds, or 1.1023 short tons.

MOBILE SOURCE: A moving vehicle that emits pollutants. Such sources include airplanes, cars, trucks and ground support equipment.

MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER: The Montreal Protocol and its amendments control the phase-out of ozone depleting substances production and use. Under the Protocol, several international organizations report on the science of ozone depletion, implement projects to help move away from ozone depleting substances, and provide a forum for policy discussions. In the United States, the Protocol is implemented under the rubric of the Clean Air Act Amendments of 1990.

MOTOR GASOLINE: A complex mixture of relatively volatile hydrocarbons, with or without small quantities of additives, obtained by blending appropriate refinery streams to form a fuel suitable for use in spark-ignition engines. Motor gasoline includes both leaded and unleaded grades of finished gasoline, blending components, and gasohol.

NATURAL GAS: Underground deposits of gases consisting of 50 to 90 percent methane (CH_4) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C_3H_4) and butane (C_4H_{10}).

NITROGEN OXIDES (NOx): Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced, for example, by the combustion of fossil fuels in vehicles and electric power plants. In the atmosphere, nitrogen oxides can contribute to formation of photochemical ozone (smog), impair visibility, and have health consequences; they are considered pollutants.

NITROUS OXIDE (N_2O): A powerful greenhouse gas with a global warming potential most recently evaluated at 310. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

ORGANIC COMPOUND: Molecule that contains atoms of the element carbon, usually combined with itself and with atoms of one or more other element such as hydrogen, oxygen, nitrogen, sulfur, phosphorus, chlorine, or fluorine.

OXIDIZE: To chemically transform a substance by combining it with oxygen.

OXYGEN CYCLE: Cyclic movement of oxygen in different chemical forms from the environment, to organisms, and then back to the environment.

OZONE: A colorless gas with a pungent odor, having the molecular form of O3, found in two layers of the atmosphere, the stratosphere and the troposphere. Ozone is a form of oxygen found naturally in the stratosphere that provides a protective layer shielding the Earth from ultraviolet radiation's harmful health effects on humans and the environment. In the troposphere, ozone is a chemical oxidant and major component of photochemical smog. Ozone can seriously affect the human respiratory system.

OZONE DEPLETING SUBSTANCE (ODS): A family of man-made compounds that includes, but is not limited to, chlorofluorocarbons (CFCs), bromofluorocarbons (halons), methyl chloroform, carbon tetrachloride, methyl bromide, and hydrochlorofluorocarbons (HCFCs). These compounds have been shown to deplete stratospheric ozone, and therefore are typically referred to as ODSs.

OZONE LAYER: Layer of gaseous ozone (O_3) in the stratosphere that protects life on Earth by filtering out harmful ultraviolet radiation from the sun.

OZONE PRECURSORS: Chemical compounds, such as carbon monoxide, methane, nonmethane hydrocarbons, and nitrogen oxides, which in the presence of solar radiation react with other chemical compounds to form ozone, mainly in the troposphere.

PARTICULATE MATTER (PM): Solid particles or liquid droplets suspended or carried in the air.

PERFLUOROCARBONS (PFCs): A group of human-made chemicals composed of carbon and fluorine only. These chemicals (predominantly CF_4 and C_2F_6) were introduced as alternatives, along with hydrofluorocarbons, to the ozone-depleting substances. In addition, PFCs are emitted as by-products of industrial processes and are also used in manufacturing. PFCs do not harm the stratospheric ozone layer, but they are powerful greenhouse gases: CF_4 has a global warming potential (GWP) of 6,500 and C_2F_6 has a GWP of 9,200.

PETROLEUM: A generic term applied to oil and oil products in all forms, such as crude oil, lease condensate, unfinished oils, petroleum products, natural gas plant liquids, and nonhydrocarbon compounds blended into finished petroleum products.

POLLUTION: A change in the physical, chemical, or biological characteristics of the air, water, or soil that can affect the health, survival, or activities of humans in an unwanted way. Some expand the term to include harmful effects on all forms of life.

POLYVINYL CHLORIDE (PVC): A polymer of vinyl chloride. It is tasteless, odorless and insoluble in most organic solvents. A member of the family vinyl resin, used in soft flexible films for food packaging and in molded rigid products, such as pipes, fibers, upholstery, and bristles.

RADIATION: Energy emitted in the form of electromagnetic waves. Radiation has differing characteristics depending upon the wavelength. Because the radiation from the Sun is relatively energetic, it has a short wavelength (e.g., ultraviolet, visible, and near infrared) while energy reradiated from the Earth's surface and the atmosphere has a longer wavelength (e.g., infrared radiation) because the Earth is cooler than the Sun.

RADIATIVE FORCING: A change in the balance between incoming solar radiation and outgoing infrared (i.e., thermal) radiation. Without any radiative forcing, solar radiation coming to the Earth would continue to be approximately equal to the infrared radiation emitted from the Earth. The addition of greenhouse gases to the atmosphere traps an increased fraction of the infrared radiation, reradiating it back toward the surface of the Earth and thereby creates a warming influence.

RECYCLING: Collecting and reprocessing a resource so it can be used again. An example is collecting aluminum cans, melting them down, and using the aluminum to make new cans or other aluminum products.

RENEWABLE ENERGY: Energy obtained from sources that are essentially inexhaustible, unlike, for example, fossil fuels, of which there is a finite supply. Renewable sources of energy include wood, waste, geothermal, wind, photovoltaic, and solar thermal energy.

RESIDENCE TIME: Average time spent in a reservoir by an individual atom or molecule. Also, this term is used to define the age of a molecule when it leaves the reservoir. With respect to greenhouse gases, residence time usually refers to how long a particular molecule remains in the atmosphere.

SECTOR: Division, most commonly used to denote type of energy consumer (e.g., residential) or according to the Intergovernmental Panel on Climate Change, the type of greenhouse gas emitter (e.g., industrial process).

SHORT TON: Common measurement for a ton in the United States. A short ton is equal to 2,000 lbs. or 0.907 metric tons.

SINK: A reservoir that uptakes a pollutant from another part of its cycle. Soil and trees tend to act as natural sinks for carbon.

SOLAR ENERGY: Direct radiant energy from the sun. It also includes indirect forms of energy such as wind, falling or flowing water (hydropower), ocean thermal gradients, and biomass, which are produced when direct solar energy interact with the Earth.

SOLAR RADIATION: Energy from the Sun. Also referred to as short-wave radiation. Of importance to the climate system, solar radiation includes ultra-violet radiation, visible radiation, and infrared radiation.

SOURCE: Any process or activity that releases a greenhouse gas, an aerosol, or a precursor of a greenhouse gas into the atmosphere.

STRATOSPHERE: Second layer of the atmosphere, extending from about 19 to 48 kilometers (12 to 30 miles) above the Earth's surface. It contains small amounts of gaseous ozone (O3), which filters out about 99 percent of the incoming harmful ultraviolet (UV) radiation. Most commercial airline flights operate at a cruising altitude in the lower stratosphere.

SULFUR DIOXIDE (SO_2): A compound composed of one sulfur and two oxygen molecules. Sulfur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulfate aerosols. These aerosols are believed to result in negative radiative forcing (i.e., tending to cool the Earth's surface) and do result in acid deposition (e.g., acid rain).

SULFUR HEXAFLUORIDE (SF_6): A colorless gas soluble in alcohol and ether, slightly soluble in water. A very powerful greenhouse gas used primarily in electrical transmission and distribution systems and as a dielectric in electronics. The global warming potential of SF_6 is 23,900.

TEMPERATURE: Measure of the average speed of motion of the atoms or molecules in a substance or combination of substances at a given moment.

TRANSPORTATION SECTOR: Consists of private and public passenger and freight transportation, as well as government transportation, including military operations.

TROPOSPHERE: The lowest layer of the atmosphere and contains about 95 percent of the mass of air in the Earth's atmosphere. The troposphere extends from the Earth's surface up to about

10 to 15 kilometers. All weather processes take place in the troposphere. Ozone that is formed in the troposphere plays a significant role in both the greenhouse gas effect and urban smog.

ULTRAVIOLET RADIATION (UV): A portion of the electromagnetic spectrum with wavelengths shorter than visible light. The sun produces UV, which is commonly split into three bands of decreasing wavelength. Shorter wavelength radiation has a greater potential to cause biological damage on living organisms. The longer wavelength ultraviolet band, UVA, is not absorbed by ozone in the atmosphere. UVB is mostly absorbed by ozone, although some reaches the Earth. The shortest wavelength band, UVC, is completely absorbed by ozone and normal oxygen in the atmosphere.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC): The international treaty unveiled at the United Nations Conference on Environment and Development (UNCED) in June, 1992. The UNFCCC commits signatory countries to stabilize anthropogenic (i.e., human-induced) greenhouse gas emissions to "levels that would prevent dangerous anthropogenic interference with the climate system". The UNFCCC also requires that all signatory parties develop and update national inventories of anthropogenic emissions of all greenhouse gases not otherwise controlled by the Montreal Protocol. http://www.ipcc.ch/

VEHICLE MILES TRAVELED (VMT): One vehicle traveling the distance of one mile. Thus, total vehicle miles traveled is the total mileage traveled by all vehicles.

VOLATILE ORGANIC COMPOUNDS (VOCs): Organic compounds that evaporate readily into the atmosphere at normal temperatures. VOCs contribute significantly to photochemical smog production and certain health problems.

WATER VAPOR: The most abundant greenhouse gas; it is the water present in the atmosphere in gaseous form. Water vapor is an important part of the natural greenhouse effect. While humans are not significantly increasing its concentration, it contributes to the enhanced greenhouse effect because the warming influence of greenhouse gases leads to a positive water vapor feedback. In addition to its role as a natural greenhouse gas, water vapor plays an important role in regulating the temperature of the planet because clouds form when excess water vapor in the atmosphere condenses to form ice and water droplets and precipitation.

WEATHER: Weather is the specific condition of the atmosphere at a particular place and time. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate is the average of weather over time and space. A simple way of remembering the difference is that climate is what you expect (e.g. cold winters) and 'weather' is what you get (e.g. a blizzard).

WORLD RESOURCE INSTITUTE (WRI): The World Resources Institute (WRI) is an environmental think tank. WRI, in combination with the World Business Council for Sustainable Development published guidance in 2005 concerning the development of greenhouse gas inventories. www.wri.org

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1200 King County Courthouse
516 Third Avenue
Seattle, WA 98104

KING COUNTY

Signature Report

May 10, 2011

Motion

Proposed No. 2011-0208.1 **Sponsors** Ferguson, Hague, Phillips, Patterson and McDermott

A MOTION relating to county efforts to reduce climate pollution and prepare for the effects of climate change on the environment, human health and the economy and to minimize King County's operational environmental footprint; and rescinding Motion 12362.

WHEREAS, there is consensus among the world's leading scientists, including the National Academies and the Intergovernmental Panel on Climate Change, that human sources of climate pollution such as carbon dioxide and methane are causing unprecedented and severe changes in global and local climate systems, and the related impacts are among the most significant environmental challenges facing the world, and

WHEREAS, climate scientists at the University of Washington report that significant changes to the Pacific Northwest climate are causing environmental changes including decreasing mountain snowpack and increasing flooding, and are negatively impacting infrastructure, forests, salmon, human health and the Puget Sound, and

WHEREAS, King County's diversity of natural habitats and species, known as biodiversity, helps to support pollination of crops, flood and erosion control, fisheries and recreation, and

WHEREAS, climate change is causing increased stress and changes in distribution of plant and animal species due to vegetation range shifts, streamflow

changes, invasive species invasions and increased freshwater and marine water temperatures, and

WHEREAS, left unaddressed, human induced changes to the climate system will severely impact economic prosperity and quality of life in King County and elsewhere, and

WHEREAS, buildings account for thirty-five percent of greenhouse gas emissions that occur in King County, and

WHEREAS, transportation accounts for forty-eight percent of greenhouse gas emissions that occur in King County, and

WHEREAS, King County citizens, businesses, and governments also share responsibility for the greenhouse gas emissions associated with goods and services that are produced outside the region and consumed locally, and

WHEREAS, projects that reduce climate pollution, such as energy efficiency improvements, can have multiple benefits to the county and its citizens, including reducing operating costs and creating new revenue sources for King County government, improving public health, and building a green economy, and

WHEREAS, the integration of land use and transportation planning to create vibrant urban communities where residents can conveniently walk, bicycle, van pool, ride share or take transit to places of work, school and shopping can reduce climate pollution and improve health, and

WHEREAS, protecting and restoring natural areas such as wetlands and forests naturally sequesters carbon dioxide and also supports a healthy and robust ecosystem that is more resilient to local climate change impacts, and

WHEREAS, actions to reduce climate pollution support many other county priorities from protecting the Puget Sound to addressing health inequities among King County residents, to building a green economy, and

WHEREAS, the 2010 King County Strategic Plan established environmental sustainability as one of King County's eight goals, and outlines objectives to reduce climate pollution and prepare for the effects of climate change on the environment, human health and the economy and to minimize King County's operational environmental footprint, and

WHEREAS, the 2010 King County Energy Plan established near-term goals for energy efficiency in county buildings and vehicles, promotes the use and production of renewable and greenhouse gas-neutral energy, and calls for integrated monitoring and reporting of climate, energy and green building outcomes, and

WHEREAS, RCW 70.235.020 requires that by 2020 Washington State reduce overall greenhouse gas emissions to 1990 levels, and that by 2050 emissions are further reduced to fifty percent below 1990 levels, and

WHEREAS, the King County Comprehensive Plan directed that the county collaborate with other local governments to reduce greenhouse gas emissions in the region to eighty percent below 2007 levels by 2050 and incorporate climate change considerations into county plans, programs and projects among other related policies and goals, and

WHEREAS, the King County green building and sustainable development ordinance, Ordinance 16147, requires the incorporation of green and sustainable practices into the design, construction and operation of capital improvement projects to reduce

greenhouse gas emissions, reduce energy and other operating costs and create healthier and more appealing environments for the public, and

WHEREAS, the 2011 King County Board of Health Planning for Healthy Communities Guidelines call for residents in all communities in King County to have access to safe and convenient opportunities for physical activity and exercise that will result in a cobenefit of reducing vehicle miles traveled and reducing climate pollution, and

WHEREAS, people located within one mile of public amenities such as regional trails are more likely to access those trails for mobility and recreation, which will result in a co-benefit of reducing vehicle miles traveled and reducing climate pollution, and

WHEREAS, climate policies were integrated throughout the King County Comprehensive Plan during the last major update in 2008, and the next major Comprehensive Plan update in 2012 provides an opportunity to revise climate goals and policies to reflect new direction from Puget Sound Regional Council's Vision 2040 and the updated King County Countywide Planning Policies, and

WHEREAS, the Growth Management Planning Council is considering adoption of a countywide planning policy calling for development of a countywide greenhouse gas emissions reduction target in 2011 while integrating climate policies throughout the document, and

WHEREAS, King County is partnering with the city of Seattle and the Puget Sound Clean Air agency to update the King County geographic greenhouse gas emissions inventory, assess emissions associated with all King County consumption regardless of

where the emissions occur, and to develop framework for assessing progress towards countywide emissions reduction goals, and

WHEREAS, emissions from King County operations represent only a small percentage of all King County greenhouse gas emissions, and significant progress in meeting emissions reduction targets can only happen through collaborative action at a countywide scale, and

WHEREAS, King County is carrying out a wide range of transportation, land use, open space and resource land protection, land management, energy efficiency, green building, waste reduction, recycling and outreach initiatives to reduce climate pollution and prepare for the inevitable impacts of climate change, and

WHEREAS, long-term and significant reductions in climate pollution will only be achieved through commitments to specific targets and actions and to reduce climate pollution and by assessing the results of these actions, and

WHEREAS, the climate and energy motion, Motion 12362, adopted in 2006 outlined a series of near-term actions and opportunities related to climate change and should be updated;

NOW, THEREFORE, BE IT MOVED by the Council of King County:

A. Motion 12362 is hereby rescinded.

B. With respect to conducting emissions inventories, establishing greenhouse gas emissions reduction targets and performance measures, and ensuring accountability:

1. The county will continue its collaboration in 2011 with the city of Seattle and the Puget Sound Clean Air Agency to finalize new King County countywide greenhouse

gas emissions inventories and use the data to guide projects, programs and policies that best support community-scale emissions reductions;

2. The county, through its participation in the Growth Management Planning Council, will collaborate with cities to develop a countywide-level emissions reduction target that is informed by the recent emissions inventory work and meets or exceeds the current state requirements for reducing greenhouse gas emissions. This includes establishing a 2020 goal for reduction of net energy use and greenhouse gas emissions from King County operations informed by recent emissions inventories and reporting protocols used by the National Climate Registry;

3. As part of the 2012 Comprehensive Plan update, the county will review and revise its climate and energy goals as needed to ensure that it is doing its part both operationally and at the community scale to advance the emissions reduction targets being established by the growth management planning council;

4. The county will join The Climate Registry in 2011 and monitor and report greenhouse gas emissions from government operations using protocols approved by The Climate Registry beginning in 2012;

5. King County should continue to participate as a test community in the development of national standards for measuring sustainability at a community scale, through the "STAR Communities" program sponsored by ICLEI - Local Governments for Sustainability, and use lessons learned from this effort to inform both future actions and performance measures;

6. The executive will monitor and report to the council annually on actions to reduce operational and community-scale greenhouse gas emissions as part of integrated

annual reporting on climate, energy, green building, and environmental purchasing beginning in June 2011; and

7. The county will develop and report on specific climate mitigation and adaptation strategies, performance measures and targets as part of the King County Strategic Plan Performance Measurement Framework, and use performance findings on an ongoing basis to update targets and strategies.

C. With respect to managing land use and transportation to reduce greenhouse gas emissions:

1. As part of the 2012 Comprehensive Plan Update, King County will review and update policies related to land use and transportation based on changes in federal and state requirements, current climate science, the outcome of updated community and operational emissions inventories, multicounty planning policies and updated countywide planning policies;

2. Consistent with the 2011 King County Board of Health Planning for Healthy Communities Guidelines and as part of the 2012 Comprehensive Plan Update, King County will review and update policies and regulations to encourage a mix of land uses with well-designed public spaces so that residents in all communities have access to safe and convenient opportunities for daily physical activity and exercise, which helps prevent chronic disease and premature death;

3. The county will work with developers, community groups and the Sustainable Cities Roundtable to identify and establish additional incentives to locate new development within established urban centers, use design standards that will reduce energy use and greenhouse gas emissions beyond what is required by current building

and energy codes, and maximize carbon sequestration functions of soils and vegetation through site layout and restoration. As part of this effort, the county will evaluate use of the state environmental policy act review as a tool for evaluating alternatives for relative greenhouse gas emissions and mitigating impacts;

4. The county will work with cities, the Puget Sound Regional Council, regional transit agencies, and housing groups as part of implementing the Sustainable Communities Grant to develop policies and strategies to encourage and guide transit oriented development along high capacity corridors. As part of this effort, the county will carry out a "catalyst" project around the Northgate Transit Hub, promoting integrated planning and support for housing, mixed use development, and seamless connections between bus and light rail transportation modes. The county will also promote transit oriented development at park and ride lots around the county, including South Kirkland Park and Ride. In participating in joint planning efforts for transit oriented development, the county should encourage use of green building standards;

5. Consistent with the Regional Transit Task Force recommendations and the Metro Transit Strategic Plan for Public Transportation, the county will plan transit service by more closely linking employment centers and residential density to service, while also ensuring social equity and considering geographic value concerns;

6. As funding allows, the county will expand Metro's participation in the Washington state Commute Trip Reduction employer partnerships program to achieve a ten percent reduction in drive alone commuting by 2015;

7. Building on the successful establishment of the RapidRide Line between Federal Way and Tukwila in 2010, the county will continue to aggressively seek federal

funding to continue implementation of the RapidRide program with the following target implementation dates for new lines, subject to funding availability: Bellevue to Redmond in 2011; downtown Seattle to West Seattle and Ballard in 2012; downtown Seattle to the King-Snohomish line in 2013; and Renton to Burien in 2013;

8. Consistent with the 2010 King County Energy Plan, the county will replace diesel buses if sufficient funding and appropriate technologies are available to help to achieve the county's energy and climate goals. In 2011, the county will take delivery of one hundred ninety-four new diesel electric hybrid vehicles and continue to pursue grant funding to expand the purchase of low or no emission vehicles;

9. The county will continue to lead efforts to promote electric vehicles and participate in infrastructure improvements to support widespread adoption of this technology. In 2011, King County plans to acquire twenty-five all-electric vehicles and work with private employers and publically owned facilities such as park-and ride garages to install approximately seventy charging stations; and

10. King County will continue to develop and maintain an interconnected countywide system of regional trails in order to promote options for nonmotorized transportation, especially in historically underserved geographies and communities with poor health outcomes relative to the county population as a whole.

D. With respect to managing land and providing technical assistance and incentives to enhance carbon sequestration and reduce greenhouse gas emissions:

1. King County will continue to promote the use of conservation easements on private property as well as acquire, steward and restore natural public lands for ecological and recreational purposes. These protected lands will provide biological carbon storage

in forests and soils and will help reduce local climate change impacts such as increasing flooding;

2. The county will continue to support forestry and agriculture technical assistance, tax incentives and property acquisitions as a way to offset greenhouse gas emissions through carbon sequestration;

3. The county will launch on-line technical assistance program by the end of 2011 to encourage private land owners to retain and enhance forest and soil cover and productivity to improve carbon sequestration and reduce climate change impacts;

4. The county will consider establishment of tax incentives through the public benefit rating program tied to commitments by landowners to enhance carbon sequestration through retention and enhancement of forest and soil cover productivity; and

5. King County will pursue opportunities to support forest and soil management and restoration projects, and conduct these projects in ways that prioritize biological carbon sequestration and plan for changing climate conditions.

E. With respect to environmental management, emergency preparedness, and preparing for impacts of climate change:

1. As part of the next update to the flood hazard management plan beginning in 2011, the county will review available information on the potential impacts of climate change on winter floods, and consider these impacts in updating flood risk reduction policies and capital improvements plans and projects;

2. The county will continue working with the Federal Emergency Management Agency to update coastal flood hazard maps and will revise coastal flood hazard

development standards for Vashon Island. King County's elevation requirements for the first finished floor will continue to include a factor of safety to reflect uncertainty tied to climate change impacts on coastal flooding. The revised coastal flood hazard development standards will be transmitted to the council in 2011;

3. By the end of 2012, the county will inventory essential county facilities, including roads and wastewater treatment and conveyance facilities, that are subject to inundation or landslide risks due to sea level rise**,** and develop strategies for reducing risks and mitigating future damages;

4. The county, consistent with the Regional Wastewater Services Plan and Reclaimed Water Plan should evaluate alternatives for production and use of reclaimed water for industrial, irrigation and environmental restoration purposes to determine if it is a reasonable means of mitigating the climate change impacts projected to decrease summer stream flows and affect water supplies; and

5. To foster resistance and resilience to climate change in ecosystems and species, the county will prioritize the restoration of riparian vegetation to reduce warming in cold water systems, restore wetlands to reduce drought and flooding, improve connections between different habitats and protect and restore areas most likely to be resistant to climate change.

F. With respect to improving energy efficiency and reducing greenhouse gas emissions from county operations:

1. The county shall implement the adopted 2010 King County Energy Plan, including actions to achieve the following near-term goals: produce, use, or purchase renewable energy equal to fifty percent of total county energy requirements by 2015,

reduce net normalized energy usage in county buildings by ten percent by 2012 and reduce net normalized energy use in county vehicles by ten percent by 2015;

2. The county shall develop medium and long-term energy goals in 2012 needed to support achievement of the community-level greenhouse gas emissions reduction targets and county operational emissions targets established through the countywide planning policy update and King County Comprehensive Plan updates;

3. The county will continue to maximize the creation of resources from products such as biogas, biosolids and heat produced by wastewater treatment and solid waste disposal in a manner that produces renewable energy and reduces greenhouse gas emissions;

4. The county will seek, subject to budget, operational, and maintenance limitations, to utilize the most energy-efficient commercially viable vehicles for its fleet. King County will also seek to deploy these vehicles in an energy-efficient manner through vehicle routing, idling reduction, and operator practices;

5. Consistent with 2010 King County Energy Plan, the county will evaluate options and develop policy guidance and budgeting practices for 2012 to enable county agencies to capture verified operating savings from purchase of hybrid vehicles and building efficiency projects, and apply the savings to up-front capital investment in vehicle purchase or efficiency improvements;

6. The county will transition to use of one-hundred percent recycled content paper in 2012 and carry out a campaign to reduce paper use by an additional 20 percent by 2013;

7. The county will continue to provide internal training and technical assistance to ensure consistent implementation of the green building and sustainable development ordinance, Ordinance 16147; and

8. The county will continue its participation in the United States Environmental Protection Agency's WasteWise program to promote internal waste prevention, recycling collection and purchase of recycled products. The county will continue to quantify and report the reductions in greenhouse gas emissions associated with these actions.

G. With respect to community outreach, education, advocacy and information sharing with other local governments and universities:

1. As funding allows, the county will continue to participate in national and regional organizations of local governments sharing strategies to reduce emissions and prepare for climate change. The county will continue to advocate for federal initiatives and grant programs, like the Better Buildings Initiative and Energy Efficiency Community Development Block Grants, which support local investments in projects to reduce energy use and efficiency while creating green jobs;

2. The county will continue to advocate for national emissions inventory standards that recognize the unique role of local governments, particularly counties, and managing land use and transportation in a manner that reduces community-scale emissions;

3. The county will continue to carry out green building programs, which provide technical assistance to local governments, businesses, non-profit organizations, and residents to implement green building practices while addressing critical environmental issues, such as climate change, critical habitat restoration and solid waste reduction;

4. The county will participate in and support the King County-Cities Climate Pledge and Collaboration, a partnership between the cities of King County and King County itself to increase the effectiveness of local governments' sustainability and climate change efforts;

5. The county will continue to pursue waste reduction and recycling initiatives, including education and technical assistance to cities, to divert waste from disposal and reducing associated greenhouse gas emissions;

6. Consistent with the Regional Economic Strategy for Central Puget Sound, King County will work with the business community to help identify effective and efficient green manufacturing practices that reduce energy use and greenhouse gas emissions, and promote King County and the Puget Sound region as a center for green manufacturing. The county will also work with community groups to promote the consumption of green-manufactured products;

7. The county will continue to partner with the University of Washington to identify and plan for the impact of climate change on human health, including synthesizing data on the effects of changing temperature on illness and death in King County; and

8. The county will develop and incorporate into existing outreach efforts public health messages related to the health implications of climate change, particularly in urban

communities, and the benefits of actions, such as using alternative transportation options that simultaneously reduce greenhouse gas emissions and improve public health.

KING COUNTY COUNCIL
KING COUNTY, WASHINGTON

_____

Larry Gossett, Chair

ATTEST:

_____

Anne Noris, Clerk of the Council

APPROVED this _____ day of _____, _____.

_____

Dow Constantine, County Executive

Attachments: None

APPENDIX B

Boeing Field Greenhouse Gas Calculations

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King County International Airport-related CO2 Emissions 2007

User/Source Category	WRI Scope	2007 CO2 (tons/ year)	2007 Percent of User	2007 Percent of Total	CO2 Emissions 1990 Backcast	CO2 Emissions 2020 Forecast
King County-owned/controlled						
Facilities/Stationary Sources						
Electrical	2	44	6.4%	0.0%	127	53
Other (oil, gas)	1	381	55.6%	0.1%	323	487
Facilities Total		425	62.0%	0.2%	449	541
County Fleet Vehicles (on- and off-road)	1	260	38.0%	0.1%	288	267
Ground Access Vehicles (tie down users on-airport travel)	3	0.3	0.0%	0.0%	0	0
King County-owned/controlled Total		**686**	**100.0%**	**0.3%**	**737**	**809**
Airlines/Aircraft Op/Tenants-owned/controlled**						
Aircraft						
Approach	3	8,628	3.3%	3.3%	6,694	10,006
Taxi/Idle/Delay	3	21,837	8.3%	8.3%	15,557	25,102
Takeoff	3	10,343	3.9%	3.9%	7,318	12,077
Climbout	3	5,945	2.3%	2.3%	4,592	6,733
Subtotal LTO	3	46,752	17.8%	17.7%	34,161	53,918
Residual/Cruise/APU	3	212,776	81.2%	80.8%	149,333	245,628
Aircraft Total	3	**259,528**	**99.1%**	**98.5%**	**183,494**	**299,547**
Ground Support Equipment	3	**2,001**	**0.8%**	**0.8%**	**2,211**	**2,055**
Ground Access Vehicles (on-airport and off-airport)	3					
Tenant Ground Access Vehicles	3	**308**	**0.1%**	0.1%	**340**	**316**
Tenant Employee Commute	3	**82**	**0.0%**	0.0%	**91**	**84**
Ground Access Vehicles Total	3	**390**	**0.1%**	**0.1%**	**431**	**401**
Stationary Sources	3	**-**	**0.0%**	**0.0%**	-	-
Airline/Tenant-owned/controlled Total		**261,919**	**100.0%**	**99.4%**	**186,136**	**302,002**
Public-owned/controlled**						
Passengers (on and off airport)	3	378	46.7%	0.1%	122	651
County Employee Work Commute (on and off airport)	3	327	0.1%	0.1%	362	563
Tiedown users (off airport)	3	104	12.8%	0.0%	115	106
Public-owned-controlled Total		**810**	**100.0%**	**0.3%**	**599**	**1,321**
Total Metric Tons		**263,414**		**100%**	**187,472**	**304,132**
Operations		**300,184**			**331,643**	**308,242**
Enplanements		**27,352**			**8,837**	**47,060**

King County Interionational Airport - 2007

Power Type	Use	Units	Use	Source	CO2 Emission Rate (lb/unit)	Conver	Unit Conv	CO2 (tons)
Electrical	**5,376,028**	Kwh	Total airport	Seattle Light (lb/kwh)	0.018	0.000453592	lbs to ton	44
Natural Gas	**71,884**	Therms	Heating	NG (kg/therm)	5.31	0.001	kg to ton	381
		ft3		NG (lb/1000 ft3)	120.593	0.000453592	lbs to ton	0
Fuel Oil/Diesel	-	Ga	Generators	Diesel (lb/gal)	22.384	0.000453592	lbs to ton	0
Source: Russ Simonson from Stacey Fox					Total			425

Tenant Facilities

Power Type	Use	Units	Use	Source	CO2 Emission Rate (lb/unit)	Conver	Unit Conv	CO2 (tons)
Electrical		Kwh	Total airport	City Electric		0.000453592	lbs to ton	0
				Holy Cross Energy		0.000453592	lbs to ton	0
				GreenPwr		0.000453592	lbs to ton	0
Natural Gas		Therms	Heating	NG (kg/therm)		0.001	kg to ton	0
		ft3		NG (lb/1000 ft3)		0.000453592	lbs to ton	0
Fuel Oil/Diesel		Ga	Generators	Diesel (lb/gal)		0.000453592	lbs to ton	0
					Total			0

Energy Roll up spreadsheet from King County - see excerpt below

Tenant power not available

Reported in Metric Ton

BTU Conversion - electric: 3412 BTU per Kwh

Natural Gas: 100,000 BTU per Therm

Diesel - 137,700 BTU per gallon (Data Energy Book B.4)

Gas - 125,000 BTU per gallon (Data Energy Book B.4)

Informaiton from the Seattle Climate Partnership electronic tool

			Convert to kg to lb/kwh
Seattle City Light, 2005	0.026	kgCO2/kWh	0.05732
Seattle City Light, 2007	0.008	kgCO2/kWh	0.01786
Puget Sound Energy	0.386	kgCO2/kWh	0.85154

CNG CO2 rate	120.593	lb/ft3 per 1000
	0.4536	convert lb/kg 1 lb=0.4536 kg
	0.054701	kg/ft3
	97.37	1 therm = (100,000/1027)=97.37ft3
	5.31	kg/therm

1 lb=.45359237 kg

Estimate of Electrical in 1990

2007 electrical	5,376,028	kWh
Change in activity	0.094858025	(1990-2007)
1990 electrical	4,866,069	kwh
PSE emission factor	0.85154	
Tons CO2 in 1990 using PSE	1,879.53	
Tons CO2 in 1990 using 2005	126.52	

2007

	Baseline	Utility Manager Database							Renewable Energies		
	2007 Fuel Sources	Electric	Natural	Steam	Propane	Heating Oil	Gasoline	Diesel	Electric	Biodiesel	Biogas
DOT	Fleet Administration	228,136	13,995	0	0	0	1,282,755	316,162		61,786	
DOT	King County Airport	5,376,028	71,884	0	0	0	22,256	5,555			
DOT	Road Services		8,894	0	0	0	0	0	5,234,151		
DOT	Metro Transit	30,664,295	738,474	21	0	0	996,160	9,801,051		1,524,261	
DOT	Metro Transit TOH	16,600,663	0	0							
DOT	DOT Subtotal	52,869,122	833,247	21	0	0	2,301,171	########	5,234,151	1,586,047	0

	Baseline	Utility Manager Database (MMBTU)							Renewable Energies		
	2007 Energy	Electric	Natural	Steam MMBTU	Propane MMBTU	Heating Oil	Gasoline	Diesel	Electric	Biodiesel	Biogas
DOT	Fleet Administration	778	1,400	0	0	0	148,030	40,690	0	8,125	0
DOT	King County Airport	18,343	7,188	0	0	0	2,568	715	0	0	0
DOT	Road Services	0	889	0	0	0	0	0	17,859	0	0
DOT	Metro Transit	104,627	73,847	25	0	0	114,957	1,261,395	0	200,434	0
DOT	Metro Transit TOH	56,641	0	0	0	0	0	0	0	0	0
DOT	DOT Subtotal	180,389	83,325	25	0	0	265,555	1,302,800	17,859	208,559	0

	Baseline	ENERGY TOTALS, MMBTU					Normalization			
	2007 Energy	Non-	Renewabl	% Renewable	TOTAL	% of Total	Basis	Units	Use	Units
DOT	Fleet Administration	190,898	8,125	4.1%	199,022	5.7%	18,412,965	ehicle-mile	10,809	Btu/mile
DOT	King County Airport	28,815	0	0.0%	28,815	0.8%	522,352	Sq-ft	55	Kbtu/sq-ft
DOT	Road Services	889	17,859	95.3%	18,748	0.5%	110,802	Sq-ft	169	Kbtu/sq-ft**
DOT	Metro Transit	1,554,851	200,434	11.4%	1,755,285	50.0%	48,894,721	Miles	37,058	Btu/mile
DOT	Metro Transit TOH	56,641	0	0.0%	56,641	1.6%				
DOT	DOT Subtotal	1,832,094	226,418	11.0%	2,058,512	58.6%				
	Transit Only	1,611,492	200,434	11.1%	1,811,927	51.6%				
	Non-Transit	1,405,718	292,389	17.2%	1,698,107	48.4%				

Notes:

1 Gasoline totals for Fleets include personal vehicles used for County business.
2 In some cases there may be multiple or different normalizations for different sites / energy supplies - add these disaggregations as needed, keeping as simple as practical
3 Biogas counted in this inventory is only that which is effectively employed to displace other "non renewable" fuels
4 Biodiesel reported gallons are from CCX reporting by Matt Kuharic, 05/2008

** Energy Intensity (EI) values for WLRD, Roads, Public Health and Sheriff's Office are problematic. Is sqft the measure of service?. Consider alternate normalization

King County Fleet Vehicle Emissions

King County International Airport Fleet Vehicles - 2007

Power Type	Use	Units	Use	Conversion Factors	Converted	CO2 factor	Units CO2	CO2 (tons)
Gasoline	**22,256.0**	gal	on and off rd	none	None	19.564	Lbs/gal	197.50
CNG	-	gal equiv		Convert to ft3	-	120.593	lb/ft3	-
CNG	-	ft3		none	None	120.593	lb/ft3	-
Diesel	**6,197.7**	Gal	on and off rd	none	None	22.384	lbs/gal	62.9
						Total		260.4

Source: County data below for diesel (87 gallons higher than Sept 2008 spreadsheet (KC Study Data File Sept 08)

Gasoline -- used largest of the three data sets (Energy Roll Up from Master CCX Data 2000 2007 2008 2009)

Reported in Metric Ton See worksheet "Energydata" for sources

CO2 Factor Source: See worksheet EnergyData

to calculate the energy eqivalent of CNG to gallons

Diesel	137,700	BTU/gal	
CNG	960	BTU/ft3	Transportation Data Energy Book
Motor Gas	125,000	BTU/gal	
CNG gal equiv	130.2083333	ft3/gal	@sum(125,000/960)

CNG	120.593	lb CO2/1000 ft3

0.00045359237 Lbs/ton

Tenant Vehicles -- Tenant Fleet Vehicles and Employees - 2007

Power Typ	Use	Units	Use	Conversion Factors	Converted	CO2 factor	Units CO2	CO2 (tons)
Tenant Fleet Vehicles								
Gasoline	**16,629.88**	gal	on and off rd	none	None	19.564	Lbs/gal	147.57
Propane	**80.00**	gal	on and off rd	none	none	12.669	lbs/gal	0.46
Diesel	**15,752.00**	gal	on and off rd	none	None	22.384	lbs/gal	159.9
						Total		308.0
Employee Commute								
Gasoline	**8,494**	gal	on and off rd	none	None	19.564	Lbs/gal	75.38
Diesel	**674**	gal	on and off rd	none	None	22.384	lbs/gal	6.8
						Total		82.2

Source: See below County Survey of Tenants

Reported in Metric Ton See worksheet "Energydata" for sources

CO2 Factor Source: See worksheet EnergyData

CNG 120.593 lb CO2/1000 ft3

0.00045359 Lbs/ton

Tenant Survey Summary (see details below)

Landside vehicles - gas	16,629.88	gallons					
Landside vehicles - diesel	15,752.00	gallons					
Landside vehicles - other	80.00	propane					
Airside vehicles							
Employee days	6,292.14	FTE assume 5 day week					
Employee VMT	188,764.29	assume 30 miles round trip					
Gas - 90% vehicles	169,887.86	vmt	8,494.39	galls	22.5	National Energy Data Report Edition 28 Table 4.1	
Diesel - 10%	18,876.43	vmt	674.16	galls	22.5	National Energy Data Report Edition 28 Table 4.1	

2007 Airline GSE

Emissions Calculation (CO2 lbs)

	Lbs CO2 Diesel	Lbs CO2 Gas	Lbs CO2 Prop	Lbs CO2 Electric
Tons CO2	1,230	771	-	-
Total Tons	2,001			

Fuel type assumed diesel/gas
Default fleet and time from EDMS

			Survey			Fuel Type Distribution				CO2 Emissions Rate (NONROAD)					
GSE Type	**REFERENCE**	**Fuel**	**Estimated Hp**	**Load Factor**	**Annual Hours**	**Diesel %**	**Gas %**	**Prop %**	**Elect %**	**Diesel g/hp-hr**	**Gas g/hp-hr**	**CNG g/hp-hr**	**Prop g/hp-hr**	**Elect g/hp-hr**	**Lbs CO2 From Diesel**
Air Start	ACE 180	Diesel	383.9	0.70	191	100.0%	0.0%	0.0%	0.0%	543.26	848.39	494.29	644.99	0	61,485
Aircraft Tractor	ACE 300/400	Diesel	213.1	0.80	230	100.0%	0.0%	0.0%	0.0%	542.41	830.48	488.64	640.30	0	46,896
Baggage Tractor	Stewart & Stevenson TUG MC	Diesel	70.9	0.55	1,237	100.0%	0.0%	0.0%	0.0%	608.68	868.69	488.20	643.02	0	64,741
Belt Loader	Stewart & Stevenson TUG GT-	Diesel	54.3	0.50	19	100.0%	0.0%	0.0%	0.0%	608.68	868.69	488.20	643.02	0	692
Bobtail	Stewart & Stevenson TUG GT-	Diesel	112.7	0.55	257	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	19,247
Cargo Loader	Stewart & Stevenson TUG T-75	Diesel	100.7	0.50	265	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	16,120
Cart	Stewart & Stevenson TUG 660	Diesel	55.0	0.50	2	100.0%	0.0%	0.0%	0.0%	608.68	868.69	488.20	643.02	0	74
Forklift	Hi-Way F650	Diesel	155.5	0.30	1,839	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	103,649
Fuel truck	FMC Commander 15	Diesel	188.6	0.25	2,681	100.0%	0.0%	0.0%	0.0%	542.41	830.48	488.64	640.30	0	151,187
Generator	FMC Commander 30	Diesel	158.3	0.82	5	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	784
GPU	Taylor Dunn	Diesel	163.1	0.75	36	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	5,320
Hydrant Truck	Hi-Way / TUG 660 chasis	Diesel	175.0	0.70	197	100.0%	0.0%	0.0%	0.0%	542.41	830.48	488.64	640.30	0	28,863
Lavatory Cart	Hi-Way F650	Diesel	55.0	0.50	1,173	100.0%	0.0%	0.0%	0.0%	608.68	868.69	488.20	643.02	0	43,294
Lavatory Truck	F750, Dukes Transportation Se	Diesel	167.5	0.25	18,462	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	934,042
Other	TLD 1410	Diesel	140.4	0.50	566	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	48,005
Passenger Stand	TLD, 28 VDC	Diesel	100.3	0.57	14,438	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	997,277
Service Truck	TLD, 400 Hz AC	Diesel	173.6	0.20	710	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	29,783
Sweeper	F250 / F350	Diesel	53.3	0.51	3,537	100.0%	0.0%	0.0%	0.0%	608.68	868.69	488.20	643.02	0	129,042
Other	Wollard TLS-770 / F350	Diesel	158.6	0.20	828	100.0%	0.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	31,732
Cargo Tractor	Stewart & Stevenson TUG MA	Gas	95.0	0.54	11,086	0.0%	100.0%	0.0%	0.0%	607.99	886.52	478.08	640.38	0	-
Cart	Stewart & Stevenson TUG 660	Gas	55.0	0.50	3,499	0.0%	100.0%	0.0%	0.0%	608.68	868.69	488.20	643.02	0	-
Passenger Stand	TLD, 28 VDC	Gas	125.1	0.57	213	0.0%	100.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	-
Service Truck	TLD	Gas	131.4	0.20	7,407	0.0%	100.0%	0.0%	0.0%	547.93	871.10	490.24	643.86	0	-
														Tot Lbs	2,712,233
														Tons CO2	1,230
														Tons CO2	2,001
														M BTU	16,685

	Units CO2	CO2 factor
LPG	Lbs/gal	12.669
Gas	Lbs/gal	19.564
Diesel	lbs/gal	22.384
		Total

Emission factors from NONROAD2005 (averages for hp-ranges by fuel)

0.002205	conversion of grams to lbs
0.0004536200	Conversion of lbs to metric tons

King County International Airport Ground Access Vehicles

Passenger Travel

Passenger On Road Travel	%	Pax	MPG	RoundTrip Dist (mi)	Fuel (Gallons)	CO2 lbs/gal	CO2 (lbs)
Annual Passengers							
Total Passengers		54,704	TAF				
O&D Percent/Pax	100%						
Mode split (Estimate)							
On-Airport Roads		Assumes that the travel party size of 2 people					
Private vehicle (Gas)	68%	18,599	22.5	0.5	413	19.5640	8,086.2
Rental Car (gas)	5%	1,368	22.5	0.5	30	19.5640	594.6
Taxi/Limo (gas)	12%	3,282	22.5	0.5	73	19.5640	1,427.0
Taxi/Limo (CNG)	3%	821	22.5	0.5	18	120.5930	286.3
Other (gas)	7%	1,915	22.5	0.5	43	19.5640	832.4
Kenmore Shuttle Gas	2.5%	Gas use supplied assume 2%			35	19.5640	693.7
Kenmore Shuttle Diesel	2.5%	Gas use supplied assune 2%			53	22.384	1,185.5
	100.00%		Subtotal		666	**Tons -->**	5.9
Off-Airport Travel							
Private vehicle Gas	47%	12,855	22.5	49.5	28,282	19.5640	553,308.4
Rental Car	10%	2,735	22.5	49.5	6,017	19.5640	117,725.2
Taxi/Limo (gas)	20%	5,470	22.5	7	1,702	19.5640	33,296.0
Taxi/Limo (CNG)	6%	1,641	22.5	7	511	120.5930	8,017.1
Other	7%	1,915	22.5	10	851	19.5640	16,648.0
Kenmore		Gas use supplied assume 98%			1,737	19.5640	33,991.3
Kenmore Shuttle to SEA		Gas use supplied assune 98%			2,595	22.384	58,089.6
			Subtotal		41,695	**Tons -->**	372.4
MPG - Transp Data Energy Book #27 Table				**Total**	42,361	**Tons -->**	378.4

BTU conversion below — As passengers above are total, they reflect enplanements and deplanements

Mapquest from Westlake Center to KCIA - 6.39 miles - Assume 10 miles to account for o&d from outside city center

Estimates of mode splits - disussion with G. Molyneaux 10-4-2010

Estimates from review of ALP

MPG from National Energy Data Book Table 4.1 (Cars) Ed28 and Table 4.2 (Trucks)

rental car assumptions -- same as Sea-Tac

King County Airport Employees Commute Travel

Employee On Road Travel	Trips	Trips/fuel	MPG	Rnd trip Dist (mi)	Fuel (Gallons)	CO2 lbs/gal	CO2 (lbs)
Off-airport travel	**26,834**						
Employees gas (90% of employees)		24,151	22.5	30	32,201	19.5640	629,976
Diesel (10% of employees)		2,683	22.5	30	3,578	22.3840	80,087
(53 FTE + 12 interns (3 mos, 3 days/wk)							710,063
				Total	35,779	**Tons**	322
On-airport travel							
Employees gas (90% of employees)		24,151	22.5	0.5	537	19.5640	10,500
Diesel (10% of employees)		2,683	22.5	0.5	60	22.3840	1,335
							11,834
				Total	596	**Tons**	5

County has 53 FTEs, 12 interns (3 mos work - 3 days) — Trips — 26,834.00 — Calculated as (53 FTE*5days*49weeks*2trips)+(12interns*(3mos*4weeks*3days*2trips))

TieDown Users Travel

Employee On Road Travel	trips	Employees	MPG	Rnd trip Dist (mi)	Fuel (Gallons)	CO2 lbs/gal	CO2 (lbs)
Off-airport travel	**341.5**						
Gas (95% of users)		307	19.1	28	450.78	19.5640	8,819
Diesel (5% users)		34	19.1	28	50.09	22.3840	1,121
							9,940
				Total	501	**Tons**	104
On-airport travel							
Gas (95% of users)		307	19.1	2	32.20	19.5640	630
Diesel (5% users)		34	19.1	2	3.58	22.3840	80
							0.3
				Total	36	**Tons**	7

Tiedown user trips -- County survey below, including MPG

CO2 Factor Source: See worksheet EnergyData

to calculate the energy eqivalent of CNG to gallons 0.000453592 Lbs/ton

Diesel	137,700	BTU/gal	
CNG	960	BTU/ft3	Transportation Data Energy Book
Motor Gas	125,000	BTU/gal	
CNG gal equiv	130.2083	ft3/gal	@sum(125,000/960)

CNG 120.593 lb CO2/1000 ft3

Kenmore Air Survey December 2010 Inserted into the spreadsheet above

Gas consumed in 2009 -- assumed equal to 2007 for purposes of this study

Gas 1,772.9 gal

Diesel 2,648.1 gal Average of 7 trips per day with average of 76 passengers

Vehicles

1996 Ford E350 BFI Big Blue Bus

2001 GMC 3500 Blue GMC

2001 Chevy 3500 "Old" BFI Mini-bus

Trip records indicate 2008 and 2009 similar, 2010 trips are increased based on fueling logs

Aircraft CO2 Emissions

Aircraft	2007 KG Fuel Burn	1990 KG Fuel Burn	2020 KG Fuel Burn	Convert Factor kg to Lbs Fuel	Lbs Fuel	Convert Factor Lbs to Gal	Gallons	Convert gal to CO2 (lbs/gal)	2007 CO2 (lbs)	2007 CO2 Tons
JET A										
Approach	2,280,784	1,604,201	2,650,222	2.2046	5,028,217	6.8200	737,275	21.095	15,552,822	7,054.6
Taxi-Idle-Delay	6,852,230	4,806,565	7,873,905	2.2046	15,106,427	6.8200	2,215,019	21.095	46,725,817	21,194.5
Takeoff	3,227,491	2,233,945	3,772,454	2.2046	7,115,326	6.8200	1,043,303	21.095	22,008,476	9,982.9
Climbout	1,549,989	1,042,995	1,764,640	2.2046	3,417,105	6.8200	501,042	21.095	10,569,477	4,794.2
Subtot	13,910,494	9,687,705	16,061,220		30,667,075		4,496,639		94,856,592	43,026.2
AvGas										
Approach	514,230	566,138	591,387	2.2046	1,133,673	6.0000	188,945	18.355	3,468,093	1,573.1
Taxi-Idle-Delay	209,993	225,418	244,379	2.2046	462,950	6.0000	77,158	18.355	1,416,242	642.4
Takeoff	117,583	133,400	133,604	2.2046	259,223	6.0000	43,204	18.355	793,007	359.7
Climbout	376,238	446,600	416,578	2.2046	829,454	6.0000	138,242	18.355	2,537,438	1,151.0
Subtot	1,218,044	1,371,557	1,385,948		2,685,300		447,549.9		8,214,779	3,726.2
Total LTO	15,128,538				33,352,375		4,944,189			46,752.4
Fuel Dispensed						**Jet A 2007**	26,453,952	21.095	558,046,117	253,125.5
						Av Gas 2007	768,998	18.355	14,114,958	6,402.4
						Total	27,222,950		572,161,076	259,527.9
Cruise (Fuel dispensed - LTO)						**Jet A**	21,957,313	21.095	463,189,526	210,099.2
						Av Gas	321,448	18.355	5,900,179	2,676.3
						Total	22,278,761		469,089,705	212,775.5

Source: Fuel dispensed -- County records

Source: EDMS run for LTO -- see LTO emissions

0.00045359237 Lbs/ton

1 gallon = 6.84 lbs Jet A lbs Jet A

6.0 lbs Av-Gas (100LL) lbs Av-Gas (100LL)

P&WA handbook

P&WA handbook

Jet A-1 is 0.812 density (a liter of Jet A-1 weighs .812 grams)

Estimate of Fuel Dispensed in Past and Future Years

	2007	%change in LTO	
Jet A	26,453,952	-30.7%	15.3%
AvGas	768,998	11.4%	14.4%
Relationship		1990	2020
between LTO			
and fuel disp			
Jet A	5.88305		
AvG	1.71824		

King County International Airport

For Jan 1, 2007 thru December 31, 2007

COMPANY	GALLONS PURCHASED TOTALS 2007	2006	2005	2004
TOTAL JET A	**26,453,952**	**20,672,669**	**21,501,055**	**21,740,027**
TOTAL AV GAS	**768,998**	**769,479**	**864,514**	**1,158,227**
GRAND TOTALS	**27,222,950**	**21,442,148**	**22,365,569**	22,898,254

	Fuel type	Taxi Out	Takeoff	Climb Out	Approach	Taxi-In	Total	
2007 Kg of fuel in LTO	JetA	4,885,465	3,227,491	1,549,989	2,280,784	1,966,765	13,910,494	
	AvGas	145,878	117,583	376,238	514,230	64,115	1,218,044	
1990 Kg of fuel in LTO	JetA	3,443,438	2,233,945	1,042,995	1,604,201	1,363,126	9,687,705	1990 JetA
	AvGas	156,263	133,400	446,600	566,138	69,155	1,371,557	1990 AvGas
2020 Kg of fuel in LTO	JetA	5,614,506	3,772,454	1,764,640	2,650,222	2,259,399	16,061,220	2020 JetA
	AvGas	169,781	133,604	416,578	591,387	74,598	1,385,948	2020 Avgas

King County International Airport 2007 Aircraft Emissions

#	Aircraft Name	Engine	Annual LTO	Annual T&Go's	Fuel Type	Jet A Fuel (EDMS Output) Taxi Out (kg)	Takeoff (kg)	Climb Out (kg)	Approach (kg)	Taxi In (kg)	Total Jet Fuel (kg)
1	Agusta A-109	250	54	-	JET	1130.686	5.775	N/A	464.138	477.601	2,078
2	Airbus A300F4-600 Series	PW4158 Reduced smoke	7	-	JET	3,356	2,273	887	930	1,478	8,924
3	Airbus A320-200 Series	V2527-A5	-	-	JET	1,696	933	283	391	717	4,021
4	Airbus A321-200 Series	CFM56-5B1/2P DAC-II	-	-	JET	1,908	1,525	427	614	839	5,314
5	Airbus A330-300 Series	CF6-80C2B5F 1862M39	10	-	JET	1,092	1,034	345	346	478	3,295
6	Bell 206 JetRanger	250	126	-	GAS						-
7	Boeing 707-300 Series	CFM56-2A series	980	-	JET	675,386	815,811	186,319	326,730	281,846	2,286,092
8	Boeing 727-100 Series	TAY 650 Pedhead	6	-	JET	2,863	1,141	430	879	1,129	6,441
9	Boeing 727-200 Series	JT8D-15 Reduced emissions	5	-	JET	2,936	1,046	466	630	1,128	6,207
10	Boeing 737-200 Series	JT8D-15 Reduced emissions	1	-	JET	392	177	70	117	157	912
11	Boeing 737-200 Series	JT8D-15 Reduced emissions	21	-	JET	8,222	3,721	1,470	2,447	3,301	19,160
12	Boeing 737-300 Series	CFM56-3-B1	1	-	JET	302	133	106	89	123	753
13	Boeing 737-400 Series	CFM56-3	6	-	JET	1,924	920	631	557	784	4,817
14	Boeing 737-500 Series	CFM56-3C-1	-	-	JET						-
15	Boeing 737-700 Series	CFM56-7B22	695	-	JET	174,506	95,889	67,997	64,851	72,864	476,107
16	Boeing 737-800 Series	CFM56-7B26	1,145	-	JET	309,408	244,531	53,043	153,145	127,850	887,977
17	Boeing 737-900 Series	CFM56-7B24	177	-	JET	46,227	37,961	8,204	23,764	19,184	135,340
18	Boeing 747-100 Series	JT9D-7A	5	-	JET	5,593	5,230	1,512	2,182	2,135	16,653
19	Boeing 747-200 Series	CF6-50E2 Low emissions fuel	4	-	JET	3,456	5,695	2,146	2,344	1,353	14,995
20	Boeing 747-400 Series	CF6-80C2A5	7	-	JET	6,584	4,770	4,846	2,583	2,514	21,297
21	Boeing 757-200 Series	PW2043	559	-	JET	240,038	137,951	113,001	92,464	99,964	683,417
22	Boeing 757-200 Series	RB211-535E4	40	-	JET	19,085	9,482	7,685	6,495	7,891	50,637
23	Boeing 767-200 Series	CF6-80A	1,010	-	JET	401,574	383,554	198,719	177,050	172,145	1,333,042
24	Boeing 767-300 Series	CF6-80C2B7F 1862M39	960	-	JET	516,559	398,075	222,013	248,203	220,640	1,605,490
25	Boeing 767-400 ER	CF6-80C2B8FA 1862M39	2	-	JET	1,087	648	608	506	452	3,301
26	Boeing 777-200 Series	PW4077	19	-	JET	10,454	8,670	7,009	5,772	4,056	35,961
27	Boeing 777-300 Series	GE90-110B1 DAC	68	-	JET	15,692	7,001	6,299	5,604	5,934	40,530
28	Boeing CH-46 Sea Knight	T58-GE-16	11	-	JET	1,370	3	N/A	456	579	2,408
29	Boeing DC-10-30 Series	CF6-50C2 Low emissions fuel	5	-	JET	3,240	4,329	1,637	1,605	1,266	12,078
30	Boeing DC-8 Series 70	JT3D-7 series Smoke fix 14-7	420	-	JET	284,998	187,628	63,831	85,712	114,420	736,588
31	Boeing F/A-18 Hornet	F404-GE-400	120	-	JET	25,001	38,172	4,136	8,660	9,212	85,181
32	Boeing MD-11	CF6-80C2D1F 1862M39	53	-	JET	39,124	33,971	13,201	13,762	15,160	115,218
33	Boeing MD-87	JT8D-217 series	465	-	JET	152,741	65,177	60,162	48,742	60,883	387,705
34	Bombardier CRJ-200	CF34-3B	22	-	JET	2,592	1,550	1,253	1,803	1,001	8,200
35	Bombardier Challenger 30	AE3007A1 Type 2	429	-	JET	45,212	16,928	3,371	12,201	17,751	95,463
36	Bombardier Challenger 60	ALF 502L-2	852	-	JET	107,724	30,015	6,545	21,833	41,508	207,623

	Fuel type	Taxi Out	Takeoff	Climb Out	Approach	Taxi-In	Total	
2007 Kg of fuel in LTO	JetA	4,885,465	3,227,491	1,549,989	2,280,784	1,966,765	13,910,494	
	AvGas	145,878	117,583	376,238	514,230	64,115	1,218,044	
1990 Kg of fuel in LTO	JetA	3,443,438	2,233,945	1,042,995	1,604,201	1,363,126	9,687,705	1990 JetA
	AvGas	156,263	133,400	446,600	566,138	69,155	1,371,557	1990 AvGas
2020 Kg of fuel in LTO	JetA	5,614,506	3,772,454	1,764,640	2,650,222	2,259,399	16,061,220	2020 JetA
	AvGas	169,781	133,604	416,578	591,387	74,598	1,385,948	2020 Avgas

King County International Airport 2007 Aircraft Emissions

#	Aircraft Name	Engine	Annual LTO	Annual T&Go's	Fuel Type	Jet A Fuel (EDMS Output) Taxi Out (kg)	Takeoff (kg)	Climb Out (kg)	Approach (kg)	Taxi In (kg)	Total Jet Fuel (kg)
37	Bombardier Challenger 60	CF34-3B	8	-	JET	907	291	74	178	354	1,804
38	Bombardier Learjet 25	CJ610-6	50	-	JET	8,482	1,335	288	1,036	3,180	14,322
39	Bombardier Learjet 28	CJ610-6	15	-	JET	2,545	429	95	334	955	4,357
40	Bombardier Learjet 31	TFE731-2-2B	149	-	JET	9,479	4,365	1,156	3,071	3,762	21,832
41	Bombardier Learjet 35	TFE731-2-2B	1,875	-	JET	119,279	58,695	15,842	41,367	47,516	282,699
42	Bombardier Learjet 36	TFE731-2-2B	22	-	JET	1,400	689	186	485	558	3,317
43	Bombardier Learjet 40	TFE731-2-2B	40	-	JET	2,545	1,172	310	825	1,010	5,861
44	Bombardier Learjet 45	TFE731-2-2B	395	-	JET	25,128	11,571	3,065	8,142	9,972	57,878
45	Bombardier Learjet 55	TFE731-3	135	-	JET	7,994	3,398	900	2,391	3,155	17,839
46	Bombardier Learjet 60	TFE731-2/2A	235	-	JET	7,994	3,398	900	2,391	3,155	17,839
47	Cessna 150 Series	O-200	11,898	11,898	GAS						-
48	Cessna 172 Skyhawk	IO-360-B	25,144	16,671	GAS						-
49	Cessna 206	IO-360-B	4,095	95	GAS						-
50	Cessna 208 Caravan	PT6A-114A	3,142	142	JET	41,725	12,653	9,739	29,137	15,375	108,629
51	Cessna 441 Conquest II	TPE331-10A	5,283	283	JET	150,396	69,838	3,145	54,831	56,224	334,434
52	Cessna 500 Citation I	JT15D-1 series	17	-	JET	1,036	609	103	343	405	2,497
53	Cessna 501 Citation ISP	JT15D-1 series	67	-	JET	4,085	2,402	404	1,352	1,597	9,840
54	Cessna 525 CitationJet	JT15D-1 series	276	-	JET	16,826	7,939	1,529	4,455	6,472	37,223
55	Cessna 550 Citation II	JT15D-4 series	658	-	JET	39,987	14,105	9,834	16,662	15,662	96,250
56	Cessna 560 Citation V	JT15D-5, -5A, -5B	431	-	JET	33,816	8,285	6,414	9,869	12,953	71,337
57	Cessna 560 Citation XLS	JT15D-5, -5A, -5B	867	-	JET	68,024	16,665	12,903	19,853	26,055	143,501
58	Cessna 650 Citation III	TFE731-3	123	-	JET	8,477	3,542	2,519	5,143	3,218	22,899
59	Cessna 750 Citation X	AE3007C Type 2	643	-	JET	64,255	31,152	18,938	52,793	25,221	192,360
60	Cirrus SR22	TIO-540-J2B2	8,254	8,286	GAS						-
61	Convair CV-580	501D22A	98	-	JET	19,976	2,630	2,992	2,529	7,543	35,669
62	Dassault Falcon 20-C	CF700-2D	29	-	JET	3,843	2,290	697	1,428	1,494	9,753
63	Dassault Falcon 2000	PW308C Annular	368	-	JET	43,700	16,308	8,982	27,336	16,959	113,284
64	Dassault Falcon 50	TFE731-3	170	-	JET	17,574	4,966	1,319	3,399	6,699	33,956
65	Dassault Falcon 900	TFE731-3	284	-	JET	25,327	6,483	1,732	4,440	9,622	47,604
66	DeHavilland DHC-6-300 T	PT6A-27	34	-	JET	1,298	174	269	389	481	2,612
67	DeHavilland DHC-8-200	PW123C	15	-	JET	1,299	229	246	194	487	2,455
68	Embraer EMB120 Brasilia	PW118A	220	-	JET	15,576	2,082	2,444	2,635	5,855	28,591
69	Embraer ERJ135	AE3007A1/3 Type 3 (reduced	82	-	JET	8,807	3,149	3,625	5,226	3,575	24,383
70	Fokker F100	TAY Mk650-15	3	-	JET	946	566	245	480	394	2,631
71	Gulfstream G200	PW306A Annular	506	-	JET	48,770	16,986	23,517	19,244	19,517	128,034
72	Gulfstream II-B	SPEY Mk511 Transply IIH	136	-	JET	45,782	7,962	11,688	7,696	17,587	90,716
73	Gulfstream IV-SP	TAY 611-8C Transply IIJ	378	-	JET	90,732	12,863	15,798	14,478	34,848	168,719

	Fuel type	Taxi Out	Takeoff	Climb Out	Approach	Taxi-In	Total	
2007 Kg of fuel in LTO	JetA	4,885,465	3,227,491	1,549,989	2,280,784	1,966,765	13,910,494	
	AvGas	145,878	117,583	376,238	514,230	64,115	1,218,044	
1990 Kg of fuel in LTO	JetA	3,443,438	2,233,945	1,042,995	1,604,201	1,363,126	9,687,705	1990 JetA
	AvGas	156,263	133,400	446,600	566,138	69,155	1,371,557	1990 AvGas
2020 Kg of fuel in LTO	JetA	5,614,506	3,772,454	1,764,640	2,650,222	2,259,399	16,061,220	2020 JetA
	AvGas	169,781	133,604	416,578	591,387	74,598	1,385,948	2020 Avgas

King County International Airport 2007 Aircraft Emissions

#	Aircraft Name	Engine	Annual LTO	Annual T&Go's	Fuel Type	Jet A Fuel (EDMS Output) Taxi Out (kg)	Takeoff (kg)	Climb Out (kg)	Approach (kg)	Taxi In (kg)	Total Jet Fuel (kg)
74	Gulfstream V-SP	BR700-710A1-10	383	-	JET	77,850	16,893	18,566	16,780	30,152	160,241
75	Israel IAI-1125 Astra	TFE731-2/2A	200	-	JET	11,854	5,878	1,530	3,258	4,708	27,228
76	Lockheed ES-3A Shadow	TF34-GE-400	18	-	JET	2,915	763	286	1,092	1,107	6,163
77	Lockheed P-3 Orion	T56-A-14	156	-	JET	30,748	9,465	12,101	7,025	11,957	71,295
78	Mitsubishi MU-2	TPE331-10	580	-	JET	25,213	2,664	4,078	5,985	9,337	47,277
79	Mitsubishi MU-300 Diamor	JT15D-4 series	120	5,673	JET	8,302	57,236	99,423	57,238	3,160	225,360
80	Piper PA-34 Seneca	IO-360-B	5,673	3,940	GAS						-
81	Raytheon Beech 18	R-1820	7,940	36	JET	235,717	133,796	129,295	368,016	88,009	954,833
82	Raytheon Beech 1900-D	PT6A-67D	4,036	250	JET	182,080	61,553	4,950	40,017	67,853	356,454
83	Raytheon Beech 99	PT6A-36	4,250	567	JET	165,599	38,775	60,684	87,895	61,699	414,653
84	Raytheon Beech Baron 58	TIO-540-J2B2	4,567	-	GAS						-
85	Raytheon Beechjet 400	JT15D-5, -5A, -5B	289	-	JET	22,675	7,266	1,564	4,395	8,599	44,499
86	Raytheon Hawker 800	TFE731-3	89	-	JET	6,134	3,091	2,027	3,669	2,316	17,235
87	Raytheon Hawker 900	TFE731-3	557	-	JET	33,080	10,746	8,339	19,030	12,602	83,797
88	Robinson R22	IO-320-D1AD	542	-	GAS						-
89	Saab 340-B	CT7-9B	602	-	JET	30,079	4,184	6,592	7,462	11,454	59,770
90	Sikorsky S-76 Spirit	T700-GE-700	39	580	JET	1,737	11	N/A	860	734	3,341
	LTOs -->		**104,471**		Kilograms	**4,885,465**	**3,227,491**	**1,549,989**	**2,280,784**	**1,966,765**	
	T&Go's -->			**48,421**						Total Jet fuel (kg)-->	13,910,494
	Total Operations -->			**305,784**						**Total Jet Consumption (kg)--**	**15,128,538**

EDMS output assigned to AvGas or JetA based on aircraft engine type
All Jets and TP are Jet A, Props are AvGas
Source: BridgeNet International Run of EDMS

1 pound = 0.00045359237 metric tons

-edits made by the Airport's BFO

Site ID	Site Name	Address	City	Electric Accounts	Gas Accounts	Steam Account	Dominant Electric Source	2008 Energy Use MMBTU	Facility ft²	kBTU/ft²	2009 Electric Energy Use (kWh)	Dominant source	2009 Natural Gas (Therms)
19029	Orcas Maintenance Shop	701 S Orcas Stre	Seattle	01-0452333-430005	816-694-773		5	2,088	27,680	75.4			
								Airport Sq footages in purple from Airport records (parcel view)					
TRIA-01	Airport - 7300 Building	7300 Perimeter F	Seattle	01-0456268-264580	375-858-300		6	1,533	25,260	60.7	339,890	5	3,822
TRIA-02	Airport - Aerocopter Site	8013 Perimeter F	Seattle	01-0455830-264588				103	12,105	8.5	20,018		
TRIA-03	Airport - Airpark Hangers D&E	9210-9230 E Ma	Seattle	01-0456312-263553				455	46,050	9.9	82,405		
TRIA-03	Airport - Airpark Hanger C	9210-9230 E Ma	Seattle	01-0456200-250843				455	46,050	9.9	18,220		
TRIA-04	Airport - AOC Building	9010 E Marginal	Seattle	01-0456143-263551			1	3,512	85,545	41.1	1,080,480		
TRIA-05	Airport - ARFF Police & Fire	8190 E Marginal	Seattle	01-0456028-262023	851-257-500			183	5,350	34.2	144,800		1,804
TRIA-06	Airport - Arrivals Building	7299 Perimeter F	Seattle	01-0456155-251659				983	24,812	39.6	369,760		
TRIA-35	Airport - Caliber Site	7500 Perimeter F	Seattle	01-0456155-264583	No PSE meter activity			23	8,818	2.6	5,864		0
TRIA-07	Airport - FAA Traffic Control T	8200 E Marginal	Tukwila	01-0456022-250827	Meter 604395		8	1,031	6,341	162.6	307,900	3	5,323
TRIA-36	Airport - Fedex Site	7607 Perimeter F	Seattle	01-1362888-264584	129-524-400-6			183	19,235	9.5	41,358		145
TRIA-38	Airport - Finelli Site	7201 Perimeter F	Seattle	01-1330954-264578				500	6,400	78.1	34,015	6	2,244
TRIA-37	Airport - Ft Lawton Noise Moni	3801 W Governn	Seattle	01-1319011-951820							0		
TRIA-39	Airport - Groundwater Remedi	7677 Perimeter F	Seattle	01-1422019-962037				21			9,019		
TRIA-09	Airport - Lighting			01-0179149-257344 01-0179150-251656 01-0179235-250825 01-0432902-251660 01-0433259-258226 01-0455830-251664				25					
TRIA-10	Airport - Main Terminal	7277 Perimeter F	Seattle		851-080-700		2	2,397	24,990	95.9		2	23,498
TRIA-11	Airport - Maintenance Shop	6518 Ellis Avenu	Seattle	01-0456053-262024	875-784-700			931	52,085	17.9	2,496	1	45,451
TRIA-xx	Airport - Midfield Hangar A1	8700 E Marginal	Tukwila	01-0456022-921501	372-990-025						12,209		456
TRIA-14	Airport - Midfield Hangar A2	8700 E Marginal	Tukwila	01-0456022-921500	372-990-025			56	2,636	21.2	3,269		621
TRIA-15	Airport - Midfield Hangar A3	8700 E Marginal	Tukwila	01-0456022-921499	372-990-025			49	2,636	18.6	2,982		17
TRIA-16	Airport - Midfield Hangar A4	8700 E Marginal	Tukwila	01-0456022-921498	372-990-025			10	2,636	3.8	4,968		106
TRIA-17	Airport - Midfield Hangar A5	8700 E Marginal	Tukwila	01-0456022-921497	372-990-025			24	2,636	9.1	3,939		934
TRIA-18	Airport - Midfield Hangar B1	8700 E Marginal	Tukwila	01-0456022-928543	372-990-025			128	3,520	36.4	7,798		974
TRIA-19	Airport - Midfield Hangar B2	8700 E Marginal	Tukwila	01-0456022-928542	372-990-025			53	3,520	15.1	8,740		25
TRIA-20	Airport - Midfield Hangar B3	8700 E Marginal	Tukwila	01-0456022-928541	372-990-025			13	3,520	3.7	7,018		0
TRIA-21	Airport - Midfield Hangar B4	8700 E Marginal	Tukwila	01-0456022-928540	372-990-025			104	3,520	29.5	4,612		958
TRIA-22	Airport - Midfield Hangar B5	8700 E Marginal	Tukwila	01-0456022-928539	372-990-025			66	3,520	18.8	14,135		1,562
TRIA-23	Airport - Midfield Hangar B6	8700 E Marginal	Tukwila	01-0456022-921909	372-990-025			147	3,520	41.8	13,448		1,347
TRIA-24	Airport - Midfield Hangar ASH	8700 E Marginal	Tukwila	01-0456022-921503				21	13,182	1.6	6,337		
TRIA-25	Airport - Midfield Hangar BHS	8700 E Marginal	Tukwila	01-0456022-921502				35	21,119	1.7	9,558		
TRIA-26	Airport - Midfield Hangar CHS	8700 E Marginal	Tukwila	01-0456022-928545				174	14,599	11.9	37,297		
TRIA-27	Airport - Midfield Hangar DHS	8700 E Marginal	Tukwila	01-0456022-928546				114	10,354	11.0	32,245		
TRIA-28	Airport - NE T Hangar	6671, 6691, 671	Seattle	01-0455849-251657				289	32,540	8.9	81,776		
TRIA-29	Airport - North Annex	7233 Perimeter F	Seattle	01-0456301-251662	372-990-324-9			66	11,041	6.0	12,548		1,515
TRIA-30	Airport - Old Arrivals Building	7299 Perimeter F	Seattle	01-0456177-264579			7	1,512	24,812	60.9	402,160		
TRIA-32	Airport - South Pump House	6450 Ellis Ave S	Seattle	01-0456028-262023			4	2,131			371,040		
TRIA-33	Airport - Unit Gate	6301 Perimeter F	Seattle	01-0456330-258726				11			2,115		
TRIA-XX	Airport - Main Terminal	7277 Perimeter F		01-0456155-943685			3	2,339			680,760		
TRIA-XX	Airport - SW Pumphouse	8642 E. Marginal		01-0456028-923824							21,640		
TRIA-34	Ruby Chow Park	6265 Stanley Ave	Seattle	01-0456273-430240							31		
SHRIF-09	Contract Police - KCIA	7233 Perimeter F	Seattle	01-0456038-264597	Meter 573424			135			37,417	4	4,659

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