**AIR QUALITY BASELINE (2016) CONDITION REPORT**

**Sustainable Airport Master Plan (SAMP)**

**Environmental Review**

**Seattle-Tacoma International Airport**

**Preliminary Draft**

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**Prepared for:**



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| **ACRONYMS** |
| --- |
| The following is a list of acronyms used in this Report. |

AEDT Airport Environmental Design Tool

ANOMS Aircraft Noise and Operations Monitoring System

APU Auxiliary Power Unit

ASPM Aviation System Performance Metrics

ATADS Air Traffic Activity System

BTU British Thermal Unit

CAA Clean Air Act

CH4 Methane

CO Carbon monoxide

CO2 Carbon dioxide

CO2E Carbon dioxide equivalent

FAA Federal Aviation Administration

GAV Ground Access Vehicle

GHG Greenhouse Gas

GSE Ground Support Equipment

H2OWater vapor

H2SO3 Sulfurous acid

H2SO4 Sulfric acid

HFC Hydrofluorocarbon

LFA LeighFisher

NAAQS National Ambient Air Quality Standards

NEPA National Environmental Policy Act

NH3 Carbon dioxide

NO Nitric oxide

NOX Nitrogen oxides

NO2 Nitrogen dioxide

O3 Ozone

PFCs Perfluorocarbon

PM10 Coarse Particulate Matter

PM2.5 Fine Particulate Matter

Pb Lead

SAMP Sustainable Airport Master Plan

SEPA State Environmental Policy Act

SF6 Sulfur hexafluoride

SIP State Implementation Plan

SOx Sulfur oxide

SO2 Sulfur dioxide

SO3 Sulfur trioxide

USEPA United States Environmental Protection Agency

VOC Volatile Organic Compounds

air quality

BASELINE (2016) conditions

###### 1.0 INTRODUCTION

The Port of Seattle, as the owner and operator of the Seattle-Tacoma International Airport (Sea-Tac or Airport), is currently completing a Sustainable Airport Master Plan (SAMP). The Master Plan will identify airport development projects for implementation. In order for the Port of Seattle to move forward with implementing these potential development projects, environmental approval will be required. It is anticipated that environmental documentation will be prepared to investigate, analyze, and disclose the potential environmental impacts of the proposed action and the reasonable alternatives in compliance with the National Environmental Policy Act of 1969 (NEPA) and the Washington State Environmental Policy Act (SEPA).

The preparation of the environmental documentation will follow Federal Aviation Administration (FAA) regulations and policies for implementing NEPA published in FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*, and FAA Order 5050.4B, *NEPA Implementing Instructions for Airport Actions.* Potential air quality and climate impacts are categories that are required to be analyzed per these regulations. This report describes the regulatory setting and the existing air emissions generated by and at the Airport in advance of the formal NEPA/SEPA process and the identification of the preferred alternative in the Master Plan.

###### 2.0 REGULATORY SETTING

# 2.1 NATIONAL AMBIENT AIR QUALITY STANDARDS

The Clean Air Act (CAA), including the 1990 Amendments, provides the establishment of standards and programs to evaluate, achieve, and maintain acceptable air quality in the United States. Under the CAA, the United States Environmental Protection Agency (USEPA) established a set of standards, or criteria, for six pollutants determined to be potentially harmful to human health and welfare.[[1]](#footnote-1)

The USEPA considers the presence of the following six criteria pollutants to be indicators of air quality:

* Carbon monoxide (CO);
* Nitrogen dioxide (NO2);
* Ground-level Ozone (O3);
* Sulfur dioxide (SO2);
* Particulate matter (PM10 and PM2.5);[[2]](#footnote-2) and,
* Lead (Pb).[[3]](#footnote-3)

The National Ambient Air Quality Standards for the criteria pollutants, known as the NAAQS, are summarized in **Table 1**. For each of the criteria pollutants, the USEPA established primary standards intended to protect public health, and secondary standards for the protection of other aspects of public welfare, such as preventing materials damage, preventing crop and vegetation damage, and assuring good visibility. Areas of the country where air pollution levels consistently exceed these standards may be designated nonattainment by the USEPA.

A nonattainment area is a homogeneous geographical area[[4]](#footnote-4) (usually referred to as an air quality control region) that is in violation of one or more NAAQS and has been designated as nonattainment by the USEPA as provided for under the CAA. Some regulatory provisions, for instance the CAA conformity regulations, apply only to areas designated as nonattainment or maintenance.

A maintenance area describes the air quality designation of an area previously designated nonattainment by the USEPA and subsequently redesignated attainment after emissions are reduced. Such an area remains designated as maintenance for a period up to 20 years at which time the state can apply for redesignation to attainment, provided that the NAAQS were sufficiently maintained throughout the maintenance period.

Table 1   
NATIONAL AMBIENT AIR QUALITY STANDARDS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Pollutant** | | **Primary/** | **Averaging Time** | **Level** | **Form** |
| **Secondary** |
| Carbon Monoxide | | primary | 8-hour | 9 ppm | Not to be exceeded more than once/year |
| 1-hour | 35 ppm |
| Lead(2) | | primary & secondary | Rolling 3 month average | 0.15 μg/m3 (1) | Not to be exceeded |
| Nitrogen Dioxide | | primary | 1-hour | 100 ppb | 98th percentile of 1-hr daily maximum concentrations, averaged over 3 years |
|
| primary & secondary | Annual | 53 ppb(2) | Annual Mean |
| Ozone | | primary & secondary | 8-hour | 0.075 ppm (3) | Annual 4th-highest daily maximum 8-hr concentration, averaged over 3 years |
| Particulate Matter | PM2.5 | primary | Annual | 12 μg/m3 | annual mean, averaged over 3 years |
| secondary | Annual | 15 μg/m3 | annual mean, averaged over 3 years |
| primary & secondary | 24-hour | 35 μg/m3 | 98th percentile, averaged over 3 years |
| PM10 | primary & secondary | 24-hour | 150 μg/m3 | Not to be exceeded more than once/year on average over 3 years |
| Sulfur Dioxide | | primary | 1-hour | 75 ppb (4) | 99th percentile of 1-hr daily maximum concentrations, averaged over 3 years |
|
| secondary | 3-hour | 0.5 ppm | Not to be exceeded more than once/year |

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

(2) The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)).  A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Notes: ppm is parts per million; ppb is parts per billion, and μg/m3 is micrograms per cubic meter.

Source: EPA, <https://www.epa.gov/criteria-air-pollutants/naaqs-table> accessed August 2017.

# 2.2 DESCRIPTION OF POLLUTANTS

The pollutants of concern related to airport activities in this analysis include ozone, carbon monoxide, volatile organic compounds, nitrogen dioxide, sulfur dioxide, particulate matter, and carbon dioxide. Since 1975, lead emissions have been in decline due in part to the introduction of catalyst-equipped vehicles and decline in production of leaded gasoline. In general, an analysis of lead is limited to projects that emit significant quantities of the pollutant (i.e. lead smelters) and are generally not applied to transportation projects and therefore not included in this emissions inventory.

**Ozone (O3)** – Ozone is a pollutant which is not directly emitted; rather, ozone is formed in the atmosphere through photochemical reaction with nitrogen oxides (NOX), volatile organic compounds (VOC), sunlight, and heat. Ozone is the primary constituent of smog and, because it is formed in the atmosphere, may result in health problems many miles away from the pollutant sources.

People with lung disease, children, older adults, and people who are active can be affected when ozone levels are unhealthy. Numerous scientific studies have linked ground-level ozone exposure to a variety of problems, including:

* lung irritation that can cause inflammation much like a sunburn;
* wheezing, coughing, pain when taking a deep breath, and breathing difficulties during exercise or outdoor activities;
* permanent lung damage to those with repeated exposure to ozone pollution; and
* aggravated asthma, reduced lung capacity, and increased susceptibility to respiratory illnesses like pneumonia and bronchitis.

***Carbon Monoxide (CO) -*** Carbon monoxideis acolorless, odorless gas primarily associated with the incomplete combustion of fossil fuels in motor vehicles. Carbon monoxide combines with hemoglobin in the bloodstream and reduces the amount of oxygen that can be circulated through the body. High carbon monoxide concentrations can lead to headaches, aggravation of cardiovascular disease, and impairment of central nervous system functions. Carbon monoxide concentrations can vary greatly over comparatively short distances. Relatively high concentrations are typically found near crowded intersections, along heavily used roadways carrying slow‑moving traffic, and at or near ground level. Even under the most severe meteorological and traffic conditions, high concentrations of carbon monoxide are limited to locations within a relatively short distance of heavily traveled roadways. Overall carbon monoxide emissions are decreasing as a result of the Federal Motor Vehicle Control Program, which has mandated increasingly lower emission levels for vehicles manufactured since 1973.

***Volatile Organic Compound (VOC)*** – Volatile organic compounds aregases that are emitted from solids or liquids, such as stored fuel, paint, asphalt, and cleaning fluids. VOCs include a variety of chemicals, some which can have short and long‑term adverse health effects. VOCs are precursor pollutants that react with heat, sunlight and nitrogen oxides to form ozone. VOCs can also mix with other gases to form fine particulate matter (PM2.5).

***Nitrogen Dioxide (NO2) -*** Nitrogen gas, normally relatively inert (unreactive), comprises about 80% of the air. At high temperatures (i.e., in the combustion process) and under certain other conditions it can combine with oxygen, forming several different gaseous compounds collectively called nitrogen oxides (NOx). Nitric oxide (NO) and nitrogen dioxide are the two most important compounds. Nitric oxide is converted to nitrogen dioxide in the atmosphere. Nitrogen dioxide is a red-brown pungent gas. Motor vehicle emissions are the main source of NOx in urban areas.

Nitrogen dioxide is toxic to various animals as well as to humans. Its toxicity relates to its ability to form nitric acid with water in the eye, lung, mucus membrane and skin. In animals, long-term exposure to nitrogen oxides increases susceptibility to respiratory infections lowering their resistance to such diseases as pneumonia and influenza. Laboratory studies show susceptible humans, such as asthmatics, exposed to high concentrations of NO2 can suffer lung irritation and potentially, lung damage. Epidemiological studies have also shown associations between NO2 concentrations and daily mortality from respiratory and cardiovascular causes and with hospital admissions for respiratory conditions.

While the NAAQS only addresses NO2, NO and the total group of nitrogen oxides is of concern. NO and NO2 are both precursors in the formation of ozone and secondary particulate matter. Because of this and that NO emissions largely convert to NO2, NOx emissions are typically examined when assessing potential air quality impacts.

***Sulfur Dioxide (SO2)*** - Sulfur oxides (SOx) constitute a class of compounds of which sulfur dioxide and sulfur trioxide (SO3) are of greatest importance. SO2 is commonly expressed as SOX since it is a larger subset of sulfur dioxides. SO2 is a colorless gas that is typically identified as having a strong odor and is formed when fuel-containing sulfur, like coal, oil, and/or jet fuel, is burned. SO2 combines easily with water vapor, forming aerosols of sulfurous acid (H2SO3), a colorless, mildly corrosive liquid. This liquid may then combine with oxygen in the air, forming the even more irritating and corrosive sulfuric acid (H2SO4). Peak levels of SO2 in the air can cause temporary breathing difficulty for people with asthma who are active outdoors. Longer-term exposures to high levels of SO2 gas and particles cause respiratory illness and aggravate existing heart disease.

***Particulate Matter (PM10 and PM2.5) -*** Particulate matter includes both aerosols and solid particles of a wide range of size and composition. PM10 is considered coarse particles with a diameter of 10 micrometers or less, and PM2.5, fine particles with a diameter of 2.5 micrometers or less. Emissions of PM2.5 are a subset of emissions of PM10. Particulate matter can be any particle of these sizes, including dust, dirt, and soot. Smaller particulates are of greater concern because they can penetrate deeper into the lungs than large particles.

PM2.5 is directly emitted in combustion exhaust and formed from atmospheric reactions between various gaseous pollutants including nitrogen oxides (NOx), sulfur oxides, and volatile organic compounds . PM10 is generally emitted directly as a result of mechanical processes that crush or grind larger particles or the resuspension of dust, most typically through construction activities and vehicular movements. PM2.5 can remain suspended in the atmosphere for days and weeks and can be transported over long distances. PM10 generally settles out of the atmosphere rapidly and is not readily transported over large distances.

The principal health effect of airborne particulate matter is on the respiratory system. Short-term exposures to high PM2.5 levels are associated with premature mortality, increased hospital admissions, and emergency room visits. Long-term exposures to high PM2.5 levels are associated with premature mortality and development of chronic respiratory disease.

***Carbon Dioxide (CO2) -*** Carbon dioxide isa colorless, odorless gas produced through the incomplete combustion of fossil fuels. Carbon dioxide is considered to be the most significant greenhouse gas (GHG) that traps heat in the earth's atmosphere. Both naturally occurring and man-made greenhouse gases primarily include CO2,water vapor (H2O), methane (CH4), and nitrous oxide (N2O). These different chemical species that are emitted have a different effect on climate. The carbon dioxide equivalent (CO2E) method is a way to show relative impacts on climate change of different chemical species.

# 2.3 KING COUNTY AIR QUALITY STATUS

Sea-Tac is located within King County, Washington, which is included in the Puget Sound Intrastate Air Quality Control Region.[[5]](#footnote-5) The area was previously designated maintenance for ozone under the 1-hour ozone standard; however, the 1-hour standard was revoked by USEPA effective June 15, 2005. In the past, King County was also designated as nonattainment for CO; however, on October 11, 1996, the USEPA determined the area had attained the standard and the region was redesignated to attainment. The area now operates under a maintenance plan for CO. Several areas within King County are classified as maintenance for the PM10 standard, including Kent, Duwamish and Tacoma; however the Sea-Tac is not within any of these areas. The region is considered attainment for all other criteria pollutants including PM2.5, nitrogen dioxide, sulfur dioxide, and lead.

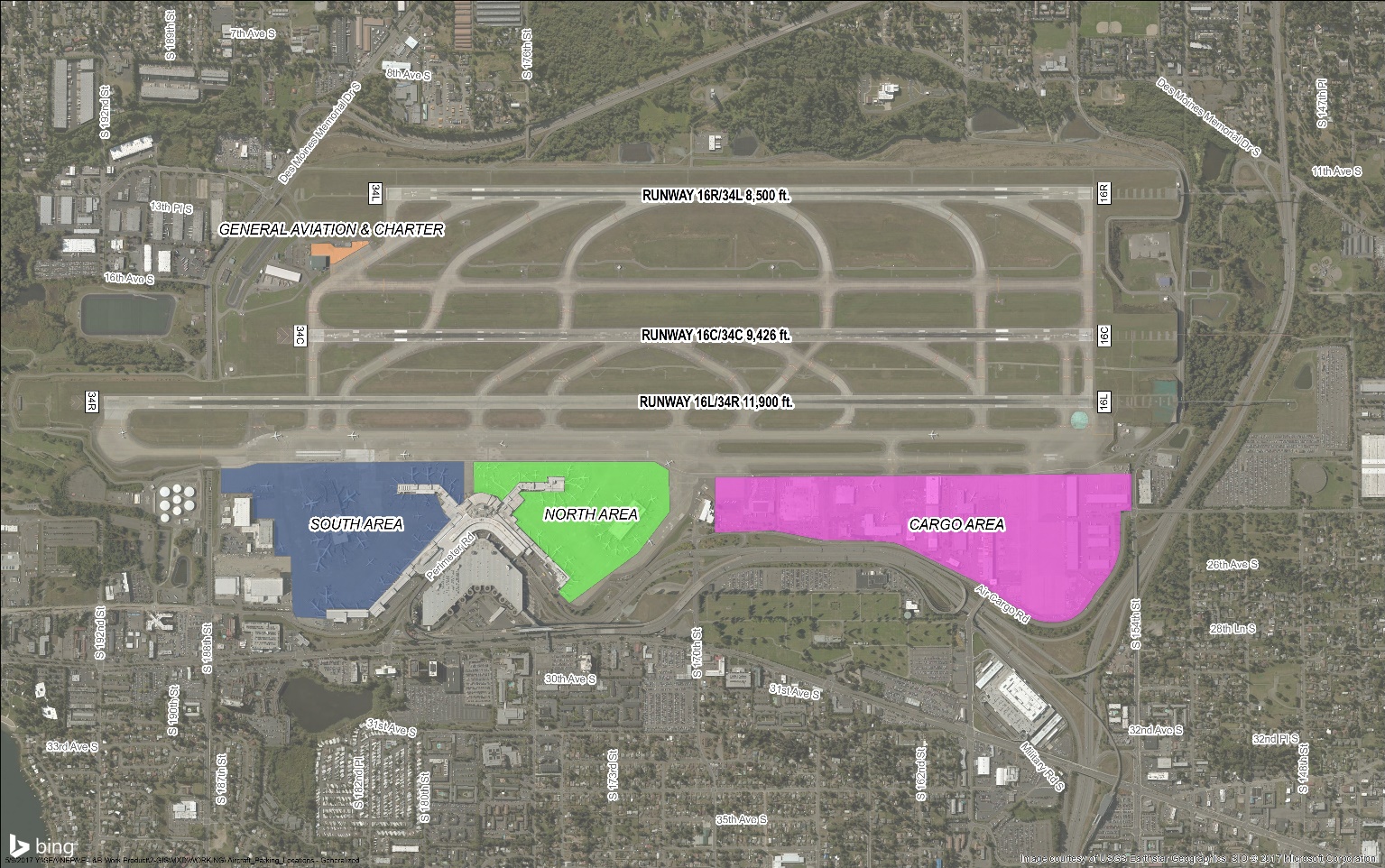
###### 3.0 BASELINE (2016) CONDITIONS

# 3.1 DESCRIPTION OF EXISTING AIRPORT

The Airport has three parallel runways. Runway 16L/34R is 11,900 feet long by 150 feet wide, Runway 16C/34C is 9,426 feet long by 150 feet wide, and Runway 16R/34L is 8,500 feet long by 150 feet wide. The passenger facilities at Sea-Tac are comprised of a terminal building including Concourses A, B, C, and D. In addition, there are two satellite concourses, referred to as the North and South satellites.

For the purposes of this analysis, aircraft operations that occurred at Concourse A, B, and the South Satellite were considered to operate in the South area as shown in **Exhibit 1**. Aircraft operations that occurred at Concourse C, D, and the North Satellite were considered to operate in the North area. Cargo operations operated to the north in the area considered the cargo area. General Aviation and charter activity occurred to the south between Runway 16R/34L and Runway 16C/34C.

Exhibit 1   
Sea-tac gENERAL OPERATING AREAS



Source: Aerial imagery from Bing Maps, 2016; Landrum & Brown analysis, 2017.

The airport primarily operates in a south flow configuration. When the airport operates in this configuration, aircraft arrive from the north, landing on Runways 16L, 16C, and 16R; and depart to the south, taking off from Runways 16C, 16L, and to a lesser extent Runway 16R. When in a north flow configuration, aircraft arrive from the south, landing on Runways 34L, 34C, and 34R, and depart to the north, taking off on Runways 34C, 34R, and, to a lesser extent, 34L.

# 3.2 AIR QUALITY MONITORING IN REGION

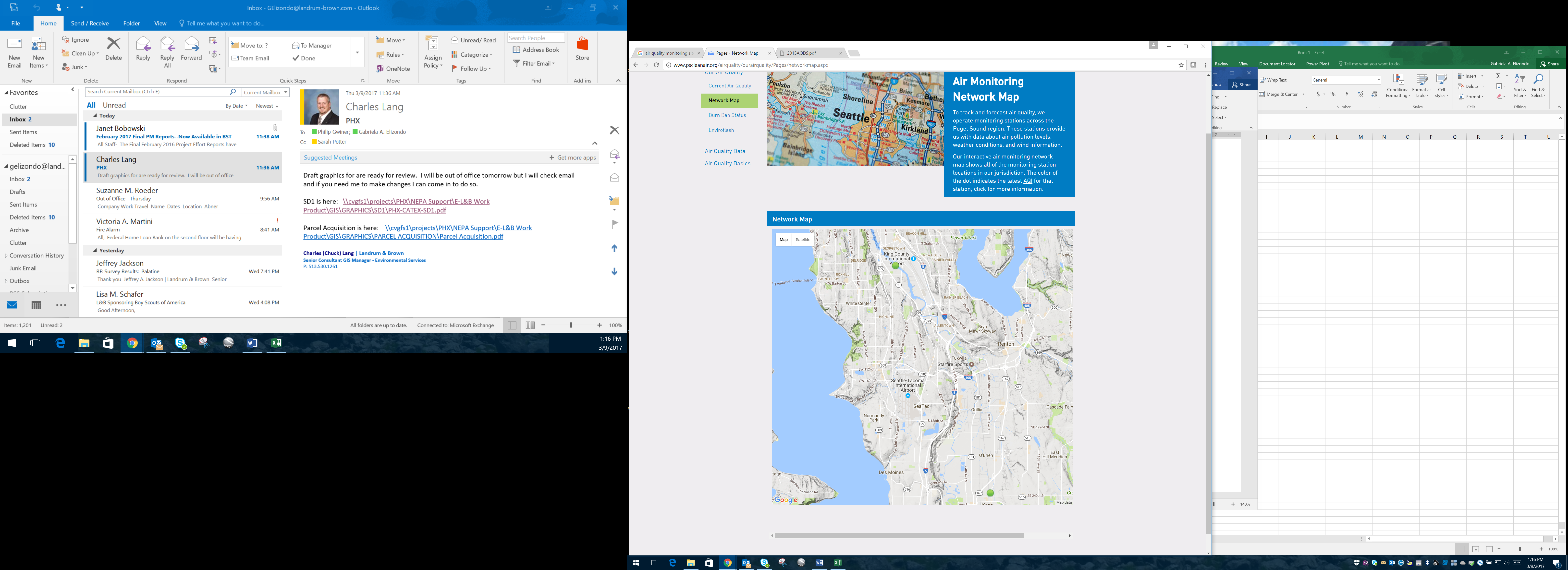
The State of Washington’s Department of Ecology established an air monitoring network around the state that measures air pollution. King County’s air quality monitoring stations are maintained by the Puget Sound Clean Air Agency. The two air quality monitoring stations closest to Sea-Tac are Seattle South Park and Kent. The air quality monitoring station at Kent is shown in **Exhibit 2**. The locations relative to Sea-Tac are provided in **Exhibit 3**. These two stations primarily monitor for the pollutant fine particulate matter (PM2.5). Data from these monitors indicate if the air quality falls below the standard.[[6]](#footnote-6)

Exhibit 2   
Air Quality monitor



Source: Puget Sound Clean Air Agency.

Exhibit 3   
Air Quality monitor locations near Sea-tac



**Sea-Tac**

**Kentt**

**South Park**

Note: The two air quality monitoring stations (green identifier) nearest the Airport.

Source: Puget Sound Clean Air Agency.

# 3.3 EMISSION SOURCES

3.3.1 AIRCRAFT

The number and type of aircraft operations directly affects emissions. The existing conditions emissions inventory is based on aircraft operations occurring during calendar year 2016. Therefore, Air Traffic Activity System (ATADS) radar data was obtained for January 2016 through December 2016. A representative aircraft was determined based on the data obtained and JP Fleets was used to assign engine types for each aircraft.

In 2016, there were a total of 412,170 operations at Sea-Tac. Passenger operations comprised 97 percent of the total operations. Cargo, air taxi, charter, and general aviation operations make up the remaining three percent of the total operations. **Table 2** shows the breakdown of operations by type of operation.

Table 2   
2016 ANNUAL OPERATIONS

|  |  |  |
| --- | --- | --- |
| **TYPE OF OPERATION** | **ANNUAL OPERATIONS** | **PERCENT OF ANNUAL OPERATIONS** |
| Passenger | 398,593 | 97% |
| Cargo | 9,195 | 2% |
| Air Taxi | 453 | < 1% |
| Charter | 66 | < 1% |
| General Aviation | 3,863 | < 1% |
| **Total** | **412,170** | **100%** |

Note: Totals may not sum exactly due to rounding.

Source: Sea-Tac radar data for the period January 1, 2016 through December 31, 2016, Air Traffic Activity System (ATADS); Landrum & Brown analysis, 2017.

In 2016, there were a total of 398,593 passenger operations. Alaska Airlines made up approximately 29 percent of passenger operations. Horizon Air and Delta Airlines made up approximately 20 percent and 11 percent of passenger operations, respectively. The top passenger airlines are shown in **Table 3**.

Table 3   
TOP 5 PASSENGER AIRLINES AT SEA-TAC

|  |  |
| --- | --- |
| **PASSENGER AIRLINE** | **PERCENT OF PASSENGER OPERATIONS** |
| Alaska Airlines | 29.70% |
| Horizon Air | 20.15% |
| Delta Airlines | 11.34% |
| SkyWest Airlines | 10.21% |
| Southwest Airlines | 6.90% |

Source: Seattle-Tacoma International Airport EnvironmentalVue Monitoring System Data, January 2016-December 2016, Air Traffic Activity System (ATADS); Landrum & Brown analysis, 2017.

Horizon Air’s Bombardier de Havilland Dash 8 Q400 was the most used passenger aircraft as it served approximately 20 percent of the passenger operations. This is followed by Alaska Airlines’ Boeing 737-900 Series and Boeing 737-800 with winglets which served 14 percent and 10 percent of passenger operations. The detailed passenger aircraft fleet mix is shown in **Table 4**.

Table 4   
2016 PASSENGER AIRCRAFT FLEET

| **AIRLINE** | **AIRCRAFT** | **ENGINE TYPE** | **OPERATIONS** |
| --- | --- | --- | --- |
| Aeromexico | Boeing 737-800 with winglets | CFM56-7B27 | 4 |
| Air Busan | Airbus A320-200 Series | V2527-A5 | 16 |
| Air Busan | Boeing 737-500 Series | CFM56-3C-1 | 11 |
| Air Canada | Airbus A319-100 Series | CFM56-5A5 | 274 |
| Air Canada | Airbus A320-200 Series | CFM56-5-A1 | 26 |
| Air Canada | Embraer ERJ190-AR | CF34-10E5 | 841 |
| Alaska Airlines | Boeing 737-400 Series | CFM56-3C-1 | 12,218 |
| Alaska Airlines | Boeing 737-700 Series | CFM56-7B22 | 9,724 |
| Alaska Airlines | Boeing 737-800 with winglets | CFM56-7B24 | 38,947 |
| Alaska Airlines | Boeing 737-900 Series | CFM56-7B24 | 57,478 |
| All Nippon Airways | Boeing 777-300-ER | GE90-115B | 6 |
| All Nippon Airways | B787-8R | Trent 1000-J2 | 513 |
| All Nippon Airways | Boeing 787-900 Dreamliner | Trent 1000-J2 | 228 |
| American Airlines | Airbus A319-100 Series | CFM56-5B6/2 | 766 |
| American Airlines | Airbus A320-100 Series | V2527-A5 | 1,554 |
| American Airlines | Airbus A321-200 Series | V2533-A5 | 7,220 |
| American Airlines | Boeing 737-800 with winglets | CFM56-7B26 | 8,649 |
| American Airlines | Boeing 757-200 Series | RB211-535E4 | 33 |
| American Airlines | Boeing 767-300 ER | CF6-80C2B6 | 5 |
| American Airlines | B787-8R | GENX-1B70 | 4 |
| American Airlines | Boeing MD-83 | JT8D-217 | 8 |
| Asiana Airlines | Airbus A330-300 Series | PW4168 | 164 |
| Asiana Airlines | Boeing 747-400 Series | CF6-80C2B1F | 341 |
| Asiana Airlines | Boeing 777-200-ER | PW4090 | 426 |
| Atlas Air | Boeing 747-400 Series | CF6-80C2B1F | 12 |
| Atlas Air | Boeing 767-300 ER Freighter | CF6-80C2B7F | 132 |
| British Airways | Boeing 747-400 Series | RB211-524H | 397 |
| British Airways | Boeing 777-200-ER | GE90-85B | 331 |
| British Airways | Boeing 777-300-ER | GE90-115B | 436 |
| Compass Airlines | Embraer ERJ175-LR | CF34-8E5 | 11,344 |
| Compass Airlines | Embraer ERJ175 | CF34-8E5 | 3 |
| Compass Airlines | Embraer ERJ175-LR | CF34-8E5 | 959 |
| Compass Airlines | Embraer ERJ175-LR | CF34-8E5 | 5,765 |
| Condor | Boeing 767-300 ER | PW4062 | 275 |
| Delta Airlines | Airbus A319-100 Series | CFM56-5A5 | 301 |
| Delta Airlines | Airbus A320-200 Series | CFM56-5A3 | 821 |
| Delta Airlines | Airbus A330-200 Series | PW4168 | 1,098 |
| Delta Airlines | Airbus A330-300 Series | PW4168 | 1,304 |
| Delta Airlines | Boeing 717-200 Series | BR700-715A1-30 | 6,713 |
| Delta Airlines | Boeing 737-800 Series | CFM56-7B26 | 10,813 |
| Delta Airlines | Boeing 737-900-ER | CFM56-7B26 | 8,988 |
| Delta Airlines | Boeing 747-400 Series Freighter | PW4056 | 224 |
| Delta Airlines | Boeing 757-200 Series | PW2037 | 7,986 |
| Delta Airlines | Boeing 757-300 Series | PW2043 | 2,325 |
| Delta Airlines | Boeing 767-300 ER | PW4060 | 4,214 |
| Delta Airlines | Boeing 767-400 ER | CF6-80C2B8F | 118 |
| Delta Airlines | Boeing 777-200-LR | GE90-110B1 | 278 |
| Delta Airlines | Boeing 777-200-LR | GE90-110B1 | 12 |
| Delta Airlines | Boeing MD-90 | V2525-D5 | 6 |
| Emirates Airlines | Boeing 777-200-LR | GE90-110B1 | 501 |
| Emirates Airlines | Boeing 777-300-ER | GE90-115B | 871 |
| EVA Air | Boeing 747-400 Series | CF6-80C2B1F | 293 |
| EVA Air | Boeing 777-300-ER | GE90-115B | 505 |
| Executive Jet Management | Cessna 750 Citation X | AE3007C | 6 |
| Executive Jet Management | Raytheon Hawker 800 | TFE731-3 | 8 |
| Flexjets | Bombardier Challenger 300 | HTF7000 (AS907-1-1A) | 28 |
| Flexjets | Bombardier Global Express | BR700-710A2-20 | 5 |
| Flexjets | Gulfstream IV-SP | TAY 611-8C | 8 |
| Flexjets | Bombardier Learjet 75 | TFE731-3 | 14 |
| FlightOptions | Raytheon Beechjet 400 | JT15D-5, -5A, -5B | 14 |
| FlightOptions | Cessna 750 Citation X | AE3007C2 | 6 |
| FlightOptions | Embraer 505 | BIZLIGHTJET\_F | 22 |
| Frontier Airlines | Airbus A319-100 Series | CFM56-5A5 | 1,185 |
| Frontier Airlines | Airbus A320-100 Series | CFM56-5B4 | 1,000 |
| Frontier Airlines | Airbus A321-200 Series | V2533-A5 | 48 |
| Hainan Airlines | Airbus A330-200 Series | Trent 772 | 93 |
| Hainan Airlines | Airbus A330-300 Series | Trent 772 | 527 |
| Hainan Airlines | B787-8R | GEnx-1B74/75/P1 | 355 |
| Hainan Airlines | Boeing 787-900 Dreamliner | GEnx-1B74/75/P1 | 30 |
| Hawaii Airlines | Airbus A330-200 Series | Trent 772 | 1,523 |
| Hawaii Airlines | Boeing 767-300 ER | PW4060 | 4 |
| Horizon Air | Bombardier de Havilland Dash 8 Q200 | PW123C | 6 |
| Horizon Air | Bombardier de Havilland Dash 8 Q400 | PW150A | 80,327 |
| Iceland Air | Boeing 757-200 Series | RB211-535E4 | 961 |
| Jazz Aviation LP | Bombardier CRJ-200-ER | CF34-3B | 12 |
| Jazz Aviation LP | Bombardier CRJ-900-ER | CF34-8C5 | 273 |
| Jazz Aviation LP | Bombardier de Havilland Dash 8 Q300 | PW123 | 1,413 |
| Jazz Aviation LP | Bombardier de Havilland Dash 8 Q400 | PW150A | 1,979 |
| JetBlue Airways | Airbus A320-200 Series | V2527-A5 | 4,381 |
| JetBlue Airways | Airbus A321-200 Series | V2533-A5 | 4 |
| Korean Air | Boeing 747-400 ER | PW4060 | 165 |
| Korean Air | Boeing 747-800 Freighter | GENX-2B67 | 220 |
| Korean Air | Boeing 777 Freighter | GE90-110B1 | 607 |
| Lufthansa | Boeing 747-400 Series | CF6-80C2B1F | 59 |
| Mountain Aviation "FOOT HILLS" | Cessna 560 Citation V | JT15D-5, -5A, -5B | 8 |
| Mountain Aviation "FOOT HILLS" | Bombardier Learjet 31 | TFE731-2-2B | 4 |
| Netjets Aviation "EXECJET" | Cessna 560 Citation XLS | JT15D-5, -5A, -5B | 87 |
| Netjets Aviation "EXECJET" | Cessna 680 Citation Sovereign | PW306B | 26 |
| Netjets Aviation "EXECJET" | Cessna 750 Citation X | AE3007C | 44 |
| Netjets Aviation "EXECJET" | Bombardier Challenger 300 | HTF7000 (AS907-1-1A) | 33 |
| Netjets Aviation "EXECJET" | Bombardier Challenger 600 | AS907-1-1A | 12 |
| Netjets Aviation "EXECJET" | Embraer 505 | BIZLIGHTJET\_F | 37 |
| Netjets Aviation "EXECJET" | Dassault Falcon 2000 | PW308C | 24 |
| Netjets Aviation "EXECJET" | Bombardier Global Express | BR700-710A2-20 | 12 |
| Netjets Aviation "EXECJET" | Raytheon Hawker 800 | TFE731-3 | 29 |
| Netjets Aviation "EXECJET” | Cessna 560 Citation V | PW530 | 38 |
| Omni Air | Boeing 767-300 ER | CF6-80C2B6 | 447 |
| SkyWest Airlines | Bombardier CRJ-200-ER | CF34-3B | 571 |
| SkyWest Airlines | Bombardier CRJ-700-ER | CF34-8C1 | 26,983 |
| SkyWest Airlines | Bombardier CRJ-900-ER | CF34-8C5 | 4,578 |
| SkyWest Airlines | Embraer ERJ170 | CF34-8E5 | 2,513 |
| SkyWest Airlines | Embraer ERJ175 | CF34-8E5 | 6,043 |
| Southwest Airlines | Boeing 737-300 Series | CFM56-3-B1 | 3,075 |
| Southwest Airlines | Boeing 737-700 Series | CFM56-7B22 | 17,504 |
| Southwest Airlines | Boeing 737-800 Series | CFM56-7B26 | 6,924 |
| Spirit Airlines | Airbus A319-100 Series | V2524-A5 | 1,017 |
| Spirit Airlines | Airbus A320-200 Series | V2527-A5 | 1,152 |
| Sun Country Airlines | Boeing 737-700 Series | CFM56-7B22 | 262 |
| Sun Country Airlines | Boeing 737-800 with winglets | CFM56-7B27 | 826 |
| Travel Management Company | Raytheon Hawker 800 | TFE731-3 | 10 |
| Turkish Airlines | Boeing 737-700 Series | CFM56-7B22 | 4 |
| United Airlines | Airbus A319-100 Series | V2522-A5 | 1,708 |
| United Airlines | Airbus A320-200 Series | V2527-A5 | 4,474 |
| United Airlines | Boeing 737-700 Series | CFM56-7B24 | 374 |
| United Airlines | Boeing 737-800 Series | CFM56-7B26 | 3,769 |
| United Airlines | Boeing 737-900-ER | CFM56-7B26 | 7,949 |
| United Airlines | Boeing 757-200 Series | PW2037 | 81 |
| United Airlines | Boeing 757-300 Series | RB211-535E4B | 835 |
| United Airlines | Boeing 767-300 ER | PW4060 | 7 |
| United Airlines | Boeing 767-400 | CF6-80C2B8F | 8 |
| United Airlines | Boeing 787-900 Dreamliner | GEnx-1B74/75/P1 | 12 |
| Virgin America | Airbus A319-100 Series | CFM56-5B6/2 | 2,014 |
| Virgin America | Airbus A320-200 Series | CFM56-5B4 | 3,067 |
| Volaris | Airbus A320-200 Series | CFM56-5B4 | 158 |
| Xiamen Airlines | B787-8R | Trent 1000-J2 | 86 |
| XOJet | Cessna 750 Citation X | AE3007C2 | 16 |
| XOJet | Bombardier Challenger 300 | AS907-1-1A | 8 |
| **Total PASSENGER OPERATIONS** | | | **398,593** |

Source: Seattle-Tacoma International Airport EnvironmentalVue Monitoring System Data, January 2016-December 2016, Air Traffic Activity System (ATADS); Landrum & Brown analysis, 2017.

In 2016, there were a total of 9,195 cargo operations. FedEx Express made up approximately 47 percent of cargo operations. Empire Airlines and ABX Air made up approximately 15 percent and 10 percent of cargo operations, respectively. FedEx Express’ Boeing MD-11 Freighter was the most used cargo aircraft as it served approximately 19 percent of the cargo operations. This is followed by Empire Airlines’ Cessna 208 Caravan and FedEx Express’ Boeing MD-10-30 which served 15 percent and 12 percent of the cargo operations. The detailed cargo aircraft fleet mix is shown in **Table 5**.

Table 5   
2016 CARGO AIRCRAFT FLEET MIX

| **AIRLINE** | **AIRCRAFT** | **ENGINE TYPE** | **OPERATIONS** |
| --- | --- | --- | --- |
| ABX Air | Boeing 767-200 Series Freighter | CF6-80A | 694 |
| ABX Air | Boeing 767-300 ER Freighter | CF6-80C2B6 | 192 |
| Air Bridge Cargo | 7478 | GEnx-2B67 | 58 |
| Air China Cargo | Boeing 777 Freighter | GE90-110B1 | 30 |
| Air Transport International | Boeing 757-200 Series Freighter | PW2037 | 432 |
| Air Transport International | Boeing 767-200 Series Freighter | CF6-80A2 | 77 |
| Air Transport International | Boeing 767-300 Series | CF6-80C2B6 | 164 |
| Asiana Airlines | Airbus A330-300 Series | PW4168 | 6 |
| Asiana Airlines | Boeing 747-400 Series | CF6-80C2B1F | 20 |
| Atlas Air | Boeing 767-200 Series Freighter | JT9D-7R4D, -7R4D1 | 6 |
| Atlas Air | Boeing 767-300 ER Freighter | CF6-80C2B7F | 6 |
| Cargolux | Boeing 747-400 Series Freighter | CF6-80C2B1F | 104 |
| Cargolux | Boeing 747-800 Freighter | GENX-2B67 | 202 |
| China Airlines | Boeing 747-400 Series | CF6-80C2B5F | 554 |
| China Cargo Airlines | ATR 42-200 | PW120 | 46 |
| Empire Airlines | Cessna 208 Caravan | PT6A-114 | 1,383 |
| FEDEX EXPRESS | Airbus A300F4-600 Series | CF6-80C2A5 | 760 |
| FEDEX EXPRESS | Airbus A310-200 Series Freighter | CF6-80A3 | 4 |
| FEDEX EXPRESS | Boeing 757-200 Series Freighter | RB211-535E4 | 534 |
| FEDEX EXPRESS | Boeing 767-300 ER Freighter | CF6-80C2B6 | 157 |
| FEDEX EXPRESS | Boeing 777 Freighter | GE90-110B1 | 40 |
| FEDEX EXPRESS | Boeing MD-10-30 | CF6-50C2 | 1,063 |
| FEDEX EXPRESS | Boeing MD-11 Freighter | CF6-80C2D1F | 1,751 |
| Kalitta Air | Boeing 747-200 Series Freighter | JT9D-7A | 22 |
| Kalitta Air | Boeing 747-400 Series Freighter | CF6-80C2B5F | 37 |
| Kalitta Charters | Boeing 727-200 Series Freighter | JT8D-15 | 12 |
| Kalitta Charters | Bombardier Learjet 35 | TFE731-2-2B | 6 |
| Korean Air | Boeing 747-400 ER | PW4060 | 26 |
| Korean Air | Boeing 747-800 Freighter | GENX-2B67 | 6 |
| Lufthansa | Boeing 747-400 Series | CF6-80C2B1F | 624 |
| Polar Air Cargo | Boeing 747-400 Series Freighter | CF6-80C2B5F | 17 |
| Polar Air Cargo | Boeing 747-800 Freighter | GENX-2B67 | 4 |
| Singapore Airlines Cargo | Boeing 747-400 Series Freighter | PW4056 | 123 |
| UPS Airlines | Boeing 757-200 Series Freighter | RB211-535E4 | 4 |
| UPS Airlines | Boeing 767-300 ER Freighter | CF6-80C2B6 | 8 |
| Volga-Dnepr Airlines | Antonov 124 Ruslan | D-36 | 23 |
| **Total CARGO OPERATIONS** | | | **9,195** |

Source: Seattle-Tacoma International Airport EnvironmentalVue Monitoring System Data, January 2016-December 2016, Air Traffic Activity System (ATADS); Landrum & Brown analysis, 2017.

In 2016, there were a total of 453 air taxi operations. Airpac Airlines, Inc and Ameriflight made up approximately 52 percent and 47 percent of air taxi operations, respectively. Ameriflight’s Raytheon Beech 99 was the most used air taxi aircraft as it served approximately 47 percent of the air taxi operations. This is followed by Airpac Airlines, Inc’s Piper PA-31 Navajo which served 45 percent of the air taxi operations. The detailed air taxi aircraft fleet mix is shown in **Table 6**.

Table 6   
2016 AIR TAXI AIRCRAFT FLEET MIX

| **AIRLINE** | **AIRCRAFT** | **ENGINE TYPE** | **OPERATIONS** |
| --- | --- | --- | --- |
| Airnet Express | Bombardier Learjet 35 | TFE731-2-2B | 4 |
| Airpac Airlines, Inc | Cessna 208 Caravan | PT6A-114 | 32 |
| Airpac Airlines, Inc | Piper PA-31 Navajo | TIO-540-J2B2 | 203 |
| Ameriflight | Raytheon Beech 99 | PT6A-20 | 214 |
| **Total AIR TAXI OPERATIONS** | | | **453** |

Source: Seattle-Tacoma International Airport EnvironmentalVue Monitoring System Data, January 2016-December 2016, Air Traffic Activity System (ATADS); Landrum & Brown analysis, 2017.

In 2016, there were a total of 66 charter operations. Xtra Airways made up approximately 50 percent of the charter operations. Xtra Airways’ Boeing 737-400 Series was the most used charter aircraft as it served approximately 40 percent of the charter operations. The detailed charter aircraft fleet mix is shown in **Table 7**.

Table 7   
2016 CHARTER AIRCRAFT FLEET

| **AIRLINE** | **AIRCRAFT** | **ENGINE** | **OPERATIONS** |
| --- | --- | --- | --- |
| Ameristar Air Cargo | Boeing DC-9-10 Series | JT8D-7 series | 8 |
| Miami Air International/Quest Cargo International | Boeing 737-800 with winglets | CFM56-7B26 | 13 |
| Red Wing Charter | Cessna 560 Citation V | JT15D-5, -5A, -5B | 4 |
| Royal Air | Dassault Falcon 200 | CF700-2D | 4 |
| Royal Air | Bombardier Learjet 35 | TFE731-2-2B | 4 |
| Xtra Airways | Boeing 737-400 Series | CFM56-3C-1 | 26 |
| Xtra Airways | Boeing 737-800 with winglets | CFM56-7B27 | 7 |
| **Total CHARTER OPERATIONS** | | | **66** |

Source: Seattle-Tacoma International Airport EnvironmentalVue Monitoring System Data, January 2016-December 2016, Air Traffic Activity System (ATADS); Landrum & Brown analysis, 2017.

In 2016, there were a total of 3,863 general aviation operations. The Cessna 208 Caravan aircraft and the Cessna 172 Skyhawk aircraft were the most used general aviation aircraft as they served approximately 34 percent and 17 percent of general aviation operations, respectively. The detailed general aviation aircraft fleet mix is shown in **Table 8**.

Table 8   
2016 GENERAL AVIATION AIRCRAFT FLEET

| **AIRCRAFT** | **ENGINE** | **OPERATIONS** |
| --- | --- | --- |
| Bombardier Challenger 600 | CF34-3B | 148 |
| Bombardier Learjet 35 | TFE731-2-2B | 151 |
| Cessna 172 Skyhawk | IO-320-D1AD | 659 |
| Cessna 182 | IO-360-B | 140 |
| Cessna 208 Caravan | PT6A-114 | 1,298 |
| Cessna 560 Citation Excel | JT15D-5, -5A, -5B | 288 |
| Cessna 680 Citation Sovereign | PW306B | 77 |
| DeHavilland DHC-6-100 Twin Otter | PT6A-20 | 222 |
| EADS Socata TB-9 Tampico | O-320 | 232 |
| Falcon 900DX | TFE731-3 | 443 |
| Gulfstream IV-SP | TAY Mk611-8 | 138 |
| Piper PA-28 Cherokee Series | IO-320-D1AD | 67 |
| **Total general aviation OPERATIONS** | | **3,863** |

Source: Seattle-Tacoma International Airport EnvironmentalVue Monitoring System Data, January 2016-December 2016, Air Traffic Activity System (ATADS); Landrum & Brown analysis, 2017.

3.3.2 AUXILAIRY POWER UNITS

The larger jet aircraft use auxiliary power units (APUs) while at the gate to operate the heating, air conditioning, and electric systems. The APU is also used to start or restart the aircraft engines before departing from the gate area. APU usage causes emissions and is under the control of the pilot; therefore, APU use and emissions can vary greatly from one airline to another and even one aircraft to another. Therefore, APUs are modeled by aircraft operation. For the existing conditions emissions inventory, AEDT defaults were used for APUs.

3.3.3 MOBILE SOURCES

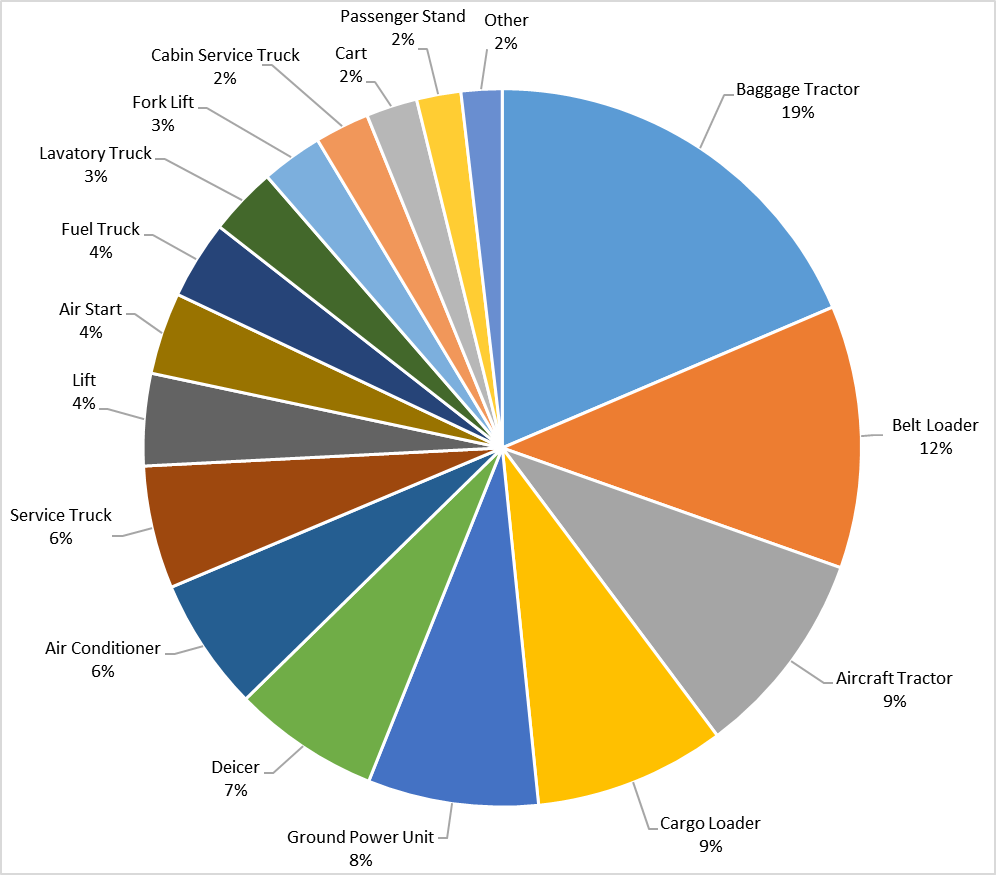
Mobile sources of air pollution include motor vehicles and other engines and equipment that can be moved from one location to another. These are typically classified as road sources and non-road sources. Non-road sources include ground support equipment (GSE) and construction equipment. Road sources include automobiles, light duty and heavy-duty trucks, buses, and motorcycles referred to as Ground Access Vehicles (GAVs). The determination of GAV emissions will be conducted during the formal NEPA/SEPA process.

For this baseline conditions emissions inventory, it is important to identify all of the types of GSE in order to determine emissions. Typical GSE includes air conditioning, air start, baggage tractors, belt loaders, catering vehicles, and emergency vehicles that support airport operations.

GSE can be modeled using two different methods: 1) GSE assignment to a specific aircraft operation and 2) by total GSE equipment population. For the method of assigning GSE to an aircraft by operation, GSE emissions are dependent upon the number of specific aircraft operations and type of aircraft. GSE emissions generated per operation are the product of the emission factor, horsepower, load factor, and operating time per the aircraft operation. GSE may also be modeled by the equipment population method. For a known population of GSE, the emissions are the product of the emission factor for the given pollutant, horsepower, load factor, usage, and population.

For this analysis, GSE was modeled by total population. Data was provided by Sea-Tac. For the existing conditions, there are a total of 651 GSE units supporting Sea-Tac. The reported number of baggage tractor and belt loader units are the highest out of the rest of the GSE equipment, as shown in **Exhibit 4**.

Exhibit 4   
GSE equipment



Source: LeighFisher, 2016.

GSE usage from 2014 was obtained from Sea-Tac. It was assumed that GSE for 2016 would be directly related to projected increases in annual aircraft operations.  In 2016, baggage tractors were the most frequently used GSE. Belt loaders and cargo loaders are the second and third most used GSE. The 2016 GSE equipment inventory the total annual usage and the fuel type is shown in **Table 9**.

Table 9   
2016 GROUND SUPPORT EQUIPMENT INVENTORY

| **FUEL TYPE** | **GSE TYPE** | **REFERENCE** | **POPULATION** | **HORSEPOWER** | **LOAD FACTOR** | **YEAR** | **ANNUAL USAGE (HOURS)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Diesel | Air Conditioner | ACE 802 | 3 | 300 | 0.75 | 1998 | 977 |
| Diesel | Air Conditioner | ACE 802 | 1 | 300 | 0.75 | 1999 | 977 |
| Diesel | Air Conditioner | ACE 802 | 1 | 300 | 0.75 | 2000 | 977 |
| Diesel | Air Conditioner | ACE 802 | 1 | 300 | 0.75 | 2004 | 977 |
| Diesel | Air Conditioner | ACE 802 | 1 | 300 | 0.75 | 2007 | 977 |
| Diesel | Air Conditioner | ACE 802 | 4 | 300 | 0.75 | 2008 | 977 |
| Diesel | Air Conditioner | ACE 802 | 28 | 300 | 0.75 | 2003 | 977 |
| Gasoline | Air Start | ACE 180 | 1 | 425 | 0.90 | 1997 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 2006 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 1986 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 1990 | 403 |
| Diesel | Air Start | ACE 180 | 13 | 425 | 0.90 | 1997 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 1992 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 1995 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 1997 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 1998 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 2001 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 2002 | 403 |
| Diesel | Air Start | ACE 180 | 1 | 425 | 0.90 | 2003 | 403 |
| Gasoline | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1995 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1998 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 2000 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 2 | 0 | 0.80 | 2001 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 2005 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 2008 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 46 | 0 | 0.80 | 1995 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1985 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1987 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1988 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1989 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1990 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1991 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1993 | 775 |
| Diesel | Aircraft Tractor | Stewart & Stevenson TUG GT-35, MC | 1 | 0 | 0.80 | 1994 | 775 |
| Gasoline | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 37 | 71 | 0.55 | 1998 | 1813 |
| Gasoline | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 2 | 71 | 0.55 | 1986 | 1813 |
| Gasoline | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2001 | 1813 |
| Gasoline | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2002 | 1813 |
| Gasoline | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2003 | 1813 |
| Gasoline | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2007 | 1813 |
| Gasoline | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 6 | 71 | 0.55 | 2009 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 3 | 71 | 0.55 | 1993 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 2 | 71 | 0.55 | 1998 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 4 | 71 | 0.55 | 1999 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2000 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2001 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2002 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 1 | 71 | 0.55 | 2004 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 2 | 71 | 0.55 | 2005 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 3 | 71 | 0.55 | 2006 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 18 | 71 | 0.55 | 1999 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 33 | 71 | 0.55 | 1998 | 1813 |
| Diesel | Baggage Tractor | Stewart & Stevenson TUG MA 50 | 3 | 71 | 0.55 | 1985 | 1813 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 22 | 71 | 0.50 | 2001 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 1 | 71 | 0.50 | 1990 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 1 | 71 | 0.50 | 1991 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 1 | 71 | 0.50 | 1998 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 6 | 71 | 0.50 | 2000 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 2 | 71 | 0.50 | 2002 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 2 | 71 | 0.50 | 2003 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 1 | 71 | 0.50 | 2005 | 1572 |
| Gasoline | Belt Loader | Stewart & Stevenson TUG 660 | 1 | 71 | 0.50 | 2006 | 1572 |
| Diesel | Belt Loader | Stewart & Stevenson TUG 660 | 29 | 71 | 0.50 | 2001 | 1572 |
| Diesel | Belt Loader | Stewart & Stevenson TUG 660 | 6 | 71 | 0.50 | 2007 | 1572 |
| Diesel | Belt Loader | Stewart & Stevenson TUG 660 | 1 | 71 | 0.50 | 2009 | 1572 |
| Propane | Belt Loader | Stewart & Stevenson TUG 660 | 1 | 71 | 0.50 | 2001 | 1572 |
| Propane | Belt Loader | Stewart & Stevenson TUG 660 | 3 | 71 | 0.50 | 1999 | 1572 |
| Gasoline | Cabin Service Truck | Hi-Way F650 | 3 | 210 | 0.53 | 2000 | 1934 |
| Gasoline | Cabin Service Truck | Hi-Way F650 | 1 | 210 | 0.53 | 1994 | 1934 |
| Diesel | Cabin Service Truck | Hi-Way F650 | 11 | 210 | 0.53 | 2000 | 1934 |
| Diesel | Cabin Service Truck | Hi-Way F650 | 1 | 210 | 0.53 | 2006 | 1934 |
| Gasoline | Cargo Loader | FMC Commander 15 | 7 | 80 | 0.50 | 1998 | 1330 |
| Diesel | Cargo Loader | FMC Commander 15 | 21 | 80 | 0.50 | 1998 | 1330 |
| Diesel | Cargo Loader | FMC Commander 15 | 1 | 80 | 0.50 | 1987 | 1330 |
| Diesel | Cargo Loader | FMC Commander 15 | 1 | 80 | 0.50 | 1991 | 1330 |
| Diesel | Cargo Loader | FMC Commander 15 | 1 | 80 | 0.50 | 1992 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 8 | 80 | 0.50 | 2000 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 1 | 133 | 0.50 | 2001 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 2 | 133 | 0.50 | 2002 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 1 | 133 | 0.50 | 2004 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 3 | 133 | 0.50 | 2006 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 2 | 133 | 0.50 | 2007 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 1 | 133 | 0.50 | 1993 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 2 | 133 | 0.50 | 1994 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 1 | 133 | 0.50 | 1995 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 1 | 133 | 0.50 | 1997 | 1330 |
| Diesel | Cargo Loader | FMC Commander 30 | 2 | 133 | 0.50 | 2007 | 1330 |
| Propane | Cargo Loader | FMC Commander 30 | 1 | 80 | 0.50 | 1998 | 1330 |
| Gasoline | Cart | Taylor Dunn | 12 | 25 | 0.50 | 1998 | 121 |
| Gasoline | Cart | Taylor Dunn | 3 | 25 | 0.50 | 1998 | 121 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 32 | 165 | 0.95 | 1991 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 1 | 165 | 0.95 | 1982 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 1 | 165 | 0.95 | 1989 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 1 | 165 | 0.95 | 1993 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 4 | 165 | 0.95 | 1991 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 1 | 165 | 0.95 | 1997 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 1 | 165 | 0.95 | 1986 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 1 | 165 | 0.95 | 1996 | 604 |
| Gasoline | Deicer | FMC Tempest II, Single engine | 1 | 165 | 0.95 | 1997 | 604 |
| Diesel | Fork Lift | Toyota 5,000 lb | 5 | 55 | 0.30 | 1998 | 1180 |
| Propane | Fork Lift | Toyota 5,000 lb | 13 | 55 | 0.30 | 1998 | 1180 |
| Diesel | Fuel Truck | F750, Dukes Transportation Services, DART 3000 to 6000 gallon | 1 | 175 | 0.25 | 1995 | 682 |
| Diesel | Fuel Truck | F750, Dukes Transportation Services, DART 3000 to 6000 gallon | 21 | 175 | 0.25 | 1997 | 682 |
| Diesel | Fuel Truck | F750, Dukes Transportation Services, DART 3000 to 6000 gallon | 1 | 175 | 0.25 | 1998 | 682 |
| Gasoline | Ground Power Unit | TLD, 400 Hz AC | 1 | 194 | 0.75 | 2001 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 36 | 194 | 0.75 | 2001 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 1 | 194 | 0.75 | 2011 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 1 | 194 | 0.75 | 1987 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 2 | 194 | 0.75 | 1988 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 1 | 194 | 0.75 | 1996 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 2 | 194 | 0.75 | 1999 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 2 | 194 | 0.75 | 2000 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 1 | 194 | 0.75 | 2001 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 2 | 194 | 0.75 | 2004 | 2055 |
| Diesel | Ground Power Unit | TLD, 400 Hz AC | 1 | 194 | 0.75 | 2008 | 2055 |
| Gasoline | Lavatory Truck | TLD 1410 | 13 | 56 | 0.25 | 1994 | 1804 |
| Diesel | Lavatory Truck | Wollard TLS-770 / F350 | 7 | 235 | 0.25 | 1994 | 1804 |
| Gasoline | Lift | *EPA Default* | 1 | 115 | 0.50 | 1996 | 412 |
| Gasoline | Lift | *EPA Default* | 1 | 115 | 0.50 | 2000 | 412 |
| Gasoline | Lift | *EPA Default* | 2 | 115 | 0.50 | 2001 | 412 |
| Gasoline | Lift | *EPA Default* | 1 | 115 | 0.50 | 2006 | 412 |
| Diesel | Lift | *EPA Default* | 20 | 115 | 0.50 | 2001 | 412 |
| Propane | Lift | *EPA Default* | 2 | 115 | 0.50 | 2001 | 412 |
| Gasoline | Other | *EPA Default* | 1 | 140 | 0.50 | 2001 | 1990 |
| Diesel | Other | *EPA Default* | 11 | 140 | 0.50 | 2001 | 1990 |
| Gasoline | Passenger Stand | Wollard CMPS170 / CMPS228 | 4 | 65 | 0.57 | 1998 | 227 |
| Diesel | Passenger Stand | Wollard CMPS170 / CMPS228 | 1 | 65 | 0.57 | 2001 | 227 |
| Diesel | Passenger Stand | Wollard CMPS170 / CMPS228 | 1 | 65 | 0.57 | 2007 | 227 |
| Diesel | Passenger Stand | Wollard CMPS170 / CMPS228 | 1 | 65 | 0.57 | 2011 | 227 |
| Diesel | Passenger Stand | Wollard CMPS170 / CMPS228 | 4 | 65 | 0.57 | 1998 | 227 |
| Diesel | Passenger Stand | Wollard CMPS170 / CMPS228 | 1 | 65 | 0.57 | 1971 | 227 |
| Propane | Passenger Stand | Wollard CMPS170 / CMPS228 | 1 | 65 | 0.57 | 1998 | 227 |
| Gasoline | Service Truck | F250 / F350 | 5 | 235 | 0.20 | 2005 | 1016 |
| Diesel | Service Truck | F250 / F350 | 1 | 235 | 0.20 | 2002 | 1016 |
| Diesel | Service Truck | F250 / F350 | 26 | 235 | 0.20 | 2005 | 1016 |
| Diesel | Service Truck | F250 / F350 | 1 | 235 | 0.20 | 2008 | 1016 |
| Natural Gas | Service Truck | F250 / F350 | 1 | 235 | 0.20 | 2005 | 1016 |
| Propane | Service Truck | F250 / F350 | 2 | 235 | 0.20 | 2005 | 1016 |

Source: LeighFisher, 2016 and Landrum & Brown analysis, 2017.

3.3.4 STATIONARY SOURCES

Stationary sources of air pollution include generators and boilers located on Airport property. These stationary sources are a small percentage of the overall emission inventory and are unlikely to change significantly from year‐to‐year. It is important for the modeling of air pollution that run-time hours and estimated energy used by boilers are identified. In 2016, the most frequently used boiler was the wall-fired boiler fueled by natural gas. The boiler inventory is shown in **Table 10**.

Table 10   
2016 STATIONARY SOURCES INVENTORY - BOILERS

| **TYPE** | **10003 CUBIC METERS PER YEAR** |
| --- | --- |
| Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled | 59.22 |
| Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled | 8,015.16 |
| Natural Gas: Residential Furnace | 16.14 |
| Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled | 76.60 |
| Natural Gas: Wall Fired Boiler, <100 Million BTU/hr, Uncontrolled | 144.86 |
| Natural Gas: Residential Furnace | 23.78 |
| Natural Gas: Residential Furnace | 3.50 |

Source: LeighFisher, 2016.

The most frequently used generator was the generator with a horsepower of 2,400, operating approximately 630 hours per year. The generator inventory is shown in **Table 11**.

Table 11   
2016 STATIONARY SOURCES INVENTORY - GENERATORS

| **FUEL TYPE** | **HORSEPOWER (HP)** | **ANNUAL USAGE (HOURS)** |
| --- | --- | --- |
| Diesel Fuel | 2,400 | 122.7 |
| Diesel Fuel | 2,400 | 122.7 |
| Diesel Fuel | 2,400 | 122.7 |
| Diesel Fuel | 2,400 | 87.7 |
| Diesel Fuel | 2,400 | 87.7 |
| Diesel Fuel | 2,400 | 87.7 |
| Diesel Fuel | 67 | 4 |
| Diesel Fuel | 80 | 5.2 |
| Diesel Fuel | 380 | 1 |
| Diesel Fuel | 1,341 | 33 |
| Diesel Fuel | 1,341 | 33 |
| Diesel Fuel | 240 | 3.5 |
| Diesel Fuel | 2012 | 2 |
| Diesel Fuel | 2012 | 2 |
| Diesel Fuel | 235 | 4.4 |
| Diesel Fuel | 412 | 6.8 |
| Diesel Fuel | 412 | 6.6 |
| Diesel Fuel | 412 | 2.6 |
| Diesel Fuel | 412 | 7.4 |
| Diesel Fuel | 380 | 4.5 |
| Diesel Fuel | 380 | 5.6 |
| Diesel Fuel | 380 | 4.4 |
| Diesel Fuel | 503 | 4.1 |
| Diesel Fuel | 165 | 16.6 |

Source: LeighFisher, 2016; Landrum & Brown analysis, 2017.

# 3.4 EMISSION INVENTORIES

3.4.1 2014 EDMS INVENTORY

A 2014 emissions inventory was prepared for the SAMP by LeighFisher (LFA) using the Emissions and Dispersion Modeling System (EDMS) version 5.1.4.1. **Table 12** shows the total emissions for 2014 conditions as modeled in EDMS.

Table 12   
2014 EDMS ANNUAL EMISSIONS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **EMISSION SOURCE** | **SHORT TONS OF POLLUTANTS (2014)** | | | | | |
| **NOX** | **VOC** | **CO** | **SOX** | **PM10** | **PM2.5** |
|
| Aircraft Engines | 1,623 | 242 | 1,329 | 158 | 8 | 8 |
| APUs | 72 | 5 | 48 | 9 | 22 | 22 |
| GSE | 307 | 78 | 2,292 | 21 | 20 | 19 |
| Stationary Sources | 17 | 1 | 12 | 0 | 1 | 1 |
| TOTAL | 2,019 | 326 | 3,681 | 188 | 51 | 50 |

Source: LeighFisher, 2016.

3.4.2 2016 AEDT INVENTORY

To prepare a baseline condition for the future NEPA/SEPA work, an emission inventory was developed for the Airport’s sources during 2016 using the FAA’s AEDT Version 2c Service Pack 2. AEDT is now the FAA’s required software system that models aircraft performance in space and time to estimate fuel consumption, emissions, noise, and air quality consequences at airports. **Table 13** shows the total emissions for the Baseline (2016) Condition as modeled in AEDT.

Table 13   
BASELINE (2016) CONDITION AEDT ANNUAL EMISSIONS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **EMISSION SOURCE** | **SHORT TONS OF POLLUTANTS (2016)** | | | | | | |
| **NOX** | **VOC** | **CO** | **SOX** | **PM10** | **PM2.5** | **CO2 \*** |
| Aircraft Engines | 1,775 | 261 | 1,455 | 162 | 13 | 13 | 396,306 |
| APUs | 40 | 3 | 33 | 5 | 5 | 5 | - |
| GSE | 370 | 94 | 2,769 | 19 | 25 | 25 | - |
| Stationary Sources | 18 | 1 | 12 | 0 | 1 | 1 | - |
| TOTAL | 2,267 | 379 | 4,841 | 190 | 48 | 47 | 396,306 |

Source: Landrum & Brown analysis, 2017.

\*Note: CO2 annual emissions are reported in metric tons.

**Table 14** shows the percent change between the 2014 and 2016 emission inventories, for comparison of the results from the EDMS and AEDT models.

Table 14   
PERCENT CHANGE BETWEEN 2014 AND 2016 ANNUAL EMISSIONS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **EMISSION SOURCE** | **PERCENT CHANGE** | | | | | |
| **NOX** | **VOC** | **CO** | **SOX** | **PM10** | **PM2.5** |
|
| Aircraft Engines | 9% | 8% | 9% | 3% | 67% | 67% |
| APUs | -45% | -43% | -31% | -39% | -77% | -77% |
| GSE | 21% | 21% | 21% | -10% | 27% | 27% |

Source: Landrum & Brown analysis, 2017.

Specific data was available to determine APU use for the 2014 emission inventory. However, for 2016 default values for APUs were used in AEDT, which resulted in lower total emissions of APUs.

The increase in total emissions from 2014 to 2016 is primarily a result of the increase in aircraft operations from 340,478 in 2014 to 412,170 in 2016.

1. USEPA, Code of Federal Regulations, Title 40, Part 50 (40 CFR Part 50) *National Primary and Secondary Ambient Air Quality Standards (*NAAQS), July 2011. [↑](#footnote-ref-1)
2. PM10 and PM2.5 are airborne inhalable particles that are less than ten micrometers (coarse particles) and less than 2.5 micrometers (fine particles) in diameter, respectively. [↑](#footnote-ref-2)
3. Airborne lead in urban areas is primarily emitted by vehicles using leaded fuels. [↑](#footnote-ref-3)
4. A homogeneous geographical area, with regard to air quality, is an area, not necessarily bounded by state lines, where the air quality characteristics have been shown to be similar over the whole area. This may include several counties, encompassing more than one state, or may be a very small area within a single county. [↑](#footnote-ref-4)
5. USEPA, Title 40 Code of Federal Regulations Part 81.32. [↑](#footnote-ref-5)
6. Puget Sound Clean Air Agency. 2015 Air Quality Data Summary, August 2015. [↑](#footnote-ref-6)