Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Draft 28 February 2020

NOTE

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prepared by: Stantec RICKER CUNNINGHAM SINCE 1993

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Draft 28 February 2020

Prepared for the:
Washington State Department of Commerce
as authorized by ESSB 6032

Prepared by:

Stantec

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SINCE 1993

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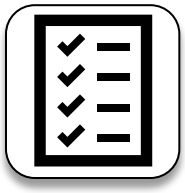

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EXECUTIVE SUMMARY

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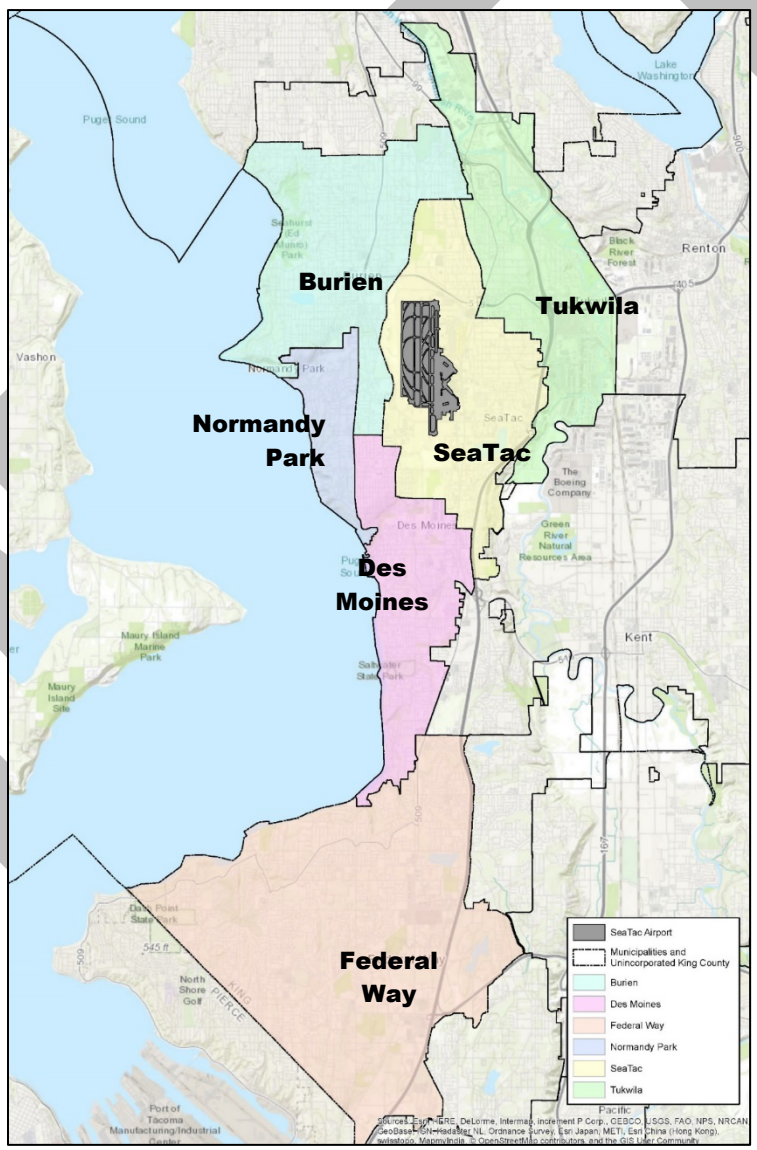
EXECUTIVE SUMMARY

A. STUDY OVERVIEW

This Study (hereafter referred to as the 2020 Study) was authorized under Engrossed Substitute Senate Bill (ESSB) 6032 – Section 127(63) during the 2018 regular session to evaluate the current and ongoing impacts of the Seattle-Tacoma International Airport upon the six cities that surround it – the Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac, and Tukwila (shown in Figure ES.1). ESSB 6032 provided for a total of $600,000 – half from the State's general fund and half from the Study Area Cities.

Figure ES.1
Study Area



It is important to note that this 2020 Study does **not** oppose or impede the operations, growth, or success of Seattle-Tacoma International Airport. And while it may have some similar characteristics to a previous study completed in 1997 that focused on the then-proposed third runway, this Study is **not** an extension or continuation of the 1997 Study.

B. A SHARED HISTORY

The Study Area has been inhabited by for hundreds (perhaps thousands) of years prior to the development of Seattle-Tacoma International Airport. It was initially the home to the Lushootseed-speaking tribes of the Muckleshoot, Puyallup, Duwamish, and Suquamish peoples who established encampments for fishing, clamming, hunting and agriculture. By the mid-1800's, settlers began establishing small communities throughout the area.

As is common with metropolitan areas, the six Study Area Cities grew at different paces. Tukwila was the first to incorporate as a city (1908), with Normandy Park and Federal Way becoming cities in the 1950's (1953 and 1959 respectively). Federal Way and SeaTac both incorporated on the same day in 1990, with Burien officially becoming a city in 1993. And while they all incorporated at different times, they all were growing as early "suburbs" to the larger City of Seattle.

Burien, Normandy Park and Federal Way were developing neighborhoods and communities that had a combination of Puget Sound views, dramatic topography, and dense tree cover. Some referred to Normandy Park as "Boeing-ville" because of the number of Boeing executive who were building their new homes in the community. And all Study Area Cities leveraged some mode of transportation – highway, railroad, or boat – as a means to grow their communities. Tukwila's strategic location along Interstate 5 and with area railroad freight lines helped it become a leader in retail and warehouse/distribution development.

An industry closely tied to Seattle and King County is aviation. Aircraft manufacturer Boeing has been an important part of the region for over 100 years. Interest in aviation accelerated after World War I, initially for mail and cargo delivery, then for commercial routes in the 1920's. Boeing Field (King County International Airport) began offering passenger service in 1928 and was eventually replaced by Seattle-Tacoma International Airport as the region's main passenger airport in 1947. (The US military had taken control of Boeing Field in the 1940's as a response to the Pearl Harbor attack.)

Despite "growing up together", many of the Study Area Cities have had previous concerns with operations at Seattle-Tacoma International Airport, including the development of the second runway in 1970 (Runway 16C/34C) and its associated noise and air quality. Those concerns were echoed 27 years later with the 1997 proposal of a third runway (Runway 16R/34L). Both runways were constructed despite local objections.

Growth

From 2000 to 2018, the entire Study Area, as well as the City of Seattle, King County, and the Seattle metropolitan statistical area (MSA) experienced growth, but at varying rates – from 22.8% for the Study Area to 32.2% for the City of Seattle. (The City of Burien did exhibit a larger growth rate due to a significant annexation in 2010 that added 1,600 acres and 14,292 residents to the City at once. Without the annexation, Burien's growth rate would have been closer to 20%.)

While it is growing, the Study Area is not growing as fast as other parts of the area (refer to Figure ES.2). But the largest growth rate in the Study Area (2000 to 2018) is associated with both the number of passengers at Seattle-Tacoma International Airport (75.5%) and Air Carrier operations (80.7%). Non-air carrier operations (including Air Taxi, General Aviation, Military and Civil operations) all decreased during the same period, indicating a rise in the prominence of commercial activity (passenger and cargo) at Seattle-Tacoma International Airport.

Figure ES.2
Area Growth: 2000-2018

Area	2000 Population	2018 Population	Growth: 2000-2018
City of Burien	31,881	51,908	62.8%
City of Des Moines	29,267	32,364	10.6%
City of Federal Way	83,259	97,044	16.6%
City of Normandy Park	6,392	6,660	4.0%
City of SeaTac	25,496	29,239	14.7%
City of Tukwila	17,181	20,294	18.1%
Total: Study Area Cities	**193,476**	**237,449**	**22.8%**
City of Seattle	563,374	744,955	32.2%
King County	1,737,034	2,233,163	28.6%
Seattle MSA	3,043,878	3,939,363	29.4%
Airport (Annual Passengers):			
Total: Annual Passengers	**28,408,553**	**49,849,520**	**75.5%**
Airport (Annual Operations):			
Air Carrier	236,355	427,170	80.7%
Air Taxi	203,723	8,509	(-95.8%)
General Aviation	5,448	2,625	(-51.8%)
Military	95	87	(-8.4%)
Civil	56	0	(-100.0%)
Total: Annual Operations	**445,677**	**438,391**	**(-1.6%)**

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census

Based solely on the above data, no direct correlation can be made between dramatic growth at the Airport and relatively slower growth rates in the Study Area.

Since the above data was initially collected, the Port of Seattle published their 2019 annual passenger and operation counts. The 2019 annual passenger count increased 6.2% over 2018 (to 51,829,239 passengers), while operations fell 5.8% from the previous year (down to 412,916). This disparity may be related to increasing seat count in aircraft and/or the use of larger aircraft on select routes.

Case Studies

This Study examined three other airports that shared similar characteristics with Seattle-Tacoma International Airport – US airports with international service, with similar land area, and that are surrounded by other development or by water. The three case study airports were:

- Boston Logan International Airport (Boston, Massachusetts)
- Miami International Airport (Miami, Florida)
- Phoenix Sky Harbor International Airport (Phoenix, Arizona)

Figure ES.3 shows the comparison of the above airports with Seattle-Tacoma International Airport. All three airports had concerns with noise impacts on surrounding residential areas and addressed them in different ways.

The following summarizes some of the highlights of the comparison Seattle-Tacoma International Airport with the three case study airports (note that 2018 annual passenger and operations counts were used because they were the latest full-year figures available at the time):

- Seattle-Tacoma International Airport is a very efficient facility. It has the highest ratio of passengers per operation and handles over 1,700 passengers per gate per day every day (2018 annual average).
- The experience of Phoenix Sky Harbor with the NextGen procedures closely parallels those experienced in the Study Area Cities, resulting in a similar lawsuit.

- The land use redevelopment strategy at Phoenix Sky Harbor went beyond standard mitigation practices. Phoenix is working with the community to return acquired parcels to active development, adding jobs and revenue back into the region.
- Miami's community outreach programs, including a van equipped with mobile noise monitors, was the most far-reaching effort of the airports studied. The designed "art noise" wall, while not a perfect solution, was an indicator of Massport's interest in providing some measure of abatement approaches that are sensitive to its surroundings. Boston also had a more extensive community outreach effort. Both Miami and Boston implemented policies and procedures designed to protect the environment, from ISO certification to LEED building practices to how aircraft are powered and cooled while parked at the gate.

Figure ES.3
Airport Comparisons

Attribute	Seattle-Tacoma	Boston Logan	Miami	Phoenix Sky Harbor
Year Opened	1944	1923	1928	1928
Size (acres)	2,500 acres	2,384 acres	3,230 acres	3,400 acres
# of runways	3 runways	6 runways	4 runways	3 runways
# of terminals	3 terminals	4 terminals	4 terminals	3 terminals
# of gates	80 gates	103 gates	131 gates	116 gates
Passengers (2018)	49,849,520	40,941,925	45,044,312	44,943,686
Operations (2018)	438,391	424,024	416,032	434,252
Efficiency ratios (2018):				
▪ **Annual passengers per operation**	113.7	96.6	108.3	103.5
▪ **Annual passengers per gate**	623,119.0	397,494.4	343,849.7	387,445.6
▪ **Daily passengers per gate**	1,707.2	1,089.0	942.0	1,061.5

The case studies in this document do not cover every comparable US airport to Seattle-Tacoma International Airport. But it does indicate areas where comparable airports are doing as much or more to address community concerns.

This is should not be interpreted in any way as a critique or condemnation of the efforts to-date by the Port of Seattle. It does indicate that comparably-sized landlocked airports with similar annual passenger and operation performance have done more to address community concerns regarding their facilities. To get a more complete picture of how US airports comparable to Seattle-Tacoma International Airport address their community compatibility issues, funding of a more extensive survey is recommended.

The National Plan of Integrated Airport Systems

Every two years, the Secretary of Transportation is required to submit to Congress the National Plan of Integrated Airport Systems (NPIAS) – which "estimates the costs associated with establishing a system of airports that adequately meets the needs of civil aviation and supports the US Department of Defense and the US Postal Service."

This is the mechanism for developing public-use airports in the US and supports the US Department of Transportation's (DOT) and the Federal Aviation Administration's goals of safety, infrastructure, innovation, and accountability as mandated by Title 49 USC, Section 47103.

On page 1 of the most recent Report to Congress (26 September 2018), the NPIAS defines a list of eight attributes that should be followed. These principles were articulated more than 25 years ago and were reaffirmed by both the Federal Aviation Administration and the aviation industry in 2011. Of the eight attributes, principle number 5 is especially appropriate with regards to how airport-area communities are addressed:

> **"Airports should be compatible with surrounding communities, maintaining a balance between the needs of aviation, the environment, and the requirements of residents."**

Additionally, Executive Order 12893 (31 January 1994) requires that "Federal investments should be cost beneficial". This Executive Order also included other key principles that the Federal Aviation Administration supports through its administration of the NPIAS, including:

- Support of State and local planning and information management systems;
- Support for private sector participation; and,
- Support for effective administration of grant programs like AIP (airport improvement program).

Given that every US airport is required to abide by the attributes and guiding principles established in the NPIAS, this Study recommends that the Port of Seattle and Seattle-Tacoma International Airport take these principles into account, especially Principle #5 regarding compatibility with surrounding communities.

C. WHAT WE HEARD FROM THE PUBLIC

In addition to research data over a 22-year period, the Consultant Team received input from the public to help establish the concerns and priorities that were concerns of the residents of the Study Area. Public input was gathered in a variety of ways, including:

- A Technical Advisory Committee (TAC) composed of staff and citizen representatives of each city in the Study Area;
- A series of 1-on-1 and small group stakeholder interviews comprised of citizens, homeowners, business owners, and other interests in the Study Area Cities; and,
- Two Public Workshops (July 2019 and November 2019) to gather public comment regarding the 2020 Study and draft preliminary findings.

During this process, almost 200 people were involved, including both long-time and new residents. The top concerns voiced were regarding noise and air quality (for a more in-depth discussion of public comments, please refer to Section 4/Community Input):

- **Noise**
  Noise was the primary concern among the residents that commented during the 2020 Study. Noise complaints date back to the development of the third runway more than 20 years ago (and some go as far back as the second runway in 1970). Noise-related complaints were relatively constant from 1997 until 2017 with a few thousand each year -those complaints spiked dramatically in 2018 (over 170,000 complaints) and 2019 (over 400,000 complaints). This spike in 2018 and 2019 is consistent with the increase in annual operations and annual passengers at Seattle-Tacoma International Airport.

- **Air Quality**
  Air quality concerns were a close second, especially how impacts to air quality can affect health, the environment, and property values, and quality of life. A new type of air pollutant – Ultrafine Particulates (UFPs) was also a concern of the public. (A concurrent study on UFPs was being conducted by the University of Washington, which did not detail impacts on human health.)

Other concerns raised by the public during the 2020 Study included the following:

- Failure of mitigation packages as part of the third runway mitigation process
- Traffic congestion, specifically on Airport Expressway, along International Boulevard/US Highway 99 at Arrivals Drive/South 182nd Street, on State Route 518 westbound (west of the I-5/I-405 interchange), and State Route 518 eastbound (west of the Des Moines Memorial Drive interchange).
- Concerns that South King County is a "dumping ground", noting the development of the Federal Detention Center (2425 South 200th Street) and the Federal Aviation Administration Flight Standards District Office (2200 South 216th Street) – neither of which contribute property tax revenues to the local communities; and,
- A general mistrust by members of the public of the Federal Aviation Administration, the Port of Seattle, and Seattle-Tacoma International Airport. This level of skepticism appears to most acute in areas generally north and south of the Airport – Burien, Des Moines, Federal Way, Normandy Park, and the City of SeaTac.
- Violent crime, property crime, and motor vehicle theft in the Study Area Cities is disproportionate;
- Property crime activity in the study area cities is disproportionate;
- Motor vehicle theft and related activity in the study area cities is disproportionate;
- Homelessness is a regional problem and is pervasive near the Airport;
- Airport proximity influences health statistics;
- Airport proximity exceeds appropriate health standards;
- There are noise-induced health concerns;
- Port programs and other efforts (sustainability and fly quiet) have been ineffective;
- Previous noise mitigation packages are ineffective;
- The relationship with the Port is generally poor, but also varies by community;
- Airport revenues are not shared with South King County communities;
- The most vulnerable groups are being the most adversely affected;
- Positive and negative impacts vary among the Study Area Cities;
- The housing that is most adversely impacted is near the Airport;
- School performance has suffered due to Airport impacts;
- The Port of Seattle is not responsive to the Cities in the Study Area;
- The impact of NextGen procedures has enhanced adverse impacts; and,
- Airport employment levels for area residents are not what they used to be.

In some cases, members of the public provided the Consultant Team with data and other studies, especially regarding noise and air quality. The Consultant Team reviewed and included this information when it could be independently verified and validated. When that was not possible, the information was taken as an anecdotal indicator of public concern regarding specific aspects of the Airport and its operation.

It is important to note that the public did not speak with a "unified monolithic voice". Concerns varied from City to City within the Study Area:

- Input from those west and south of the Airport tended to prioritize noise and air quality as primary concerns (predominantly Burien, Des Moines, Normandy Park and Federal Way, with some areas in the City of SeaTac immediately north of the Airport); and,
- Those living northeast and east of the Airport tended to have more issues with noise from Boeing Field/King County International, noted more concerns with traffic, and were interested in ways to increase and improve economic development.

This anecdotal information is important in that it augments gaps in objective data. These comments tend to point to areas of concern that need to be addressed on either a local or a community-wide level. It also helped inform the Consultant Team regarding the recommendations included in this document.

D. IMPACTS

The Consultant Team was tasked with evaluating a variety of impacts to determine a baseline of what impact Seattle-Tacoma International Airport has on the Study Area Cities. Impacts were studied as far back as 1997 and up to the most currently available. While the contract for the Study was for June 2019 through May 2020, the Consultant Team researched, evaluated and analyzed above impact metrics between June 2019 and January 2020.

In addition to research, public input was solicited through a variety of methods, including stakeholder interviews, Public Workshops, and monthly meetings with a Technical Advisory Committee. In all, over 200 people were involved. The public input component helped identify and rank those impacts most critical to the Study Area Cities. The top concerns involved Noise and Air Quality, with additional concerns about Quality of Life and Mobility.

Impacts: Noise and Vibration

The following is a summary of impacts from noise and vibration in the Study Area (for a more in-depth analysis and review, please refer to Section 5/Noise & Vibration).

As stated above, noise was the top concern voiced by residents of the Study Area. This was not entirely unexpected, as similar complaints were raised in the 1997 Study and noise tends to be a common critique of airports by their surrounding communities.

While an average residential structure can provide some measure of sound attenuation, there is no known technology that mitigates noise impacts in outdoor areas (yards, parks). Increases in air carrier operations at Seattle-Tacoma International Airport from 1997 to 2019 have increased the number of complaints, as well as concerns of adverse associated effects of noise exposure, including:

- Annoyance;
- Sleep disturbance;
- Cardiovascular effects;
- Children's learning and cognitive impairment;
- Speech interference;
- Depressed property values; and,
- Impacts on wildlife and domestic pets.

The incidence of noise related complaints generally aligns with flight tracks, late night operations, and occasional on-airfield maintenance run-ups and reverse thrusting. Despite being in what Federal standards consider to be "acceptable", many of these complaints are located within the 65 DNL noise contour. The DNL method of averaging noise over a 24-hour period is not an accurate representation of how area residents, workers, and visitors experience noise, which is as an individual single event.

Impacts: Air Quality

The following is a summary of impacts upon air quality in the Study Area (for a more in-depth analysis and review, please refer to Section 6/Air Quality).

The data regarding air quality does not tell the whole story regarding Study Area impacts. While the data indicates that King County is in attainment with Federal standards, the lack of working air quality monitors in the Study Area does not accurately depict the Study Area's air quality.

There have been some improvements on a macro-scale. Toxic emissions are showing a downward trend and the Airport has taken initiatives to reduce emissions, with a plan to fuel all flights at the Airport with sustainable aviation fuels by 2028. But without an adequate and operational air quality monitor network, the impact of these improvements upon the Study Area cannot be adequately measured. Despite those positive signs, negative impacts on air quality continue:

- Increased aircraft operations negatively affect local and regional air quality;
- Reports of "black soot" on Study Area properties, which requires additional independent testing to determine its chemical composition and source;
- Black carbon emissions from aircraft also contribute to atmospheric warming; and,
- Concerns about UFP pollution (which requires further study);

Numerous data gaps impact the 2020 Study's ability to specifically list air quality impacts, including:

- The inability to compare data from EDMA to AEDT models;
- Differences between 2016 and 2017 emissions data;
- Dated EIS data relating to air quality and emissions; and,
- Toxic concentration information which is not based on data from local monitoring stations; and,
- Additional study is required regarding UFPs to determine the extent of potential health impacts.

Despite some positive steps towards less polluted air, additional study and monitoring is required.

Impacts: Mobility

The following is a summary of impacts upon mobility in the Study Area (for a more in-depth analysis and review, please refer to Section 7/Mobility).

Since 1997, the Study Area, King County, City of Seattle, and the Seattle MSA have all grown. Positive impacts include:

- Airport Expressway – Construction of Airport Expressway provide a direct route to the Airport that does not rely on local streets;
- Transit Improvements – Transit use is promoted by Sound Transit's Link light rail line, Express bus, RapidRide service and Park & Ride lots;
- Cell Phone Lot – The Cell Phone Lot provides a nearby waiting area for drivers meeting arriving passengers;

- Consolidated Rental Car Facility – Development of the remote Consolidated Rental Car Facility has removed dozens of shuttle buses previously operated by the individual rental car companies;
- Local Street Improvements – Traffic flow improvements on local surface roads including center turn lanes and dedicated bus lanes. Also included are improvements to local sidewalks and bike lanes to encourage walking and bike access;
- Airport Employee Parking – The Port of Seattle has developed dedicated employee parking areas north and south of the Airport; and,
- Local Parking – Local parking requirements are generally higher than industry standards. And Airport-area parking in adjacent neighborhoods is not the problem it was first thought.

Negative impacts include:

- Highway Capacity – Since 2000, the capacity of the regional highway network (Interstates 5 and 405, State Routes 509 and 518) has not kept pace with regional population growth. Improvements have favored transit and high-occupancy vehicle (HOV) access (such as HOV lanes and preferential ramp signals;
- Congestion – During certain peak travel periods (Thanksgiving, Christmas, etc.), there is visible traffic congestion on Airport Expressway, which can backup to connecting highways and local streets. Average Level of Service (LOS) ratings have worsened since 1997 on surrounding local streets; and,
- Airport Employee Parking in Park & Ride Lots – Some citizens have noted that Park & Ride facilities, such as the Angle Lake Light Rail Station garage are being used by Airport employees.

It is currently not known what impact the on-demand car services (Uber and Lyft) – which did not exist in 1997 – have on local and regional traffic.

There have been improvements to the transportation network, but these have tended to favor transit, pedestrian, and bicycle access. The overall capacity of the area network has not substantially increased since 1997. And while the Airport is thought to contribute to local and regional traffic, the data is insufficient to determine the extent of this contribution.

Impacts: Surface Water Quality

The following is a summary of impacts upon surface water quality in the Study Area (for a more in-depth analysis and review, please refer to Section 8/Surface Water Quality).

The Port of Seattle has made several investments in the infrastructure to preserve and protect the quality of surface water, including:

- Construction of 112 acres of wetland near the Airport;
- Enhanced about 2 miles of stream habitat including the relocation of 1,000 feet Miller Creek's stream channel;
- Excavated 60-acre feet of floodplain storage capacity;
- Installed 200 pieces of large woody debris, removed two culverts that blocked fish passage, and focused on stabilizing four eroded portions of Miller Creek's stream channel;
- Supplements streamflow to Miller and Des Moines creeks every summer to ensure adequate water levels for fish;
- Created and enhanced 65 acres of off-site wetland and wetland buffer adjacent to the Green River in Auburn to mitigate the loss of wetland habitat for waterfowl near the Airport;

- Upgraded the IWS and SDS stormwater management systems to more efficiently capture and treat stormwater runoff from the Airport; and,
- Kept stormwater discharges from the Airport well below permit limits with low variability in comparison to other airports and industrial stormwater.

The near-constant monitoring of stormwater runoff water quality required by the NPDES permitting program and adjustments to stormwater management in response to water quality results leave little in the way of negative impacts to surface water quality and habitat in the immediate area. However, Seattle-Tacoma International Airport occasionally exceeds those criteria, and even short-term violations can affect salmon habitats. With instances of pre-spawning mortality already recorded in Miller, Walker, and Des Moines Creeks, and throughout the Puget Sound region it is important to understand the impacts any pollution can have on salmon populations.

Impacts: Groundwater and Soil

The following is a summary of impacts upon groundwater and soil quality in the Study Area (for a more in-depth analysis and review, please refer to Section 9/Groundwater & Soil Quality).

Incidents of on-Airport contaminated and NPDES exceedances have been documented by the Port of Seattle, the Department of Ecology, and other agencies. The Port of Seattle has taken steps to address areas of concern, but on-going work and monitoring is required.

Known negative impacts include:

- Known on-Airport contaminated sites include Budget Auto Facility, Concourse B/Gate B, Continental Airlines Hydrant System, Delta Airlines Auto Gas Tank Cluster, Delta Airlines Fuel Farm, Northwest Airlines Hangar Tanks, Northwest Airlines Fuel Farm, Northwest Airlines Hydrant Systems, South Satellite Baggage Tunnel, Pan Am Airlines Avgas (Aviation Gas) Tanks, Pan Am Airlines Fuel Farm, Consolidated Rental Car Facility, and United Air Lines (UAL) Fuel Farm/Continental Airlines Fuel Farm;
- Surface water quality exceedances detected in Miller and Des Moines Creeks and several sites within Airport property that have chemicals of concern;
- Several underground storage tanks which are not on Airport property were noted to be leaking according to the Department of Ecology's database;
- There may be long-term impacts that were also associated with the operation of the former Asarco Tacoma Smelter (opened in 1917, closed in 1985); and,
- Citizens raised concerns regarding the impact on soils, gardens, and landscaping from "black soot" that they believe are the result of air pollution associated with aircraft.

Impacts: Light

The following is a summary of impacts from light in the Study Area (for a more in-depth analysis and review, please refer to Section 10/Light).

Seattle-Tacoma International Airport is replacing the older-generation of lighting (metal halide) with energy efficient LED fixtures which also create less glare. This helps to reduce increased skyglow which are often a problem with standard metal halide lighting.

The data indicates that light intrusion or pollution is being reduced at Seattle-Tacoma International Airport as a result of improving its light fixtures and high-mast lighting.

Impacts: Public Safety

The following is a summary of impacts upon public safety in the Study Area (for a more in-depth analysis and review, please refer to Section 11/Public Safety):

- Crime has stabilized and, in some cases, decreased in the Study Area, including motor vehicle thefts, violent crimes, and property crimes.
- Normandy Park has the lowest incidence of most crimes, while Tukwila reported the highest rate of most reported crimes. While this may be due to major regional retail destinations in Tukwila (such as Southcenter Mall), it may also be that more crimes are reported to police in Tukwila.
- Incidents of human trafficking and drug trafficking were not traceable in the Study Area due to insufficient readily-available data.

Impacts: Public Health

The following is a summary of impacts upon public health in the Study Area (for a more in-depth analysis and review, please refer to Section 12/Public Health).

- There are some positive health outcomes in the Study Area, including creases in the accident rate, and some declines in the rates of cancer and heart disease in the Study Area Cities and King County between 2012 and 2016;
- Life expectancy in the Study Area Cities is almost equal to the average for the State of Washington and the US and is only slightly below the King County average; and,
- Negative concerns still outweigh positive impacts including increases in suicides, a reduction in those with access to medical care, an increase in poor health habits, and other factors that contribute to poor health.

Impacts: Socio-Economics

The following is a summary of impacts on various other socio-economic metrics in the Study Area (for a more in-depth analysis and review, please refer to Section 13/Socio-Economics):

- Positive impacts include Seattle-Tacoma International Airport is a source of employment for the Study Area Cities, revenue from hotel rooms and supporting businesses in the vicinity of the Airport, proximity to air service as a locational advantage for companies within a 30 minute drive of the Airport.
- Neutral impacts include lower median home sale prices, areas located farthest from the Airport considered more valuable, and commercial vacancy rates well below equilibrium, a consistent trend being experienced in many cities since the Great Recession.
- Negative impacts include school districts with a "lower socio-economic profile" than that of King County, median household incomes below the average for King County, and owner-occupied households that spend 30% or more of their income for housing.

E. RECOMMENDATIONS

Figure ES.4 on the following pages lists 70 recommendations proposed by the Consultant Team to address impacts and concerns in the Study Area. (For a more in-depth description of each recommendation, please refer to Sections 7 through 13 of this Study.)

The recommendations address the principal concerns of impacts from noise and impacts upon air quality. Many of the sources of these impacts also cross recommendation categories. For example, aircraft overflights which generate complaints about noise may also be sources of air pollution that impact groundwater, soil, surface water, and various socio-economic metrics.

The challenge is that the data sources for all of the metrics researched and evaluated during the study period (1997 to the present) are not always consistent, do not present data in the same fashion from year to year, have changed modelling approaches, or are simply incomplete or non-existent. These "data gaps" impacted the Consultant Team's ability to comprehensively assess impacts associated with Seattle-Tacoma International Airport under the terms of the assignment (schedule, scope and budget). The Consultant Team was limited to researching, evaluating and assessing data from existing and readily-available sources. No new modelling, sampling, or data collection was included in the State grant's scope. Therefore, more study is necessary to create a longitudinal dataset that can be a more precise and complete picture of impacts within the Study Area.

Many of the following recommendations include the need for additional studies to supplement existing data (like an origin-destination survey which can augment daily traffic counts).

Additionally, the way certain data has been collected throughout the Study Area was found to be insufficient to make an accurate impact assessment. For example, there is an immediate need for more working air quality monitors within the Study Area if an accurate impact of air quality issues in the Study Area is to be determined.

One last area that impeded the Consultant Team was the project budget. The entire $600,000 was not available to the Consultant Team, as $100,000 was set aside by the State to cover internal costs. Only 83.3% of the total grant ($500,000) was available for the actual consultant study. By comparison, the budget for the 1997 Study administered by the precursor agency (the Department of Commerce, Trade and Economic Development) was $775,000 for a similar study (assessing the impacts of the then-proposed third runway). In current dollars, the 1997 Study's budget would be over $1.2 million. Therefore, a follow-up Phase 2 study is recommended to address the data gaps noted herein, with an appropriate budget to meet study scope and schedule requirements.

Figure ES.4
Study Recommendations

Recommendations: Noise & Vibration	
N.1	Develop a set of alternative noise metrics that do not rely on DNL contours.
N.2	Increase the arrival glideslope to a minimum of 3-degrees.
N.3	Conduct an Environmental Review for flight track changes.
N.4	Institute Noise Abatement procedures for late-night operations
N.5	Expand Noise Monitor locations to include Study Area permanent and mobile monitors.
N.6	Address existing Mitigation Packages to fix faulty installations.
N.7	Revise the Port Commission makeup to include direct representation from the Study Area.
N.8	Conduct additional vibrational monitoring in the Study Area.
N.9	Determine the impacts associated with SELs.
N.10	Determine the effectiveness of sound insulation practices, especially those utilized by the Port of Seattle in their mitigation packages.

Figure ES.4 (continued)

Recommendations: Air Quality	
AQ.1	Improve the current monitoring network by increasing the number and location of monitors in and around the Airport.
AQ.2	Establish monitoring guidelines for new locations that consider economics, security, logistics, and atmospheric and pollution considerations.
AQ.3	Deploy Purple Air monitors to get a general sample of air quality trends.
AQ.4	Research the connection of Ultrafine Particles and health impacts.
AQ.5	Conduct a study and the improve the monitoring network to determine the extent of regional air pollution impacts that are directly related to Airport activity.
Recommendations: Mobility	
M.1	Generate rental car forecasts for annual service demand.
M.2	Conduct an Annual Parking Demand Study for the Main Parking Garage and employee parking lots.
M.3	Conduct an Annual Cell Phone Lot Demand Study to determine if the Cell Phone Lot reduces congestion at the arrivals and departures areas in front of the terminal.
M.4	Inventory Private Parking Lot Data to determine impact on Main Parking Garage.
M.5	Conduct an Airport Mobility Modes Survey to assess how passengers and employees travel to and from the Airport.
M.6	Conduct a Drop-Off/Pick-Up Zone Study to assess congestion and vehicle and pedestrian flow in and around the Airport property.
M.7	Forecast Employee/Vendor/Tenant Demand to ensure there are parking and mobility options to accommodate changing employment.
M.8	Develop an Airport Parking Master Plan in collaboration with Airport vendors and employees, surrounding cities, King County Metro, and Sound Transit.
M.9	Develop a Transportation Improvement Program database of all historical and current capital improvements in the Seattle-Tacoma International Airport area to demonstrate network changes over time.
M.10	Conduct a Rental Car Origin-Destination Study to understand vehicle patterns and movements along the transportation network around the facility as well as understand where vehicles are traveling from to reach the facility.
M.11	Develop a Targeted Annual Traffic Monitoring System to create a consistent and reliable database that monitors congestion over time.
M.12	Conduct an Annual Transit Demand Analysis to document transit demand in the Study Area and ways to improve transit ridership to the Airport
M.13	Improve Airport Passenger and Employee Transit Utilization.
M.14	Analyze Park & Ride Utilization to determine how many individuals use the facilities to access the Airport.
M.15	Conduct a Park & Ride License Plate Analysis to determine where vehicles originate and to better understand Park & Ride demand patterns.
M.16	Conduct an Off-Street Parking License Plate Analysis to understand where vehicles originate from in the Study Area and the use of certain on-and off-street facilities.
M.17	Conduct a Transit Origin/Destination Study to analyze travel patterns and average daily traffic in the Study Area.

Figure ES.4 (continued)

Recommendations: Mobility (continued)	
M.18	Conduct an Annual Pedestrian Counts to determine the number of individuals that utilize the sidewalk along the front of the terminal and the Link Light Rail Airport/SeaTac station pedestrian bridge to access the Airport.
M.19	Identify and eliminate pedestrian mobility barriers.
M.20	Conduct an On-Going On-Street Parking Study in Burien, Tukwila, and SeaTac to monitor supply, utilization, duration, and areas with excessively high use from non-residents.
M.21	Establish an Existing/Baseline Conditions for specific off-and on-street parking facilities in Burien, SeaTac, and Tukwila.
M.22	Establish and maintain a Parking Supply Database to provide insight on parking demand in the area and give local communities an inventory that can be expanded and monitored over time.
M.23	Adopt or expand Parking Permit Programs in Burien and Tukwila to discourage long-term Airport passenger and employee parking on residential streets.
M.24	Create an informational program to educate Airport employees and passengers regarding local parking restrictions
M.25	The Port of Seattle should adopt a formal policy that prohibits Airport employees from utilizing on-street off-Airport parking during working hours.
Recommendations: Water Quality	
WQ.1	Correct potential errors and data gaps to create a more consistent data record.
WQ.2	Improve receiving stream data through more permanent monitoring stations downstream and a suite of water quality parameters that are collected at outfalls regularly to make results more consistent and comparable.
WQ.3	Further study air pollution impacts on surface water through independent analyses of citizen-reported pollution samples on surface water locations.
Recommendations: Groundwater & Soil	
GW.1	Conduct independent testing of "black soot" to determine its chemical composition and potential source(s)
GW.2	Conduct ongoing monitoring and sampling of AOMA groundwater monitoring wells on a 3-year cycle for key indicator parameters.
GW.3	Coordinate with Study Area Comprehensive Plans to ensure the ongoing health and preservation of
Recommendations: Light	
L.1	Update Airport high mast lighting and replace with LED sources.
L.2	Adopt Study Area Lighting Standards which would establish guidelines for future developments and renovations of existing facilities.

Figure ES.4 (continued)

Recommendations: Public Safety	
PS.1	Modify the second level study to include areas to the north of Seattle-Tacoma International Airport.
PS.2	Consider an Airport Impact Overlay District to address crime on a multi-city level.
PS.3	Pursue multiple approaches to assist victims of sex trafficking
PS.4	Consider CPTED principles in portions of the Study Area.
Recommendations: Public Health	
PH.1	Establish an independent noise monitoring authority to determine if thresholds for noise established by the Federal Aviation Authority are adequate given local circumstances, as well as appropriate strategies for mitigating impacts.
PH.2	Expand the Study Area to include other neighborhoods that may be impacted by Seattle-Tacoma International Airport, including West Seattle, Beacon Hill, and Renton.
PH.3	Develop more detailed public health statistics at the census tract or enumeration district level to afford a more detailed comparison of health impacts and Airport-related data (noise contours, flight tracks, etc.).
PH.4	Approve/reauthorize bills to address mitigation packages that have failed or are inadequate.
PH.5	Audit local building and zoning standards to identify any inconsistencies between local regulations and federal rules
PH.6	Identify new construction potentially impacted by Airport use.
PH.7	Establish a Health Impact Assessment process to determine potential health impacts of new developments.
PH.8	Require alternative fuel use for Airport users.
PH.9	Expand the Late Night Noise Limitation Program to reduce impact on neighborhoods.
PH.10	Replant trees throughout the Study Area to help absorb noise and air toxins.
PH.11	Expand Port efforts to promote public health.
Recommendations: Socio-Economics	
SE.1	All parties should commit to a shared objective.
SE.2	Consider a "Study Area-Wide" Impact Overlay District.
SE.3	Conduct additional analyses.
Recommendations: General	
G.1	Establish a single source data clearinghouse for impact metrics and data.
G.2	Expand the Study Area to incorporate areas to the north so that the Airport is located in the center of the Study Area.
G.3	Expand participation by the Port of Seattle in any follow-up studies.
G.4	Improve the Airport/Community relationship.
G.5	Develop a plan for Airport-adjacent perimeter areas.
G.6	Follow NPIAS Attribute #5 regarding surrounding communities.
G.7	Conduct an expanded Phase 2 Study.

F. THE FUTURE

The 2020 Study has also noted future potentials which may impact the Study Area, King County, and the region. But these future potentials are speculative at best. Not only is there no guarantee that any of these future potentials will come to pass, there are likely many more unknown innovations that could impact the Study Area.

For example, during the 1997 Study, there was no realistic prediction of innovations like smartphones, on-demand car services (other than conventional taxis), digital assistants, streaming video, social media, etc. Even light rail access to Seattle-Tacoma International Airport was a general concept. In 2020, all these unknown "futures" had become part of daily routine and have changed the way we live, work and play.

There are some promising technological innovations on the horizon, but no one in 2020 can accurately say how, when (or even if) they will become a reality. This includes such conceptual or experimental technologies as:

- Autonomous vehicles and connected cars (currently being tested worldwide in numerous cities);
- Flying cars and taxis (to be tested in several cities by 2023);
- Advanced aircraft engines that rely on alternative energy sources or hybrid engines;
- Short Take-Off and Landing (STOL) and Vertical Take-Off and Landing (VTOL) aircraft for large-scale passenger and cargo service; and,
- "Hyperloop" and below-grade high-speed tunnel systems (proof-of-concept being tested).4

Advances in telecommunication technology – specifically 5G cellular service – holds the promise of fiber optic cable speeds delivered wirelessly. In 2020, the nationwide 5G network is being constructed by various service providers, soon to be followed by a variety of 5G-capable devices. Proponents of 5G tout its ability to allow people to office anywhere, which might have some impact on commuting and air travel patterns, but there are no examples to-date of widespread applications that are changing our daily lives in such a fashion.

The new 5G service will also introduce a new generation of connected devices – home, car, office, retail, and w – that create IoT – the "Internet of Things". Projections vary on how many connected devices are in service in 2020 (smartphones, computers, tablets, smart televisions, digital assistants, etc.), but the numbers exceed the global population. By 2030, these devices are expected to increase exponentially to perhaps 30 billion worldwide (or more). The deployment of billions of new connected devices and vehicles may have some impact on travel and commuting, but their impacts remain hypothetical at present. This Study recommends policy decisions and capital expenditures remain flexible enough to accommodate these as-yet unknown changes to the future.

New Airport

The Seattle metropolitan area is currently served by three airports – Seattle-Tacoma International Airport, Paine Field, and Boeing Field (the latter provides commercial charter service). Discussion of a potential fourth airport to address the increasing passenger demand has been studied since 1994:

- In 1994, the Puget Sound Regional Council (PSRC) studied the potential for a new airport at several locations, all of which received significant opposition. The 1994 PSRC study ended with no further action.
- In 2005, Alaska Airlines and Southwest Airlines proposed using nearby Boeing Field, but their proposal was rejected by King County. (In addition to Seattle-Tacoma International Airport, Alaska Airlines now provides passenger service from Paine Field in Everett.)

Previous studies yielded no viable candidate locations, yet regional growth continues. In 2019, Governor Jay Inslee signed a bill sponsored by State Senator Karen Keiser (Des Moines) to create a commission tasked with locating a new airport. The commission will identify 6 candidate locations by January 2021, with a preferred site being located by January 2022.

Developing a brand-new airport from the ground up is a lengthy and complex process. The most recent brand new US airport was Denver International Airport (DIA), which opened in February 1995 after 15 years of study, design, review and construction (the initial planning for DIA began in 1980). Should the State of Washington

identify a preferred location for a new airport by 2022, it is conceivable the new airport might not be operational until 2037 (or later, not including any political issues or opposition).

At the same time the potential for a new airport is being investigated, the Port of Seattle is expanding Airport facilities by an additional 19 gates to address increasing passenger demand. But in November 2019, Alaska Airlines – one of the primary carriers at Seattle-Tacoma International Airport – stated its opposition to this expansion effort, citing issues with security clearance, passenger convenience, and increased congestion. Alaska Airlines contended that Seattle-Tacoma International Airport "is not on land big enough to sustain the expansion for a major airport" and cited Dallas/Fort Worth International Airport and Denver International Airport as examples. Seattle-Tacoma International Airport's expansion appears to be moving forward in spite of this opposition.

The 2020 Study does not discourage the investigation of a potential new airport, nor does it discourage facility improvements at the existing Seattle-Tacoma International Airport. A brand new airport is an attractive future potential, but it does not address the immediate concerns and impacts in the Study Area. The 2020 Study promotes the site investigation for a new airport while concurrently addressing the needs and concerns of the Study Area communities.

G. CLIMATE CHANGE

While the issue of climate change was not part of the project scope, the issue arose as a question from several community members during this project. The Consultant Team was asked "what are you doing to address climate change" and some community members expressed frustration that this was not part of the project.

To clarify, the Consultant Team was not asked to investigate any impacts that Seattle-Tacoma International Airport might have on climate change. The project resources (time and budget) were also insufficient to address such a broad and complex issue.

The 2020 Study agrees with the bulk of climate research – that the climate has been increasingly affected by human activity. This is supported by research by scientists and academicians across the world. In 2016, 196 countries signed the Paris Accords to address climate change and its underlying causes. (The US withdrew from the agreement in June 2017.)

The 2020 Study did not research the issue of aviation-induced climate change, but it was addressed at the 2019 Paris Air Show. An article in Fortune magazine (June 2019) contained the following quote:

> "Aviation currently accounts for around 2.5% of global carbon emissions and the industry has pledged to halve its 2005-level footprint by 2050 through an offsetting program. Therefore, engineering firms were keen to showcase a range of eco-friendly inventions such as hybrid engines, urban mobility vehicles, and autonomous flight systems at the annual event, the largest for the aerospace industry. . . .It's not just environmental considerations driving the research: UBS estimates sales of hybrid engines will be worth $178 billion by 2040, while the electric vertical take-off and landing (eVTOL) market will be a $285 billion business by 2030."

The above quote did not specify which components of "aviation" account for 2.5% of global carbon emissions nor the source of this figure. It could be limited to aircraft emissions while operational, or it could involve the entire product life-cycle – from manufacture to decommissioning. The 2.5% figure likely does not address other airport-related activities, including ground transportation by travelers and employees.

The above quote makes an economic case for changes in aircraft technology (likely as a cost-savings for airlines and owners), which will have a secondary benefit of addressing environmental concerns. These remain speculative projections at this point, but it is hoped that advances in hybrid and electromotive propulsion will have the added benefit of significantly reducing noise and air pollution.

Beyond aircraft technology, there are promising trends in market acceptance of automobiles and light trucks with hybrid and fully-electric engines. This can help to reduce tailpipe emissions but may also shift some energy-generation burdens to the power grid (for electric vehicle recharging). Simpler and perhaps more effective measures are those that promote developments that encourage walkability, biking, and transit use – something that is happening across the region and the US.he Port of Seattle is taking steps to address environmental concerns – from replacing old high-mast lighting with high-efficiency LEDs and usage of more hybrid and electric vehicles, to development of the Sustainable Airport Master Plan. But the 2020 Study will not address – and was not asked to address – any potential climate change impacts associated with operations at Seattle-Tacoma International Airport. This is an issue that is worthy of a separate investigation and study.

H. CONCLUSION

The 2020 Study was initiated with the notion that it could generate a baseline to measure impacts in the Study Area and use that as a basis for future impacts as the Airport grew. The 2020 Study has determined that Noise and Air Quality have been the primary concerns during the study period (1997 to the present). Both Noise and Air Quality impacts also have the potential to affect other areas, including annoyance, learning disruption, environmental impacts, human health impacts, economic impacts, and slower municipal growth rates. However, there is no single metric, no "experience index" to accurately incorporate all concerns into a single baseline metric.

Noise and air quality concerns are not uncommon issues for areas close to airports. The further definition of airborne particulate matter – specifically UFPs – merits further study to determine any epidemiological impacts. The 2020 Study does not have the data or local sampling evidence to reach a conclusion regarding UFP impacts in the Study Area.

The 2020 Study recommends further work be done to repair the relationship between the Study Area Cities and the Port of Seattle/Seattle-Tacoma International Airport, and with the Federal Aviation Administration. Decades of mistrust and skepticism hamper progress in building a relationship that addresses the needs of all involved. There remains significant skepticism on the part of the public that their needs and concerns are being adequately addressed by the Port of Seattle (and by extension Seattle-Tacoma International Airport) and the Federal Aviation Administration.

The Study Area and the Airport have grown up together in South King County for more than 75 years. Their past, present, and futures are inextricably linked. A poor working relationship will continue to inhibit positive growth for all parties.

I. EPILOGUE

Change has been the one constant in South King County and the region. The Study Area Cities and Seattle-Tacoma International Airport have grown up together for more than 75 years. There are portions of the Study Area Cities that are much more urbanized in 2020 than they were years earlier. And while the Airport has continued to grow, the pace of its growth has accelerated since 2000, far eclipsing the pace of growth locally and regionally.

The 1997 Study could not predict the rise of such innovations as smartphones, social media, or app-driven car services. Twenty-three years later, much has changed that is now part of everyday life. Even something as basic as light rail was only a proposal in 1997 – but in 2020, it is an important link in accessing Seattle-Tacoma International Airport.

So, in the next 23 years – by 2043 – there could be new changes that are presently beyond imagination, including new modes of travel, new means of aircraft propulsion, and new technologies that change how we live, work, play and travel.

As enticing as the future is, there are pressing concerns that face the Study Area Cities in 2020. While an important component in the region's economy, Seattle-Tacoma International Airport should also strive to minimize impacts from its operation so that the residents of Burien, Des Moines, Federal Way, Normandy Park, SeaTac, and Tukwila do not bear an undue burden, primarily due to noise and air quality impacts.

Often attributed to President John F. Kennedy, a well-known aphorism states, "a rising tide lifts all boats". It is recommended that this be a guiding principle in the development and operation of Seattle-Tacoma International Airport. What benefits the Airport should have an associated benefit to the surrounding Study Area Cities. And by extension, operations at the Airport should not negatively impact its neighbors.

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SECTION 1

INTRODUCTION

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SECTION 1

INTRODUCTION

A. BASIS FOR THE STUDY

On 21 March 2018, the Washington State Legislature formally asked the State Department of Commerce via a "two-corners" letter to complete a study that evaluates the current and ongoing impacts of the Seattle-Tacoma International Airport. The Washington State Legislature enacted Engrossed Substitute Senate Bill (ESSB) 6032 – Section 127(63) during the 2018 regular session to implement this Study.

ESSB 6032 provided a total of $600,000 for this Study – $300,000 from the State's general fund and $300,000 in matching funds from six airport-area cities on matching funds. The six cities include Burien, Des Moines, Federal Way, Normandy Park, SeaTac, and Tukwila. Of the $600,000, a total of $500,000 was made available to hire a consultant to prepare this Study. The remaining $100,000 was dedicated towards the covering of Department of Commerce staff time in support of this project.

This Study (hereafter referred to as the 2020 Study) is not intended to oppose or impede the operations, growth, or success of Seattle-Tacoma International Airport. And while it has some similarity to a previous study completed in 1997 regarding the third runway, it is not an extension or continuation of that 1997 Study.

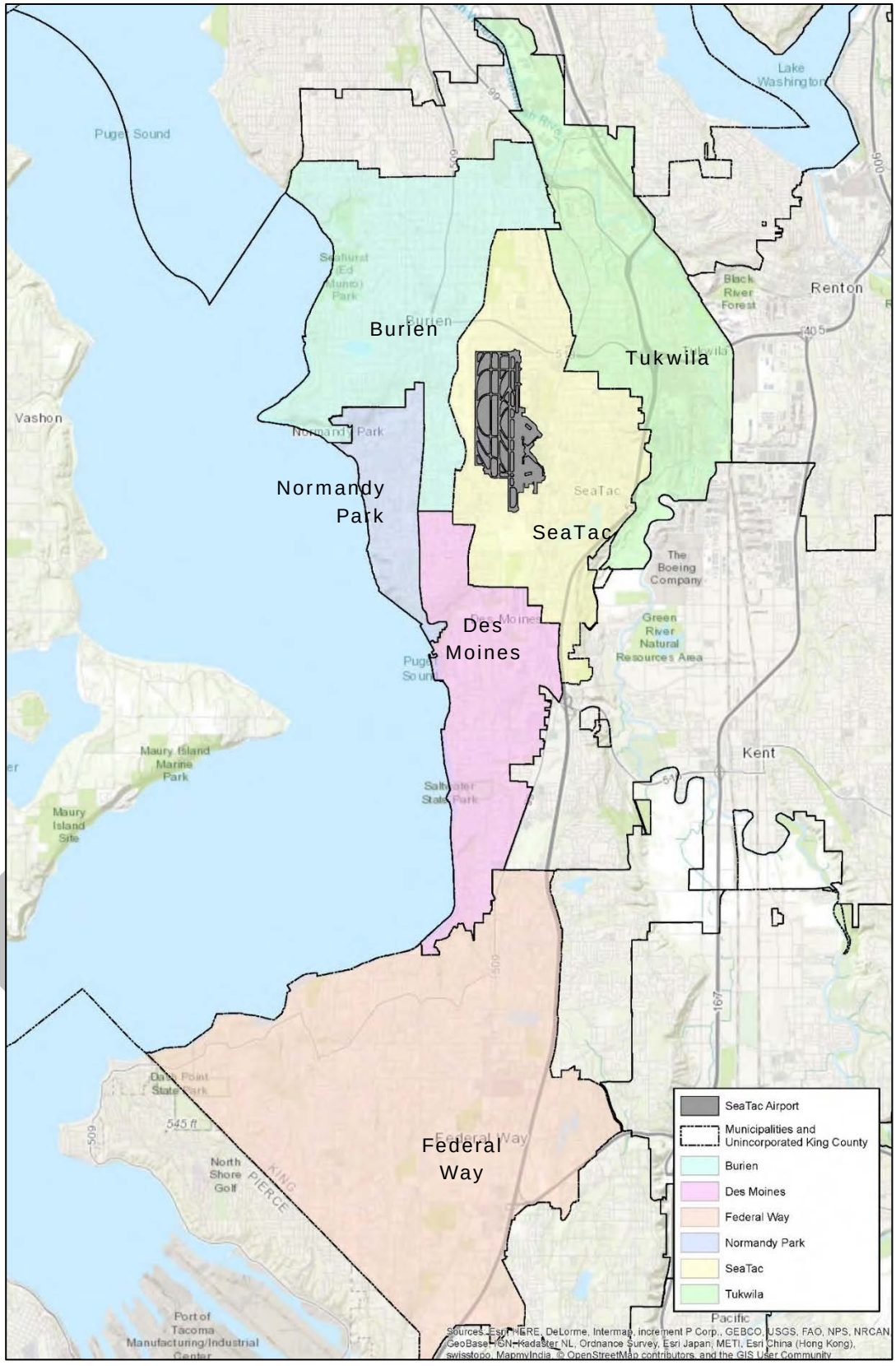
Difference Between the 2020 Study and the 1997 Study

The 1997 Study – the "Sea-Tac International Airport Mitigation Study" (February 1997) – was authorized by a 1995 grant by then-State Senator Mike Heavy and was administered by the Department of Commerce's predecessor – the Department of Community, Trade, and Economic Development (CTED). It was in response to concerns regarding the potential for increased aviation-related impacts upon neighboring communities as a result of Seattle-Tacoma International Airport's then-proposed third runway. The 1997 Study was tasked with assessing the third runway's projected construction and operation impacts of the ten-proposed third runway, and developing mitigation strategies for the cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila, the Highline School District, and the Highline Community Hospital. That Study was completed in February 1997.

The 1997 Study reviewed the draft Environmental Impact Statement and considered the impacts of an expanded airport when the third runway was operational. It considered proposed impacts. This current Study is looking at historical data between 1997 and roughly 2019 and seeks to establish a baseline of impacts tied to the performance criteria of Seattle-Tacoma International Airport using a variety of metrics. Where the 1997 Study was projecting future impacts, this current Study is looking at historical data to the present.

The two studies are not the same, have slightly different study areas, and are not to be considered as directly related. The 2020 Study is not an extension of the 1997 Study.

Figure 1.1
Study Area



B. THE STUDY AREA

The current and 1997 Studies do have some degree of similarity – Burien, Des Moines, Federal Way, Normandy Park, and Tukwila were included in both studies (the City of SeaTac was not officially a part of the 1997 Study). While the current Study does not include the Highline School District and the Highline Community Hospital, the expansion of the City of Burien's corporate limits now includes many of these same areas. Figure 1.1 shows a map of the current Study Area. Figure 1.2 details the six Study Area cities.

Figure 1.2
Study Area Cities

City	Incorporated	Total Area (in square miles)	2018 Population	Average Density (people per square mile)
City of Burien	1993	10.11	51,908	5,134.3/sq. mi.
City of Des Moines	1959	6.41	32,364	5,049.0/sq. mi.
City of Federal Way	1990	22.49	97,044	4,330.4/sq. mi
City of Normandy Park	1953	2.51	6,649	2,649.0/sq. mi.
City of SeaTac	1990	10.24	29,239	2,855.4/sq. mi.
City of Tukwila	1908	9.60	20,294	2,113.9/sq. mi.
	TOTALS	**61.36**	**237,498**	**3,870.6/sq. mi.**

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census

The Study Area covers over 61 square miles (approximately 2.65% of the total area of King County), but its population of 237,498 residents represents 10.7% of the King County population. Its density is also roughly 3.3 times greater than the County average – 3,396.3 persons per square mile in the Study Area versus 1,034 in King County. These numbers suggest that the Study Area is more densely populated and more urbanized than the average in King County. This concentration of population close to Seattle-Tacoma International Airport has contributed to concerns regarding the compatibility of Airport operations, going back many decades.

C. THE CONSULTANT TEAM

In response to ESSB 6032, the Department of Commerce solicited proposals in early 2019., advertised both locally (metropolitan Seattle area) and nationally. A shortlist was selected for interviews in April 2019 and upon conclusion, a consultant team lead by Stantec was selected to conduct this Study. Stantec is a multi-disciplinary engineering-planning-architecture firm with over 23,000 persons working in 400 offices worldwide. The Stantec team includes staff from the Seattle metropolitan region as well as other offices. (The Stantec Project Director leading this effort also led the 1997 Third Runway Study while with a previous firm.) As part of the Stantec Team, Denver-based Ricker Cunningham is providing real estate economics, community strategies, and addressing "quality of life" indicators for the Study Area. Ricker Cunningham and the leadership of the Stantec team have more than 20 years of experience in working together on similar projects.

D. STUDY APPROACH

This report documents the Consultant Team's analysis which was conducted during the period June 2019 through May 2020, including presentations to various local, regional and State organizations. During the Study, the Consultant Team met regularly with citizens, city staff, elected officials, staff from the Port of Seattle, and representative from various city, County, regional, State, and Federal agencies.

The purpose of the 2020 Study is to **objectively** and **independently** evaluate and assess a variety of impacts associated with Seattle-Tacoma International Airport – positive, negative, and neutral – and to establish a baseline of said impacts which may be used to evaluate current and future operations:

- Positive impacts include such factors as higher-paying jobs, increased tax revenue, etc.;
- Negative impacts include such factors as concerns about noise, air quality, public health, etc.; and,
- Neutral impacts are those with little to no measurable positive or negative effect.

It is important to note that while the 2020 Study acknowledges that Seattle-Tacoma International Airport is a significant regional and statewide asset, the 2020 Study takes no sides. It does not argue for or against Seattle-Tacoma International Airport, nor does it advocate for any city, neighborhood, organization, or resident. The 2020 Study attempts to address the following basic questions:

- Do the Study Area Cities enjoy any benefits by being close to Seattle-Tacoma International Airport; and,
- Are the Study Area Cities shouldering a disproportionate burden because of their location?

These questions are not easily answered. In the years between the 1997 and 2020 Studies, the region (as well as the Study Area Cities) have experienced multiple changes, and there has been ongoing regional growth which has roughly doubled the population of the Seattle metropolitan area. The 2020 Study is tasked with determining the following:

- What are the impacts that are directly related to Seattle-Tacoma International Airport operations?
- What are the impacts that are the result of natural organic regional growth (induced impacts)?

The approach to this Study makes the following assumptions:

- **Available Data**
  That there will be available data from 1997 through the present to sufficiently analyze and evaluate any impacts associated with Seattle-Tacoma International Airport. Information to be reviewed would come from such diverse agencies as the Port of Seattle, the Study Area Cities, King County, the City of Seattle, the Puget Sound Regional Council (PSRC), the Puget Sound Clean Air Agency (PSCAA), various State and Federal agencies, etc.

- **No New Modelling, Sampling or Data Collection**
  That no new information, data, studies, or models would be developed as part of the 2020 Study. (The Consultant Team advised that the project's budget and schedule would be insufficient to conduct such a wide array of new modelling and data collection);

- **Public Input**
  That information would also be considered and reviewed as provided by individual citizens in the Study Area. The Consultant Team would attempt to independently verified and/or validate the provided information prior to being included in the Study. If the information could not be verified or validated, it would be considered as part of the anecdotal public input which helped identify the concern, scope, and magnitude of public concerns with airport operation;

- **Annual and Milestone Dates**
  That whenever possible and based on the availability of data, various types of impacts (positive, negative, and neutral) would be identified on an annual basis between 1997 and 2019 and compared with growth of Seattle-Tacoma International Airport to determine what – if any – correlation there might be between these impacts and the Airport's operations. Three key milestone years would also be established:
  - 1997 represents the base year utilizing information available from the Third Runway Study;
  - 2009 represents the first full year of operations of the third runway; and,
  - 2019 represents the most current year of available data.

- **Evaluation Standards**
  That appropriate existing State and Federal legislation, policies, and regulations would be used to evaluate and assess the impacts of the various metrics being analyzed. The existence of proposed metrics, ongoing research and international studies, while of interest, have no basis for enforceability or implementation at this time. However, their relevance as appropriate will be noted.

E. THE TECHNICAL ADVISORY COMMITTEE

To assist the Consultant Team, a Technical Advisory Committee (TAC) was established, comprised of staff and citizen representatives from each Study Area City. Additionally, two members of the Washington State Legislature were included as part of the TAC. Several members of the Department of Commerce staff also attended TAC meetings. Many of the TAC members are also members of local city airport commissions, were interviewed as part of the stakeholder interview process, and have been involved in issues relating to Seattle-Tacoma International Airport and the Port of Seattle for many years. Their insights and local knowledge were an invaluable resource during the project. The TAC membership is shown below.

Figure 1.3
Technical Advisory Committee

Organization	Name	Role
City of Burien	Rose Clark Brian Wilson	Citizen Representative City Manager
City of Des Moines	Steve Edmiston Michael Matthias	Citizen Representative City Manager
City of Federal Way	David Berger Bill Vadino	Citizen Representative Policy Advisor to the Mayor
City of Normandy Park	Mark Hoppen Kathleen Waters	City Manager Citizen Representative
City of SeaTac	Steve Pilcher, Roger Kadeg	Director of Community & Economic Development Citizen Representative
City of Tukwila	Brandon Miles Jim Haggerton	Economic Development Liaison, Mayor's Office Citizen Representative
Washington State Legislature	Rep. Tina Orwall Rep. Mike Pellicciotti	33rd Legislative District 30th Legislative District
Washington Department of Commerce	Gary Idleburg Dave Anderson Mark Barkley Matthew Ojennus *Mark McCaskill* *Ike Nwankwo*	Project Manager Managing Director Assistant Director, Local Government Division Senior Planner *Director, Growth Management Services Unit (former)* *Western Washington Manager (retired)*

(Note: Names in *italics* are Department of Commerce staff that left the agency prior to the completion of the project.)

TAC membership was extended to the Port of Seattle, however they declined to participate. Port of Seattle staff did participate through the provision of various studies, reports, technical information and data to the Consultant Team during the project research and analysis.

TAC generally convened on a monthly basis during the project so the Consultant Team could present a variety of draft information for review and discussion. While TAC meetings were open to the public, they were not intended to be "public meetings" and did not include public comment or discussion.

F. PUBLIC INPUT

Information and insight from the public was provided during the Study. Several opportunities were open for public input during the Study including:

- Ongoing input from the citizen representatives on the Technical Advisory Committee;
- A series of interviews of nearly 50 stakeholders representing the six Study Area Cities (stakeholders were named by each individual city);
- Two public information meetings (July and November 2019) which presented the Study's approach, scope, and schedule (July meeting) and early interim research observations (November meeting);
- The Consultant Team was present at meetings conducted by Representative Tina Orwall regarding citizen concerns with the mitigation packages offered by the Port of Seattle;
- A meeting with selected citizen representatives (January 2020) was conducted to solicit additional detailed input on the Study's approach and findings to-date;
- A series of City-specific presentations of the draft report to gather additional public input; and,
- Multiple presentations of the final report findings.

Some citizens offered additional data to the Consultant Team during the course of the Study. This citizen-provided data was utilized provided it could be independently verified and validated. Information that could not be verified was considered as anecdotal input, which also assisted the Consultant Team in identifying issues important to the public.

The purpose of the Study was to conduct an independent and objective evaluation of potential impacts resulting from the operation of Seattle-Tacoma International Airport – both positive and negative – and not to advocate on behalf of any single individual. The intent was to establish a baseline of said impacts which may be used to evaluate current and future operations.

Many citizens were disappointed that the Study did not go far enough in advocating for their interests or did not extend geographically to neighborhoods which were not part of the ESSB 6032 study grant area. However, the Study was specifically limited to the six cities previously identified – and the project's schedule and budget also limited what the Consultant Team could focus on during the project.

There were many residents with long-standing concerns about how operations at Seattle-Tacoma International Airport have impacted them and their communities. Some of these concerns date back to 1970 and the opening of the second runway. These concerns range from the quality of noise mitigation packages to nighttime flight operations to issues regarding property values and public health impacts, to name a few.

While the Consultant Team acknowledges the importance of these issues, the 2020 Study is not a forum for additional concerns regarding Seattle-Tacoma International Airport. As mentioned above, public input does assist in determining the magnitude of some concerns, especially where data was unavailable, inconsistent, or incomplete. Those disparities are noted as part of this Study.

SECTION 2

BACKGROUND

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SECTION 2

BACKGROUND

A. A SHARED HERITAGE

Before airport cities, or even communities, the region – and the area now known as southern and southwestern King County – have a common shared heritage. The earliest known inhabitants in the region were the First Nation Lushootseed-speaking tribes of the Muckleshoot, Puyallup, Duwamish, Suquamish that established encampments for fishing, clamming, hunting and agriculture.

These tribal activities predate settlement by white and European settlers by hundreds, if not thousands, of years. They are the original inhabitants of the region. Not much of this influence is visibly remaining, but it is an important part of the shared common heritage shared by the Study Area Cities and the Seattle-Tacoma International Airport.

B. SEATTLE-TACOMA INTERNATIONAL AIRPORT

The Seattle metropolitan area is one of the most vibrant and active regions in the nation. Few cities outside Silicon Valley are so closely aligned with technology – Microsoft, Nintendo, Adobe, and Amazon are a few of the tech giants that call Seattle home. But it is not just technology – retail giants from Nordstrom to Starbucks got their start here. And Seattle enjoys a robust tourism industry, both as a destination and as a starting point for discovering the Pacific Northwest.

But before e-commerce, before coffee, before software, there was aviation. For over 100 years, the history of Seattle and of the metropolitan region have been inextricably linked to aviation.

Ports, Wooden Planes, and Airports

In 1911, the voters of King County approved a measure to put Seattle's waterfront under the coordinated control of a single public entity – the Port of Seattle. At that time, the City's economy and growth were highly dependent on port activity, especially moving freight between ships and the railroad. Creation of the Port allowed the development of improvements that would assure the City's long-term economic success, including expansion of international markets. Officially, the Port of Seattle is a special purpose municipal corporation. From the Port's own website, they proclaim that their mission is:

> "To create economic development, advance trade and commerce, promote manufacturing and maritime growth, and stimulate economic development".

In 1916, partners William Boeing and Conrad Westervelt built their first single-engine floatplane (the Boeing Model 1) with the intent of entering the then-nascent aviation industry. In those early years, flying was little more than a curiosity, something limited to the military or daredevils. But from that humble beginning arose the Boeing Company – one of the world's premier designer and builder of defense and aerospace products. Boeing's corporate footprint covers the United States and beyond, but it is most strongly linked with Seattle. And Mr. Boeing's innovations would require a location to operate.

The popularity of flight increased in the early 1900s and airplanes landed just about anywhere there was a flat grassy strip of land, or in the case of floatplanes, on the water. World War I saw the prominence of military aviation and cities across the US began to establish military airfields. After WW I, the Navy began construction of a new airfield in 1922 at Sand Point on Lake Washington.

Figure 2.1
July 9, 1949: Opening Day Ceremony at Sea-Tac Airport
(photo courtesy of the Museum of History & Industry)

Non-military aviation use greatly expanded after WWI. In 1925, the Kelly Act authorized the US Post Office to contract with private air carriers for air mail and cargo. Now with established routes, regular scheduled passenger service could be a financial reality. And by 1926, Western Air Express (the precursor to Delta Airlines) flew the first successful scheduled commercial passenger service between Salt Lake City to Los Angeles. swTwo years later, regular air passenger service began in Seattle at Boeing Field (now owned and operated by King County).

World War II and the Baby Boom

The runup to the US involvement in WWII provided the impetus to expand the region's capacity and to improve its military preparedness. The site that would eventually become Seattle-Tacoma International Airport was developed in direct response to the attack on Pearl Harbor in 1941. Seattle's west coast location meant that a new military presence was needed to protect the region. Once again, the Port provided the means to develop a new site near Bow Lake to be designated as Seattle-Tacoma Airport (with the cooperation of the City of Tacoma and Pierce County). Construction of the new Seattle-Tacoma Airport began in 1943 and was completed in 1944 but was used exclusively for military purposes.

In 1947, commercial passenger began to slowly transition from Boeing Field to the new airport – now no-longer exclusively a military base. A new passenger terminal opened in July 1949, ushering in a new era of commercial passenger service, as the bulk of passenger service moved to the new Seattle-Tacoma Airport. (Boeing Field continues to provide limited passenger service but is primarily for cargo, freight, and private operations.) Service grew rapidly at the new Seattle-Tacoma Airport and by 1970, a second runway was added to meet demand.

Growth and Expansion

By the mid-1990s, a third runway was proposed by the Port of Seattle – an 8,500-foot long north/south runway on the Airport's western side (Runway 16R/34L). In response to concerns regarding the potential for increased aviation-related impacts upon the neighboring communities, the State of Washington initiated a grant in 1995 to assess the impacts of the proposed third runway. The grant (authored by State Senator Mike Heavy) was administered through the State's Department of Community, Trade, and Economic Development (CTED) – the predecessor to the State's Department of Commerce.

The purpose of that study was to assess the projected impacts of the proposed third runway and to develop mitigation strategies for the Cities of Burien, Des Moines, Federal Way, Normandy Park, and Tukwila, the Highline School District, and the Highline Community Hospital.

At that time, the third runway was proposed to be used only for landings during inclement weather. After much discussion and legal challenges, the third runway was officially operational in November 2008. Today, Seattle-Tacoma International Airport encompasses 2,500 acres and is served by three terminals (one main terminal with 4 concourses, a North Satellite Terminal, and a South Satellite Terminal), and the following three runways:

- 16L/34R (11,901 feet) .....original single runway (extended since its original length);
- 16C/34C (9,426 feet) .....center runway, added in 1970; and,
- 16R/34L (8,500 feet).....westernmost runway, opened in 2008.

Since 1997, the Seattle-Tacoma International Airport has significantly grown through improvements such as the addition of the third runway, while being landlocked by existing communities on all sides (see Figure 1.1).

Figure 2.2
2008: Commercial Aircraft Test of New Third Runway
(photo courtesy of the Port of Seattle)

The Airport has significantly increased its annual passenger count since 1997, adding over 25 million annual passengers – a 101.6% increased – due in part to increased expansion of Alaska Airlines and a larger local presence by Delta Airlines. While total annual operations have grown more modestly, increasing by 53,909 operations (14% growth), that number is slightly deceiving due to the decline of air taxi operations at the Airport. Just counting air carrier operations, growth has been more pronounced – from 235,445 in 1997 to 427,170 in 2018 – an 81.4% growth in air carrier operations.

In 2019, the Airport showcased many of its superlatives, including:

- Eighth busiest US airport;
- 51.8 million passengers and almost 413,000 operations;
- 32 passenger airlines serving 91 non-stop domestic and 29 international destinations;
- More than 87,300 direct jobs and 64,100 indirect jobs; and,
- $3.8 billion in direct earnings, generating over $442 million in State and local taxes.

No airport rests on their accomplishments. Seattle-Tacoma International Airport continues to look to the future and plans for growth and change. This is consistent with the Port of Seattle's history of ongoing expansion and improvement to the Airport's facilities. To address projected future needs as the Seattle metropolitan area continues to grow, the Port of Seattle has embarked on an initiative to implement a variety of projects that will, in their words:

> "Improve efficiency, safety, access to the airport, and support facilities for airlines and the airport."

This list of near-term projects is included in the Sustainable Airport Master Plan (SAMP), which when completed in 2027, will increase annual airport operations to almost 500,000, handling over 56 million passengers each year.

To accommodate this growth, the SAMP's near-term projects include:

- Construction of a second terminal;
- A centralized maintenance campus;
- Off-airport cargo handling facilities;
- Realignment of airport roadways; and
- Expansion of the fueling facilities.

As part of the scoping for these projects, a series of public community meetings were held in 2018, many within the Study Area cities. There were a total of 304 attendees, providing 133 comment sheets and 43 people giving testimony to an on-site court report. Those comments have been included in the project document by the Port of Seattle and were grouped into 13 "themes":

1. Master Plan/Purpose & Need/Proposed Action;
2. Alternatives;
3. Air Quality/Climate;
4. Noise;
5. Human Health;
6. Transportation;
7. Water Resources;
8. Socioeconomic;
9. Biological and Natural Resources;
10. Public Properties and Resources;
11. NEPA/SEPA Process;
12. General Scoping Comments; and,
13. Other General Comments.

Many of these parallel the metrics being evaluated by this Study.

Community Concerns

Seattle-Tacoma International Airport is surrounded by established communities on all sides, and it has a lengthy experience in dealing with neighbors who often take issue with the Airport's operations and are concerned about the impacts on their communities.

Area residents raised concerns as long ago as 1970 when the second runway opened, citing noise, vibration, smoke, and other issues. Lawsuits were brought against the Port of Seattle to address these concerns and by 1976, the Port and King County adopted the "Sea-Tac Communities Plan" to address these problems and help guide the growth of the area.

One part of this plan was an effort to acquire close-in sensitive properties (residences and schools) and to pay for sound insulation and improved window system in other homes and structures. Over $100 million was spent, however there are long-time residents who receive those initial mitigation packages who report that the insulation measures were either inadequate or, in some cases, failed.

When the government deregulated the airline industry during the Carter administration (1978), airlines were free to set their own fare structures and routes, resulting in increased competition, and in some cases, increased operations at select airports. About this same time, the Federal government started requiring airport' develop noise compatibility programs, which included the development of noise contours to identify areas for acquisition or mitigation. Many area residents continued to dispute the noise contours as the appropriate measure of noise impact. It was also alleged that many of the contractors performing mitigation renovations were not reliable and had subsequently gone out of business.

As operations at Seattle-Tacoma International Airport continued to grow, local officials began considering a major expansion (a third runway) by the early 1990's. Local area communities, understandably, disagreed and banded together to oppose the expansion of the Airport and construction of the third runway. This included five cities (Burien, Des Moines, Federal Way, Normandy Park, and Tukwila), the Highline School District and the Highline Hospital District. The city of SeaTac was not part of this group opposing the third runway.

Since Seattle-Tacoma International Airport is on a relatively small and land-locked site, a 1994 study was undertaken to determine a potential site for a new future airport. That study was unable to find a suitable site and recommended the Port of Seattle continue with its plans to expand, while also looking for a location for a smaller supplementary airport in a nearby county.

The previously referenced 1997 Third Runway Study (see Section 1, page 1) was the State's response to assisting the area cities in considering the impacts of the new facility (including construction and operation of the runway). That study recommended a more far-reaching mitigation program, and despite local legal challenges, the third runway received the necessary approvals and was opened in November 2008, costing over $1 billion.

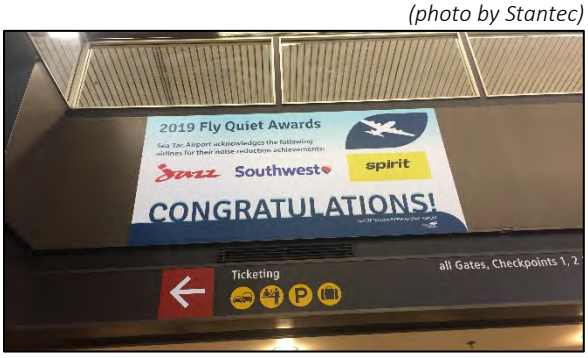
In the decade since the third runway became operational, the Airport has experienced significant growth in both passengers and annual operations. Changes in the nature of the airline business and partially as a result of the Great Recession, the air taxi component at Seattle-Tacoma International Airport began to decrease but was quickly replaced (and exceed) by growth in commercial passenger service. By 2018, the Airport was hitting historically high annual passenger figures, indicating it was surpassing its previous growth projections.

At the same time, local area communities believed they were shouldering a disproportionate share of the "costs" of this growth – represented by concerns in air quality, noise, home values, traffic congestion, crime, quality of life, health impacts, and other similar metrics. Area residents are concerned with such issues as:

- Increased daily operations frequency, sometimes as often as 90 seconds or less between departures;
- Increased late-night passenger and cargo flights directly over residential areas, disrupting sleep and impacting quality of life;
- Low glide-slope departures resulting in lower altitudes over neighborhoods and populated areas;
- Mid-field crossing departing aircraft (Q400s) which fly over residential areas that re not aligned with the runway headings;
- Air emissions associated with arrival and departure flights, with associated health and pollution concerns; and,
- Increased aircraft activity that devalues residential properties, to name a few.

Noise has traditionally been a concern at almost every airport with nearby residential areas. In 2002, the Port of Seattle established a voluntary "Fly Quiet Incentive Program", penalizing airlines for late night flights (between midnight and 5:00 AM) and to recognize those airlines that are sensitive to the impact of aircraft noise on their neighbors. While the Fly Quiet program is one way to address noise concerns, there are no identified penalties for violating the voluntary measures. The Port noted that there were 237 exceedances of these standards during the third quarter of 2019.

Figure 2.3
Fly Quiet Banner in Seattle-Tacoma International Airport
(photo by Stantec)



Partially in response to these community concerns, the Port of Seattle established the StART (Sea-Tac Airport Stakeholder Advisory Round Table) Committee in 2018 to "to engage with Port of Seattle staff and aviation industry representatives. StART provides a chance to develop a shared understanding, discuss community concerns and voice feedback on the airport's construction projects, programs, and operations". StART meetings are held monthly and membership was extended to the 6 Study Area cities, who each have 3 members representing each community. However, due to the strained relationship with some communities, by Summer 2019, several area cities have voluntarily departed from the StART Committee.

Similar to the Fly Quiet program, in September 2019 the Port of Seattle revised its Runway Use Agreement with the Federal Aviation Administration in order to implement "Late Night Noise Limitation Program". This program promises to minimize use of Runway 16R/34L (the third runway) between midnight and 5:00 AM. The Port of Seattle also committed to raise the glide slope of Runway 34R (south-flow) to 3.0 to 3.1 degrees, as opposed to the current 2.75 degrees. A noise reporting app has also been developed to make noise complaints easier to register.

Separate from the above efforts was a recent court decision in a lawsuit filed by the City of Burien against the Federal Aviation Administration. On November 27, 2019, the Ninth Circuit Court of Appeals ruled in favor of the City of Burien regarding its claim that the flight path over the City was changed without proper environmental review. This specifically relates to automatic mid-field turns by turboprop aircraft – known as the 250-degree heading – resulting in low altitude flights over the western portion of Burien, which is largely residential. This decision will not completely eliminate turboprop aircraft flights over Burien, but it does eliminate the 250-degree turn and requires the Federal Aviation Administration to "evaluate the cumulative impacts of all of the future actions – including the planned growth addressed by the SAMP (Sustainable Airport Master Plan) in an environmental review process".

C. CITY OF BURIEN, WASHINGTON

The City of Burien is located immediately west and north of Seattle-Tacoma International Airport and shares a border with the Airport. Burien is also bordered by the cities of Normandy Park, Des Moines, Tukwila, as well as Puget Sound to the west.

Figure 2.4
Three Tree Point in Burien
(photo courtesy of Wikipedia)

Incorporated in 1993, Burien may be a relatively new city, but its roots as a community go back for many years. French-Canadian settlers came to the area in the mid-1860s, followed by a German immigrant family (Gottlieb Burian) who settled in the community in the mid-1880s. Thanks to an error in spelling over the years, the name "Burien" stuck and a community was born.

In those early years, the community was little more than open land, with few improvements. But with access to nearby Puget Sound, the community became a recreational destination, even spawning an interurban rail connection – the Highland Park and Lake Burien Railway in 1912. By 1929, even though rail service was suspended due to the growing popularity of the automobile, the line's nickname – the Highline – continues to define many portions of this part of King County.

While it was an unincorporated community, Burien continued to grow throughout the 20th Century. The area attracted many Japanese immigrants in the years before WW I, many of whom were attracted to the availability of farmland in Sunnydale/Burien. The Highline School District was also an attraction, as an alternative to the Seattle school district.

Figure 2.5
Downtown Burien Mixed-Use
(photo by Stantec)

Even in its early days as a community, Burien's fortunes were tied to aviation. In the early 1900s Boeing used timber in this part of King County, and Burien became a popular residential area, as did other neighboring communities. But it was the concern over Airport expansion and the addition of a third runway that prompted Burien to incorporate as a city in 1993. Burien further grew in 2010 when it annexed the southern portion of the North Highline area. Today, the City of Burien is 10.11 square miles and the City's population growth reflects this annexation.

In the last few years, Burien has made significant improvements to its identity. It has revitalized the City's downtown area as a "foodie" destination with many unique local dining options. The City has also made significant investments in its downtown development, including a new City Hall and Library complex which is surrounded by residential and retail buildings.

Today, more than 85% of Burien's residents are White (50.4%), Hispanic (24.5%), and Asian (11.3%), with a median age of around 37.4 years old (almost equal to the State median age of 37.7). Median household income of $59,596 is slightly below the State median of $67,106 and unemployment (4.3%) is below the State average (5.2%). Also, median home values ($350,326) are above the State median ($306,400).

Figure 2.6
Burien Population Growth: 1980-2018

Year	Population
1980	23,189
1990	25,089
2000	31,881
2010	33,313
2018 (estimate)	51,908

Source: City of Burien and US Census

With a relatively low unemployment rate, Burien also has a diverse economic base, with the following industries represented:

- Accommodation & Food Services 8.2%
- Construction 7.0%
- Healthcare 6.9%
- Educational Services 6.6%
- Transportation Equipment 6.4%
- Professional, Scientific & Technical Services 5.1%
- Administrative & Support & Waste Management Services 4.3%

Even though Burien has its fair share of Accommodation and Food Services, it is mostly composed of a variety of dining options. The City has expressed its desire to establish a more robust hospitality market, given its proximity to Seattle-Tacoma International Airport.

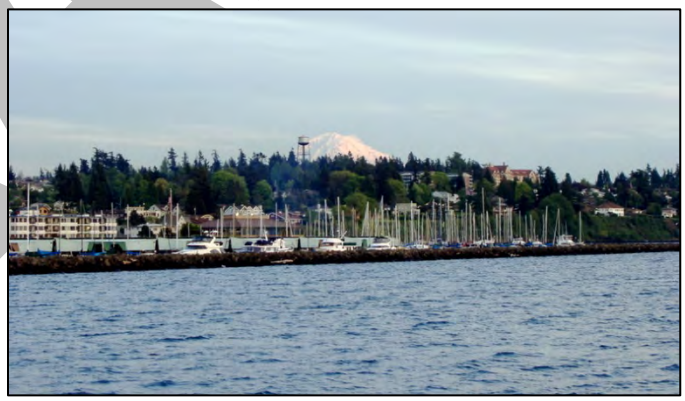
In 2018, the City adopted its current Comprehensive Plan and included the following vision statements for its future:

- A friendly community with well-established neighborhoods and a small town atmosphere;
- A culturally diverse, safety-conscious, crime free, and people-oriented community;
- A community that has established programs serving people of all ages;
- A community with an open, responsive, local government with active, informed citizens;
- A community with natural open spaces, neighborhood parks, paths, and trails;
- A community that has preserved and enhanced its historic and natural features, habitat areas, and air and water quality;
- A community with a local and regional transportation system that integrates cars, pedestrians, bicycles, and transit;
- A community with a thriving, attractive, and customer-friendly city center and business areas;
- A community with land use patterns that bring together individual, business and community goals; and,
- A model community with excellent police and fire services, outstanding schools, and quality community services and facilities.

D. CITY OF DES MOINES, WASHINGTON

The City of Des Moines is located south of Seattle-Tacoma Inter-national Airport, bordered by Burien, Normandy Park, Federal Way, Kent, and the city of SeaTac. Homesteaders and settlers began to arrive in the late 1860s. By 1887, a developer with ties to Des Moines (Iowa) who developed the core of the City along Puget Sound, creating homesteads, farms, and lumber mills.

Figure 2.7
Des Moines Marina
(photo courtesy of City-Data.com)



Access to what would become Des Moines was mostly by water, with a limited to a network of unpaved roads. Water access was provided by what was called the "Mosquito Fleet" – an informal collection of private boats and steamers that provided ferry service along the coast, principally between World Wars I and II. As the use of automobiles expanded, the need to paved roadways began to change the transportation demands of the area.

Like most of the rest of the nation, post-WWII development pushed out into the suburbs. At that time, Des Moines was still an unincorporated community, but it was experiencing growth and development beyond the capabilities of King County to manage. To address its growing pains and manage its future, Des Moines officially incorporated on June 17, 1959.

Des Moines is unique among the Study Area cities in that it has an active waterfront area that includes a marina, restaurants, retail, offices, and residential. The marina area has become the City's downtown and reinforces the City's identity as a coastal community.

A little less than 2 miles south of the marina lies Saltwater State Park – an 87-acre area that offers camping, hiking, and a long beach along the Puget Sound coastline. Saltwater State Park was dedicated in 1926 and was supposedly established as an "olive branch" between the rival cities of Seattle and Tacoma. (A hatchet was symbolically buried under a rock somewhere in the Park.) Today, the Park also is the site of one of the noise monitors from Seattle-Tacoma International Airport.

Today, a little under 85% of Des Moines residents are composed of White (53.6%), Hispanic (17.9%), and Asian (13.3%) with a median age of around 41.1 years old (older than the State median age of 37.7).

Median household income of $65,498 is slightly below the State median of $67,106 and unemployment (4.4%) is below the State average (5.2%). Also, median home values ($321,383) are above the State median ($306,400).

Figure 2.8
Des Moines Population Growth: 1980-2018

Year	Population
1980	7,378
1990	17,283
2000	29,267
2010	29,673
2018 (estimate)	32,364

Source: City of Des Moines and US Census

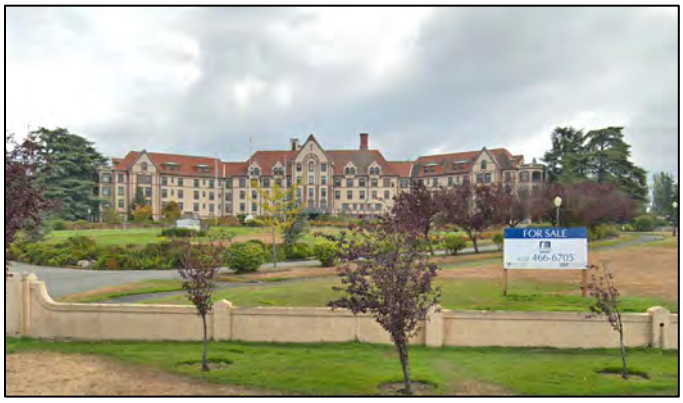
The City's population has grown steadily over the past 40 years, with significant growth during the 1980 to 1990 decade. Population has stabilized around 32,364 people, but a new residential development (across the street from City Hall) will help to increase the City's population. With a relatively low unemployment rate, Des Moines also has a diverse economic base, with the most common industries including:

- Transportation Equipment 8.0%
- Healthcare 7.3%
- Educational Services 6.8%
- Construction 6.7%
- Accommodation & Food Services 4.8%
- Finance & Insurance 4.1%

Des Moines' proximity to Seattle-Tacoma International Airport has made it a desirable destination for some corporate relocations as well as area hotels that cater to travelers using the Airport.

In 2015, the City updated its Comprehensive Plan in order to best address how to maintain its quality of life over the next two decades. As part of that effort, it adopted a vision for the City which stated that Des Moines would be "an inviting, livable, safe waterfront community, embracing change for the future while preserving our past." The 2015 Plan noted the need to grow by an additional 3,480 dwelling units (homes and apartments) and to add 5,800 new jobs in order to serve the local and regional demands of 2035.

Figure 2.9
Old Masonic Lodge in Des Moines
(photo courtesy of Google Earth)



E. CITY OF FEDERAL WAY, WASHINGTON

Federal Way is the largest of the Study Area cities, both by population and in land area. It is also the furthest away from Seattle-Tacoma International Airport, lying generally between the city of Des Moines and the King/Pierce County line. The area was settled in the late 1800s and grew rapidly. Existing trails became roads to connect strategic developments, including Fort Steilacoom and Fort Bellingham.

Figure 2.10
US 99
(photo courtesy of Historical Society of Federal Way)

With more homesteads came many small schoolhouses to serve the new residents. The City's name is derived from the eight small school districts that consolidated in 1929 to form the Federal Way School District.

Automobiles were a relative novelty in the early 1900s, so it was the predominance of bicycles and horse-drawn carriages that prompted the US to establish an office to serve these new forms of transportation. By 1915, the Bureau of Public Roads was formed to oversee and standardize the nation's growing roadway network. In 1928, Federal Highway 99 (essentially a re-designation of Military Road) provided paved access between Seattle and Tacoma.

By the start of WWII, the area that would eventually become Federal Way was comprised of many small communities – some sited to take advantage of view to Puget Sound, others clustered around local lakes. Many of these residents worked in local timber and logging industries, resulting in the growth of such major corporations as Weyerhaeuser.

Federal Way's post-WWII growth saw it become a residential destination as area corporations like Boeing grew and prospered. Many professionals looked to new developments like Marine Hills (1958) which offered unparalleled views to Puget Sound. And Weyerhaeuser leveraged its land ownership into high-quality residential developments, such as golf course communities. Weyerhaeuser was not only a significant landowner, developer and employer, they were also a major corporate resident of Federal Way until 2016, when their corporate headquarters relocated to downtown Seattle.

Figure 2.11
Weyerhaeuser Headquarters Campus, circa 1990
(photo courtesy of Weyerhaeuser)

Growth continued throughout the 1970s and 1980s, so it was not surprising that the community considered the idea of incorporating as a new city. However, residents were not quite ready for incorporation, voting the proposal down three times (in 1971, 1981 and 1985).

With new residential and commercial development continuing unabated, voters finally decided to take a more proactive position to their future. Federal Way was officially incorporated as a city on February 28, 1990. Today, over 86% of Federal Way residents are composed of White (51.7%), Hispanic (21.8%), and Asian (12.9%) with a median age of around 35.5 years old (slightly below the State median age of 37.7).

Figure 2.12
Federal Way Population Growth: 1980-2018

Year	Population
1980 (estimate)	52,016
1990	67,554
2000	83,259
2010	89,306
2018 (estimate)	97,044

Source: City of Federal Way and US Census

The median household income of $65,788 is slightly below the State median of $67,106 and unemployment (4.4%) is below the State average (5.2%). Also, median home values ($314,700) are above the State median ($306,400).

The City's population has grown steadily over the past 40 years. With a relatively low unemployment rate, Federal Way also has a diverse economic base, with the most common industries including:

- Healthcare 8.1%
- Transportation Equipment 7.0%
- Accommodation & Food Services 6.9%
- Construction 6.2%
- Educational Services 5.5%
- Finance & Insurance 5.0%
- Professional, Scientific & Technical Services 4.4%

Federal Way's proximity to both Seattle and Tacoma has historically positioned it as a "bedroom community", where working residents are mostly employed elsewhere. The *2015 Federal Way Comprehensive Plan* noted that only 16.5% of the labor force living in Federal Way also work within the city limits. The 2015 plan also noted the following seven vision characteristics that it plans to achieve by 2035:

- Government For and By the People;
- Vibrant and Diverse Growth;
- Economic Vitality;
- Efficient Transportation System;
- Safety, Infrastructure, and Utilities;
- Caring for Our Own; and,
- Quality Culture, Environment, and Play.

F. CITY OF NORMANDY PARK, WASHINGTON

Normandy Park is located between Puget Sound and the cities of Des Moines and Burien. While the area remained relatively undeveloped, a few homestead claims were filed in the late 1800s under the *Homestead Act of 1862*.

The area remained sparsely populated until the 1920s when the Seattle-Tacoma Land Company sold lots under the name of "Normandy Park", featuring homes with French Norman architecture. The community soon began to be known as an area for exclusive residences, especially those with private beach access.

But like so many other communities, Normandy Park's growth was impacted by the Great Depression of 1929. The community rode out this bleak economic period and by the late 1930s, the outlook started to improve, only to be slowed once more by the onset of WWII.

However, the post-WWII economic boom that benefited most of the US also helped Normandy Park. Its relative proximity to the then-new civilian airport (Seattle-Tacoma Airport, 1949) and the growth of the Boeing Company once again placed Normandy Park as a destination for affluent homeowners. Normandy Park was well-positioned as an affluent suburb with views and access to Puget Sound.

Figure 2.13
1920s Era Street in Normandy Park
(photo courtesy of City of Normandy Park)

It was the growth concerns of the post-WWII period that prompted local officials to consider incorporation. Some feared the community would grow uncontrolled. Others wanted to protect access to the private beaches. Regardless of the motivation, Normandy Park was officially incorporated in June 1953.

The concern for quality of life and of the local amenities (beaches, heavily treed neighborhoods, etc.) has been at the forefront of Normandy Park's emphasis for its long-range growth plans. The City has been quite cautious regarding how to (or to not) annex into certain areas, and to maintain its environment of largely single-family homes. In the mid-1990s, Normandy Park felt its quality of life was threatened by a then-proposed third runway at Seattle-Tacoma International Airport. It joined with its neighboring communities to study the proposal and to push for assurances that the new facility would not negatively impact the City.

Recently, Normandy Park has attracted some diversified development, including the Normandy Park Towne Center (1st Avenue South at South 199th Street) and a few nearby attached residential products.

The City's forest-like setting and residential character continue to define its character. As part of its most recent Comprehensive Plan (January 2016), the City incorporated the following policy framework as a basis for its future character and growth:

- Celebrate the community's proximity, access and visual relationship to Puget Sound;
- Preserve and promote safe, healthy, quiet and secure residential neighborhoods;
- Honor the City's existing low-density, forested character;
- Establish and preserve natural open spaces and environmentally-sensitive areas;
- Enhance the water quality and habitat value of local streams and shorelines;
- Protect identified critical areas;
- Promote the ongoing development of "neighborhood commercial centers" along 1st Avenue South, providing needed in-town services and a variety of compatible housing options;
- Support cost-effective management of facilities, transportation systems and services; and,
- Promote long-term economic and fiscal sustainability for the City.

Figure 2.14
Normandy Park Towne Center Entrance
(photo courtesy of Google Earth)

Today, almost 95% of Normandy Park residents are composed of White (83.3%), Asian (5.8%) and Hispanic (5.2%), with a median age of around 49.7 years old (significantly older than the State median age of 37.7)

The median household income of $97,704 is significantly above the State median of $67,106 and unemployment (3.6%) is significantly below the State average (5.2%). Also, median home values ($584,519) are about 90% higher than the State median ($306,400). These metrics support the City's reputation as a wealthy and affluent area.

Figure 2.15
Normandy Park Population Growth: 1980-2018

Year	Population
1980	4,268
1990	6,709
2000	6,392
2010	6,335
2018 (estimate)	6,660

Source: City of Normandy Park and US Census

The City's population has remained relatively stable over the past 40 years. This is due to a local preference for single-family homes over apartments and/or condominiums, and to manage local growth within reasonable amounts. Today, Normandy Park remains a predominantly residential community. It enjoys a very low unemployment rate even though most of the City is residentially-developed.

For those non-residential uses located within the City, they are generally diversified as follows:

- Educational Services 11.0%
- Transportation Equipment 8.8%
- Professional, Scientific & Technical Services 7.5%
- Construction 7.3%
- Healthcare 6.5%
- Finance & Insurance 4.5%
- Accommodation & Food Services 4.4%

Normandy Park continues to maintain its reputation as a destination for affluent residential development, surrounded by an enviable combination of heavily-treed areas, views to Puget Sound, and private beach access.

G. CITY OF SEATAC, WASHINGTON

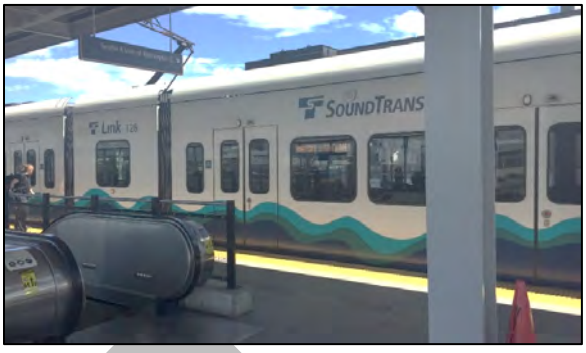
The City of SeaTac is one of the most interesting communities in the Study Area, as it encompasses and surrounds the lands occupied by Seattle-Tacoma International Airport. It shares borders with the cities of Burien, Des Moines, Tukwila, and Kent (the latter is not part the Study Area).

Early settlers began to appear in the mid-1800s. The previously-mentioned military road linking Fort Steilacoom and Fort Bellingham also made travel in the pre-automobile days a bit easier.

Prior to incorporation, SeaTac was a collection of smaller communities, including Angle Lake, Bow Lake, McMicken Heights and Riverton Heights. SeaTac's communities developed to take advantage of the area's economy, which included timber and aviation. As operations at Seattle-Tacoma International Airport grew, so too, did nearby support business including numerous hotels, restaurants, and commercial off-airport parking lots. At that time, this surrounding area was in unincorporated King County, so municipal services, as well as tax revenue collection, were not controlled by the local communities.

By the late 1980s, the local communities began to explore the idea of becoming a city through incorporation. The measure was approved by the voters and the City of SeaTac was established on February 28, 1990 – the exact same date the City of Federal Way incorporated.

Figure 2.16
SeaTac/Airport Light Rail Station
(photo by Stantec)



The City is inextricably linked to the Airport, although they are individual political entities, separated by a hyphen. "Sea-Tac" is the abbreviated name for the Airport, while "SeaTac" is the City's official name.

The economic fortunes of Seattle-Tacoma International Airport and the City of SeaTac are closely tied. The City of SeaTac is the home to the corporate headquarters to both Alaska Airlines and its subsidiary Horizon Air. There are also roughly 5,000 hotel rooms in SeaTac – most located along or near International Boulevard/US Highway 99 – most of which cater to business and tourist travelers from around the world. The City's population has grown slowly but steadily over the past 40 years. A little under 30,000 residents now call SeaTac home.

Figure 2.17
City of SeaTac Population Growth: 1980-2018

Year	Population
1980	17,961
1990	22,694
2000	25,496
2010	26,909
2018 (estimate)	29,239

Source: City of SeaTac and US Census

SeaTac has a diverse population with 90% of residents being are composed of White (32.6%), African-American (21.6%), Hispanic (19.1%), and Asian (16.7%), with a median age of around 34.2 years old (younger than the State median age of 37.7).

Figure 2.18
International Boulevard
(photo by Stantec)

The median household income of $52,976 is approximately 22% lower than the State median of $67,106, although unemployment (4.6%) is below the State average (5.2%). Median home values ($296,782) are almost equal to the State median ($306,400).

With a relatively low unemployment rate, SeaTac also has a diverse economic base that is mostly associated with Seattle-Tacoma International Airport, including:

- Accommodation & Food Services 10.8%
- Construction 9.3%
- Transportation Equipment 6.5%
- Healthcare 6.3%
- Administrative, Support & Waste Management Services 5.9%
- Educational Services 4.1%
- Other Transportation, Support Activities & Couriers 3.9%

The City of SeaTac is the only City in the Study Area to be served Sound Transit's Link light rail service at two stations:

- The SeaTac/Airport station (opened in 2009) serves the Airport and provides a direct link to Downtown Seattle. The Sea/Tac Airport station is immediately adjacent to the northside of Seattle/Tacoma International Airport and is within walking distance of the main terminal, as well as several area hotels;
- The Angle Lake station, located at South 200th Street, was opened in 2016. It is currently the southern terminus of the Link light rail line, with plans for expansion further south.

In 2015, the City of SeaTac adopted its updated Comprehensive Plan and adopted the following Vision Statement to guide its growth:

- The City of SeaTac is envisioned to be economically strong, environmentally sensitive, visually pleasing, and people-oriented with a socially diverse but cohesive population and employment mix. These attributes create a positive identity and image for the community and contribute to a city of the future that works.
- The essence of a growing, prosperous, and vibrant City of SeaTac is found not in its built or natural environment alone but in the collective spirit of those who live and who work within the SeaTac community.
- The built aspects of this community – its residential and commercial structures, transportation network, park and recreation facilities, utility systems and other public and private facilities, as well as the natural environmental setting – are not considered as ends in themselves, but as means for enhancing the quality of life and enriching the human spirit.

H. CITY OF TUKWILA, WASHINGTON

The City of Tukwila is located immediately east of the cities of Burien and SeaTac and is east/northeast of Seattle-Tacoma International Airport. Outside of the Study Area, the cities of Seattle, Kent, and Renton also share borders with Tukwila to the City's north south and east.

Figure 2.19
Downtown Tukwila, circa 1900
(photo courtesy of Tukwila Historical Society)

Tukwila is the only city in the Study Area with a name that references its indigenous heritage. The name comes from the indigenous term for hazelnut – a direct reference to the hazelnut trees native to the area.

The area that is modern Tukwila sits in a valley that had been at the convergence of two important regional rivers – the White River and the Black River, which combined to form the Duwamish River.

The first settlers began to stake their claims in Tukwila in the mid-1850s. The presence of two rivers, existing trails, and fertile lane made the area attractive for farmers, fisheries, loggers, and homesteaders. Even in the face of periodic natural and man-made economic challenges, the area continued to grow throughout the 1800s.

Tukwila is technically the oldest of the six Study Area cities, having been incorporated in 1908. Tukwila's incorporation as a city leveraged its many local assets, rather than as a response to an external condition. But a new technological innovation would soon bring opportunity and prosperity to Tukwila.

That innovation was the creation by Messrs. Boeing and Westervelt and would soon yield a nearby economic giant – the Boeing Company. Tukwila's proximity to the Boeing plant made it a natural destination for the new workers employed at the plant. And as the US prepared to enter WWII, production expanded.

Figure 2.20
Westfield Southcenter Mall
(photo by Stantec)

Aviation was not the only influencer in Tukwila. The city was located along the line of the former Seattle-Tukwila Interurban railway – an electric train that connected Seattle and Tacoma. Interurban railways were common throughout the US and provided quick and convenient access to many urban dwellers. But the increasing popularity of the automobile eventually forced these interurban lines out of business.

Tukwila's connection to major transportation modes – river, rail, road, and air – made it a natural center for commerce, especially retail and distribution. One of the City's defining features is the Westfield Southcenter Mall (opened in 1968).

It remains a major retail presence in the Pacific Northwest and is the core of a vibrant retail district. The City has grown through a combination of natural organic growth and annexation of adjacent communities. It now has a diverse population, with over three-quarters of residents being composed of White (30.7%), Asian (23.8%), African-American (18.2%), and Hispanic (3.5%), with a median age of around 34.0 years old (younger than the Stat e median age of 37.7).

The median household income of $52,979 is below the State median of $67,106 and unemployment (3.6%) is significantly below the State average (5.2%). Also, median home values ($299,7979) is slightly below the State median ($306,400).

Figure 2.21
Tukwila Population Growth: 1980-2018

Year	Population
1980	3,578
1990	11,874
2000	17,181
2010	19,107
2018 (estimate)	20,294

Source: City of Tukwila and US Census

With a relatively low unemployment rate, Tukwila has a diverse economic base, including:

- Accommodation & Food Services 8.7%
- Transportation Equipment 8.2%
- Construction 5.9%
- Healthcare 5.8%
- Educational Services 5.1%
- Administrative, Support & Waste Management Services 4.8%
- Professional, Scientific & Technical Services 4.7%

Tukwila's local economy is supported by a variety of retail and hospitality uses associated primarily with the Westfield Southcenter Mall, as well as the City's proximity to the Seattle-Tacoma International Airport. Other than retail and hospitality, other major local employers include Boeing, Kaiser Permanente and King County Metro, among others.

While the City's population grew rapidly from 1980 to 2000 and has stabilized for the last 20 years. This is due to a local preference for single-family homes over apartments and/or condominiums, and to manage local growth within reasonable amounts.

Like all cities in the Study Area, the City of Tukwila maintains and regularly updates its Comprehensive Plan. Its basic objectives include:

- Great neighborhoods;
- A vibrant and diverse Tukwila International Boulevard District;
- Good jobs along East Marginal Way; and,
- A thriving Southcenter/Urban Center for shopping, working, living and playing.

In the 2015 Plan update, Tukwila adopted the following four vision statements:

- **Respect for the Past and Present:**
  Tukwila was and will continue as a regional crossroads.
  We honor the past as we move toward the future.
- **Compassion and Support for Individuals and Families:**
  We support our residents.
  We support our families.
  We support our children.
- **Pride of Place:**
  We value our environment.
  We appreciate our surroundings.
- **Quality Opportunities for Working, Living, and Community Involvement:**
  Thriving and responsible businesses.
  Responsive government that respects individual rights.
  We seek to provide opportunities for residents.

I. STUDY AREA SUMMARY

The Study Area is a collection of six diverse cities. They share many common attributes, not the least of which is their early heritage traced to First Nation peoples.

The four westernmost cities – Burien, Normandy Park, Des Moines, and Federal Way – share a common interest in preserving the beauty and ecological integrity of Puget Sound and its coastline. The two cities on the eastside of the Study Area – SeaTac and Tukwila – do not enjoy coastline views or access, but have a more diverse economic base, including businesses that support and cater to Airport use.

The six Study Area cities combined have grown significantly over the last 40 years – growing by almost 120% to a total of 235,778 people. Growth was significant during the 1980-1990 (39%) and 1990-2000 (28%) decades, slowing down (but still growing) during the early 2000s (less than 6%). Growth during the 2010 decade has increased to approximately 16%.

Figure 2.22
Study Area Cities Population Growth: 1980-2018

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	Combined Total
1980	23,189	7,378	52,016 *	4,268	17,961	3,578	**108,390**
1990	25,089	17,283	67,554	6,709	22,694	11,874	**151,203**
2000	31,881	29,267	83,259	6,392	25,496	17,181	**193,476**
2010	33,313	29,673	89,306	6,335	26,909	19,107	**204,643**
2018 (est.)	51,908	32,364	97,044	6,660	29,239	20,294	**237,509**

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census.
* estimated (Federal Way not incorporated until 1990)

Current population and area metrics indicate that the Study Area is denser than the average for King County. The Study Area accounts for a small portion of King County (2.6%) but over 10.6% of the County's population. The result is that the Study Area density is almost 4 times denser than the County average.

Figure 2.23
Study Area and County Density

Area	2018 Total Population	Total Area (square miles)	Density (people per square mile)
Study Area	237,509	61.36 sq. mi.	3,870.7/sq. mi.
King County	2,233,163	2,307.00 sq. mi.	967.99/sq. mil

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census.

Regarding impacts that occur in the Study Area, density is one key consideration. For instance, some impacts may be shown to occur over a small area, but since the Study Area is denser than the County average, those impacts can be more significant due to density. Area (from square feet to square miles) is a significant characteristic to be considered.

It is also important to understand that the Study Area cities are not monolithic. There is a variety of sizes, densities, and characters.

Figure 2.24
Individual Study Area City Density

City	2018 Total Population	Total Area (square miles)	Density (people per square mile)
City of Burien	51,908	10.11 sq. mi.	5,134.3/sq. mi.
City of Des Moines	32,364	6.41 sq. mi.	5,049.0/sq. mi.
City of Federal Way	97,044	22.49 sq. mi.	4,330.4/sq. mi
City of Normandy Park	6,660	2.51 sq. mi.	2,653.4/sq. mi.
City of SeaTac	29,239	10.24 sq. mi.	2,855.4/sq. mi.
City of Tukwila	20,294	9.60 sq. mi.	2,113.9/sq. mi.

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census

The 2018 figures show, for example, that Federal Way is the largest city by population and area. But Burien and Des Moines are much more urbanized (denser), even though they are each roughly half the physical size of Federal Way. While the City of Normandy Park has the smallest population and area, its density is quite close to that of the larger Cities of SeaTac and Tukwila.

This Study will account for both the proximity of each Study Area City as well as relative density as a characteristic of potential impact effects.

Comparing Community and Airport Growth: 2000 to 2018

During the period 2000 to 2018, the entire Study Area, as well as the City of Seattle, King County, and the Seattle metropolitan statistical area (MSA) have grown. Overall growth during this period has ranged from 22.8% (Study Area) to 32.2% (City of Seattle).

Figure 2.25
Area Growth: 2000-2018

Area	2000 Population	2018 Population	Growth: 2000-2018
City of Burien	31,881	51,908	62.8%
City of Des Moines	29,267	32,364	10.6%
City of Federal Way	83,259	97,044	16.6%
City of Normandy Park	6,392	6,660	4.2%
City of SeaTac	25,496	29,239	14.7%
City of Tukwila	17,181	20,294	18.1%
Total: Study Area Cities	**193,476**	**237,509**	**22.7%**
City of Seattle	563,374	744,955	32.2%
King County	1,737,034	2,233,163	28.6%
Seattle MSA	3,043,878	3,939,363	29.4%
Airport (Annual Passengers):			
Total: Annual Passengers	**28,408,553**	**49,849,520**	**75.5%**
Airport (Annual Operations):			
Air Carrier	236,355	427,170	80.7%
Air Taxi	203,723	8,509	(-95.8%)
General Aviation	5,448	2,625	(-51.8%)
Military	95	87	(-8.4%)
Civil	56	0	(-100.0%)
Total: Annual Operations	**445,677**	**438,391**	**(-1.6%)**

Source: Cities of Burien, Des Moines, Federal Way, Normandy Park, SeaTac and Tukwila; and US Census

Burien's growth during this period shows the highest growth rate of the Study Area Cities. However, that includes the 2010 annexation of the southern portion of North Highline, which added 1,600 acres and 14,292 residents to the City. Had this annexation not occurred, Burien's population growth rate is projected to have been closer to 20% – still the fastest growing City in the Study Area.

The growth rate of the remaining Study Area Cities was generally in the teens. The exception is Normandy Park, which is comprised predominantly of single-family homes, and has little room to grow. There have been some recent land use development patterns that have brought some areas of more dense residential areas (in the area of the Normandy Park Towne Center), but the City's growth is generally stable at around 4%.

The growth of the Study Area is slightly behind the growth rates for King County (28.6%) and the region (29.4%). The City of Seattle has grown at the fastest rate (32.2%) which could also be attributed to increased residential density in areas such as Downtown. Since the Study Area's growth rate of 22.8% is the lowest in the region, this indicates that the Study Area – while growing – is not growing as fast as other parts of the area.

Passenger growth at Seattle-Tacoma International Airport has seen the largest increase over this same period (75.5%). This is due not only to more passenger enplanements and deplanements, but also an increase in through passengers that connect through the Airport for other destinations.

Total operations at Seattle-Tacoma International Airport do not tell the whole story. While total operations decreased by 7,286 (-1.6%) from 2000 to 2018, Air Carrier operations increased significantly (80.7%), consistent with passenger increases during this same period. The decrease in total operations at Seattle-Tacoma International Airport from 2000 to 2018 is attributed to decreases (or eliminations) in Air Taxi, General Aviation Military, and Civil operations at the Airport.

Based solely on these growth rates, the entire area has grown between 2000 and 2018. But the Study Area, as a whole, posted the lowest growth rate calculated, while Seattle-Tacoma International Airport experienced the highest growth rates in passengers and air carrier operations.

Planning: Local, State and Regional

All six cities have adopted Comprehensive Plans and have updated them in the last few years. Comprehensive Plans are the means by which each city evaluates current conditions, establishes a vision for its future growth, adopts supporting policy goals, and develops various plans to proactively guide the city's growth (such as land use, transportation, housing, etc.).

Of course, no plan can accurately project future conditions, and new opportunities and/or challenges constantly present themselves which were unknown when the plan was developed. Therefore, these plans are designed to be updated on a regular basis to take these conditions into account.

Another factor influencing Comprehensive Plans is the Growth Management Act (RCW 36.70A.140), adopted by the State of Washington in 1990, along with subsequent updates and revisions. The GMA establishes the following 14 statutory goals that each Comprehensive Plan must be consistent with:

- **Growth** – Guide urban growth to areas where urban services can be adequately provided;
- **Sprawl** – Reduce urban sprawl;
- **Mobility** – Encourage efficient multi-modal transportation systems;
- **Housing** – Encourage the availability of affordable housing to all economic segments of the population;
- **Economic Development** – Encourage economic development throughout the State;
- **Property Rights** – Assure private property is not taken for public use without just compensation;
- **Permitting** – Encourage predictable and timely permit processing;
- **Natural Resource Industries** – Maintain and enhance natural resource-based industries;
- **Open Space and Recreation** – Encourage retention of open space and development of recreational opportunities;
- **Environment** – Protect the environment and enhance the State's quality of life;
- **Citizen Participation** – Encourage the participation of citizens in the planning process;
- **Public Facilities and Services** – Ensure adequate public facilities and services necessary to support development;
- **Historic Preservation** – Identify and preserve lands and sites of historic and archaeological significance; and,
- **Coastal Management** – Manage shorelines of statewide significance.

There is also a regional initiative to coordinate planning efforts between cities in the Puget Sound area. *Vision 2040* is the regional growth strategy that coordinates long-range planning efforts in King, Pierce, Snohomish, and Kitsap Counties. It is managed by the Puget Sound Regional Council (PSRC) and all six Study Area cities are part of this regional effort. The Port of Seattle also participates as a statutory member. An update to this plan (*Vision 2050*) is in its draft stages and is scheduled for adoption in 2020.

The planning efforts at the local, regional, and Statewide level are all focused on maintaining quality of life for existing and future residents, while preserving and protecting vital natural resources and culturally significant and historic assets. These efforts are important to help local, County, regional, and State officials allocate resources, manpower, and funds to support these efforts. And it also helps position the public sector to anticipate future growth-related issues.

As both a major employer and land-use, the Port of Seattle and Seattle-Tacoma International Airport have a vested interest in the success of these planning collective efforts and of the growth and prosperity of the Study Area cities. The Port of Seattle and Seattle-Tacoma International Airport are more than a "statutory members" of this planning community. They are a major participant in the success of the region and wield significant resources that may help define the future of the region and of the Study Area.

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SECTION 3

AIRPORT CASE STUDIES

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SECTION 3

AIRPORT CASE STUDIES

A. APPROACH

The Secretary of Transportation is required to submit a report to Congress every two years – the National Plan of Integrated Airport Systems (NPIAS) – which "estimates the costs associated with establishing a system of airports that adequately meets the needs of civil aviation and supports the US Department of Defense and the US Postal Service." This is the mechanism for developing public-use airports in the US and supports the US Department of Transportation's (DOT) and the Federal Aviation Administration's goals of safety, infrastructure, innovation, and accountability as mandated by Title 49 USC, Section 47103.

Figure 3.1
National Plan of Integrated Airport Systems

On page 1 of the most recent Report to Congress (26 September 2018), the NPIAS defines a list of eight attributes that should be followed. These principles were articulated more than 25 years ago and were reaffirmed by both the Federal Aviation Administration and the aviation industry in 2011. Of the eight attributes, #5 (in bold) is especially appropriate with regards to how airport-area communities are addressed:

1) Airports should be safe and efficient, located where people will use them, and developed and maintained to appropriate standards;
2) Airports should be affordable to both users and the Government, relying primarily on producing self-sustaining revenue and placing minimal burden on the general revenues of the local, State, and Federal Governments;
3) Airports should be flexible and expandable and able to meet increased demand and accommodate new aircraft types;
4) Airports should be permanent with assurance that they will remain open for aeronautical use over the long term;
5) **Airports should be compatible with surrounding communities, maintaining a balance between the needs of aviation, the environment, and the requirements of residents;**
6) Airports should be developed in concert with improvements to the air traffic control system and technological advancement;
7) The airport system should support a variety of critical national objectives, such as defense, emergency readiness, law enforcement, and postal delivery; and
8) The airport system should be extensive, providing as many people as possible with convenient access to air transportation, typically by having most of the population within 20 miles of an NPIAS airport.

These eight attributes apply to the 13,177 airports in the NPIAS database, including 4,815 public-use airports and 8,302 private airports. Those goals are supported by 6 topic areas in the NPIAS – safety, capacity, environment, pavement condition, surface accessibility, and financial performance.

Additionally, Executive Order 12893 (31 January 1994) requires that "Federal investments should be cost beneficial". This Executive Order also included other key principles that the Federal Aviation Administration supports through its administration of the NPIAS, including:

- Support of State and local planning and information management systems;
- Support for private sector participation; and,
- Support for effective administration of grant programs like AIP (airport improvement program).

Given that every US airport is required to abide by the attributes and guiding principles established in the NPIAS, other airports like Seattle-Tacoma International Airport have had to deal with similar issues of growth and community compatibility. To better understand how these challenges are dealt with, this Study will briefly examine three other US airports with similar characteristics – an approximately 3,000-acre site which offers international passenger and cargo service while being surrounded by development (or a coastline).

B. BOSTON LOGAN INTERNATIONAL AIRPORT

Boston Logan International Airport (Boston Logan) is the largest airport in both the Stater of Massachusetts and the New England region.

Figure 3.2
Boston Logan International Airport
(photo courtesy of Bing Maps)

Boston Logan was opened in September 1923, initially for military use (the Army Air Corps and the Massachusetts Air Guard). At the time, it was referred to as "Jeffrey Field". Boston Logan is owned and managed by the Massachusetts Port Authority (known as Massport), which also owns and manages Hanscom Field and Worcester Regional Airports. Massport is an independent public authority that was funded in 1959 to replace the previous local port commission.

Boston Logan is located on an island (Apple Island) which is partially located in East Boston and Winthrop, immediately northeast of Downtown Boston, and is bracketed by residential neighborhoods in Chelsea, Revere, Suffolk, South Boston, and other urban neighborhoods.

Today, Boston Logan covers 1,700 acres and is the second smallest footprint among the Top 20 American airports. It operates 94 gates in four passenger terminals and has six runways:

- 4R/22L (10,008 feet);
- 15R/33L (10,083 feet);
- 4L/22R (7,861 feet);
- 9/27 (7001 feet);
- 14/32 (5,000 feet); and,
- 15L/33R (2,557 feet).

In 2018, Boston Logan handled 40,941,925 passengers – the busiest year in its history – along with 424,024 operations.

Boston Logan is accessible by roadway and transit. Transit modes include a bus rapid shuttle that connects all terminals with South Station in Boston's financial district. A shuttle bus also connects the terminals with the Blue Line rail (operated by Massachusetts Bay Transportation Authority, or MBTA) – there is no direct rail service.

Noise Abatement

Due to the proximity of Logan to residential communities throughout the Greater Boston Metropolitan area, Massport has been continually working to minimize the impacts of noise on the surrounding neighbors since 1975. Logan was one of the first airports in the nation to install a noise monitoring system in communities, which is now used to direct Massport's aggressive noise abatement efforts.

In 1986, Massport instituted noise abatement rules to reduce impact of noise from aircraft operations on neighboring communities. The *Boston Logan International Airport Noise Rules* included:

- Restrictions on certain runways;
- Restrictions on some ground operations; and,
- Prohibition of old, noisy engine technology called Stage 2 during the sensitive nighttime hours.

Boston Logan operates flights 24 hours a day. The noise rules, however, restrict the type of aircraft that could operate at night. Only Stage 3 commercial jet aircraft or quieter may operate at night (for over a decade, late night Stage 2 flights have been banned).

Older and noisier Stage 2 aircraft engines were partially prohibited from operation in the US in 2000, with a complete ban by 2015. This has positively impacted all US airports, including Boston Logan, which saw a steady drop in Stage 2 operations. Neighboring areas have benefited from the elimination of these Stage 2 engines as air carriers and cargo operators modernize their fleets in compliance with Federal mandates.

Massport has taken numerous steps to proactively decrease noise in neighboring areas:

- **No "Hush-Kitted" Stage 3 Aircraft**
  Massport aggressively discouraged the use of Stage 3 "hush-kitted" aircraft, which barely made the Federally-mandated noise cut off. In 2011, 99% of commercial jet activity was "new" Stage 3 and 4 aircraft (the quietest jets), up from 75% in 2000. Some of this fleet improvement was due to Massport's proactive work with air carriers who replaced their noisy shuttle fleet (about 22,000 flights per year before 2001) with newer Boeing 737-800 and Airbus 319/320 aircraft.
- **Noise Abatement Office**
  Massport has operated a Noise Abatement Office (NAO) since 1977 to ensure compliance with Federal noise standards. The NAO has worked with air carriers and the Federal Aviation Administration to analyze how noise impacts neighboring communities in order to reduce the Airport's impact on residents. The NAO operates a 24-hour noise "hotline" so neighbors can report excessive noise.
- **Early Soundproofing Tests**
  In 1981, Boston Logan was the nation's first airport to use Federal funds to test the benefits of soundproofing in public schools. East Boston High School was the first public soundproofed school under this pilot program, which led to a wider program two years later. Since then, more than $170 million has been spent on over 11,000 dwelling units and 36 schools.

- **Exposed Population Census**
  Massport follows the noise standards established by both the Federal Aviation Administration and the US Department of Housing and Urban Development. Those agencies consider exposure levels higher than 65 DNL (day-night noise level) to be incompatible with residential land use. According to Federal standards, areas below 65 DNL are considered compatible with residential use; areas at or above 65 DNL are designated "incompatible" with residential use. Massport reports population counts by 5-decibel increments of exposure each year by community to track Boston Logan's noise environment to determine if it is changing over time and from neighborhood to neighborhood.

Community Impacts

Aside from noise, Massport and Boston Logan make other efforts to be "good neighbors" in Boston:

- Massport owns, operates and maintains over 40 acres of parks and passive recreation land in the region;
- Being a good community partner is a main priority for Massport, and staff meets regularly to discuss concerns and projects with community members and elected officials;
- Massport paid almost $20 million in 2018 in PILOT (Payment In Lieu Of Taxes) to area communities, gave more than $43,000 in scholarships to local high school students, and provided over 300 Community Summer Jobs positions;
- Boston Logan was one of the first airports in the country to incorporate climate change into a sustainability plan;
- Energy reduction is a priority. New construction and renovation projects focus on energy conservation efforts and the installation of renewable energy sources;
- All airport development must integrate LEED (Leadership in Energy and Environmental Design) standards, to provide a framework to create healthy, highly efficient, and cost-saving green buildings;
- Greenhouse gas emissions per passenger have decreased by 38.1% since 2002; and,
- Boston Logan's 30% HOV (high occupancy vehicle) mode share ranks top in the country alongside San Francisco International Airport.

C. MIAMI INTERNATIONAL AIRPORT

Miami International Airport is one of three airports serving South Florida and is the main airport long-haul international flights. It is in an unincorporated portion of Miami-Dade County, located approximately 8 miles northwest of Downtown Miami and is surrounded by Miami, Miami Springs, and Virginia Gardens.

It is owned by Miami-Dade County and operated by the Miami-Dade Aviation Department (MDAD), also operates four other local airports:

- Miami Executive Airport;
- Miami-Opa-Locka Executive Airport;
- Miami Homestead General Aviation Airport; and,
- Dade-Collier Training and Transition Airport.

Figure 3.3
Miami International Airport
(photo courtesy of Google Earth)

Aviation has operated on the site since 1928 when it was initially known as Miami City Airport. Today, Miami International Airport covers 3,230 acres, has 131 gates and four runways:

- 9/27 (13,016 feet);
- 8R/26L (10,506 feet);
- 8L/26R (8,600 feet); and,
- 12/30 (9,355 feet).

In 2018, Miami International Airport handled 45,044,312 passengers and 416,032 operations. In addition to car access, it is accessible via the city's Metrorail system, the Tri-County Rail system, and local and long-haul bus routes. It also has an on-site shuttle system to connect between terminal concourses and the consolidated rental car center.

Previous Environmental Impact Statement

In August 1992, South Florida was impacted by a devastating Category 5 hurricane. Hurricane Andrew's winds were responsible for almost all damage in South Florida, which included destroying or damaging over 164,000 homes, many of which located between Miami International Airport and Florida's eastern coastline.

As part of the recovery effort, new building standards were established in an attempt to minimize future storm-related damage. These require that new construction have insulated roof systems, concrete/masonry walls, air conditioning, triple-pane windows, and other measures to withstand hurricane-force straight-line winds. This also make the homes more "noise resistant", with a 25 dB interior noise reduction as a result. The Airport has never need to offer mitigation packages as a result.

As the area was recovering, MDAD was also proposing a new fourth runway (Runway 8L/26R) and prepared an Environmental Impact Statement in 1995. That study showed there would be a total of 165,000 people living within the 65 DNL contour (mostly east of the airport to the coast). However, because of the new building standards that also significantly reduced interior noise impacts, no additional noise mitigation packages were required. Runway 8L/26R was approved and is currently in service.

Noise Abatement

While the new hurricane building standards also benefited the proposed expansion of Miami International Airport, MDAD took additional measures to be a "good neighbor" with its surrounding areas:

- **"Fly Neighborly" Policy**
  MDAD's "Fly Neighborly" policy constantly evaluates arrival and departure procedures to lessen the impact of noise exposure on residential areas, including moving aircraft off runways as quickly as possible to minimize delay and to direct aircraft over point which minimize overflight of residential areas.

- **Restricted Nighttime Operations**
  MDAD restricts nighttime operations when it closes two runways between 10:00 PM and 7:00 PM (Runways 8L/26R and 12/30). During nighttime operations, there are roughly 100 to 120 operations (combination of air carrier and cargo). Maintenance run-ups are also restricted to daylight hours only and must be performed at a mid-field location shielded by a blast fence.

- **Noise Monitors**
  MDAD previously operated a network of 20 noise monitors (known as remote monitoring stations) strategically distributed throughout the communities surrounding the airport. Locations were generally within the 65 DNL contour and were subject to political consideration before installed. Over time, all but 6 of these monitors were eventually removed because they were showing ongoing compliance with the current DNL contours. The Airport's actual flight experience has matched or has not exceeded the projected noise contours.

- **Noise Hotline**

  The Airport operates a "noise hotline" monitored by MDAD staff between 6:00 AM and 9:00 PM. Calls before and after those hours are recorded for follow-up. There is also an email address for online noise complaints. Every call is followed-up by staff, who identifies each aircraft that may be violating the adopted flight paths or noise abatement procedures and sends a follow-up letter to each person making a noise complaint, with a copy to the Federal Aviation Administration. (Since radar data is only maintained for 30 days by the Federal Aviation Administration, any noise complaints received 30 days after the incident cannot be followed-up.) MDAD staff also meets with homeowner associations and other local groups on-demand to review comments and concerns.

- **Noise Barrier Wall**

  A noise barrier wall was constructed by MDAD along the NW 36th Street edge of the Airport to reduce taxiway noise in adjacent neighborhoods. MDAD reports that aircraft noise has been decreased by 10 decibels within 500 feet of the barrier. The barrier was designed by internationally-renowned landscape architect Martha Schwartz as part of the Airport's "Art in Public Places" program.

Figure 3.4
NW 36th Street Noise Abatement Wall
(courtesy of Miami International Airport)

- **NextGen Procedures**

  The Airport has not yet enacted its NextGen procedures but anticipates these will be implemented by 2021 and further reduce noise concerns. The Airport does require that all glide-slopes be no less than 3 degrees in order to maximize the vertical distance between aircraft and land uses.

Community Impacts

There is an active community outreach program to engage the surrounding communities via a variety of efforts, including public meetings, presentations, media, and a Noise Abatement Task Force. The Task Force meets monthly to review noise-related issues and concerns to ensure they are addressed in a timely manner by MDAD. There is also a Noise Abatement Van equipped with portable noise monitors that can be deployed throughout the area to record aircraft noise levels. MDAD staff also meets with any residents or homeowner groups that have questions or concerns regarding the Airport.

MDAD is also taking steps to improve its overall impact on the community:

- **Economic Benefits**

  In its most recently published annual report (2017), Miami International Airport reported that it had an "annual financial impact on local tourism, cruise operations, international banking, trade and commerce of $33.7 billion." The Airport and its aviation-related industries were estimated to contribute to 282,724 jobs, directly and indirectly, responsible for one out of every four jobs in South Florida.

- **PFC-Funded Improvements**

  In 1994, the Federal Aviation Administration authorized MDAD to impose a Passenger Facility Charge (PFC) of $3 per passenger, revised to $4.50 effective date January 2002. PFC revenues are authorized to pay debt service related to approved capital projects and related financing costs. The PFC authorization is expected to expire in October 2037. From 1994 through 2017, PFC's yielded $1.34 billion (including accrued interest), with an unspent balance of $227.4 million.

- **ISO Certification**
  Miami International Airport was the first US airport to be ISO 14001 certified. To receive the ISO 14001 certification, written procedures must be developed for all operational areas that are likely to handle potential pollutants and employees must be trained accordingly. Those procedures must be reviewed and approved by an authorized ISO 14001 certification firm.

- **Reduction of Diesel Fuel and CO2 Emissions**
  Diesel-fueled Ground Support Equipment (GSE) has been replaced with power and pre-conditioned air from airport facilities, reducing CO2 emissions and reducing the use of diesel fuel by 131,400 gallons of diesel per year.

D. PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Phoenix Sky Harbor International Airport is the largest and busiest airport in the state of Arizona. Unlike the other airports in this case study, Sky Harbor serves both civilian and military aircraft (it serves the Arizona National Guard's 161st Air Refueling Wing).

Figure 3.5
Phoenix Sky Harbor International Airport
(photo courtesy of Google Earth)

The site lies approximately 3 miles east of Downtown Phoenix has been in operation at the site continuously since 1928 when it had a single runway. It was initially developed by a private owner who gave it the name "Sky Harbor" (but the reason for the name was never given since the airport did not operate as a "harbor" in 1928).

The City of Phoenix eventually purchased Sky Harbor in 1935, and still owns and manages it (as the Phoenix Airport System). Today, Phoenix Sky Harbor International Airport covers 3,400 acres, has 116 gates in three terminals, and is served by three runways:

- 8/26 (11,489 feet);
- 7L/25R (10,300 feet); and,
- 7R/25L (7,800 feet).

Sky Harbor has been a home base or major hub for several airlines including America West, US Airways, and most recently American Airlines (after its merger with US Airways in 2013). In 2018, Sky Harbor handled 44,943,686 passengers and 434,252 operations.

In addition to roadway and bus transit, users can access Sky Harbor using the Valley Metro light rail system. While it is not a direct light rail connection, it does have pedestrian bridge access to the Airport's SkyTrain, which connects with the main terminal.

Noise Abatement

In 2014, the Federal Aviation Administration mandated new flight tracks at Sky Harbor based on the Next Generation Air Transportation System (NextGen) satellite-based navigation procedures. This resulted in thousands of noise complaints from residential areas neighborhoods northwest and southwest of downtown Phoenix.

According to the Federal Aviation Administration, the NextGen system is a "modernization of America's air transportation system to make flying even safer, more efficient, and more predictable." The intent is to make the US airspace safer and more resilient for an estimated 2.7 million passengers and over 44,000 flights every day. It seems in the case in Phoenix, the NextGen procedures had unintended consequences. It appears that overflights in some residential areas increased because the ground-based navigation systems were no longer utilized.

By 2015, the new procedures were enough of a community concern that legal action was considered by the City and the neighborhoods against the Federal Aviation Administration. By 2018, after nearly 4 years of negotiating, appeals and further problems, the US Circuit Court of Appeals (Washington DC) closed the lawsuit and mandated that the approach/departure paths revert to the routes in effect before September 2014 (prior to the initiation of NextGen). The Court's decision mandates that the Federal Aviation Administration participate in Step 2 with the City, which entails further community workshops and alternate procedures to avoid further noise complaints.

Community Impacts

The NextGen noise lawsuit was one of the most visible issues regarding community compatibility and impact. But there are other areas to also consider:

- **Economic Impact**
  According to the City of Phoenix, Sky Harbor is directly responsible for $12.3 billion in economic impact and has 57,432 jobs at the Airport. Regionally and indirectly, the impacts increase to over $38 billion in economic impact, 269,000 jobs, and $13 billion in annual payroll.
- **Metropolitan Growth**
  The City has noted that Sky Harbor and other local airports contribute to the growth of the region. It is projected that Phoenix will be the fifth largest metropolitan region in the nation and airport access is an important component to this growth.
- **Land Use Reinvestment Strategy**
  The City is in the process of a reinvestment and redevelopment strategy for those properties that were acquired west of the Airport. This process is community-driven and is scheduled for implementation beginning in 2020, when Requests for Proposals will be advertised for "catalytic redevelopment sites".
- **Light Rail Extension**
  The Valley Metro's light rail line was extended to Sky Harbor, helping to reduce traffic congestion, Reliance on cars and trucks, and a reduction in vehicular-related air pollution.

E. SUMMARY

Of the 4 airports considered – Seattle, Boston, Miami and Phoenix – Seattle-Tacoma International Airport ranks as the second smallest site with the fewest number of gates. Yet, it has the highest annual passenger count and annual number of operations of all four airports. The following table lists the various attributes of the four airports, with the largest (or oldest) metrics shown in **bold**:

Figure 3.6
Airport Comparisons

Attribute	Seattle-Tacoma	Boston Logan	Miami	Phoenix Sky Harbor
Year Opened	1944	**1923**	1928	1928
Size (acres)	2,500 acres	2,384 acres	3,230 acres	**3,400 acres**
# of runways	3 runways	**6 runways**	4 runways	3 runways
# of terminals	3 terminals	4 terminals	4 terminals	3 terminals
# of gates	80 gates	103 gates	**131 gates**	116 gates
Passengers (2018)	**49,849,520**	40,941,925	45,044,312	44,943,686
Operations (2018)	**438,391**	424,024	416,032	434,252
Efficiency ratios (2018):				
▪ **Annual passengers per operation**	**113.7**	96.6	108.3	103.5
▪ **Annual passengers per gate**	**623,119.0**	397,494.4	343,849.7	387,445.6
▪ **Daily passengers per gate**	**1,707.2**	1,089.0	942.0	1,061.5

Source: Port of Seattle, Massport, Miami-Dade Aviation Department, and City of Phoenix

The following summarizes some of the highlights of the comparison Seattle-Tacoma International Airport with the three case study airports:

- **Performance**
  Seattle-Tacoma International Airport is an extremely efficient facility. It has the highest ratio of passengers per operation, but the number of annual passengers per gate far exceeds that of the other three airports. On a daily basis, Seattle-Tacoma International Airport is currently handling over 1,700 passengers per gate per day every day (annual average). Seattle-Tacoma International Airport has successfully leveraged a relatively small and landlocked site into a Top 10 performing airport (the eighth largest by passenger count).

- **NextGen Impacts**
  The experience of Phoenix Sky Harbor with the NextGen procedures closely parallels those experienced in the Study Area Cities. The concerns of residents primarily in Burien, Des Moines, Normandy Park, and Federal Way is that the NextGen procedures reduced the overall size of the noise contours by effectively concentrating flight paths in a narrower track directly over residential areas.

- **Legal Challenges**
  Phoenix's NextGen lawsuit and Burien's challenge of the 250-degree heading demonstrate that there may be successful challenges to Federal Aviation Administration policies and procedures.

- **Noise Abatement**
  Miami's various outreach programs, including a van equipped with mobile noise monitors, was the most far-reaching effort of the airports studied. The designed "art noise" wall may not be a perfect solution, but it is an indicator of Massport's interest in providing some measure of abatement approaches that are sensitive to its surroundings.

- **Community Outreach**
  Miami and Boston appear to have the most extensive outreach efforts of the airports researched. From jobs to art to park programs, the efforts of Miami's MDAD and Boston's Massport are worth further studying to see how they may be applied in the Study Area Cities.

- **Environmental Concerns**
  Miami and Boston also seemed to do more when it comes to policies and procedures designed to protect the environment, from ISO certification to LEED building practices to how airplanes are powered and cooled while parked at the gate.

- **Reinvestment**
  The land use redevelopment strategy at Phoenix Sky Harbor could be thought of as "mitigation plus". It is not enough just to acquire parcels that are impacted by noise. Phoenix is working with the community to return these parcels to active development, perhaps adding jobs and revenue back into the region, rather than leaving them undeveloped and empty.

While this series of case studies does not cover every comparable US airport to Seattle-Tacoma International Airport, it does point to some areas where comparable airports are doing as much or more to address community concerns. This is should not be interpreted in any way as a critique or condemnation of the efforts to-date by the Port of Seattle. It does indicate that comparably-sized landlocked airports with similar annual passenger and operation performance seem to be inclined to do more to address community concerns regarding their facilities. To get a more complete picture of how US airports comparable to Seattle-Tacoma International Airport address their community compatibility issues, funding of a more extensive survey is recommended.

F. REFERENCES

Airport IQ 5010: https://www.airportiq5010.com.

Boston Logan International Airport. https://www.massport.com/logan-airport/about-logan/airport-statistics.

Miami International Airport. http://www.mimi-airport.com.

Phoenix Sky Harbor International Airport. https://www.skyharbor.com.

Port of Seattle. https://www.portseattle.org

SECTION 4

COMMUNITY INPUT

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SECTION 4

COMMUNITY INPUT

A. APPROACH

This Study sought input from the community in a variety of ways:

- Through an Advisory Committee composed of staff and citizen representatives of each of the six Study Area Cities;
- Through a series of 1-on-1 and small group stakeholder interviews comprised of citizens, homeowners, business owners, and other interests in the Study Area Cities; and,
- From two Public Workshops which presented the Study to the community. The first Public Workshop introduced the scope and schedule and requested citizen input via comment boards in an "open-house" format. The second Public Workshop shared early draft observations in a more formal presentation, with additional dialogue and comment by the public.

B. STAKEHOLDER INTERVIEWS

Each Study Area city was asked to name 8 to 10 individuals to be interview as stakeholders for this project. During the months of June and July 2019, a total of 48 people were interviewed in 36 sessions, either 1-on-1 or in small groups. These individuals represented a cross-section of people in the Study Area cities with various interests, including current and former elected officials, city staff, residents, business owners, and others. Sessions lasted from 30 minutes to 2 hours each – most were 1 hour.

As a beginning point for each interview, each stakeholder was asked the same two questions:

1. What are the benefits/positive impacts of living/working near Seattle-Tacoma International Airport?
2. What are the challenges of living/working near Seattle-Tacoma International Airport?

Stakeholder input will help identifies areas of primary concern within the Study Area through the sharing of anecdotal experiences. This will help identify areas to be addressed that may not be currently mitigated. It will also help identify areas in need of further study (or areas where data does not exist).

It is important to note that the stakeholders did not speak with a unified monolithic voice. Responses generally varied by location:

- Stakeholders to the West and South cited **Noise** and **Air Quality** much more frequently than in other areas; and,
- Stakeholders to the Northeast and East tended to have more issues with noise from Boeing Field/King County International, noted more concerns with **Traffic**, and were interested in methods to increase **Economic Development**.

The following areas were noted by the stakeholders. (Responses are presented in Appendix A without attribution to names or relationship to the Study Area.)

Benefits/Positive Impacts

This Study is considering both the positive and negative impacts associated with operations at Seattle-Tacoma International Airport. Despite previous concerns stated by the public, it would be inaccurate to say there are only complaints. In the stakeholder interview process, there were positives noted associated with being near Seattle-Tacoma International Airport.

The most often noted positive impacts were as follows:

- Economic Benefit;
- Accessibility; and,
- Convenience.

Economic Benefit comes generally in the form of increased **Tourism** revenue – especially associated with hotel taxes, retail sales, and other similar revenues. There are approximately 5,000 hotel rooms in the cities of SeaTac and Tukwila, and while airport proximity is not responsible for all their reservations, stakeholders noted the relationship did help economically. Tukwila also has a major attraction in the Westfield Southcenter Mall, which attracts millions of visitors annually throughout the metropolitan area, the region, and elsewhere. This is compatible with those who are flying into Seattle for shopping purposes.

There is also a certain degree of economic benefit in having a **Major Employer** in close proximity. This includes jobs not only with the Port of Seattle, but also with the individual airlines and the myriad of support services they employ. However, many stakeholders also noted the desire for more good-paying jobs at or near Seattle-Tacoma International Airport.

Proximity also makes Seattle-Tacoma International Airport both **Accessible** and **Convenient** to Study Area residents. Some employers/employees and residents in the City of SeaTac can walk to the terminal. Others may also be able to bike to the terminal. These modes are a unique feature not found in many US airports.

While proximity waws viewed as a positive, it has a flip side in that it also results in more local traffic and congestion, especially on the local roads and highway interchanges with direct terminal access. Stakeholders noted some periods of excessive congestion, including holiday periods.w

These benefits represent positive impacts that stakeholders would like to see capitalized so that the Study Area cities share in the benefits and opportunities afforded by Seattle-Tacoma International Airport.

Challenges/Negative Impacts

The second question asked stakeholders to identify challenges or negative impacts associated with Seattle-Tacoma International Airport. The top negative impacts that were noted were:

- **Noise**
  It was not unexpected that this would be the top concern, especially of those stakeholders living in cities that are underneath approach and departure paths. Noise was a primary concern especially for stakeholders South and West of Seattle-Tacoma International Airport, including:
  - Take-offs/landings over residential areas, including late-night passenger and cargo flights;
  - NextGen procedures which concentrate operations in a narrower and more compact noise contour zone; and,
  - Mid-field overflights by smaller regional aircraft (such as the Bombardier Q400s)

  Noise concerns were not limited to operations aloft. There were concerns about noise associated with on-field operations, including:

- Reverse thrust on landing;
- Throttle-up to taxi to gates; and,
- Late night maintenance run-ups..

Noise mitigation was also voiced as a concern. Stakeholders reported failure of previous mitigation renovations (such as window systems). Others also noted that previously mitigated homes are not eligible for additional mitigation. And in both cases, there is no feasible method to mitigate outdoor areas.

- **Air Quality**

  Aircraft were also cited as concerns with air quality, usually noted in connection with noise concerns. Impacts noted by stakeholders included:

  - Substance on structures, pools, and decks which was attributed to jet fuel (but not independently tested): Some stakeholders said they could "smell kerosene or jet fuel";
  - Damage to landscaping and lawns (inhibited plant growth);
  - Negative impacts to human health; and,
  - Negative impacts to home values.

  Some stakeholders discussed a research project by the University of Washington regarding ultrafine particulate matter (UFPs). That study is known as "Mobile ObserVations of Ultrafine Particles" (MOV-UP) and is researching the impact of particulate matter that is less than 100 nanometers in diameter. The MOV-UP study is a separate and parallel research effort that is not connected with this project. Results from MOV-UP may not be available until 2020.

  Some stakeholders also referred a 2007 study performed by the European Regional Office of the World Health Organization (WHO), entitled "Health Relevance of Particulate Matter from Various Sources", raised concerns about the toxicity of particulate matter. While not a part of any current US Federal, State or Regional regulations, the WHO study is being reviewed by the Consultant Team to determine potential relevance to this Study,

- **Public Health**

  Both noise and air quality/pollution were noted as having adverse effects on public health. Some stakeholders reported cancers, cardio-vascular disease and other health issues in their neighborhoods.

  The above MOV-UP and WHO studies were cited by some stakeholders as proof of a connection between airport operations and public health impacts. However, it should be noted that the MOV-UP study has not reached conclusions as of this writing and that the WHO study calls for more study to determine the impacts on human health.

- **Mobility**

  These issues paralleled the previous comments regarding proximity, noting areas of congestion and traffic volume, particularly regarding accessing Seattle-Tacoma International Airport and on-airport congestion.

  While Sound Transit Light Rail was generally seen as a positive, it was not not enough of an impact to significantly reduce local traffic congestion.

  Stakeholders from the City of SeaTac noted that they were experiencing some illegal overnight parking that may be attributable to airport visitors, workers or travelers. At the time of this Study, the City was testing "permit parking" to address the concern.

- **Relationship**

  Stakeholders often cited a lack of trust and/or a deteriorating relationship with the Port of Seattle and the Federal Aviation Administration. The following issues were often cited as the reasons for the poor relationship:

  - Airport operations have increased since 2011 but impacts have not been acknowledged by the Port of Seattle;
  - Stakeholders say the third runway is used daily, which is a "misrepresentation" of how it was originally proposed (to be used only for landings during inclement weather);
  - Since Port of Seattle Commissioners are elected at-large, "they are not accountable" to the Study Area Cities;
  - Stakeholders have concerns that the Port of Seattle's primary driver is economic development over the concerns of the area communities.

  Other concerns noted also include:

- **Socio-Economic Impacts**

  Stakeholders reported that while home values have increased, the rate of increase is much slower than other areas (such as in Seattle, Bellevue, Mercer Island, Medina, etc.).

  Some stakeholders also noted that South King County is a "dumping ground" for uses no one else wants in the area (such as the Federal Detention Center and the Airport). But direct causality to the Airport was not provided.

  This raises the question - did the Airport locate in South King County because it was a "low-income area" or did it cause it to decrease in value over time? (This is one of the questions this Study will attempt to address.)

- **Public Safety**

  Some stakeholders noted that the Study Area is subjected to some "crimes of opportunity" including:

  - Thefts from baggage claim area (bags are carried out by thieves and taken across the street to areas in the City of SeaTac, where the discard suitcases are left on residential lawns);
  - Car theft due to high number of parked cars at and around Westfield Southcenter Mall, the Consolidated Car Rental Garage, hotels and nearby short/long-term parking lots; and,
  - Prostitution and drug activity near area hotels.

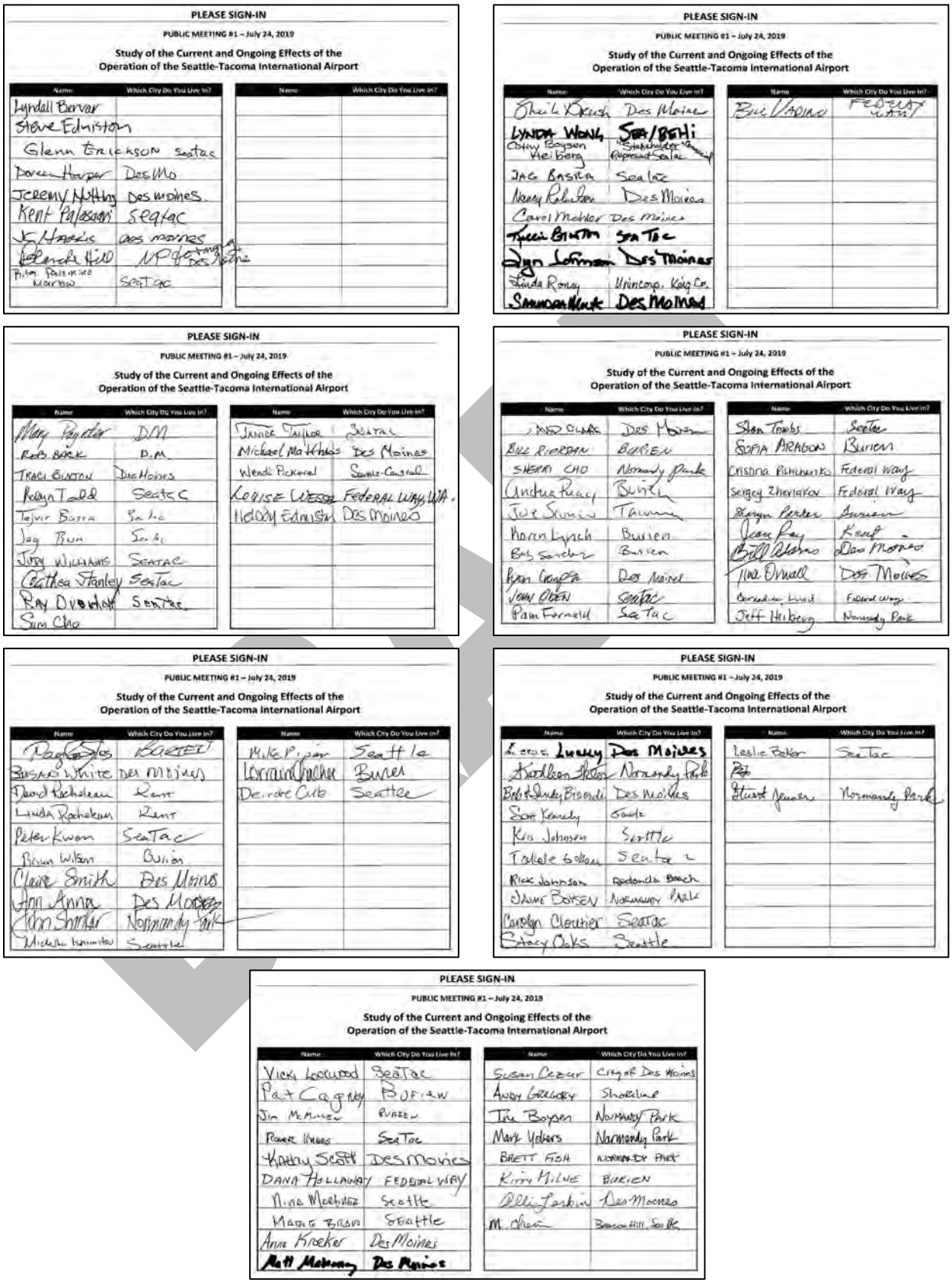
  Stakeholders noted that many crimes were no worse or no better than in other areas. And that many of these "crimes of opportunities" are occurring because of the presence of major destinations (retail centers, hotels, airport) that naturally attract thousands of vehicles. But few stakeholders reported other crimes that were directly attributable to Seattle-Tacoma International Airport.

C. PUBLIC WORKSHOP #1

On July 24, 2019, a workshop was held to present the Study to the public. The workshop was conducted in the cafetorium of Tyee High School (in the city of SeaTac) from 6:00 PM to 8:00 PM.

A total of 96 people signed-in for the workshop, although more people were observed at the workshop than signed in. It is estimated that between 100 and 110 people were in attendance in total. Figure 4.1 shows the sign-in sheets and Figure 4.2 shows the breakdown of attendees by city who signed in.

Figure 4.1
Public Workshop #1 Sign-In Sheets



PLEASE SIGN-IN

PUBLIC MEETING #1 – July 24, 2019

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Name	Which City Do You Live In?
Lyndall Berver	
Steve Edmiston	
Glenn Erickson	SeaTac
Doreen Harper	Des Mo
Jeremy Nutting	Des Moines
Kent Palasagi	SeaTac
K Harris	Des Moines
Rolanda Hill	MP Formerly Des Moines
Pilot Participant Morrow	SeaTac

Name	Which City Do You Live In?

PLEASE SIGN-IN

PUBLIC MEETING #1 – July 24, 2019

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Name	Which City Do You Live In?
Sheila Kreuk	Des Moines
LYNDA WONG	SEA/BETHEL
Ostery Boysen Heiberg	Shareholder Representative SeaTac
JAG BASRA	SeaTac
Nancy Robertson	Des Moines
Carol Mahler	Des Moines
Traci Burton	SeaTac
Dan Lofman	Des Moines
Linda Ronay	Unincorp. King Co.
Shannon Mark	Des Moines

Name	Which City Do You Live In?
Bill Vadino	Federal Way

PLEASE SIGN-IN

PUBLIC MEETING #1 – July 24, 2019

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Name	Which City Do You Live In?
Mary Register	DM
Rob Beck	D.M.
Traci Burton	Des Moines
Robyn Todd	SeaTac
Tejvir Basra	SeaTac
Jag Basra	SeaTac
Judy Williams	SeaTac
Cathea Stanley	SeaTac
Ray Dvorak	SeaTac
Sun Cho	

Name	Which City Do You Live In?
Janice Taylor	SeaTac
Michael Matthias	Des Moines
Wendi Pickerel	Seattle-Central
Louise Wessa	Federal Way, WA
Melody Edmiston	Des Moines

PLEASE SIGN-IN

PUBLIC MEETING #1 – July 24, 2019

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Name	Which City Do You Live In?
John Clark	Des Moines
Bill Riordan	Burien
Sherri Cho	Normandy Park
Cinthia Ruacy	Burien
Jeff Stewart	Tacoma
Karen Lynch	Burien
Bob Sanders	Burien
Ryan Crapps	Des Moines
John Olden	SeaTac
Pam Fernald	SeaTac

Name	Which City Do You Live In?
Stan Tombs	SeaTac
Sofia Aragon	Burien
Cristina Pshunenko	Federal Way
Sergey Zhevlakov	Federal Way
Sharon Porter	Burien
Jean Ray	Kent
Bill Wahas	Des Moines
Tina O'Neill	Des Moines
Cornelius Lund	Federal Way
Jeff Heiberg	Normandy Park

PLEASE SIGN-IN

PUBLIC MEETING #1 – July 24, 2019

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Name	Which City Do You Live In?
Roy Estes	Burien
Susan White	Des Moines
David Richelsen	Kent
Linda Richelsen	Kent
Peter Kwan	SeaTac
Brian Wilson	Burien
Claire Smith	Des Moines
Ann Anna	Des Moines
John Snyder	Normandy Park
Michelle Hummel	Seattle

Name	Which City Do You Live In?
Mike Pipon	Seattle
Lorraine Thacker	Burien
Deirdre Cole	Seattle

PLEASE SIGN-IN

PUBLIC MEETING #1 – July 24, 2019

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Name	Which City Do You Live In?
Lucy	Des Moines
Kathleen Alston	Normandy Park
Bob & Judy Bisordi	Des Moines
Scott Kennedy	Seattle
Kris Johnson	Seattle
Tuliele Tolleson	SeaTac
Rick Johnson	Redondo Beach
Jaime Boysen	Normandy Park
Carolyn Chevalier	SeaTac
Stacy Oaks	Seattle

Name	Which City Do You Live In?
Leslie Baker	SeaTac
Stuart Nemser	Normandy Park

PLEASE SIGN-IN

PUBLIC MEETING #1 – July 24, 2019

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport

Name	Which City Do You Live In?
Vicki Lockwood	SeaTac
Pat Coggins	Burien
Jim McMullen	Burien
Power Knees	SeaTac
Kathy Scott	Des Moines
Dana Hollaway	Federal Way
Nina Martinez	Seattle
Mario Bravo	Seattle
Anne Kroeker	Des Moines
Matt Mahoney	Des Moines

Name	Which City Do You Live In?
Susan Cezar	City of Des Moines
Andy Gregory	Shoreline
Jim Boysen	Normandy Park
Mark Yokers	Normandy Park
Brett Fish	Normandy Park
Kitty Milne	Burien
Allie Larkin	Des Moines
M. Shaw	Beacon Hill, Seattle

Figure 4.2
Public Workshop #1 Attendance by City

City	Attendees	Percentage
City of Burien	10 people	10.4%
City of Des Moines	31 people	32.3%
City of Federal Way	6 people	6.3%
City of Normandy Park	9 people	9.4%
City of SeaTac	22 people	22.9%
City of Tukwila	0 people	0.0%
Outside the Study Area	18 people	18.8%
TOTAL	**96 people**	**100.0%**

Source: Stantec Public Workshop sign-in sheets

More than half of the attendees (55.2%) represented the cities of Des Moines and SeaTac. A little less than 20% of the attendees were from outside the Study Area – from Seattle, Kent, and unincorporated King County. Only the city of Tukwila did not have anyone in attendance who signed in (there may have been attendees from Tukwila who did not sign in).

During this first workshop, the public the opportunity to meet with members of the Consultant Team and ask questions regarding various aspects of the Study. This was a chance to introduce the Study to the public – no findings or analyses were presented.

Figure 4.3
Pubic Workshop #1
(photo by Stantec)

Attendees were also asked to write their comments on a large comment board. A total of 89 comments were received. Figure 4.3 shows the breakdown of comments by type.

Figure 4.4
Public Workshop #1 Comments

General Topic Area	Comments	Percentage
Comments about Noise	31	34.6%
Comments about the Study Approach	13	14.6%
Comments about Air Quality/Environment	11	12.4%
Comments about Port of Seattle	11	12.4%
Comments about the Workshop	7	7.9%
Comments about Transportation	5	5.6%
Comments about Public Health & Safety	5	5.6%
Comments about the Study Area	4	4.5%
Other Comments (not related to the Study)	2	2.2%
TOTAL	**89**	**100.0%**

Source: Stantec Public Workshop comment cards

The comments received at Public Workshop #1 have been transcribed and are listed in Appendix A. They are summarized as follows.

- **<u>Comments About Noise</u> (31 comments)**
  Noise was the most-often cited concern among those in attendance – more than one-third of all comments involved noise, including the following:
  - Noise has increased in the last few years;
  - Noise impacts sleep patterns and disrupts education at schools;

- Noise from late-night passenger and cargo flights;
- More complaints in areas directly underneath flight paths; and,
- Impacts to homes and home values.

This parallels the concerns and comments received during the stakeholder interview process – noise is the #1 complaint heard from the public.

It also has contributed to other concerns, such as a deteriorating relationship with the Port of Seattle and Seattle-Tacoma International Airport (the public does not distinguish between these two entities). Many comments indicate a concern that increased operations have had a parallel increase in noise, without the Port/Airport seeking public input before increasing operations.

Concerns about noise also include dissatisfaction with previous mitigation strategies offered to abate noise as part of the third runway project.

Noise concerns also tended to parallel general concerns about air quality and the environment. Simply stated, if there was aircraft activity above an area, there were combined concerns relating to noise, air quality, and the environment.

- **Comments About the Study (13 comments)**

  There were a significant number of comments (13 comments or 14.6%) about the project itself. This is to be expected, since the purpose of this first workshop was to introduce the Study to the public.

  Comments regarding the Study generally sought to expand the scope and approach to the project – from expanding the Study Area cities to doing actual environmental monitoring.

  There were also other suggestions regarding the airports selected for comparison as case studies (the reasons for those airports being used as case studies has described in Section 3).

  The Study scope is defined by the contract, budget and schedule established by the Washington Department of Commerce. Those requirements were developed in concert with members of the Technical Advisory Committee (at least 5 TAC members attended the first workshop and had signed in).

  The scope and Study area were crafted to meet the State's real-world requirements of budget and schedule. However, should there be a continuation of this project (a "Phase 2"), these comments would be appropriate to consider at that time when scoping any future follow-up.

- **Comments About Air Quality and the Environment (11 comments)**

  These comments largely tracked comments regarding noise and aircraft activity – since both concerns also involve air pollution and perceived impacts on air quality and the environment.

  Commenters noted concerns about residue on the ground, grass, plants, trees, structures, vehicles, and pools. While there was no indication that this material had been tested by an independent laboratory, those commenting were attributing the residue to aircraft. Some noted that they could "smell kerosene and jet fuel".

  Many of the other similar comments were linked to concerns with overall climate change. Those comments tended to want to see the Study greatly expanded to account for these extant conditions.

- **Comments About the Relationship with the Port (11 comments)**

  Those commenting did not distinguish between the Port of Seattle, Seattle-Tacoma International Airport, the airlines, or the Federal Aviation Administration. These comments uniformly blame "the Port" for all the concerns in the Study Area. There is a high degree of mistrust by the commenter with "the Port" and allegations of lying or otherwise not being honest and open with the public. Specific examples included:

  - How the third runway is used versus how it was initially presented;
  - Increasing airport operations without public input;

- Changing flight paths with no public input; and,
- Poor previous experience with Port-offered mitigation packages.

This degree of mistrust was evident at the beginning of the workshop, when the Department of Commerce made some brief introductory opening remarks. Some attendees immediately accused the Consultant Team of "working for the Port" and that the workshop was not interested in public opinion. Both of those statements are completely incorrect.

- **Comments About Public Workshop #1 (7 comments)**
  A few commenters thought the workshop would be a formal presentation and were disappointed in the town hall/"come-and-go" approach. Some wanted more information than was presented, but the purpose of the first workshop was to present the scope and schedule of the project and to solicit public comment. A more formal presentation is to be part of Public Workshop #2.

- **Comments on Transportation & Mobility (5 comments)**
  Public comments regarding traffic and mobility were analogous to those from the stakeholders. Congestion, wayfinding and parking in residential areas were all noted as areas of a-concern.

- **Comments About Public Health & Safety (5 comments)**
  A few commenters noted the ongoing concerns with South King County's reputation as a "dumping ground" and how that impacts health and safety. A few requests were made to expand the Study to include more detailed health studies and risk assessments. These currently fall outside of the contractual scope but may be warranted as part of a follow-up study.

- **Comments About the Study Area (4 comments)**
  A few commenters were adamant about expanding the Study Area to include other areas not currently defined in the State's scope. This included a neighborhood northeast of the Study Area and portions of the City of Seattle. While it may be worthwhile to study these areas, since they are outside the scope of the project, they would be best addressed as a part of a follow-up study or in some other fashion.

- **Other Comments (2 comments)**
  There were 2 comments that were basically unrelated to the Study. One involved the closure of a local post office. The other was promoting the benefits of hyperloop technology (currently being tested in several locations but not a proven technology yet).

In summary. Public Workshop #1 helped to validate many of the comments heard during the stakeholder interview process – namely the prominence of **Noise**, **Air Quality**, the **Environment**, **Transportation**, **Public Health**, and **Public Safety** as major public concerns.

Figure 4.5
Public Workshop #1 Presentation Boards

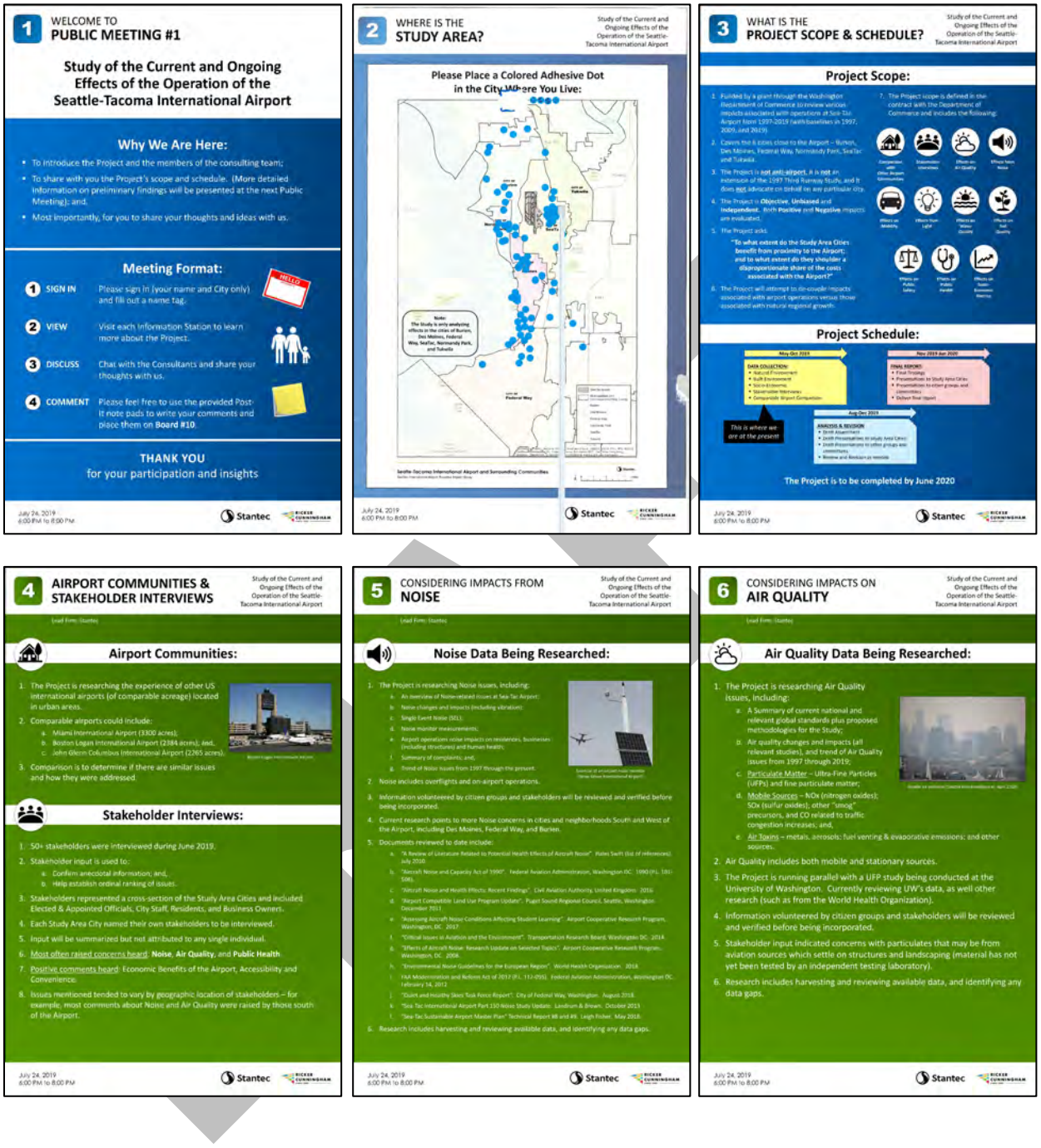
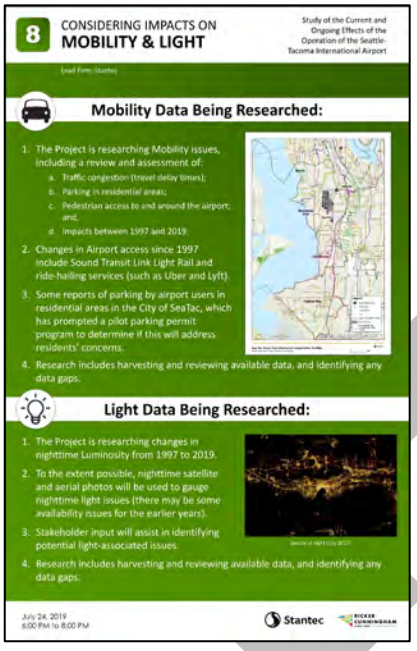
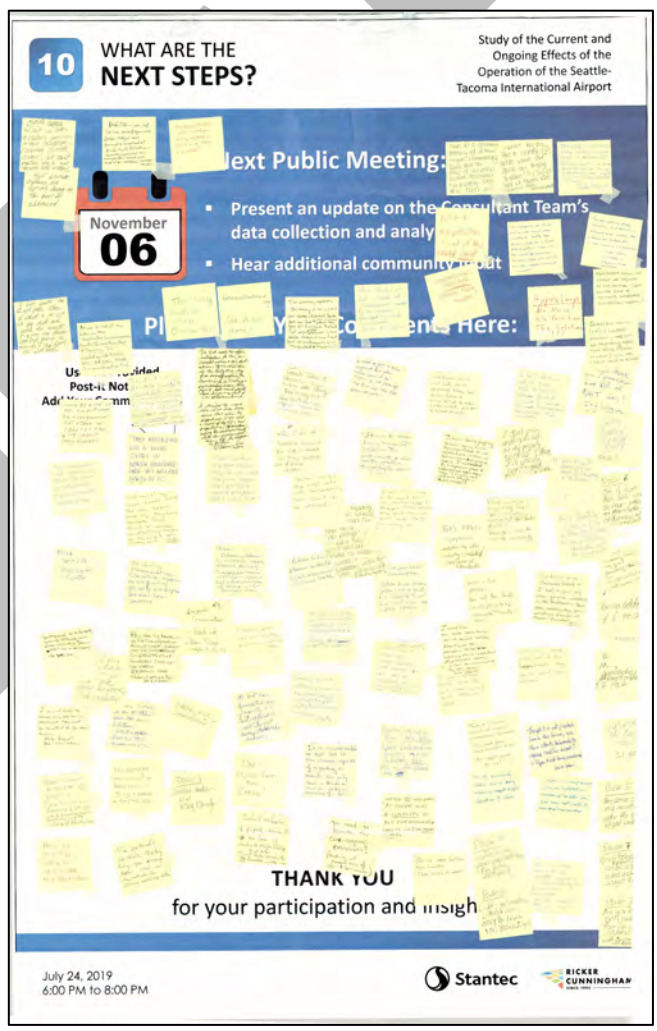


Figure 4.5 (continued)
Public Workshop #1 Presentation Boards





D. PUBLIC WORKSHOP #2

The second public workshop was conducted on November 6, 2019 at Burien City Hall (multi-purpose room/council chamber). Unlike the first workshop, this included a more formal presentation, along with a question-and-answer portion.

A total of 49 people attended Public Workshop #2 (based on the sign-in sheets). Attendees were also asked to fill out comment cards so their questions could be part of the Study document.

Figure 4.6
Public Workshop #2 Attendance by City

City	Attendees	Percentage
City of Burien	10 people	20.4%
City of Des Moines	8 people	16.3%
City of Federal Way	7 people	14.3%
City of Normandy Park	7 people	14.3%
City of SeaTac	10 people	20.4%
City of Tukwila	0 people	0.0%
Outside the Study Area	7 people	14.3%
TOTAL	**49 people**	**100.0%**

Source: Stantec Public Workshop sign-in sheets

Members of the Department of Commerce and the Consultant Team presented the initial observations of the Study which included summaries of the research and analysis of:

- Air quality;
- Noise and vibration;
- Mobility;
- Water and soil;
- Light; and,
- Socio-economic analysis.

A Question & Answer/Discussion session followed the presentations. The attendees gave some helpful input regarding the data and their personal observations. The general tone of the questions was more confrontational than Public Workshop #1, attributable to residents' years of frustration with dealing with issues associated with the Airport. The Consultant Team understands this is the result of those who have dealt with these concerns for a long time.

The questions included the following:

- **Question #1 – Air Quality:**
  - "What monitoring station is the team using to determine air quality in and around the Airport?"
  - "Acknowledge that the closest monitoring station closed in 1998."
  - "Acknowledge that the next closest monitoring station is in Georgetown (Seattle) and it does not monitor all sources."
  - "Acknowledge that the monitoring station in Bellevue provides full air quality monitoring; whereas it is far from the Airport."
  - "Understand the concern that the data sources appear to be unreliable and it appears to be 'fake data'."
  - "Acknowledge that the Airport accounts for 25% of the carbon emissions but jets are exempt from the monitoring."

Figure 4.7
Public Workshop #2 Sign-In Sheets

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport — Public Workshop #2 November 6, 2019

Please Print Your Name & the City Where You Live

	Name	City Where You Live
1.	Jeff Cox	Tacoma
2.	Beth McCasland	Burien
3.	DANA HOLLAWAY	FEDERAL WAY
4.	John Resing	FW
5.	JEFF HARBAUGH	BURIEN
6.	JC HARRIS	des moines
7.	Shaundra Mock	Des Moines
8.	Steve Edmiston	Des Moines
9.	Matt Maloney	Des Moines
10.	Sam Cho	Kirkland
11.	Vicki Lockwood	SeaTac
12.	Anne Krueker	Des Moines
13.	BEN BAKKENTA	Seattle
14.	Nancy Tosta	Burien

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport — Public Workshop #2 November 6, 2019

Please Print Your Name & the City Where You Live

	Name	City Where You Live
1.	Jimmy Matha	Burien
2.	MARIANNE MARICKANEN	SEATAC
3.	Debi Wagner	Burien
4.	AMY YAHNKE	NORMANDY PARK
5.	Ira Wynn	Normandy Park
6.	Kathleen Sherry	Normandy Park
7.	Blanche Hill	Normandy Park
8.	Vicky Hartley	Burien
9.	Rose Winterhalder	Burien
10.	Peter Kwon	SeaTac
11.	JUDY WILLIAMS	SEATAC
12.	Meg Van Wyk	Burien
13.	Kent Palosaari	seaTac
14.	LARRY CRIPA	BURIEN

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport — Public Workshop #2 November 6, 2019

Please Print Your Name & the City Where You Live

	Name	City Where You Live
1.	Joel Machtolf	SeaTac
2.	Pam Fennell	SeaTac
3.	Sue Peterson	Fed Way
4.	Penny Thomas	SeaTac
5.	mark topping	Federal Way
6.	MARK REICH	BELLEVUE
7.	Ryan Crompton	Des Moines
8.	Dave Kaplan	Des Moines
9.	LYDIA ASSEFA-DAWSON	City of Federal Way
10.	Lauren Wheeler	Seattle
11.	Madison Brown	Seattle
12.	BILL VAPIM	FED WAY
13.	ERIN SITTERLEY	SEATAC
14.	Kathleen Waters	Normandy Park

Study of the Current and Ongoing Effects of the Operation of the Seattle-Tacoma International Airport — Public Workshop #2 November 6, 2019

Please Print Your Name & the City Where You Live

	Name	City Where You Live
1.	Bernadina Lund	Federal Way
2.	Annie-Rose Ucnt	Normandy Park
3.	Robert Hodgson	Olympia
4.	ROGER KADEG	SeaTac
5.	Mia Gregerson	SeaTac
6.	Michelle Sipes-Marvin	Normandy Park
7.	Sue-Ann Hohimer	Normandy Park
8.	Rose Clark	Burien
9.		
10.		
11.		
12.		
13.		
14.		

- **Question #2 – Noise:**
  - "Incorporate the noise complaint map (from the presentation) into the final report."
  - "Include noise complaints outside the Study area (e.g., Tacoma)."
  - "Acknowledge that Federal Way has experience population turnover; whereas, there has been in and out migration over the years."
  - "Clarify what are air taxis."
  - "Identify Airport impacts even though they comply standards."

- **Question #3 – Data Sources:**
  - "Acknowledge that the data in the presentation has several errors (sources). "
  - "Employ caution when making recommendations to policy makers since the data sources appear to be unreliable."

- **Question #4 – Impacts:**
  - "Incorporate disproportionate impacts to less-affluent populations as referenced in the 1997 report."
  - "Spell out impacts and make recommendations on how to spend public money to address impacts."
  - "Clarify that the Study will identify areas where the Airport impacts are greater than the benefits."

- **Question #5 – Crime:**
  - "Acknowledge concern for Tukwila crime statistics; whereas, the City's daytime population increases with workers and shoppers."
  - "Identify flaws or gaps in the data."

- **Question #6 – Input:**
  - "Clarify how people can provide input through the process and the report components."

- **Question #7 – Process & Data:**
  - "Clarify the criteria the team used to interview local stakeholders."
  - "Acknowledge concern that the criteria/process was not random (since the individual cities identified the interviewees)."
  - "Acknowledge that life expectancy would be contributed to lifestyle/living conditions from the past."

- **Question #8 – Air Quality:**
  - "Acknowledge that a Normandy Park resident can smell jet fuel when outdoors at her residence."
  - "Identify methods for better/accurate air quality monitoring."
  - "Clarify how the project team will form their recommendations."
  - "Clarify whether aircraft emissions and air quality will poison people. "

- **Question #9 – Mobility:**
  - "Explore how parking prices will affect trips and travel modes to/from the Airport (e.g., people taking rideshare or other modes to be dropped off at the Airport – multiple vehicle trips)."

  - "Explore origin and destination data."

- **Question #10 – Noise & Noise Mitigation Program:**
  - "Acknowledge that only one house in 2018 was retrofitted with the noise abatement program; explore why the program is not widely implemented."
  - "Acknowledge that the criteria for retrofits make many newer homes ineligible for the program."

- **Question #11 – Mobility/Park & Ride:**
  - "Acknowledge that there is a perception that Airport employees park at the Angle Lake light rail station to avoid parking fees; the parking lot is full by 7:00 AM."
  - "Examine the parking fees for the Airport employees.

Comment Cards

In addition to the Q&A/Discussion, attendees were given the opportunity to write their comments on provided Comment Cards (some of these comments were also discussed in the Q&A portion). A total of 17 individuals submitted Comment Cards which contained 34 comments. While the majority of the omments were constructive and offered helpful information, a few were critical such as those that focused on how the information was presented (rather than the information itself).

The Comment Cards have been transcribed verbatim and are offered below with no editorial commentary and in no order of hierarchy:

- **Comment Card #1 – Sea Tac Resident:**
  - "Are you aware of the Purple Air devises [sic] around the Airport & around the world?"
  - "What is your monitoring of PM 2.5 indoors?"

- **Comment Card #2 – Sea Tac Resident:**
  - "All stats relative to SeaTac & Tukwila need to be tempered by the fact that both cities have a population during the course of the day that are 100 times the size of the resident population
  - "I've been politically active & involved with the Port for 45 years. The Port has always been a bad neighbor and untruthful & unreliable. I was on the south slope of Queen Anne in Seattle, calling the Port about airplanes so low and close I could give them #'s off the planes without the need for binoculars for 40 of those 45 years."
  - "If the data shows no pollution – noise, light, etc. – are within OK limits you need to closely review who did monitoring & where the monitors are. None are where the large impacts are."

- **Comment Card #3 – Normandy Park Resident:**
  - "Many of the area citizens in attendance could have presented more accurate information because we live with the impacts of the Airport growth on our health, environment, significant impact to housing values due to increasing air traffic & endless noise. A significant portion of the material presented was irrelevant to the issues at hand."

- **Comment Card #4 – Normandy Park Resident:**
  - "This evening was largely worthless. The people in this room know all this & more. Your time was wasted if this is all you have. Don't waste tax money again. Read Lights Out by Wiley & Formby & Over my head by Debi Wagner. You have no data!"

- **Comment Card #5 – Federal Way Resident:**
  - "Utilize Washington Environmental Health Disparities Map. Its online interactive mapping tool created by UW Dept. of Environmental & Occupational Health Sciences (DEOHS), DOH, ECY, PSSCAA for health risks, exposure, etc."
  - "Contact Pat Defeo, Admin to Facebook page "Flight Pattern Kids @SeaTac Airport @Santa Monica @McChord AFB. He has testing data around city of SeaTac. Has "disease cluster maps", cancer, autoimmune diseases, birth defects. Has tested soil, blood, hair, urine, etc. got toxic chemicals/minerals. I don't understand why your presentation did not show either of these sources."
  - "You need to show "gas" or lack of air monitoring near Airport as printed out by Debi Wagner.

- **Comment Card #6 – SeaTac Resident:**
  - "Thank you for coming & presentation."
  - "Are you going to be able to collect evidence of ultrafine particles? Need monitors of air quality."
  - "On noise presentation, where did [you] get the figures on how many homes were given Port packages? Only homes built before 1987 are eligible. Speaker at a previous meeting said only 1 home was approved."

- **Comment Card #7 – Burien Resident:**
  - "My concern is about tax structure. All $ [dollars] spent within the FAA is considered federal. So communities do not benefit from my property tax revenue. This affects our schools. Highline has to pay more in levy $ than other districts with high property tax income like downtown Seattle or Bellevue. And we have to live with the negative output of the Port (pollution, noise, traffic). This is not equitable. The car rental agency should not be allowed in FAA area. Economics of this should be considered."

- **Comment Card #8 – Des Moines Resident:**
  - "Why aren't Port packages and mold being studied?
  - "Why is Study giving "causal valence" (?) to probability, water/soil, etc. when all most residents care about is direct effects from flights (noise, pollution)?"
  - "You need to open up a new set of interviews not based on city manager simply ask for volunteers."

- **Comment Card #9 – Burien Resident:**
  - "Would like to ask you about a few pieces of underlying data on the AQ presentation?"
  - "Tire wear emits copper – geologic. There are a lot if tire wear events @ the Airport"
  - "No studies available on ground, water, soil, fauna impact if falling debris of combustible fuel."
  - "The AQ Engineer – please address?"

- **Comment Card #10 – Des Moines Resident:**
  - "The light study used data from satellites and on-the-ground visual points. Could the noise study also take unbiased data and on-the-ground monitor points, too, and not use FAA-filtered data?"

- **Comment Card #11 – Burien Resident:**
  - "I live in a home near 128th and 12th Avenues. When the large plans that are loud fly over my area, it causes my TV to change stations. Example – 116 to station 82. It takes a few seconds to a half hour to automatically change back to station I was watching. Is this something that can be researched or would Dish TV have to buy (?) to take care of it or would triple pane windows help that?"

- **Comment Card #12 – Burien/North Highline Resident:**
  - "I live directly under the north end flight path of the 3rd runway. I have measured dcb if 85 in my backyard. The planes are incoming at a rate of 1 to 1.3 minutes. The "port package" gave me insulation that consists of cellulous (ground up newspaper!). Sleep deprivation is a way of life. I am regularly awakened at 4:00 AM. Why isn't anyone talking to me and my neighbors about the impacts we are experiencing?"

- **Comment Card #13 – Des Moines Resident:**
  - "I'm concerned the DNL is not a good measure to quantify how much people are effected."
  - "I don't believe the FAA has/is taking into account noise impacts on the local community. I know they have flight path other options that they have used at other Airports and could be used here."
  - "I believe the Port of Seattle could be a bigger advocate to the FAA but have chosen not to."

- **Comment Card #14 – Anonymous (no city given):**
  - "The prior study measured the disparate benefit in other areas of King County vs the Airport cities from the Airport. # flights take per capita in Mercer Island vs Federal Way."
  - "Has the increase in cost of an overnight parking at the Airport caused people to not park but have a 2x increased in traffic due to friends & family drop-off & pick-up?"

- **Comment Card #15 – Anonymous (no city given, but likely Normandy Park):**
  - "I smell jet fuel in Normandy Park frequently (mornings when it's cold & clear). Does smell equate to terrible air quality?"

- **Comment Card #16 – Anonymous (no city given, but likely Normandy Park):**
  - "EPA sample locations are not located in the primary communities of interest, so acute AQ [air quality] impacts are completely missed in that data."
  - "AQ changes with time & weather conditions. In our communities, AQ during winter cold inversions is VERY BAD. At 6:30 AM when the planes are idling/warming up for first flights, fumes sit at ground level (I have to wear a mask to walk my dogs on those mornings – yesterday 11-5-19 for example). That's on the west side of 1st Avenue in Normandy Park. I am very concerned about the health impacts on days when the air is utterly unbreathable."
  - "For socio-economic impacts & mortality factors being very high in NP [Normandy Park] – look at age demographics. NP met its GMA density req's by adding affordable senior housing."

- **Comment Card #17 – Anonymous (no city given):**
  - "The presenters exhibited the least amount of enthusiasm as I've ever experienced since 4th grade oral book report presentations. As a group, the presenters were drones. None had any desire to inform the audience. Your ability to read between the lines with the data you have gathered is nil. You present like statistics 101 student & not a detective or anyone who can bring statistics t life. I left your presentation offended because you wasted my time. I suggest you bring some human-ness to your analytics, some personality to your presentations, some enthusiasm from your employees. I'd give your presentation a minus 10 on a scale of 0 to 100."

D. SUMMARY

During the public input process in 2019, there were almost 200 participants (some of them at meetings and workshops). The City of Tukwila appeared to not have any representation at either Public Workshop (July and November 2019) as no Tukwila residents were listed on the sign-in sheets for either meeting. (However, it is possible that some Tukwila residents attended and simply chose not to sign-in.)

The benefit of citizen input and community participation is that it helps point out areas of concern that are not immediately obvious from technical information and agency resources. Technical information often does not adequately reflect the concerns of individual homeowners and residents, so this Study sees this as an opportunity to enhance the technical review with real-world experience of the residents of the Study Area. This Study is not, however, a forum for the airing of long-term grievances against the Airport.

Through the process of soliciting input from the community, the following issues became evident:

- **Noise**

  Noise continues to be a primary concern among the residents that have commented during the Study. The noise complaints have been ongoing for quite some time, dating back to the development of the third runway more than 20 years ago. In a few cases, some long-time residents raised issue with the noise from the addition of the second runway (1970). While noise complaints are frequently experienced by areas close to airports nationwide, the noise issues in the Study Area Cities do not seem to be reducing. There have been noticeable increases in noise complaints registered at the Airport, many of which are associated with late-night flights, small Q400 flights which take an early departure angle across some of the communities, and similar issues. Noise issues are not improving according to almost all community input.

- **Air Quality**

  Public input indicates their concerns regarding air quality are almost equal to those regarding noise. Air quality issues include such concerns as:

  - Impacts on health;
  - Impacts on landscaping, gardens, trees, lawns, etc.;
  - Being able to smell jet fuel;
  - Concerns about ultrafine particles (UFPs). This is being researched in a parallel study conduction by the University of Washington, but their study has not indicated impacts on human health. (Some residents have cited a World Health Organization report conducted in Europe which investigated UFPs, but to-date there is no US standard, Federal policy, or mitigation measures that address UFPs); and,
  - There were reports of a "black soot" on rooftops, cars, lawns, and other horizontal surfaces. (While the "black soot" is attributed to air pollution associated with the Airport, no independent

scientific laboratory testing was provided to indicate the chemical makeup and possible source of this material).

- **Failure of Mitigation Packages**

  Many people that received Airport mitigation packages during the third runway expansion have reported the failure of those mitigation measures. Rep. Tina Orwall has conducted public meetings to gather information from residents and their complaints include:

  - Failure of window systems;
  - Failure of insulation materials;
  - Failure to properly ventilate and allow for air exchange, resulting in mold and stale indoor air;
  - Mitigation of only a portion of a house (i.e. insulating bedrooms and living areas, but not closets or bathrooms);
  - Poor construction practices and contractors that are no longer in business;
  - Not properly mitigating homes which might be considered historic;
  - Being unable to qualify for follow-up mitigation repairs because of the way the program policies were written; and,
  - Other general failures of the mitigation measures.

- **Traffic Congestion**

  Traffic congestion appears to be a periodic problem, often around peak travel periods and when cruise passengers are arriving/departing. Traffic tends of become congested immediately upon Airport roadways specifically Airport Expressway. Other spot problems are located along International Boulevard/US Highway 99 at Arrivals Drive/South 182nd Street, on State Route 518 westbound (west of the I-5/I-405 interchange), and State Route 518 eastbound (west of the Des Moines Memorial Drive interchange).

- **South King County is a "Dumping Ground"**

  Many residents noted that South King County has become a sort of "dumping ground" for a variety of unwanted land uses. Such land uses include:

  - The Federal Detention Center (2425 South 200th Street, west of International Boulevard/US Highway 99) which is part of the Federal Bureau of Prisons;
  - The Federal Aviation Administration Flight Standards District Office (2200 South 216th Street in Des Moines); and,
  - Even the location of the Seattle-Tacoma International Airport itself was seen as an undesirable use, even though it has been in South King County since it began military operations in 1944.

  Residents objected to Federal installations like the prison and the Flight Standards District Office for several reasons, not the least of which is that these do not pay local property taxes and further depress the local communities' ability to be able to generate economic revenue. There are also concerns as to the quality of these developments and how they reflect on the community at-large.

- **Distrust**

  Many people who attended the Public Workshops expressed a distrust of information and policies from the Federal Aviation Administration and the Port of Seattle/Seattle-Tacoma International Airport. This appears to be the result of years of poor experience by many residents in the Study Area Cities. This level of skepticism appears to most acute in areas generally north and south of the Airport – Burien, Des Moines, Federal Way, Normandy Park, and the City of SeaTac.

SECTION 5

NOISE & VIBRATION

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SECTION 5

NOISE & VIBRATION

A. NOISE

Noise is characterized as unwanted sound, but any noise that is intense enough to damage hearing, interfere with communication, disrupt sleep or is otherwise annoying is undesirable. Even though noise is individually subjective, a causal relationship exists between sound levels and the types of noise that not only cause annoyance, but that also result in a variety of potential adverse effects depending on exposure.

Noise is one of the main adverse impacts from airports and aircraft operations and the chief cause of airport complaints. Because of the flight patterns necessary for plane separation, landings and take-offs, the effects of aircraft noise are spread out over a relatively large area.

This section will address the changes in noise levels generated by Seattle-Tacoma International Airport from 1997 to 2019. There are a variety of noise sources that originate around and on the Airport itself including:

- Aircraft taxiing;
- Ground level operations (fuel trucks, food trucks, maintenance equipment, emergency equipment, etc.);
- Road traffic to and from the Airport; and,
- Periodic construction activities (although construction has been a relative constant noise source over the past 20 years).

This has created noise at and adjacent to Seattle-Tacoma International Airport which adversely effects the land-uses that are close to it. However, it is apparent that the significant noise events affecting people are related to individual aircraft runups, take-offs, landings and overflights. Therefore, this section focuses on the noise created by aircraft specifically those with jet engines during air carrier operations.

Sound is created when an object vibrates and radiates part of its energy as acoustic pressure or waves through a medium such as air, water, or a solid object:

> "Whether the sound is interpreted as pleasant (music) or unpleasant (e.g., transportation-related noise) depends on the listener's current activity, past experience, and attitude toward the source of that sound." (Oregon Airspace Initiative 2016)

The human perception of sound involves two characteristics:

- **Intensity** is the measure of the energy of the sound vibrations expressed in terms of sound pressure. The higher the pressure the more that sound energy is carried and the louder the sound it perceived.
- **Frequency** is the number of times per second the air vibrates. "Low frequency noise is characterized as rumbles or roars, while high frequency sounds are typified by sirens or screeches (Oregon Airspace Initiative 2016)."

Sound levels are expressed as **Decibels** (dB) – a logarithmic scale which provides a standard metric considering the large differences in audible sound intensities as heard by humans. Since the human ear does not respond equally to all frequencies (or pitches), measured sound levels (in dB at standard frequency bands) are often adjusted or weighted according to the frequency response of human hearing and the human perception of loudness. The weighted sound level is designated as the A-weighted sound level in decibels, known as dBA.

On the decibel scale, a 10 dB increase represents a perceived doubling of loudness to someone with normal hearing. That means that a 70 dB level will sound twice as loud as a 60 dB sound level. Under ideal listening conditions, people generally cannot detect differences of 1 dB, while differences of 2 or 3 dB can usually be detected by people with normal hearing. In the outside environment, and especially near complex noise sources such as roads or airports, sound level changes of 2 or 3 dB might not be noticeable to some people, while a 5 dB change would likely be perceived as a clear and noticeable change. Figure 5.1 shows some typical sound levels produced by various activities.

Figure 5.1
Sound Levels Produced by Common Noise Sources.

Thresholds/ Noise Sources	Sound Level (dBA)	Subjective Evaluations	Possible Effects on Humans
▪ **Human Threshold of Pain** ▪ **Carrier jet take-off at 50 feet**	140	Deafening	Continuous exposure to levels above 70 dBA can cause hearing loss in majority of population
▪ **Siren at 100 feet** ▪ **Loud rock band**	130		
▪ **Jet take-off at 200 feet** ▪ **Auto horn at 3 feet**	120		
▪ **Chain saw** ▪ **Noisy snowmobile**	110		
▪ **Lawn mower at 3 feet** ▪ **Noisy motorcycle at 50 feet**	100	Very Loud	
▪ **Heavy truck at 50 feet, maximum**	90		
▪ **Pneumatic drill at 50 feet** ▪ **Busy urban street, daytime**	80	Loud	
▪ **Normal automobile at 50 mph** ▪ **Vacuum cleaner at 3 feet**	70		
▪ **Air conditioning unit at 20 feet** ▪ **Conversation at 3 feet**	60	Moderate	Speech Interference at 60 dBA and above
▪ **Quiet residential area** ▪ **Light auto traffic at 100 feet**	50	Moderate	Sleep interference at 40 dBA and above
▪ **Library/Quiet home**	40	Faint	
▪ **Soft whisper at 15 feet**	30	Faint	No disruption
▪ **Slight rustling of leaves**	20	Very Faint	
▪ **Broadcast Studio**	10	Very Faint	
▪ **Threshold of Human Hearing**	3	Very Faint	

Source: EPA 1974.

Note that both the subjective evaluations and the physiological responses are continuums without true threshold boundaries. Consequently, there are overlaps among categories of response that depend on the sensitivity of the noise receivers

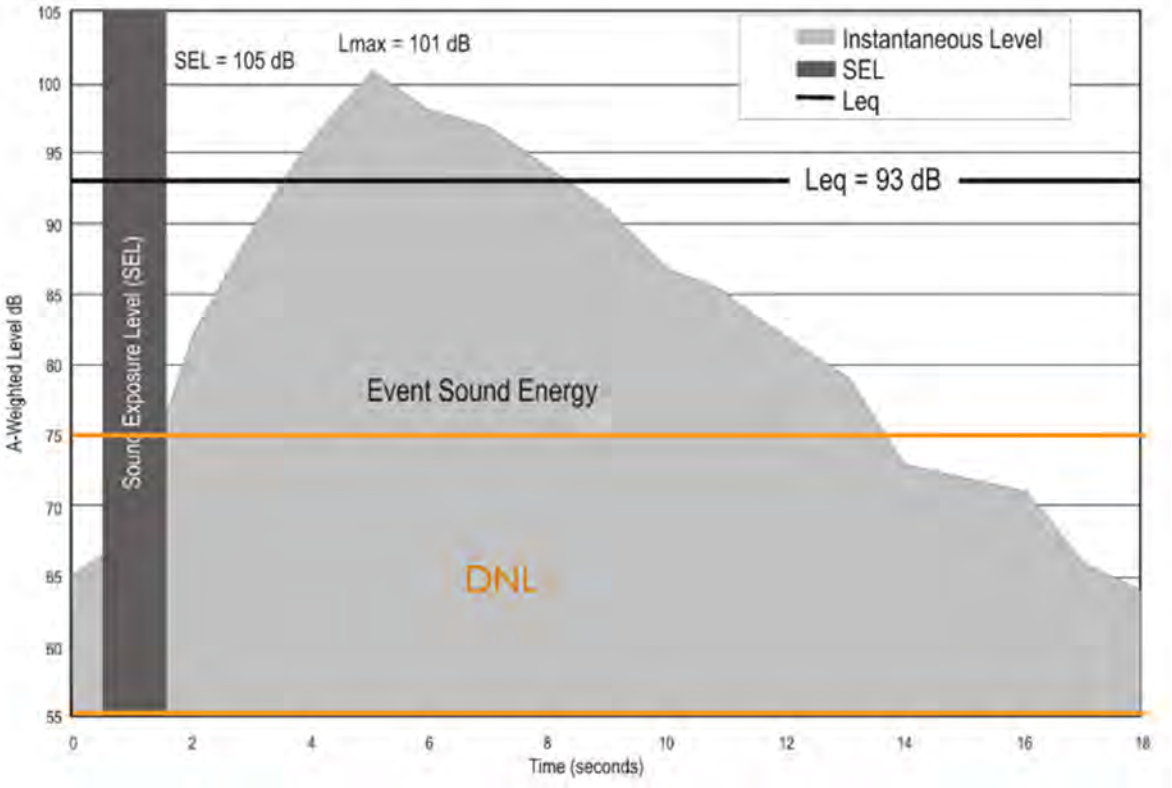
In the past, noise studies have used a variety and confusing number of noise measurements as researchers have attempted to understand and represent noise effects. However, Federal agencies such as the Department of Defense, NASA, EPA and the Federal Aviation Administration have specified those to be used for federal noise assessments of aviation noise. The metrics now used by the Federal Aviation Administration include:

- **Maximum Sound Level (Lmax)**
  This is the peak sound level measured during a single noise event such as an aircraft overflight. Lmax can provide some measure of intrusiveness, but it does not capture the total noise exposure;

- **Sound Exposure Level (SEL)**
  SEL captures total noise exposure and is a combination of the intensity of the sound and its duration. SEL is a logarithmic measure that mathematically represents the sound level of a constant sound that in 1 second would generate the same acoustic energy as the totality of the sound event. It has been well established in the scientific community that SEL measures noise impact much more reliably that just dBA; and,

- **Day-Night Average A-weighted Sound Level (DNL)**
  DNL is a computer model that averages sound levels over a 24-hour period with a 10 dB adjustment added to those noise events occurring between 10:00 PM and 7:00 AM. This 10 dB "penalty" accounts for the increased sensitivity to nighttime noise events.

Figure 5.2
Graphic Representation of Sound and Noise Metrics



A sound event is depicted by the shading in the figure and shows how the various metrics represent different aspects of the event. The SEL and DNL are important metrics for aircraft related noise as the DNL is the regulatory measure that is used for determining noise impacts by federal agencies such as the FAA, but the SEL events are typically what are most disturbing to residences and other sensitive land uses in the vicinity of airports, particularly at the runway ends and under the flight paths. The figure above shows the large variance between the two metrics, which has been a causal factor in communities pushing for the Federal Aviation Administration to change how it regulates aircraft noise and provides mitigation for noise impacted areas.

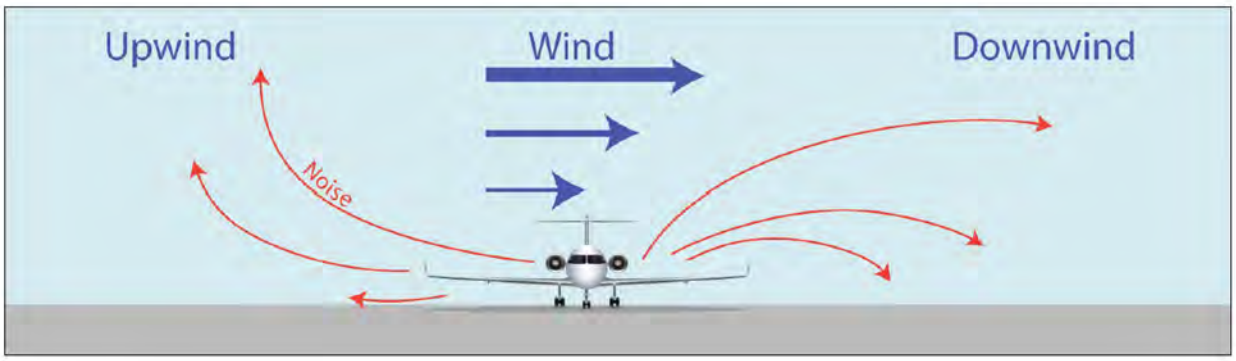
B. CHARACTERISTICS OF AIRCRAFT NOISE

Aircraft noise originates from both the airframe and engines of an aircraft. Noise is generated by the flaps, trailing edges of wings, leading edge devices (slats) and landing gear portions of the airframe, but the engines are, by far, the more significant source of noise (NASA 2004). Jet engines can produce sound levels in excess of 120 decibels (dB).

Meteorological conditions affect the transmission of aircraft noise through the air. Wind speed and direction, and the temperature immediately above ground level, cause diffraction and displacement of sound waves (Figure 5.3).

Humidity and temperature materially affect the transmission of air-to-ground sound through absorption associated with the instability and viscosity of the air (Fort Lauderdale-Hollywood International Airport Part 150 Report 2018). These atmosphere conditions influence noise levels by absorbing and/or reflecting sound. The farther the sound travels the greater the rate of atmospheric absorption. This typically becomes a factor at distances greater than 1,000 feet.

Figure 5.3
Wind Effects on Aircraft Noise

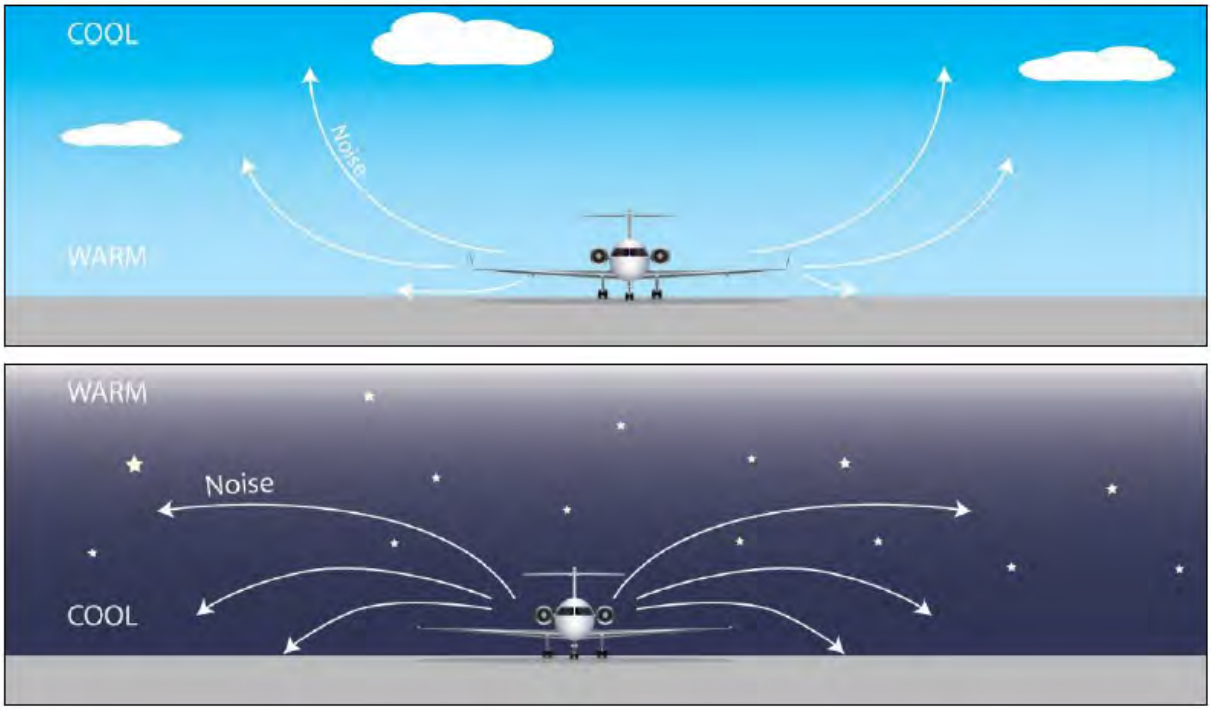


Some atmospheric conditions, such as temperature inversions, can channel or spread the sound resulting in higher sound levels. Without considering the atmosphere, sound levels typically decrease by 6 dB with every doubling of distance from the source.

Noise effects also depend on the frequencies of the generated sound and topography. For example, higher frequencies are more readily absorbed than the lower frequencies and over distance the lower frequencies become the dominant sound source as the higher frequencies are attenuated. The lower frequency noise (LFN) is discussed further in the section on vibration.

The effects of ground attenuation on aircraft noise are a function of the height of the sound source and/or receiver and the characteristics of the landscape. The closer the noise source is to the ground, the greater the ground absorption. Soft surfaces, such as vegetation, provide for more ground absorption than hard surfaces, such as paved surfaces.

Figure 5.4
Atmospheric Temperature Effects on Aircraft Noise



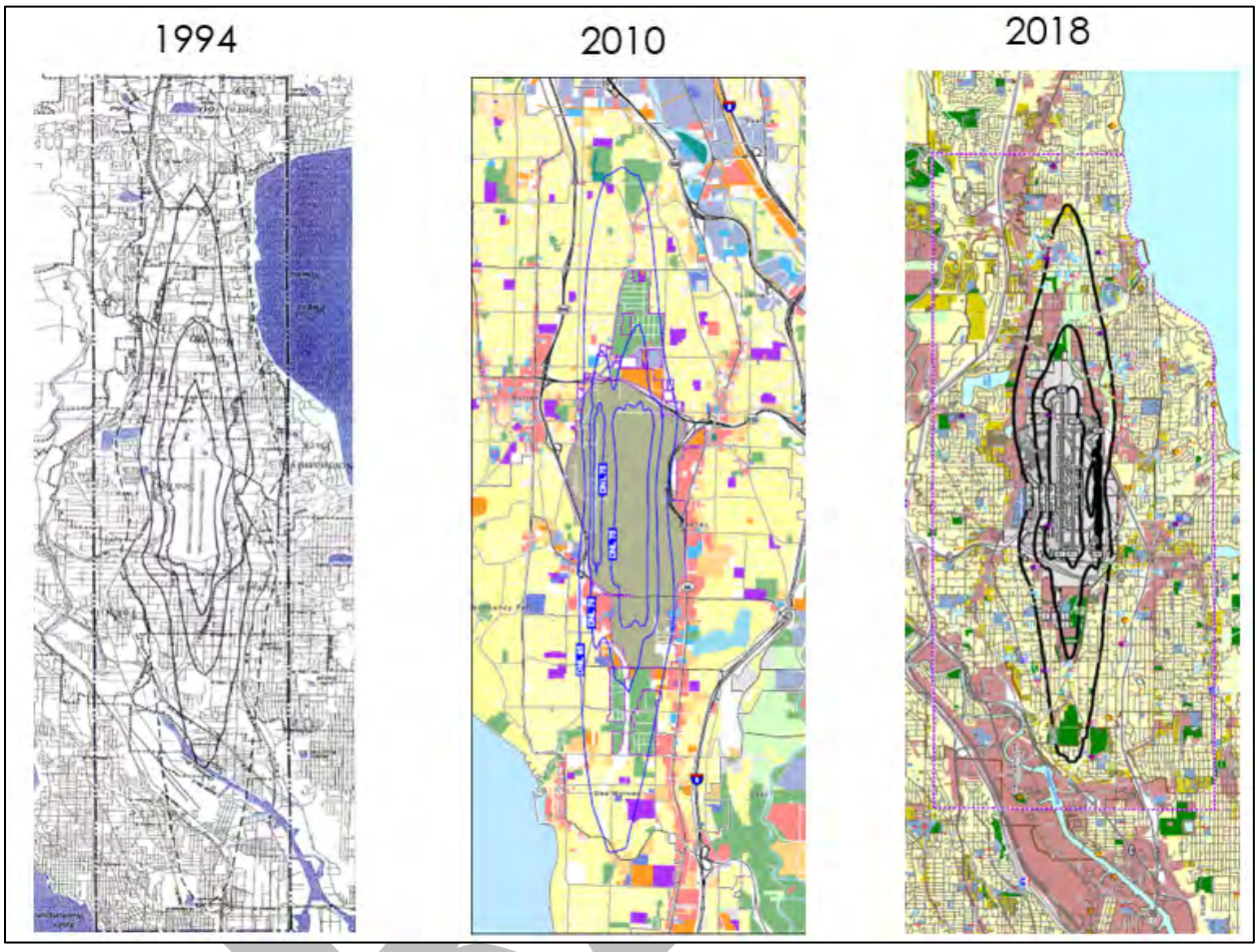
C. REGULATORY TRENDS

The Federal Aviation Administration issued the Aviation Noise Abatement Policy (ASAP) in 1976, which set the levels of significance for exposure from aircraft noise. The policy used the DNL metric and characterized aircraft noise exposures in residential areas with a DNL of 65 to 75 as "significant" and a DNL of 75 and greater as "severe". This was followed up by the Aviation Safety and Noise Abatement Act (ASNA) in 1979, which encouraged airports to carry out noise abatement programs. Subsequently, the Federal Aviation Administration published Part 150 (14 CFR Part 150), which established a voluntary program for airports to conduct studies to determine ways to reduce noise over residential and other noise sensitive areas. It also defined land use compatibility guidelines for different uses over a range of DNL noise exposure levels. This included adopting the 65 DNL for residential land use compatibility.

These policies and codes are essentially unchanged today and the 65 DNL noise threshold has been used to make policy assessments in several areas:

- Setting the federal noise goal for reducing the number of people exposed to significant noise around US airports;
- Establishing the level of aircraft noise exposure below which residential land use is compatible, as defined in the ASNA and 14 CFR Part 150; and,
- Establishing the level of aircraft noise exposure below which the noise impacts of Federal Aviation Administration actions in residential areas are not considered "significant" under the National Environmental Policy Act of 1969 (NEPA).

Figure 5.5
Seattle-Tacoma International Airport Noise Contours: 1994, 2010 and 2018

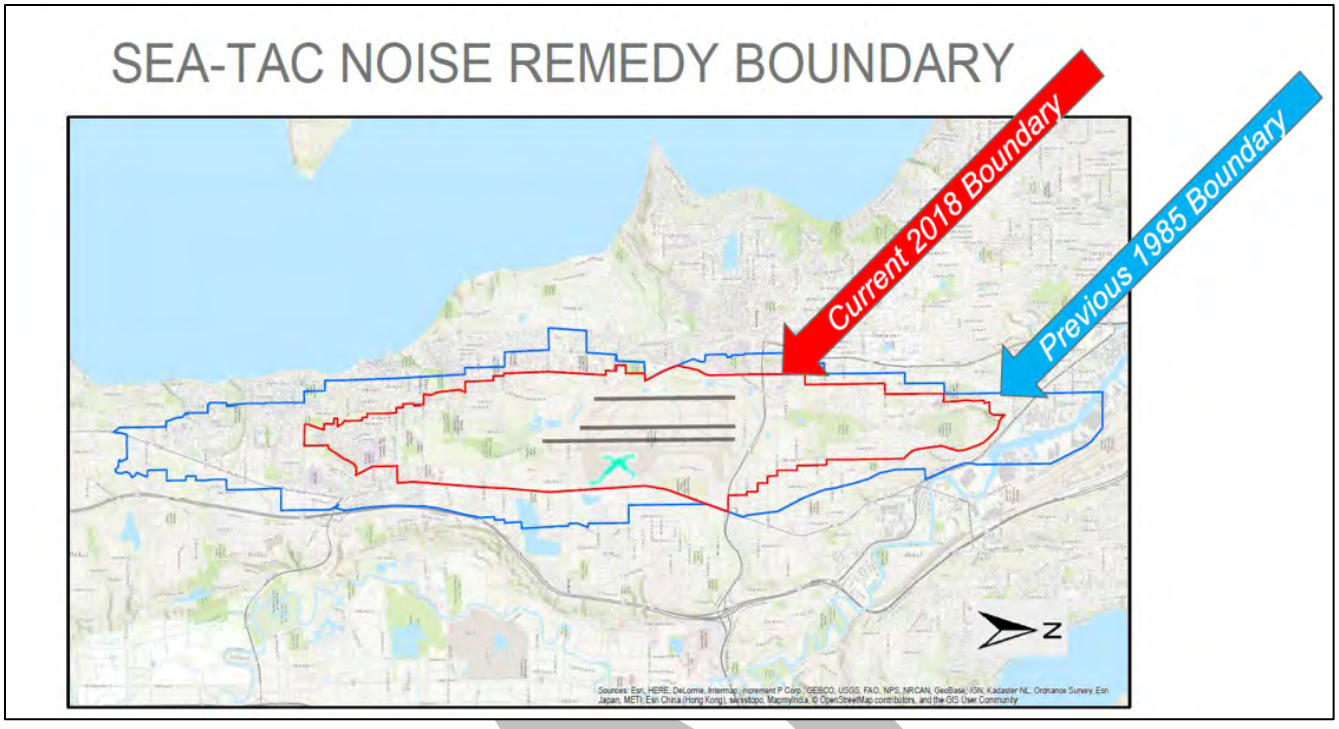


The 65 DNL threshold has also been used to determine the eligibility for noise mitigation funded from Airport Improvement Program grants, passenger facility charges and other airport revenues. Mitigation is in the form of funding for sound insulation for homes, schools, churches, health care facilities and other similar land uses that are within the 65 DNL noise contour surrounding Seattle-Tacoma International Airport.

Figure 5.5 shows how the 65 DNL noise contour has changed over time at Seattle-Tacoma International Airport. In 1994, the area within the 65 DNL contour affected approximately 12.23 square miles, 31,800 people, and 13,620 residences. By 2018, that area shrank and affected approximately 7.3 square miles and 11,389 people and 4,394 residences. This trend has largely been due to phasing out older and louder aircraft.

The use of the DNL metric has been a source of controversy based on perceptions of community annoyance and that people are clearly bothered by individual noise events (SEL). As the number of those events have increased, particularly during the night so have people's annoyance level. In addition, the 65 dB significance level does not mean that there is no annoyance or other health effects below that noise level (see discussion of negative impacts). The figure below shows an overlay how the contour has changed over two time periods.

Figure 5.6
Seattle-Tacoma International Airport Noise Contours: 1985 and 2018



Source: Port of Seattle 2019

D. PUBLIC LAW 115-254

On October 5, 2018, the Federal Aviation Administration Reauthorization Bill was signed into law to cover the years 2018-2023. There are two pertinent sections relating to the ongoing issue of aircraft noise.

- **Section 173 – Alternative Noise Metric Evaluation**

  Section 173 of the Reauthorization Bill states:

  > "N*ot later than 1 year after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall complete the ongoing evaluation of alternative metrics to the current Day Night Level (DNL) 65 standard."*

  To date there has been no movement from the Federal Aviation Administration on the evaluation of other noise metrics to replace the 65 DNL standard. Other entities have recommended different DNLs for noise exposure. For example, in 2019 the International Civil Aviation Organization (ICAO) recommends a 55 DNL, while the World Health Organization 2018 Guidelines for the European Region recommends that average noise exposure from aircraft should be limited to 45 dB during the day and 40 dB during the night. Although the US Department of Housing and Urban Development, the Department of Defense, and the Federal Aviation Administration consider 65 DNL as the threshold for significance in assessing noise impacts, this threshold does not distinguish between urban, suburban or rural settings. Residents in the Study Area Cities have expressed concerns that the 65 DNL is not an adequate metric for the noise effects from aircraft operations at Seattle-Tacoma International Airport.

- **Section 175 – Addressing Community Noise Concerns**

  Section 175 of the Reauthorization Bill states:

  > *"When proposing a new area navigation departure procedure, or amending an existing procedure that would direct aircraft between the surface and 6,000 feet above ground level over noise sensitive areas, the Administrator of the Federal Aviation Administration shall consider the feasibility of dispersal headings or other lateral track variations to address community noise concerns, if:*
  >
  > – *The affected airport operator, in consultation with the affected community, submits a request to the Administrator for such a consideration;*
  >
  > – *The airport operator's request would not, in the judgment of the Administrator, conflict with the safe and efficient operation of the national airspace system; and*
  >
  > – *The effect of a modified departure procedure would not significantly increase noise over noise sensitive areas, as determined by the Administrator."*

  There have been some flight changes at Seattle-Tacoma International Airport that have not adequately addressed the noise issue. On November 7, 2019, the City of Burien won an appeal relating to the Federal Aviation Administration's change of a flight path over the City. The Ninth Circuit Court of Appeals ruled in Burien's favor that the change came without adequate environmental review.

  The FAA's operational change concentrated the flight path of turboprops over the westerly portion of Burien in a narrow corridor called "the 250 degree heading." This flight path created intolerable noise on the ground below because the noisy turboprop aircraft turned over western Burien at low altitude. Prior to the operational change, the flight paths of turboprop aircraft were distributed citywide, so no single corridor was used. In response to the change, a coalition of residents worked with the City of Burien to mount a legal challenge to the operational change.

  The court's decision does not halt turboprops from flying over Burien, but the decision halts the automation of the turboprops' flight path over the narrow corridor previously used. The court directed the FAA to evaluate the cumulative impacts of all of the future actions – including the planned growth addressed by the Airport's Sustainable Airport Master Plan (SAMP) – in an environmental review process. (As of this Study, the environmental documentation and analysis of the SAMP was ongoing. It was hoped that the analysis from that work could be reflected in this study; however, it is uncertain when that analysis will be forthcoming since it has been delayed several times.)

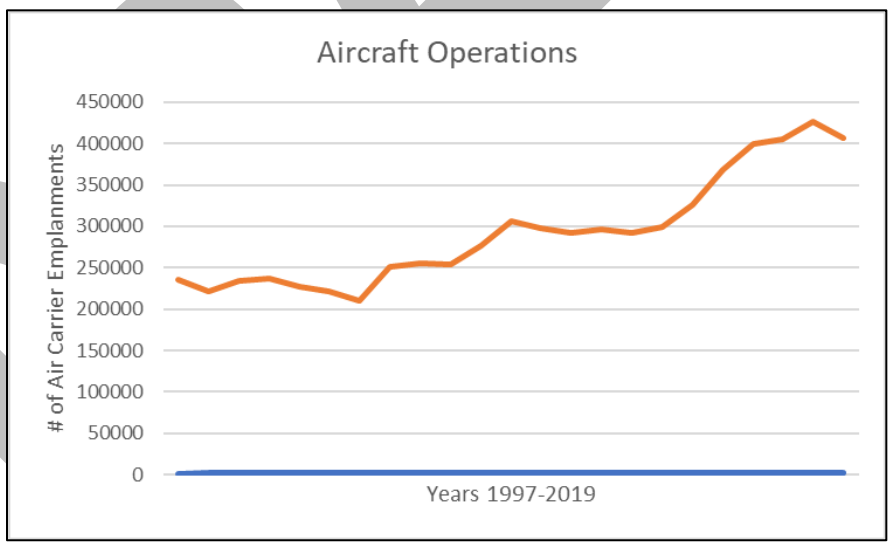
E. CHANGES AT SEATTLE-TACOMA INTERNATIONAL AIRPORT: 1997-2019

The continuing operations or changes over time that have most affected sensitive land uses around the Airport due to aircraft noise have included the dramatic increase in air carrier operations, wider range of flight paths, and use of a relatively shallow flight descent path. These effects correspond to the number and type of complaints.

Figure 5.7 shows the annual aircraft operations at the airport by class of aircraft. While there has been a modest increase in total operations, the number of air carrier operations has increased significantly from 1997. Air carrier operations increased by 26% from 1997 to 2009 and 37% from 2009 to 2018. The total change in air carrier operations from 1997 to 2019 was a 73% increase.

Figure 5.7
Seattle-Tacoma International Airport Annual Operations: 1997-2019

YEAR	ITINERANT					LOCAL			TOTAL OPERATIONS
	Air Carrier	Air Taxi	General Aviation	Military	Total	Civil	Military	Total	
1997	235,445	143,034	5,820	80	384,379	103	0	103	**384,482**
1998	221,705	180,563	5,183	126	407,577	20	0	20	**407,597**
1999	233,914	194,352	5,321	59	433,646	14	0	14	**433,660**
2000	236,355	203,723	5,448	95	445,621	56	0	56	**445,677**
2001	227,589	168,322	4,668	66	400,645	16	9	25	**400,670**
2002	220,733	139,793	4,073	59	364,658	13	0	13	**364,671**
2003	210,603	140,777	3,336	54	354,770	49	0	49	**354,819**
2004	250,605	90,521	2,410	106	301,376	93	0	93	**301,469**
2005	254,829	105,377	2,685	121	358,788	103	3	106	**358,894**
2006	253,507	83,928	2,654	59	341,470	284	8	292	**341,762**
2007	277,293	82,147	3,675	95	339,424	621	13	634	**340,058**
2008	306,919	66,056	4,357	96	347,802	883	11	894	**350,983**
2009	297,621	36,869	4,059	120	347,967	0	0	0	**353,088**
2010	292,016	17,133	3,046	73	317,873	0	0	0	**317,873**
2011	295,763	18,562	3,262	114	313,954	0	0	0	**313,954**
2012	291,664	15,324	3,708	149	314,944	0	0	0	**314,944**
2013	299,156	14,196	3,604	133	309,597	0	0	0	**309,597**
2014	325,425	14,440	3,510	80	317,186	0	0	0	**317,186**
2015	368,722	10,813	4,113	127	340,478	0	0	0	**340,478**
2016	399,742	8,401	4,160	125	381,408	0	0	0	**381,408**
2017	405,049	9,513	2,802	93	412,150	20	0	20	**412,170**
2018	427,170	8,651	2,338	86	416,124	12	0	12	**416,136**
2019	406,630	4,1279	2,081	76	412,914	0	0	0	**412,914**



Source: FAA Air Traffic Activity System 2019.

Air carrier jet aircraft create the loudest noise events as compared to general aviation or air taxi service. The 2019 total operations figure means that on average there was approximately 1,131 operations per day or 47 per hour. Since air traffic is heavier during the day, there is a steady occurrence of overflights, particularly during daylight hours. This can vary dramatically depending on the time of day, time of week, etc. however, each operation represents an individual SEL noise event, which have increased by 73% from 1997 to 2019.

Existing Aviation Noise at Seattle-Tacoma International Airport

Figure 5.8 is from the USDOT Noise Map that show the noise from road and aircraft traffic in the Seattle area. The highest sound levels occur at Seattle-Tacoma International Airport and Boeing Field and extend north and south of the airports –both airports show up in purple range at 85 to 90 dB. While the figure does not solely show aviation noise it does reflect how much louder it is in the Study Area Cities relative to other urban areas farther from the airports and from this can be inferred that the difference is the location of the airports in proximity to the Study Area Cities.

Figure 5.8
Road and Aviation Noise in the Seattle Area

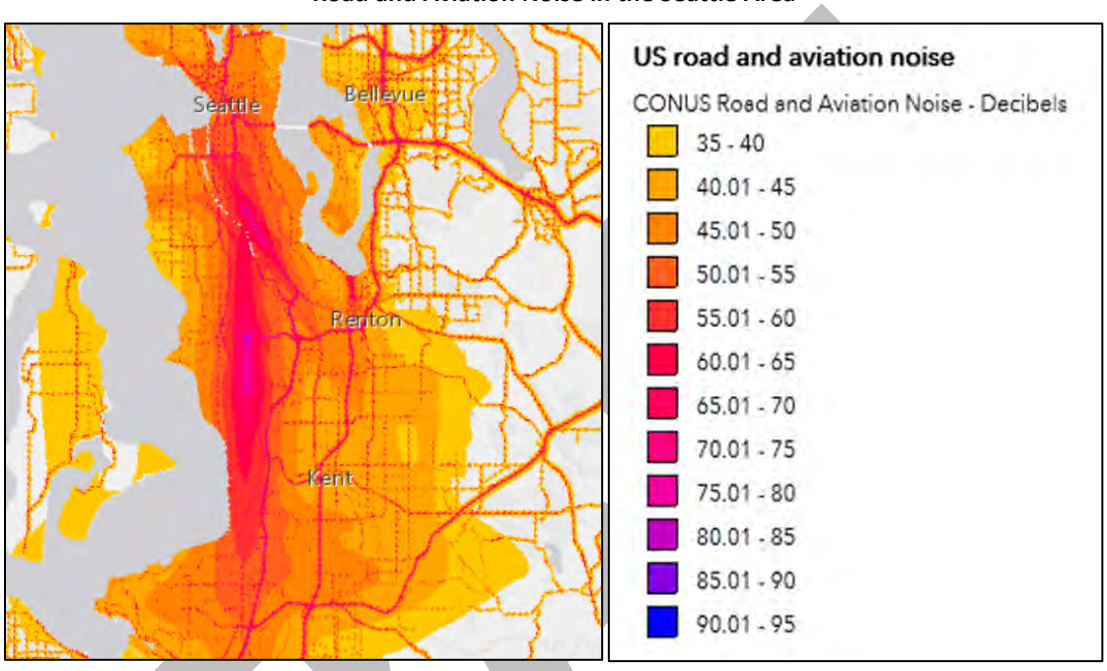
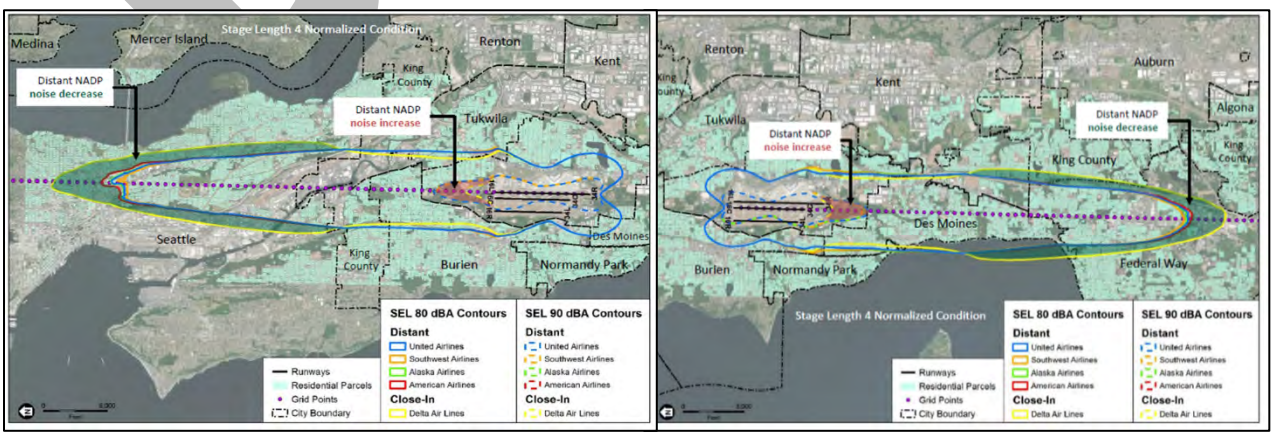


Figure 5.9 shows how extensive of an area that is affected by SEL sound events. In this case the figures show the 80 and 90 dB noise contours in 2019, which extend well beyond the 65 dB DNL contour. Even though noise contours have shrunk over time, the SEL 80 and 90 dB contours show that a wider area is impacted by overflights. The number of overflight events have increased dramatically since 1997 and the SEL events affect a larger area that is not subject to sound mitigation. The 80 and 90 dB SEL contour extends down through Des Moines and Federal Way to the south and through Burien and Seattle to the north.

Figure 5.9
Northern and Southern Flow 80 and 90 dB SEL Contours

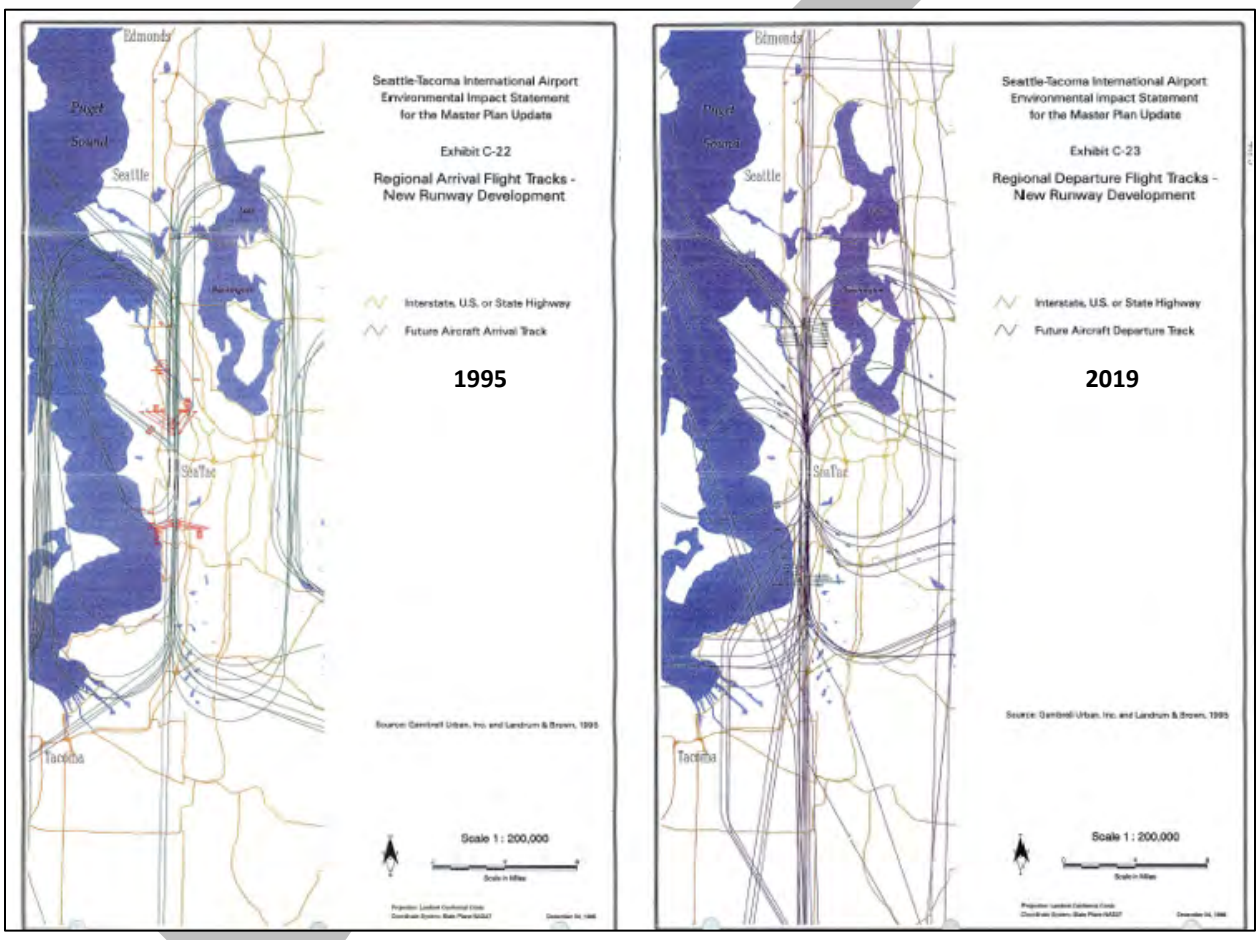


Source: AEDT 2d, 2019; ESA, September 2019.

Flight Track Changes Over Time

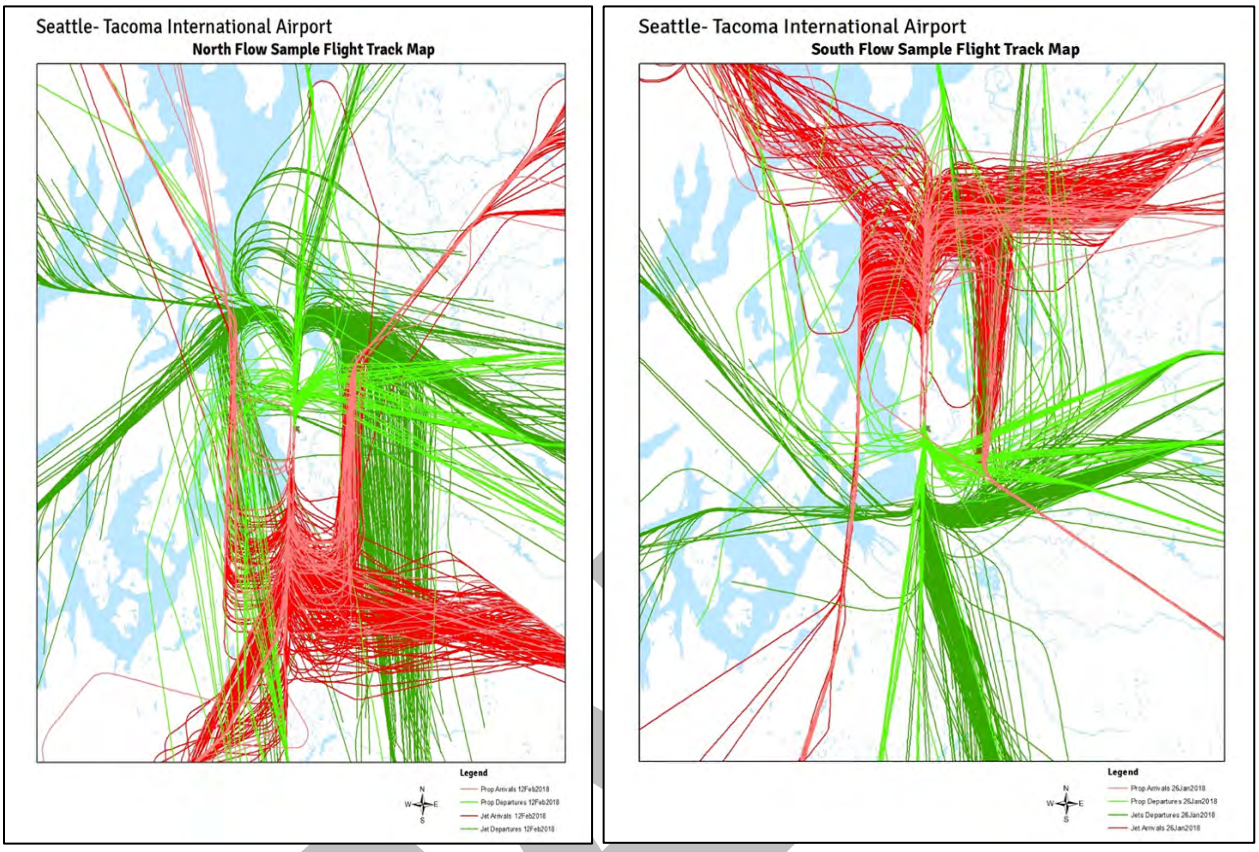
Another aspect of air operations which cause noise issues in the Study Area Cities is how flight paths have changed over time. The Federal Aviation Administration established prescribed flight patterns for jet aircraft in 1990 and these have not changed since that time. However, for a number of reasons these prescribed patterns are not always followed due to missed approaches, weather, onboard emergencies and the need for separation from other aircraft. The sheer change in volume of jet aircraft operations and changes in international airline destinations (particularly the increase in late-night Asian destinations) has resulted in more aircraft deviating from the prescribed flight patterns, thus affecting a wider area. Figure 5.10 demonstrates how aircraft overflight noise is affecting a wide area, corroborated by the location of noise complaints.

Figure 5.10
Flight Patterns: 1995 and 2019



Source: Port of Seattle

Figure 5.11
North and South Flow Flight Track Sample Maps



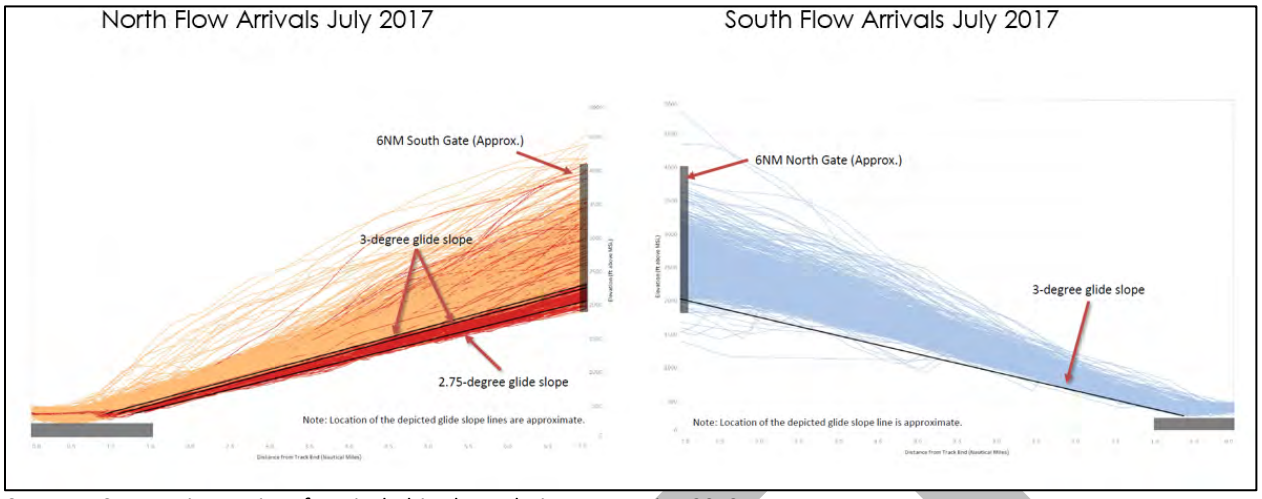
Source: Purcell, 2019.

Altitude Arrivals at Seattle-Tacoma International Airport

The Federal Aviation Administration requirement for the glideslope to Runway 34R at Seattle-Tacoma International Airport is a 2.75 degree glideslope. Generally, the standard requirements for the maximum glideslope is 3.0 degrees (which varies by airport). Steeper glideslopes result in shorter overflights, limiting the time an aircraft is closer to the ground. This would affect a smaller area on the approach to the runway with less noise due to a greater distance between aircraft and the ground.

Figure 5.12 shows the large number of aircraft using the 2.75 degree glideslope during Northern Flow in particular. Increasing the glideslope would reduce the size of the underlying area affected by aircraft noise. There are other airports where it is necessary to maintain a steeper angle. For example, London City Airport (London, UK) has a glideslope of 5.5 degrees – an angle this steep would not be a recommendation for Seattle-Tacoma International Airport).

Figure 5.12
Aircraft Arrival Altitudes at Seattle-Tacoma International Airport



Source. ESA Associates, Aircraft Arrival Altitude Analysis Presentation 2019.

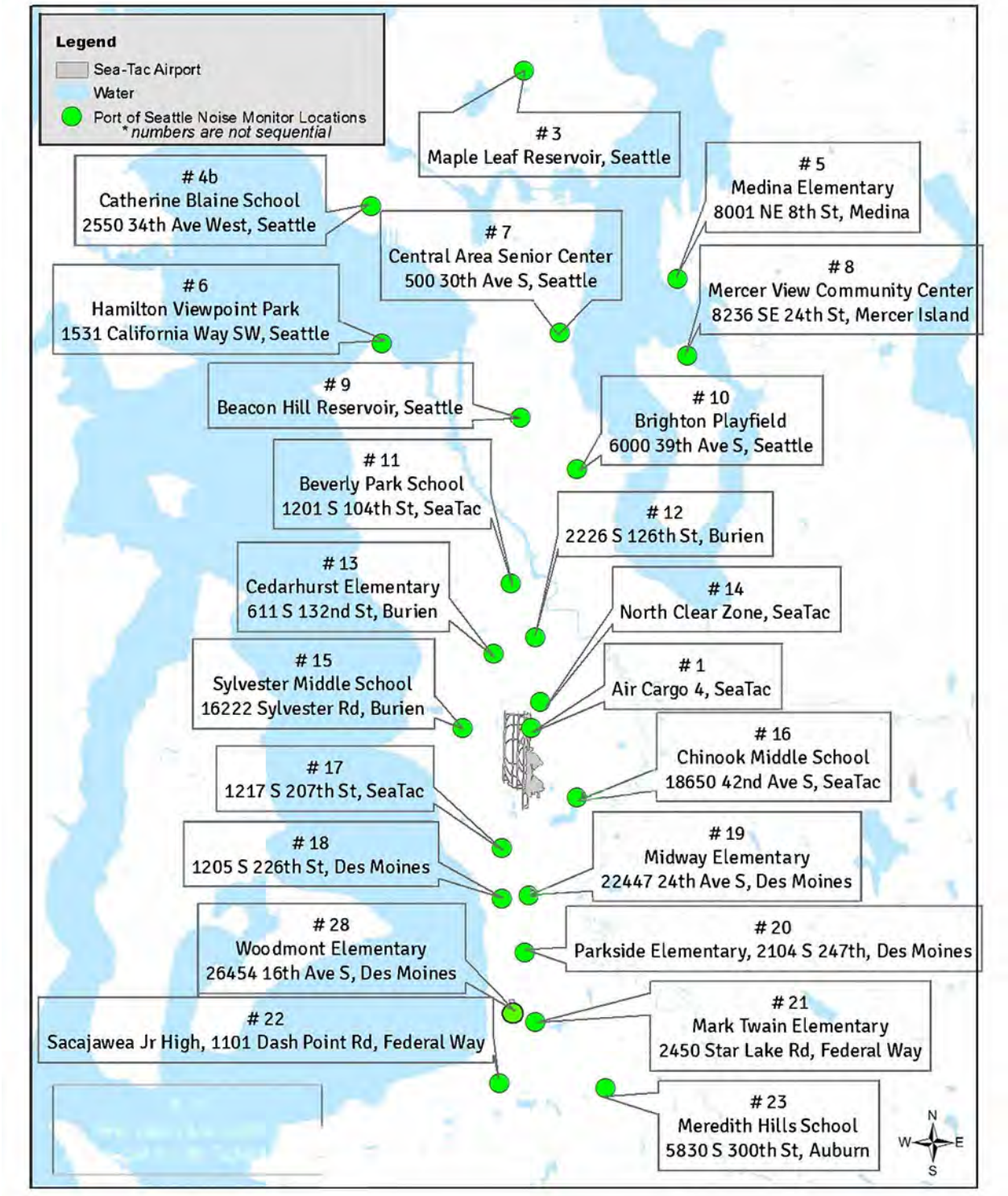
The altitude of flights also plays a significant role in the amount of noise received at ground level. Flights below 3,000 feet tend to produce more SEL noise events that have more significantly adverse impacts on residents. Taking a straight line approach of reducing sound by 6 dB for every doubling of distance, a jet producing 120 dB at 200 feet would produce 100 dB at a distance of 3,200 feet (not taking into account atmospheric conditions or ground attenuation). The number of flights below 3,000 feet at the various noise monitoring locations is shown below and the noise monitoring stations in Figure 5.13. Some of the noise monitors are located close to the runway ends and those flights would be under 3,000 feet. However, Figure 5.14 gives some estimation of how many flights are generating somewhere around or over 100 dB and their location.

Figure 5.13
Number of Flights at Seattle-Tacoma International Airport Below 3,000 Feet (Jan-Sept 2019)

Noise Monitor		Flights Below 3,000 Feet Altitude		
#	Location	# of Flights	Percent	Ave/Day
1	Air Cargo 4, Sea-Tac	90,063	100%	334
3	Maple Leaf Reservoir, Seattle	190	4%	1
4b	Catherine Blaine School, Seattle	227	30%	1
5	Medina Elementary, Medina	49	0%	0
6	Hamilton Viewpoint Park, Seattle	136	23%	1
7	Central Area Senior Center, Seattle	649	8%	2
8	Mercer View Community Center, Mercer Island	1	1%	0
9	Beacon Hill Reservoir, Seattle	109,250	75%	405
10	Brighton Playfield, Seattle	3,916	69%	15
11	Beverly Park School, Sea-Tac	140,885	94%	522
12	South 126th, Burien	59,582	99%	221
13	Cedarhurst Middle School, Burien	103,197	100%	382
14	North Clear Zone, Sea-Tac	120,698	100%	447
15	Sylvester Middle School, Burien	5,094	100%	19
16	Chinook Middle School, Sea-Tac	8,528	100%	32
17	S 207th Street, Sea-Tac	152,219	100%	564
18	S 226th Street, Des Moines	142,690	97%	529
19	Midway Elementary, Des Moines	106, 925	96%	396
20	Parkside Elementary, Des Moines	80,339	75%	298
21	Mark Twain Elementary, Federal Way	12,839	13%	48
22	Sacajawea Junior High, Federal Way	44,416	35%	165
23	Meredith Hills School, Auburn	32	2%	0
25	Twin Lakes Elementary, Federal Way	23	1%	0
28	Woodmont Elementary, Des Moines	69,384	49%	257

Source: Port of Seattle, 2019.

Figure 5.14
Seattle-Tacoma International Airport Noise Monitor Locations



Late Night Noise

One of the changes over time as been the increase in late night flights particularly by air cargo flights between the hours of midnight and 5:00 AM. During the third quarter of 2019, there were 3,874 late night operations. Of those, 239 operations exceeded the recommended SEL noise thresholds (these were established at four noise monitor locations for departures and arrivals) and 62% of those exceedances were cargo operations (Port of Seattle 2019). The SEL thresholds were established at 88 and 91 dB (at monitor #12), 82 dB (at monitor #13), 89 dB (at monitor #18), and 88 and 91 dB (at monitor #19). Any exceedances are tracked by time, airline, flight number and aircraft type, as well as the SEL noise level. Residents in the area have expressed concerns over the noise these late night flights generate and how they are disruptive to sleep.

Noise Complaints

The most important factor in reducing aircraft noise has been the transition to quieter aircraft and the regulations requiring the phasing out of older louder aircraft. For example, Stage 2 aircraft are now prohibited from use in the United States. Codified in 14 CFR Part 36, the FAA adopted increasingly restrictive noise certification standards for new aircraft. These requirements have spurred new engine and aircraft technology creating quieter aircraft and airlines have retired noisier airplanes and invested in these new airplanes.

Other factors in reducing noise effects has been to work with local communities to reduce the number of people living in areas exposed to significant aircraft noise and use of the Airport Improvement Program grants to provide sound insulation to homes, schools and healthcare facilities within the 65 DNL noise contour. However, the impact of the increase in air operations and wider flight paths has seen a dramatic increase in noise complaints at SeaTac. Figure 5.15 details the number of complaints from the period 1997 to 2019. Noise-related complaints were relatively constant from 1997 until 2017. After 2017, the number of complaints dramatically increased to 170,000 in 2018 and 400,000 in 2019.

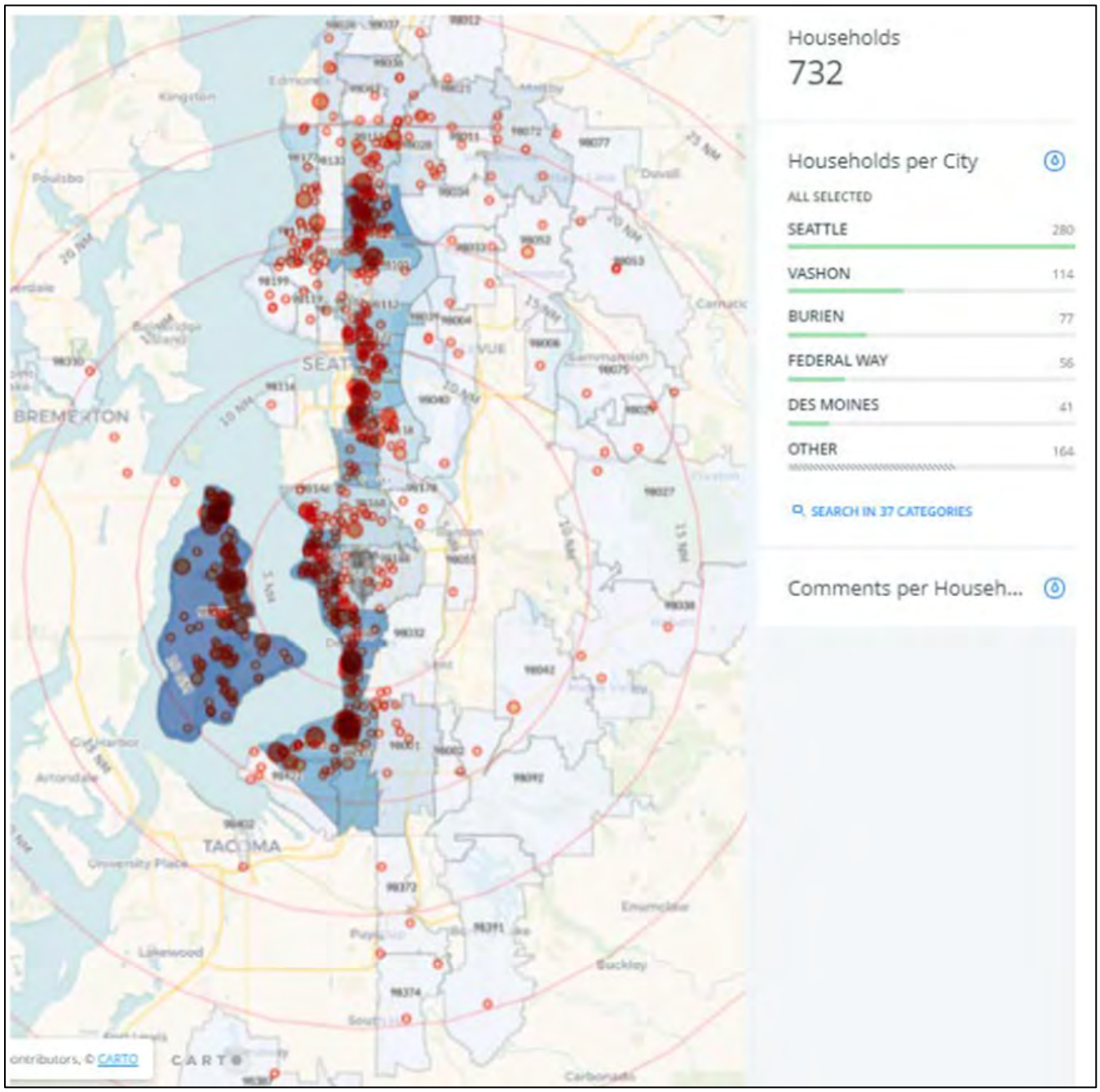
Figure 5.15
Seattle-Tacoma International Airport Noise Complaints: 1997-2019

Year	Complaints
1997	3,571
1998	4,482
1999	4,968
2000	3,941
2001	3,192
2002	2,050
2003	1,493
2004	1,432
2005	1,442
2006	1,274
2007	1,556
2008	1,927
2009	2,231
2010	2,488
2011	1,786
2012	3,868
2013	2,507
2014	2,172
2015	2,632
2016	2,959
2017	7,929
2018	**170,000**
2019	**400,000**

Source: Port of Seattle

Figure 5.16 shows where noise complaints have been received over the three-month period from July to September 2019. This demonstrates how widespread the area is that is affected by aircraft overflights.

Figure 5.16
Seattle-Tacoma International Airport Location of Noise Complaints: July-September 2019

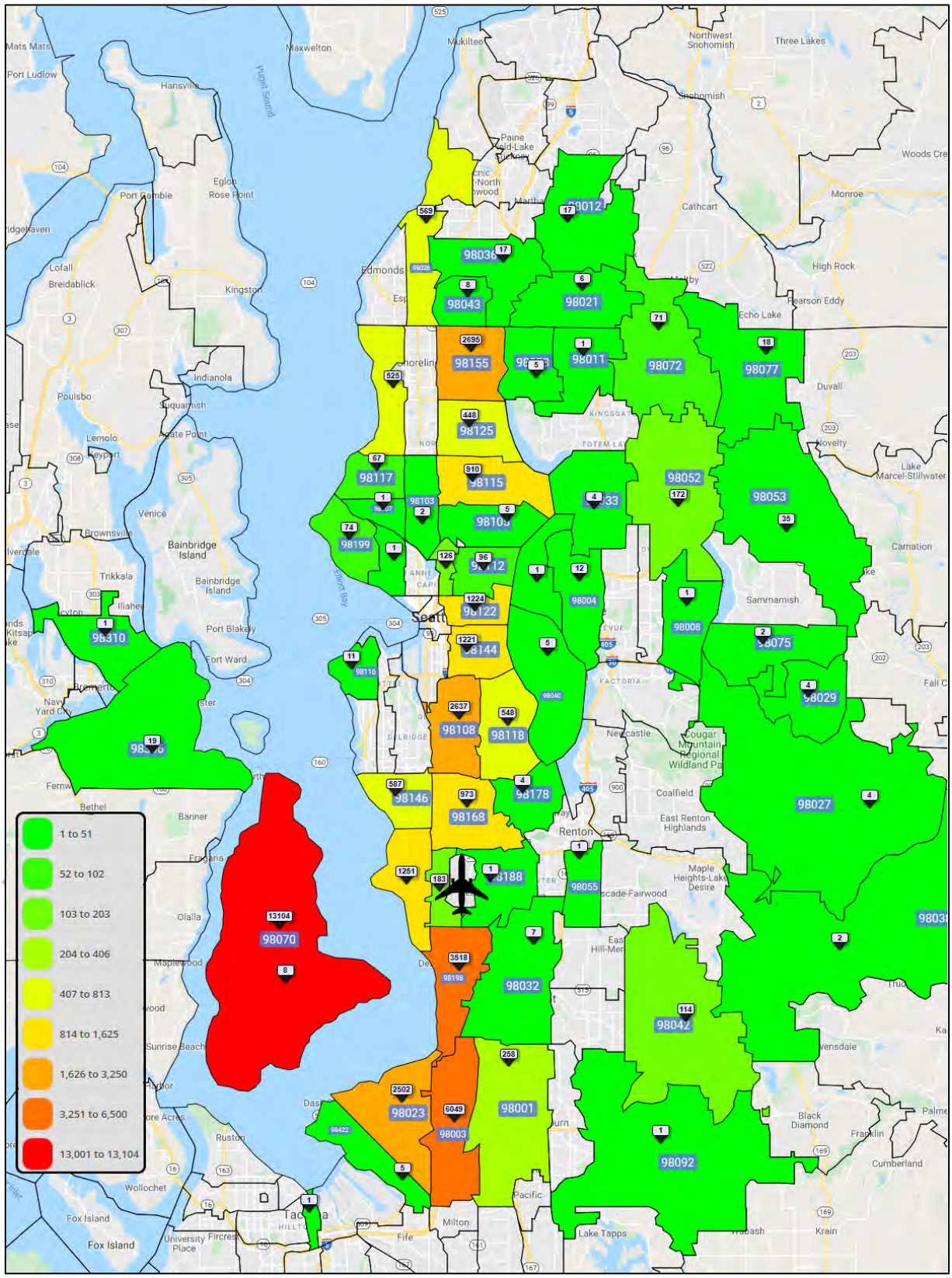


Source: Port of Seattle, Purcell 2019.

Figure 5.16 shows that the Study Area Cities are affected by noise as are surrounding communities including Shoreline, Kent, Vashon Island, Lynnwood, Woodway, Lake Forest Park, Mountlake Terrace, Seattle (particularly Beacon Hill) and the north and east sides of Lake Washington. A one-month depiction of noise complaints is shown in Figure 5.17 for August 2019.

Figure 5.17

Seattle-Tacoma International Airport Location of Noise Complaints: August 2019



Source: Port of Seattle 2019.

F. IMPACTS

Positive Impacts

There are no known positive impacts of receiving noise. Crowds cheer during air shows such as when the Blue Angels roar overhead, at the Seafair hydroplane races, or sporting events such as NASCAR or Formula 1 races, or the Super Bowl. However, those are unique and isolated events.

There is ongoing technological research and testing to develop quieter aircraft and this has been a focus of agencies such as NASA and universities including MIT and Penn State. Recent activities include investigation of all-electric and hybrid jet engines, use of all composite fuselage, and enclosing jet engines within the fuselage of aircraft to shield their noise signature, all of which could reduce the noise from take-offs, landings and overflights. Recent NASA activities include testing technologies related to the use of fairings on landing gear, cavity treatments (a cavity is formed when the landing gear is deployed), and seamless wing flap design (NASA 2018). These design changes remain experimental at present but may have future applications to reduce noise generated by the airframe. MIT has recently developed a futuristic plane with no moving parts that is powered by an ionic wind (MIT News 2018), however it may take years or longer before such technological changes are developed enough to be feasible and implemented throughout the airline industry.

Neutral Impacts

There are no known neutral impacts of noise.

Negative Impacts

The increase in air carrier operations at the airport from 1997 to 2019 has increased the number of noise events and the likelihood of adverse effects. Generally, an average residential structure can provide some sound attenuation – typically 20 dB (Oregon Airspace Initiative, 2018). Aircraft noise events within the 90 dB SEL contour previously would result in an indoor sound level of 70 dB for that event. This level (and lower and higher levels) of noise can result in a variety of negative effects.

- **Annoyance**

  The primary and perhaps most obtrusive impact from aircraft noise is community annoyance. Analyses have shown that the annoyance response is influenced by both acoustic and non-acoustic factors. Acoustic factors being the maximum sound levels, number of flights, and fleet mix distributed over time. Non-acoustic factors include personal noise sensitivity, attitude towards the noise source, mistrust of authorities, a feeling of not being fairly treated, and expectations of property devaluation (ICAO 2019). A general trend indicated by some researchers have suggested that at equal noise exposure levels, people today seem to be more annoyed by aircraft noise than they were 30 to 40 years ago (Janssen et al. 2009; Guski et al. 2017).

  The World Health Organization summarized and analyzed data from a dozen studies across airports in Europe and Asia of the association between aircraft noise and annoyance. In comparing the aircraft noise exposures at 50 and 60 dBA, their analyses revealed evidence of a high association between the sound exposure and the percent annoyance for an increase per 10 dB when data on all sound classes were assessed. Figure 5.18 presents the percentage of those annoyed by noise of varying intensities, derived from the systematic review of the studies run through regression analysis in Guski et al. The table shows low annoyance at the 40 to 50 dB level and over 50% annoyance at the 70 dB level. For each 5 dB increase in the sound level, the percent of people annoyed increased by approximately 10%.

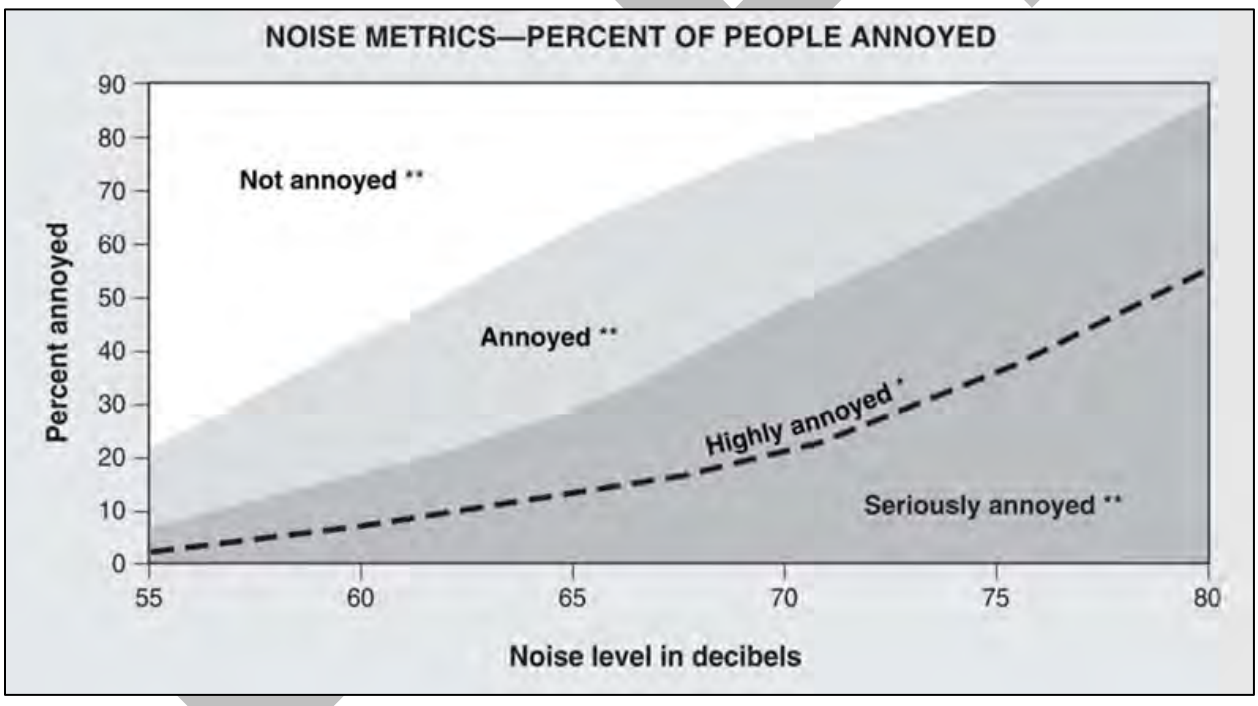
Figure 5.18
Annoyance Associated with Varying Noise Levels

DNL (db)	% Annoyance
40	1.2%
45	9.4%
50	17.9%
55	26.7%
60	36.0%
65	45.5%
70	55.5%

Source: World Health Organization

Figure 5.19 graphically shows the variability in the degree of annoyance based on people's sensitivity to noise and their perceptions of annoyance. There is a wide variation in people's sensitivity to noise, but what is important to consider is that some people may be "seriously annoyed" even at relatively low levels of noise.

Figure 5.19
Annoyance Perception Graph



- **Sleep Disturbance**

  Undisturbed sleep is a vital function necessary for daytime alertness, quality of life and health. There is ample evidence that chronic disturbance or curtailed sleep is associated with adverse health effects such as obesity, diabetes and high blood pressure. Aircraft noise is intermittent, and whether or not aircraft noise disturbs sleep is dependent on factors such a sleep depth and noise sensitivity, as well as and the number and acoustical properties of the SEL event(s).

  Noise sensitivity plays an important part in sleep disturbance. Research has shown that the elderly, children, shift-workers and those in Ill health are particularly vulnerable to be disturbed (Muzet 2007). Younger children and shift-workers tend to sleep during daytime hours when there are higher air traffic volumes.

Sleep depth also tends to decrease with age, making the elderly more likely to be awakened by noise. It has also been shown that some people (not all) will become habituated to aircraft noise over time resulting in less sleep disturbance.

For individuals sensitive to aircraft-induced noise, they can be affected by changes in sleep structures impacting sleep onset and early awakenings; cause less deep sleep and REM sleep; and more time spent in a superficial sleep stages (Basner et al 2010; Basner et al 2011). Deep and REM (rapid eye movement) sleep are important for recuperation and memory consolidation. Short-term effects from noise disturbance include perceived and actual daytime sleepiness, and impaired mood and cognitive performance (Basner 2008; Elemenhorst et al. 2010).

In 2018, the World Health Organization prepared a systematic review on environmental noise and effects on sleep evaluating exposure-response functions. It was found that significant exposure-response functions were found for aircraft-induced noise affecting sleep stage changes per 10 dB increases and highly sleep disturbed for questions mentioning the noise source. Figure 5.20 shows the association between exposure to aircraft noise and sleep disturbance found in the World Health Organization study. They recommended reducing noise levels produced by aircraft during the nighttime below 40 dB to avoid adverse effects on sleep.

Figure 5.20
Nighttime Noise and Sleep Disturbance

Nighttime Noise Level (db)	% Sleep Disturbed
40	11.3%
45	15.0%
50	19.7%
55	25.5%
60	32.3%
65	40.0%

Source: World Health Organization, 2018.

- **Cardiovascular Effects**

  Potential health effects related to long term aircraft noise exposure includes hypertension, ischemic heart disease (IHD), and metabolic effects (diabetes, obesity). Studies of hypertension related to aircraft noise have generally shown a positive association but a non-statistically significant association reflecting inconstancy between studies to date:

  - Nine cross-sectional studies of hypertension found that there was a 5% increase in hypertension per 10 dB of aircraft noise (van Kempen et al. 2018).
  - A cohort study in Sweden did not show an overall association with hypertension incidence but did show an annoyance association (Eriksson et al 2010).
  - A NORAH study found no associations overall but did find an increased risk for the subgroup that went on to develop hypertension related heart disease (Zeeb et al 2017).
  - A study in Athens found that nighttime aircraft noise produced a 2.6-fold increased risk of hypertension associated with a 10 dB increase (Dimakopoulou et al 2017). The mixed results are due to different methodologies, sample sizes, and variability in the sound sources.

  Some researchers have stated that reviews have not been carried out in a systematic way making them prone to bias. At best there is a weak association between aircraft noise and hypertension, but the results are still inconclusive.

The data on IHD is a bit more conclusive than for hypertension. The SIREN project used data covering 4.4 million people from the Swiss National Cohort and reported associations between aircraft noise and myocardial infarction mortality with an increased risk of 2.6% per 10 dB increase. The highest associations were seen with intermittent nighttime noise exposures.

Another large study in Germany forming part of the NORAH study found associations of aircraft noise with myocardial infarction at higher noise levels (> 55 dB) in the early morning hours. Another part of the NORAH study found a linear exposure-response relationship for heart failure or IHD at a rate of 1.6% percent per 10 dB in 24-hour continuous noise level. No association was found for stroke and aircraft noise in the review of several studies (van Kempen et al. 2018).

Another potential health effect that has been studied in the literature is the association between aircraft noise and metabolic effects. There have been a small number of studies that have found a positive but non-statistically significant association. "Findings [to date] are consistent with a hypothesis that noise exposure is related to stress-hormone-mediated deposition of fat centrally and other impacts on metabolic functioning and/or adverse effects of disturbed sleep on metabolic and endocrine function, also with results from a small number of studies considering road traffic noise that also found associations with diabetes, but more studies are needed to strengthen the evidence base for this outcome (ICAO 2018)."

- **Children's Learning and Cognitive Impairment**

  There have been several studies that found a correlation between aircraft noise at school and home on children's reading comprehension and memory and standardized test scores (Clark et al 2018; Haines et al 2002; Sharp et al. 2014). A study of 89 schools around airports in London (Heathrow), Amsterdam (Schiphol), and Madrid (Barajas) found exposure-response relationships between aircraft noise and poorer reading comprehension and recognition memory after taking road noise exposure and social position into account (Stansfeld et al 2005). Nighttime aircraft noise at children's homes was also associated with cognitive impairment but did not have an additional effect to that of daytime noise exposure.

  In one study, a 5 dB increase in aircraft noise exposure resulted in a two month delay in reading age in the UK and one month delay in the Netherlands (Clark et al 2006). A German study also found a one month delay in reading age with a 10 dB increase in aircraft noise (Klatte et al. 2017). The effects of aircraft noise on children's learning has been demonstrated across a range of noise metrics.

  Other noise pathways that may also affect children's learning include:

  - Noise levels that may distort a teacher's voice or make it harder to hear teachers;
  - Home exposure that may have resulted in sleep disturbance; and,
  - Annoyance from the noise causing frustration, or other physiological or psychological stress responses, which might explain poorer learning in addition to the direct noise exposure-response (Eagen et al. 2017).

  Interventions to reduce aircraft noise exposure at schools have been shown to improve learning. A study of school learning near an airport in Munich that was relocated found that two years after the airport closed, the cognitive impairment that existed when the airport was in operation was no longer present. This suggested that the effects of aircraft noise on learning and memory may be reversible if the noise exposure stops (Hygge et al. 2002).

- **Speech Interference**

  Another factor related to noise related annoyance is speech interference. Aircraft noise can disrupt routine activities such as listening to the television or music, use of the telephone, or family discussions giving rise to irritation and frustration. The quality of speech to communicate is also important in classrooms, offices, hospitals and similar land uses. It has been shown that whenever "intrusive" noise exceeds approximately 60 dB indoors that there will be speech interference (FICON 1992). A steady background sound level of 60 dB will produce 93% intelligibility; a 70 dB level produces 66% intelligibility; and a 75 dB level reduces intelligibility to 2% (USEPA 1974). Locally, residents in the Study Area have coined the phrase "the Des Moines Pause" when conversations are temporarily halted due to aircraft noise.

- **Depressed Property Values**

  Aviation noise has an indirect effect on property values because noise is a factor considered during the buyer/seller negotiations on the price of a property located near an airport. Several studies of aviation noise on property values found impacts ranging from substantial negative impacts to minimal effect.

  Newman and Beattie (1985) found that a one dB change in the cumulative airport noise resulted in a 0.5% to 2% decrease in property value. A study by Nelson (2004) developed a noise depreciation index and applied it to 23 airports in the US and Canada and found that property values in the US declined by 0.5% to 0.6% per decibel increase at noise exposure levels of 75 dB or less (in Canada the property values declined by 0.8% to 0.9% per decibel increase).

  Surveys of property values and estimates of devaluation near Seattle-Tacoma International Airport have been conducted as part of the Port of Seattle's environmental documentation. In 1997 the Port of Seattle prepared the Airport Impact Mitigation Study, which assessed the potential expected changes in land values within the cities of Burien, Des Moines, Federal Way, Normandy Park and Tukwila. That study showed a relationship between property values and distance from the Airport – property values increased with distance from the Airport. It also estimated that over time, property values were anticipated to decrease in relation to increased operations.

  An issue of concern represented by Several residents that attended the Public Workshops for this Study indicated that they had purchased properties near Seattle-Tacoma International Airport not knowing how loud it would be inside their homes. A study of 200 realtors and 70 appraisers in 35 suburban communities near Chicago O'Hare Airport found that a significant segment of buyers lacked sufficient information about the noise environment. Accordingly, their bid prices for the properties tended to be too high and their expectations for the amenity levels of their residences were a disappointment to the buyers. The disappointment of some buyers served to exacerbate conflict between homeowners and airport authorities (Frankel 1991).

  In contrast, there was one study in the City of College Park, Georgia that concluded that the noise from nearby Atlanta Hartsfield-Jackson International Airport did not significantly affect the value of residential properties. There were unique demographic and conditions, namely many of the community residents were employed in airport-related employment. Thus, a short commute distance from the airport was given more emphasis (Lipscomb 2003). However, generally the literature indicates that airport noise does have a negative effect on property values.

- **Effects on Wildlife and Domestic Pets**
  Aircraft noise also has an effect on wild animals and domestic pets. Wildlife species differ greatly in their responses to noise. Species have adapted to fill certain ecological niches and their hearing usually reflects their role. They rely on hearing to communicate with other members of their species, find food and avoid predators. Noise from aircraft can impact their ability to carry out these necessary survival skills. Both wildlife and domestic pets that are exposed to high sound levels can experience stress, hypertension and other nervous disorders similar to humans.

G. RECOMMENDATIONS

This study acknowledges that the Port of Seattle has voluntarily implemented a Part 150 Noise Study and noise mitigation program and has been actively providing sound insulation to schools, residences and others for a number of years. The Port of Seattle has also implemented a voluntary "Fly Quiet" program for air carriers operating at the Airport. In 2019, they created the Stakeholder Advisory Round Table (StART) to engage the neighboring cities to discuss and voice concerns about ongoing activities at the airport including noise reduction measures. It is our understanding that there have been some missteps as several cities have dropped out pending some revisions in the operation of StART. Ideally the concerns of the cities that have dropped out can be addressed and a full contingent of the Study Area Cities can rejoin the round table and work to address noise issues with the Port.

The following recommendations to positively influence noise mitigation at Seattle-Tacoma International Airport require changing some policies at the Federal level and, thus, may require a longer time-frame to accomplish:

- **Noise & Vibration Recommendation #1: Alternative Noise Metrics**
  Encourage the Federal Aviation Administration to complete its study of alternative noise metrics for assessing the impact of noise on residential areas. If the metric is not changed, the Port of Seattle should advocate for an alternate metric.

- **Noise & Vibration Recommendation #2: Increase Arrival Glideslope**
  Work with the Federal Aviation Administration to increase the arrival glide slope to a minimum of 3-degrees for all arrival aircraft.

- **Noise & Vibration Recommendation #3: Conduct an Environmental Review for Flight Track Changes**
  Any desired changes in flight tracks should have adequate environmental review and provide opportunities for public involvement.

- **Noise & Vibration Recommendation #4: Institute Noise Abatement Procedures**
  The Port of Seattle should consider noise reduction measure for take-off and landing procedures during low traffic and late-night hours. A limit on late-night flights (between midnight and 7:00 AM) should be considered, including both cargo and passenger flights.

- **Noise & Vibration Recommendation #5: Expand Noise Monitor Locations**
  The Port of Seattle should consider installing additional noise monitoring stations – possibly using mobile stations – to monitor noise in the areas receiving the highest number of complaints. (The Port of Seattle may have already acquired five mobile noise monitors.) This information would be valuable to get a better idea of the extent of the noise impacts and possibly use this data to inform the mitigation program.

- **Noise & Vibration Recommendation #6: Address Existing Mitigation Packages**
  There have been numerous reports of faulty installations of sound insulation features on homes within the 65 DNL contour. These were mostly mitigated during the third runway project. It is recommended that the Port of Seattle's mitigation program make some accommodation for addressing faulty and failed installations and to ensure that future installations are inspected to ensure they are properly installed. (Rep. Tina Orwall has proposed draft legislation to address concerns with the mitigation program in its current state).

- **Noise & Vibration Recommendation #7: Direct Representation on the Port Commission**
  The Port of Seattle is governed by a 5-member Commission. Each Commissioner is elected at-large and serves a 4-year term. It is recommended that the Port of Seattle designate one Commission position to be directly representative of the Study Area Cities. This "District Commissioner" would represent the constituents of the Study Area Cities and would be a resident of the City of Burien, Des Moines, Federal Way, Normandy Park, SeaTac, or Tukwila.

J. VIBRATION

In addition to noise, vibration is also a concern that is associated with noise events. Low Frequency Noise (LFN) comprises a spectrum of sound sources including natural (wind) and man-made sources (e.g., aircraft, automobiles, industrial installations, and domestic appliances). LFN has been recognized as a special environmental noise problem, particularly to sensitive people in their homes (Leventhall 2004). LFN is defined as sound frequencies below 250 hertz (Hz) to around 20 Hz and have characteristic long wavelengths that travel farther and last longer as these frequencies encounter less absorption in the atmosphere than higher frequency noise (HFN) levels. Thus, the higher the sound frequency the quicker it dissipates (Hodgdon et al. 2007). Particularly where high levels of noise occurs such as aircraft take-offs, LFN causes a secondary effect resulting in vibration, which can enter nearby residences. LFN more readily travels through structures than HFN and this has focused research and studies on LFN-generated vibration.

The noise resulting from aircraft overflights can travel from the exterior to the interior of a house through the structure itself or through the air. The aircraft sound first hits the exterior wall where some of the energy is reflected away and some it makes the wall vibrate. The wall vibrations radiate the sound to the interior surfaces through the studs and through the airspace and insulation between the studs (Oregon Airspace Initiative 2019). The most susceptible structures to vibration are loose windowpanes. While not normally something that causes major damage to structures, noise-induced vibration from aircraft can rattle windows, doors and objects such as pictures attached to walls and items on shelves. This vibration may be felt by persons inside their homes or heard as a "rumble" or "hum". Minor damage may also occur or be aggravated by vibration such as cracked plaster, loosened nails and peeling wall trim (Cant et al. 1973). Only sounds lasting for more than 1 second above a sound level of 130 dB are potentially damaging to structural components (Von Gierke et al. 1991).

A phenomenon of low frequency sound is that humans experience a more rapid growth of loudness than when experiencing higher frequencies. This contributes to a low frequency sound being perceived as "too loud" to be closer to the threshold for detectability increasing the potential for rapid annoyance with a minimal increase in loudness (Hodgdon et al 2007).

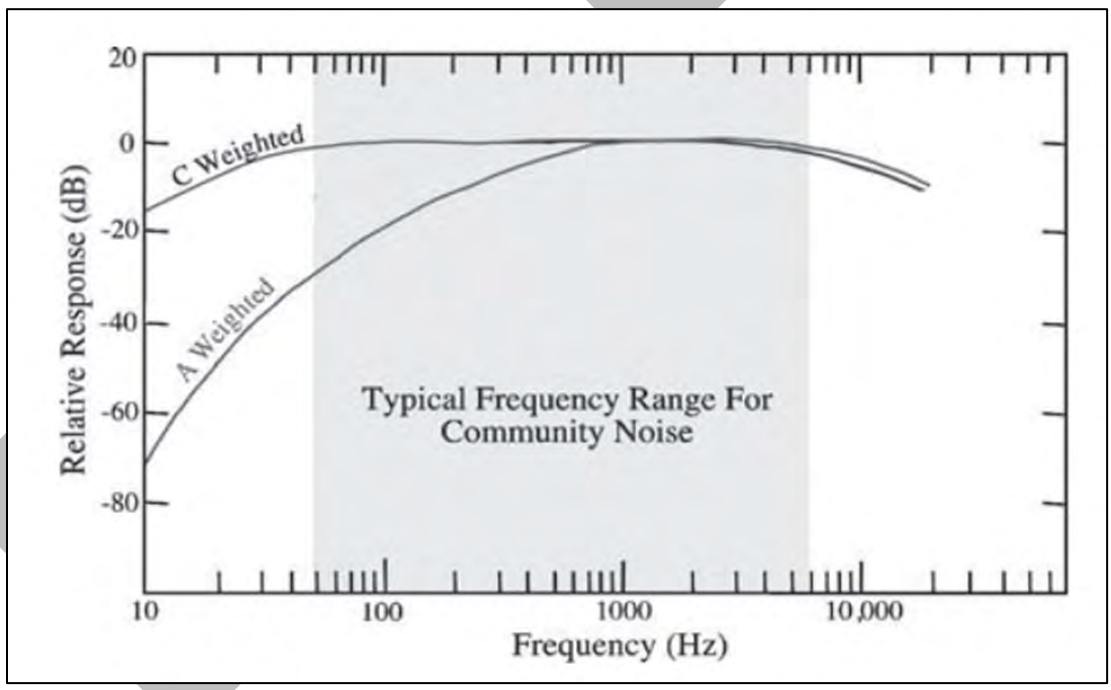
There have been a number of research studies of aircraft-generated LFN in the US and Canada by NASA, the Federal Aviation Administration, Transport Canada, the Federal Interagency Committee on Airport Noise, the American Acoustical Society, and the Journal of Low Frequency Noise and Vibration, as well as European and Asian studies particularly in the Netherlands and Japan.

LFN has been studied at airports located in Los Angeles, San Francisco, Boston, Minneapolis/St. Paul, New York (John F. Kennedy International Airport), Baltimore/Washington, and Washington DC (Dulles), to name a few. Some of the first of these studies were initiated due to the Concorde supersonic transport, which generated high noise levels and vibration on take-off.

These studies have shown that jet engines create enough low frequency noise energy to induce wall and floor vibration and rattling of windows and objects, particularly to the sides of the runway take-off/departure zones in proximity to airports. Generally, the start of take-off rolls, acceleration down a runway, and thrust reversal generate the highest levels of LFN. Measurements of noise to the sides of the take-off roll show that the larger the aircraft the higher the LFN levels, which decrease as the aircraft moves down the runway. Measurements during thrust reversal do not show the same trend with airplane size.

Overall, large jets produce SEL low frequency events that may be annoying in their own right, as well as calling attention to the aircraft operation (overflights, take-offs and thrust reversals). The DNL measurement is insensitive to these low frequency events (Fidell et al. 2002) and use of the A-weighted measurement may not adequately reflect the LFN levels causing vibration inside residences. Studies have suggested that using the C-weighted measurement may be more appropriate to measure LFN. Figure 5.21 shows the differences in how the two measurements capture LFN.

Figure 5.21
Noise Frequency Relative to A-Weighted and C-Weighted Decibels



Source: Atchley 2005.

Vibration at Seattle-Tacoma International Airport

Aircraft noise-induced vibration is not monitored or extensively studied at Seattle-Tacoma International Airport. However, there was a vibration study conducted at the Airport in 1973 (Cant et al 1973) which measured wall acceleration levels during a 24-hour continuous sampling period at 15 residences (sampling occurred for one 24-hour period at each residence). The homes were located 0.2 to 3.3 miles from the Airport and each structure was wood-frame construction except for one that was comprised of a brick veneer. All homes were habituated at the time of the study. Vibration was measured using accelerometers located on an outside bearing wall of the living room of each structure.

Background levels at all the homes were under 0.0018 g rms (g rms = root mean square acceleration, the metric used to measure vibration).

Normal activities such as radio and TV use, street traffic, children playing, appliance and furnace operation, and strong winds can cause vibration levels to fluctuate momentarily up to 0.01 g rms. Opening and closing doors can cause a momentary fluctuation up to 0.02 g rms. These normal activities do not raise the average continuous levels higher than 0.0032 g rms. The study considered average values over 0.01 g rms to be the boundary between normal levels and those temporarily caused by activities such as aircraft flyovers (the study did not determine the noise solely from aircraft).

In the 1973 study, the total number of flyovers ranged from 124 to 172 flights during the 24-hour test periods with recorded measurement values ranging from 0.0025 to 0.22 g rms. The total time spent at or above 0.01 g rms for all structures ranged from 0.05 to 2.2 hours. A check of floor vibrations were one-tenth the level of the wall acceleration. These measurements were correlated with residents indicating that vibration was detected. The study concluded that the threshold of vibration detection for the homes studied was approximately 62 to 68 dB inside the homes, which corresponded to approximately 100 to 105 dB outside sound pressure (Cant et al. 1973).

Correlating indoor response to an outdoor sound pressure level can be problematic because of the variability in transmission loss through structures due to the different building and insulation materials and the possibility of increasing vibration levels due to normal indoor activities (shutting doors, operating appliances, etc.). However, it has been shown that standard sound insulation does not sufficiently reduce LFN generated vibration (LAX Low-Frequency Aircraft Noise Study, 2010).

A 2002 study at the Los Angeles and Minneapolis-St. Paul airports suggested that using maximum C-weighted sound levels result in perceptible vibration in residences at outside sound pressures of 75 to 85 dB and this may be a better predictor of when vibration effects may occur inside residences (Fidell et al. 2002). A number of other factors have also been found to affect perceptions of vibration including the level, spectral shape, tonal content and modulation rate of the transmissions (Hodgdon et al. 2007).

Impacts of Vibration

There are no known positive or neutral impacts associated with vibration and LFN. Many of the negative effects of LFN are similar to those described previously for noise, but typically the first reaction and primary effect to the vibration caused by LFN is annoyance. This is often accompanied by secondary effects including difficulties in concentration, headaches, problems sleeping, mood effects, increased stress and palpitations (Moller and Lydolf 2003; Leventhall 2004 and 2009; Ising and Ising 2002). According to a study of local environmental health authorities, complaints due to LFN comprised about 35% of the total noise complaints from man-made sources such as aircraft, roads and industrial installations (Bengtsson and Waye 2003).

Previous research suggests that sensitivity also plays a significant role in how individuals biologically respond to low frequency noise exposure (Recio et al., 2016, Shepherd et al, 2010):

- A 2002 study (Waye et al, 2002) found that with LFN exposure, subjects who were classified as highly noise sensitive maintained higher cortisol levels compared to low-sensitive subjects, suggesting differential stress responses based on an individual's noise sensitivity.
- A 2004 study (Lusk et al, 2004) found that stress levels positively influenced heart rate.
- In 2016, the results of a panel study of cardiovascular and stress responses to short-term noise exposure also found that low frequency noise caused variability in heart rates (Walker et al. 2016).

However, "there is limited risk-assessment research in the field of LFN and health effects," (this is related to outdoor noise exposure and not occupational noise exposure) and it has been recommended that more research be undertaken, particularly relating to epidemiological effects (Baliatsas et al. 2016). Generally, the epidemiological research on LFN and its health effects is scarce and suffers from methodological shortcomings. The problem is that many of the studies occur in laboratories, are small in scale and only evaluate short-term exposure. Long-term low frequency noise in the everyday environment constitutes an issue that requires more research attention, particularly for people living in the vicinity of loud sound sources (Baliatsas et al. 2016).

Vibration Recommendations

While there is some data on LFN, there is a large data gap related to evaluating vibration impacts resulting from operations at Seattle-Tacoma International Airport. Even though monitoring for vibration effects has not occurred at the airport, it is possible to extrapolate that vibration effects have increased in frequency based on the increase in air carrier operations at the airport, as well as the likelihood that older residential units do not have adequate insulation.

If there is a desire to study LFN and vibration effects at Seattle-Tacoma International Airport, the following recommendations should be considered.

- **Noise & Vibration Recommendation #8: Additional Monitoring**
  A number of residences should be targeted in the impact zone where the louder SEL events occur that exceed 75 dB and should include monitoring of the windows, walls and floor vibration. The monitoring should occur over a longer timeframe (the previous study only evaluated the effects over a 24-hour period).

- **Noise & Vibration Recommendation #9: Targeted Study Area**
  A panel of subjects living in the vicinity of the Airport should be assembled to rate the annoyance of individual aircraft SEL events in their homes and conduct a statistical analysis to establish the best combination of measures to predict annoyance. (In the literature a possible first measure to evaluate the noise and vibration impact at residential structures is to use the Hubbard Exterior Sound Pressure Level Threshold Criteria and a measure for predicting annoyance is to use the Tokita and Nakamura Thresholds.)

- **Noise & Vibration Recommendation #10: Sound Insulation Effectiveness**
  The efficiency of the sound insulation in limiting LFN that the Port has been installing in homes under its Part 150 program should be evaluated.

K. THE FUTURE

In addition to the historic and existing issues surrounding noise and vibration, potential changes in various areas in the future may also influence these concerns:

- **New Airport**
  Air passenger service in the Seattle metropolitan region is provided principally by Seattle-Tacoma International Airport, with two smaller airports – Paine Field (served by Alaska Airlines, San Juan Airlines, and United Express), and Boeing Field/King County International Airport (served by JSX and Kenmore Air). Conversations about a new airport to relieve demand at Seattle-Tacoma International Airport have been discussed since 1994 when the Puget Sound Regional Council looked at several locations for a new airport. Those locations received significant opposition and the study ended with no further action.

In 2005, a proposal was made by Alaska Airlines and Southwest Airlines to use nearby Boeing Field, but that was rejected by King County (although Alaska Airlines does offer passenger service at Paine Field in Everett).

The concept of a new airport received support again in 2019 when Washington Governor Jay Inslee signed a bill sponsored by State Senator Karen Keiser (Des Moines) to create a commission tasked with locating a new airport. The commission will identify 6 candidate locations by January 2021, with a preferred site being located by January 2022.

Building a new "ground-up" airport is a lengthy and complex process. As an example, the most recent brand new airport in the United States (not a renovation of an existing facility) is Denver International Airport, which opened in 1995, with its initial studies dating back to 1980. The process of locating, permitting, designing, and constructing a brand new airport for Seattle could be equally as long, meaning that if a suitable site were selected by 2022, it might not be ready for service until 2037 – not accounting for any political or environmental opposition.

Even if a new airport were in the region's future, given current permitting requirements and aviation technology, it would not sufficiently address the immediate concerns raised by this Study. It could, however have the potential to reduce overflights in the Study Area Cities should a New Airport eventually be developed, which might divert some operations currently at Seattle-Tacoma International Airport.

- **Changes in Aviation Technology**

  The airline industry is interested in operating efficiently, lowering capital and operating expenses whenever possible. Aviation technology has constantly changed over the decades to create faster, larger, safer, more fuel efficient, and quieter aircraft. From the first generation of jet airliners to aerodynamic designs, composite materials, and the latest Stage 5 noise standards, there has been on ongoing improvement in commercial aircraft.

  – STOL Aircraft – There has been a long-term interest in STOL (short take-off and landing) aircraft for commercial purposes. A STOL aircraft can land or take-off on a runway of 1,500 feet or less, reducing the area needed for most airports. And while there are small STOL aircraft today, there is no existing commercial passenger aircraft capable of competing with a Boeing 737 or an Airbus A321. Only the de Havilland Canada Dash 7 which is used for limited passenger service is a STOL aircraft.

  – VTOL Aircraft – Similar to STOL's are VTOL (vertical take-off and landing) aircraft, which can land and take-off vertically and requiring little or no runway. The most common application of VTOL design is in helicopters, which are rotor-based aircraft, but there are VTOL jet aircraft for military applications. These include the Lockheed Martin F-35B Lightning II and the Boeing/BAE Systems Harrier "Jump Jet" (the tilt-rotor Bell Boeing V-22 Osprey, is also a VTOL, but not a jet). Any application of military jet VTOL technology on a large commercial scale is currently unknown, or at least many decades in the future.

  – Advanced Engines – Aircraft engine technology also continues to change. At the 2019 Paris Air Show, Fortune magazine (July 2019) noted that:

    "Aviation currently accounts for around 2.5% of global carbon emissions and with the industry has pledged to halve its 2005-level footprint by 2050 through an offsetting program. Therefore, engineering firms were keen to showcase a range of eco-friendly inventions such as hybrid engines, urban mobility vehicles, and autonomous flight systems at the annual event, the largest for the aerospace industry. It's not just environmental considerations driving the research: UBS estimates sales of hybrid engines will be worth $178 billion by 2040, while the electric vertical take-off and landing (eVTOL) market will be a $285 billion business by 2030."

While the practical application of these hybrid and alternative engines is years in the future, it is worth noting that the first commercial flight of an electrically-power aircraft took place in December 2019 in Vancouver, British Columbia. A 10-minute flight by Harbour Air demonstrated the successful conversion of a de Havilland DCH-2 Beaver to an all-electric aircraft. Harbour Air plans for have full commercial service for their fleet of 14 "eBeavers" by 2022 – each plane is a 6-passenger prop-driven seaplane.

Orville Wright's first flight was airborne for 12 seconds and the only flight of Howard Hughes' H-4 Hercules (the "Spruce Goose") lasted 26 seconds, so the modest first flight of the "eBeaver" may yet prove the viability of electro-motive aircraft technology (but not likely in the near-term).

- **Flying Cars and Taxis**

The flying car has been a dream of auto and aviation designers for over 100 years – since Glen Curtiss's "Autoplane" (1917) and Henry Ford's "Flivver" (1925). Various stops and starts have occurred, especially after WWII, but nothing beyond a few concept vehicles. More recently, there have been numerous new start-ups and concepts, many associated with the proposal for a flying taxi service.

Uber and Hyundai are partnering on a working prototype for a flying taxi service (Uber Air) which is slated to start testing in 2020 and roll out commercial service by 2023 in Los Angeles (California), Dallas (Texas), and Melbourne (Australia). These services plan to cruise at between 1,000 and 2,000 feet and would partner with select real estate developers to provide the various landing/take-off "stations".

It remains to be seen if the flying car and taxi market is viable and affordable. Should the flying taxi service become a viable travel mode, it appears to be mostly for short-haul service – replacing many conventional surface modes. It may not be a realistic mode at this point to compete with long-haul commercial air service.

Realistic private flying cars for "the masses" is likely decades away at this point. The technology being pursued seems to favor all-electric vehicles as opposed to internal combustion engines, but the start-of-the-art for engines and battery capacity are still limiting factors.

However, it should be noted that a small division of the US Department of Transportation's Federal Highway Administration is in the early stages of developing performance standards and regulatory language for flying cars and taxis. There may be a time in the future when flying vehicles are a viable and affordable travel mode, but it does not appear to be anytime soon.

- **Autonomous Vehicles**

Almost every major automobile manufacturer – and many small start-ups – are working on their version of a self-driving car. Autonomous technology has been building for almost two decades, with the initial introduction of safety systems that controlled self-braking and lane departure warning. While simple, those early systems are paving the way for fully-autonomous vehicles.

In response to this growing field, the Society for Automotive Engineers (SAE) in 2014 developed six levels of autonomy – from 0 to 5:

- Level 0: No automation (driver is in 100% control of the vehicle);
- Level 1: Driver Assistance (with hands on the wheel);
- Level 2: Partial Automation (hands off the wheel, but eyes on the road, such as Tesla's AutoPilot);
- Level 3: Conditional Automation (hands off the wheel, but eyes on the road most of the time;
- Level 4: High Automation (car does most of the controlling, but the driver can intervene); and,
- Level 5: Full Automation (car is in complete control, no steering wheel, no human needed).

Even the most advanced new cars do not exceed Level 3 automation. Reaching Level 4 and 5 will require additional reliable high-speed wireless technologies and accepted industry-wide standards (such as vehicle-to-everything communications – V2X – that allows vehicles to communicate with other similarly equipped devices, including other vehicles). Achieving Level 5 automation will also require institutional acceptance at the insurance and regulatory levels nationwide.

Despite media optimism, Level 5 autonomy is probably further away than expected. There will surely be early models and early adopters, but significant market penetration may not occur until well into the 2030 decade. This is important because if self-driving vehicles are to be a viable alternative to some air routes, there are considerable hurdles that remain to be cleared. The autonomous car will not address concerns surrounding Seattle-Tacoma International Airport in the near-term.

In the meantime, manufacturers are pressing forwards with advancing and perfecting alternative engine technologies which no longer rely on conventional fuel sources. The trend seems to be towards a new generation of fully electric vehicles with the speed and range of conventional internal combustion engines. That will be a significant step towards improving local air quality, as well as a necessary first step towards developing a practical Level 5 autonomous vehicle.

- **5G Cellular Technology**

  In 2019 and 2020, the next generation of cellular service – 5G – began its rollout in selected markets. It will take some time for the service to be available nationally and for a number of 5G-compatible devices to reach market saturation. 5G promises near fiber optic cable speeds delivered wirelessly, which could usher in a whole new generation of devices for everything from simple communications to telemedicine to widespread adoption of IoT (the Internet of Things) devices to new standards for the workplace. 5G is also integral to the deployment and operation of autonomous vehicles, which will require a high-speed and secure platform for navigation, communication, and sensing systems.

  If previous upgrades are an indicator, the adoption of 5G should be rapid and comprehensive. While it is necessary for autonomous vehicles, it is not without some concerns. The 5G spectrum is very close to passive remote sensing systems integral to weather satellites and other Earth observation systems. This has direct impacts on the national aviation safety system, including satellite operations that help predict severe weather. Other concerns include health issues from 5G radiation, and espionage and security issues associated with IoT devices (the latter which will be part of future "Smart Home" systems).

  Similar concerns were raised with previous then-new wireless technologies (such as the HD television signal). It would be reasonable to presume that these issues may be addressed as the 5G technology improves. However, how much 5G alters business and leisure travel patterns is yet to be determined. Therefore, it is not known what impacts, if any, 5G may have on growth and demand at Seattle-Tacoma International Airport.

- **Hyperloop**

  The Hyperloop is an enclosed tunnel or tub that contains a high-speed maglev (magnetic levitation) train promising speeds at or above the speed of sound (hyper-speed). The idea was first proposed by Elon Musk in 2012 as an alternative to conventional high-speed rail, since the enclosed tube solves the challenges of air resistance at high speeds. The Hyperloop is a modern variation of a similar concept proposed in London in 1799, using a train inside a pneumatic tube (the "vactrain"). This is also a variation of Musk's tunnel concept wherein individual cars are whisked along a subterranean track.

  While no viable existing Hyperloop (or tunnel) routes exist, numerous companies ()including those from Musk and Richard Branson) are developing test tracks in various locations. Proponents tout the system's ability to successfully compete with aviation routes, but as this report is being written, none of the proposed Hyperloop proposals have demonstrated this ability.

The Hyperloop is not without its critics. Some note that high-speed rail currently reaches viable speeds that do not require a sealed tube (including Japan's SCMaglev) which raises construction costs. Other cite the physical and psychological effects of riding in a narrow windowless capsule inside a sealed steel tube, subjected to high acceleration forces, buffeting, and high noise levels. Further testing is required to prove if there is market acceptance by the public.

Another hurdle is the location of many of the proposed Hyperloop stations – usually on the fringes of a metropolitan area. Airports and most conventional trains bring passengers close to their destinations in most cases. But a mode-shift would be required for use the Hyperloop, transferring from the arrival point to local transport modes, which could significantly increase cost and travel time. Other criticisms included visual, financial, and political. This study will not address those further except to say these criticisms need to be addressed for the Hyperloop to be a competitive and successful alternative to driving or flying.

Given that the Hyperloop is many years away from any viable routes, it is not considered to be a realistic alternative mode that would reduce demand at Seattle-Tacoma International Airport in the near-term. Given its development trajectory, it might be considered when – and if – a new airport is considered for future development. But the Hyperloop is not a realistic alternative to address and existing impacts on the Study Area Cities.

L. SUMMARY

Noise is a common complaint by residents in and around airports. Airports nationwide (and internationally) deal with noise complaints daily. Complaints generally are associated with aircraft overflights (especially departures, which are typically much louder than arrivals), ground activity (such as reverse thrust), and late-night maintenance run-ups. So, it was no surprise that noise was noted as one of the chief concerns in the Study Area.

Noise is more than an annoyance. Exposure can contribute to a host of issues including sleep deprivation/interruption, learning disruptions, property devaluation, and other significant impacts. And while improvements in aviation technology may reduce noise in the future, many residents believe present-day answers are required, as well as addressing concerns that have been problems for many years.

This Study should not be interpreted as being "anti-airport". There are areas where the Port of Seattle should be able to work with the Study Area communities to find common ground and realistic answers to residents' concerns. This Study has noted areas of concern and has offered various recommendation to address noise-related concerns. An improved monitoring program will help the Port of Seattle better understand and quantify the concerns of area residents. And using other alternative metrics to augment the standard DNL contour approach will help paint a more comprehensive picture of the impacts of aviation-related note.

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SECTION 6

AIR QUALITY

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SECTION 6

AIR QUALITY

A. TRENDLINE ANALYSIS

The air quality surrounding Seattle-Tacoma International Airport is affected by numerous sources and is of concern to the Study Area Cities that are near the Airport. The focus of this analysis is to evaluate changes in air quality from 1997 through present day. Three regulatory agencies are responsible for air quality issues in the Puget Sound region:

- **United States Environmental Protection Agency (USEPA)**
  USEPA Has established the National Ambient Air Quality Standards (NAAQS) for criteria pollutants: Ozone, Carbon Monoxide, Nitrogen Dioxide, Particulate Matter ($PM_{2.5}$ and PM_{10}), Sulfur Dioxide and Lead. Air quality standards specify the maximum short-term and long-term concentrates of air contaminants; and USEPA sets aircraft emissions standards.
- **Puget Sound Air Pollution Control Authority (PSAPCA)**
  PSAPCA is the primary agency for air quality in the region; responsible for enforcement of federal, state and local air quality standards for stationary sources; and responsible for developing plans and programs to attain and maintain NAAQS.
- **Washington Department of Ecology (DOE)**
  In conjunction with PSAPCA, DOE has state and local ambient air quality standards (AAQS), which must be at least as stringent as the national standards (currently the standards are the same as the NAAQS). PSAPCA and DOE operate 25 permanent air quality/meteorology monitoring stations in the Seattle-Tacoma Puget Sound area. EPA, Washington State and Puget Sound AAQS for 1997 and current year are shown in Figures 6.1 and 6.2.

The Clean Air Act (CAA) requires establishment of NAAQS for criteria air pollutants across the US, including primary standards to protect the health of the citizens and secondary standards to protect other welfare-related values (Figures 6.1 and 6.2). The CAA requires existing and proposed emission sources to demonstrate compliance with those standards. The standards have become more stringent since 1997 and some relatively recent shorter term averaging periods have been promulgated by the USEPA. Other changes include the removal of Total Suspended Participates and addition of particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$).

In ongoing review and regulatory actions, EPA and state governments designate areas as:

- **Attainment** or **Better Than NAAQS** – If monitored data demonstrate compliance with the standards;
- **Unclassifiable** or **Cannot Be Classified** – If monitored data are not available for such determinations; or
- **Non-Attainment** (for either Primary or Secondary standards) – If monitored values of the criteria air pollutants exceed the NAAQS.

Non-Attainment areas for Ozone may also be sub-classified from "marginal" to "extreme", and Non-Attainment areas for Particulate Matter with an aerodynamic diameter of 10 microns or less (PM_{10}) and Particulate Matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$) may be sub-classified as "moderate" or "serious" depending on the air quality levels. King County and the State of Washington are designated as in "Attainment" or "Unclassified" and are thereby in compliance with the NAAQS.

Figure 6.1
1997 Ambient Air Quality Standards (Federal, State, and Region)

Pollutant	Averaging Period	Unit	STANDARDS			
			FEDERAL		STATE	REGION
			Primary	Secondary	Washington State	Puget Sound
Ozone (O_3) [1]	1 hour	ppm	0.12	0.12	0.12	0.12
Nitrogen Dioxide (NO_2) [2]	Annual	ppm	0.053	0.053	0.053	0.053
Sulfur Dioxide (SO_2)	1 hour	ppm	n/a	n/a	0.40[3]	0.40[2]
	1 hour	ppm	n/a	n/a	0.25[4]	0.25[4]
	3 hours	ppm	n/a	0.05	n/a	n/a
	24 hours	ppm	0.14[3]	n/a	0.10[3]	0.10[2]
	30 days	ppm	n/a	n/a	n/a	0.04
	Annual	ppm	0.03	n/a	0.02	0.02
Carbon Monoxide (CO)	1 hour	ppm	35	n/a	9	9
	8 hour	ppm	9	n/a	150	150
Particulates (as PM_{10})	24 hour	µg/m³	150	150	150	150
	Annual	µg/m³	50	50	50	50
Particulates (as TSP)	24 hour	µg/m³	n/a	n/a	150	150
	Annual	µg/m³	n/a	n/a	50	50
Lead (Pb)	3 month rolling	µg/m³	1.5	1.5	n/a	1.5

1. Standard attained when the expected number of days per calendar year with maximum hourly average concentration above 0.12 ppm is equal to or less than one.
2. Never to be exceeded
3. Not to be exceeded more than once per year
4. Not to be exceeded more than twice in seven consecutive days
5. Standard attained when the expected annual arithmetic mean concentrations is less than or equal to 50 µg/m³
6. Standard attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m³ is equal to or less than one.

Figure 6.2
Current National Ambient Air Quality Standards (Federal, Washington State and Regional)

Pollutant	Standard	Averaging Period	Concentration		Statistical Format
			ppb	µg/m³	
Ozone (O_3) [1]	Primary & Secondary	8 hour	70	137	3-year average of the annual fourth-highest daily 8 hour concentrations
Nitrogen Dioxide (NO_2)	Primary	1 hour	100	188	3-year average of the annual 98th percentile highest daily 1 hour concentrations
	Primary & Secondary	Annual	53	100	Annual mean
Sulfur Dioxide (SO_2)	Primary	1 hour	75	196	3-year average of the annual 99th percentile highest daily 1 hour concentrations
	Secondary	3 hour	500	1,300	Not to be exceeded more than once per year
Carbon Monoxide (CO)	Primary	1 hour	35,000	40,000	Not to be exceeded more than once per year
	Secondary	8 hour	9,000	10,000	
Particulates (as PM_{10})	Primary & Secondary	24 hour	n/a	150	Not to be exceeded more than once per year on average over 3 years
Particulates (as $PM_{2.5}$)	Primary	Annual	n/a	12	Annual mean, averaged over 3 years
	Secondary	Annual	n/a	15	Annual mean, averaged over 3 years
	Primary & Secondary	24 hour	n/a	35	3-year average of the annual 98th percentile highest daily average concentrations
Lead (Pb)	Primary & Secondary	3 month rolling	n/a	0.15	Not to be exceeded

Source: 40 CFR part 50 NAAQS Table https://www.epa.gov/criteria-air-pollutants/naaqs-table

B. REGIONAL AIR QUALITY MONITORING

The United States Environmental Protection Agency (EPA) finalized an amendment to the ambient air monitoring regulations on October 17, 2006. As part of this amendment, the EPA added the following requirement for state, or where applicable local, monitoring agencies to conduct a network assessment once every 5 years, per 40 CFR 58.10(e):

> "The State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D [of 40 CFR 58.10(e)] to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network." The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. For $PM_{2.5}$, the assessment also must identify needed changes to population-oriented sites. The State, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan, to the Regional Administrator. The first assessment was due July 1, 2010."

DOE and PSCAA operates several air quality monitors throughout King County. A 15-mile radius was implemented to obtain monitoring data surrounding Seattle-Tacoma International Airport. All pertinent data was evaluated starting in 1997 through 2018. Most monitors were active for only a portion of the past 21 years. These include 13 monitors (Figure 6.3) that comprise various years of each criteria pollutant in and around King County. The 6 currently active monitors (as per the Washington Department of Ecology in 2019) are shown in Figures 6.4 through 6.9 (all images were obtained curtesy of the department) and include:

- Beacon Hill Monitoring Station;
- 10th & Weller Monitoring Station;
- East Marginal Way (Seattle-Duwamish) Monitoring Station;
- Lake Sammamish Monitoring Station;
- Kent-James & Central Monitoring Station; and,
- Auburn-M Street Monitoring Station.

Data were obtained in 3-year intervals to best correspond to the appropriate standard. Figure 6.4 provides all the currently active or previously active monitoring sites from 1997-2019 within a 15-mile radius of the airport. As illustrated in this Section, all standards are met during the years evaluated and in several cases, the region has seen a reduction of pollutant impacts. To further emphasis this reduction, DOE does not operate two NO_2/PM_{10} monitors in the City of SeaTac any longer. They were discontinued mainly due to decreasing trends as well as observed concentrations well below the NAAQS.

Each monitor within the Washington network falls under a spatial scale for which that monitor is intended to represent. A monitor can represent one of six spatial scales:

- Microscale – Area dimensions between several and 100 meters;
- Middle scale – Areas between 100 and 500 meters, typically several city blocks;
- Neighborhood scale – Areas between 0.5 and 4.0 kilometers with relatively uniform land use;
- Urban scale – Areas with city-like dimensions between 4 and 50 kilometers. Urban and neighborhood scales can overlap considerably. Heterogeneous urban areas may not have a single representative site;
- Regional scale – Areas from tens to hundreds of kilometers with relatively homogeneous geography and no large sources; and,
- National and Global scale – Scales representing the nation or the globe as a whole.

Figure 6.3
Monitoring Station Locations

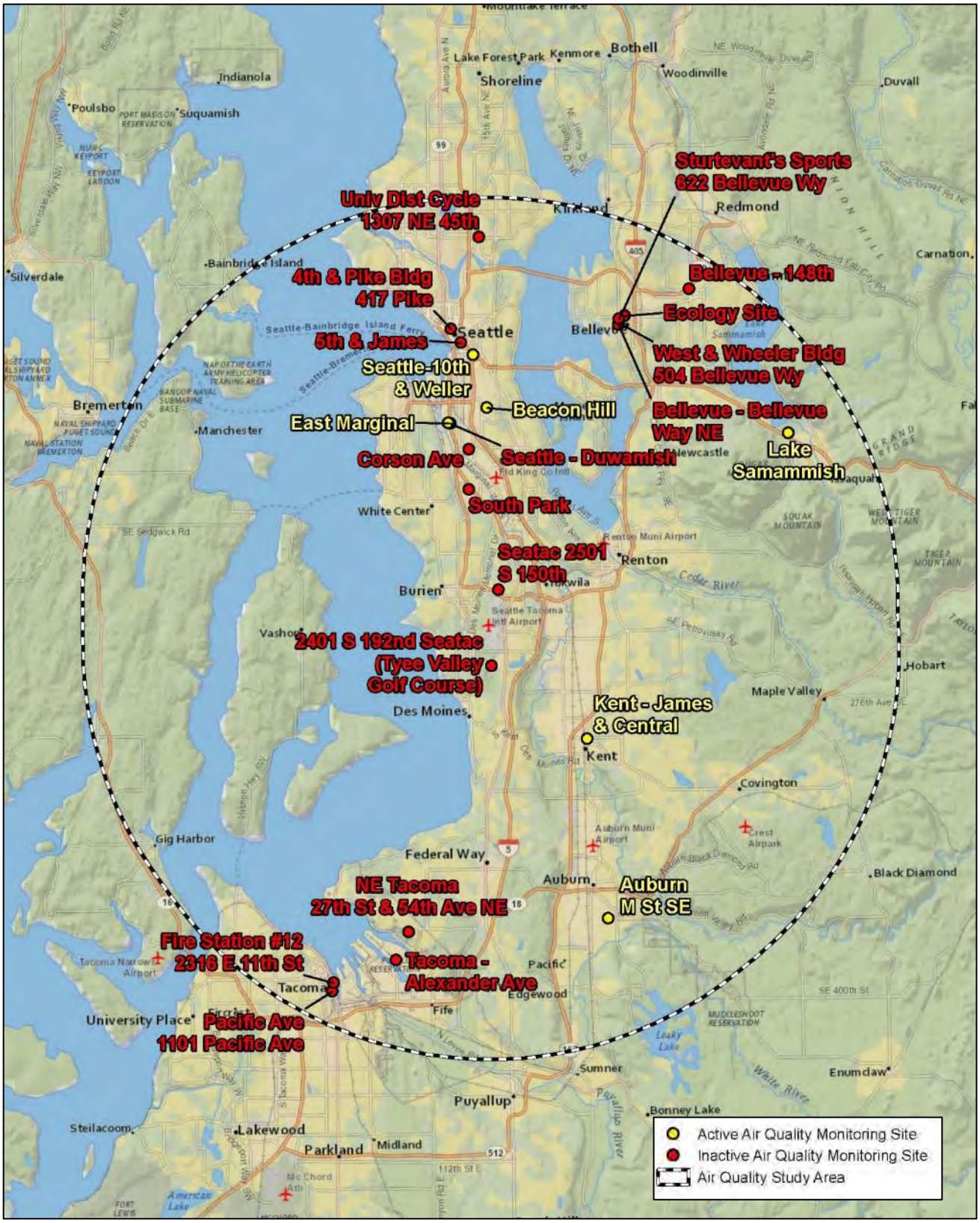


Figure 6.4
Beacon Hill Monitoring Station

Figure 6.5
10th and Weller Monitoring Station

Figure 6.6
East Marginal Way (Seattle-Duwamish) Monitoring Station

Figure 6.7
Lake Sammamish Monitoring Station

Figure 6.8
Kent-James & Central Monitoring Station

Figure 6.9
Auburn-M Street Monitoring Station

(Source: Figure 6.4 through 6.9 photographs by Stantec)

Most criteria pollutants have an applicable scale micro through neighborhood. Only O_3 and PM_{10} do not include a microscale. Additionally, O_3, SO_2 and $PM_{2.5}$ are measured on a more macroscale. The 6 currently operating monitors within a 15-mile radius of the airport have scales that range from microscale to neighborhood (3) to urban (2).

Figure 6.10
Beacon Hill Monitoring Station Data

Pollutant	Averaging Period	Units	Station Data			NAAQS
			1997-1999	Mid-Years [1,2 3]	2016-2018	
O_3	8-hr	ppb	42	42	46	70
NO_2	1-hr	ppb	58.3	57.3	45.3	100
	Annual	ppb	19.3	18.1	11.4	53
SO_2	1-hr	ppb	N/A	28.0	23.6	75
	3-hr	ppb	N/A	20.8	6.3	500
PM_{10}	24-hr	µg/m^3	55	69	54	150
$PM_{2.5}$	Annual	µg/m^3	6.0	5.5	6.4	12
	24-hr	µg/m^3	17	20	26.8	35
CO	1-hr	ppb	N/A	1,600	1,100	35,000
	8-hr	ppb	4,800	1,300	800	9,000

1. Ozone mid-years were 2006-2008.
2. Nitrogen Dioxide mid-years was 2004-2006.
3. Sulfur Dioxide and Carbon Monoxide mid-years were 2007-2009.
4. "n/a" equates to data not available for that year.

All data shown in Figure 6.3, there is a swath of all active and inactive monitors within a 15-mile radius of Seattle-Tacoma International Airport from 1997 through 2018. (Note that 2019 data was not used in analysis because the calendar year was not complete at the time of data gathering.)

A full list of all currently active and active at one time during the study period is provided in Figure 6.12. It should be noted that per the EPA King County has remained in attainment throughout the duration of the study period. Note, however, that the portion of the City of Seattle bounded on the east by IH-5/East Duwamish Greenbelt, on the south by 104th Street, on the west by the West Duwamish Greenbelt north to Fairmont Avenue SW, north on Fairmont to Elliott Bay, and Dearborn Street from Elliott Bay to IH-5 is considered to be in moderate maintenance for PM_{10}. In addition, the EPA identifies the Tacoma metropolitan area bounded on the north by Marine View Drive from Commencement Bay east to the 100-foot contour, southeast along the 100-foot contour to 64th Avenue East, south along 64th Avenue East extended to IH-5, IH-5 west to the 100-foot contour near Pacific Avenue, and north along the 100-foot contour to Commencement Bay to also be in moderate maintenance for PM_{10}.

On August 7, 1987, EPA identified Kent and the industrial areas of Seattle and Tacoma as having greater than 95% probability of violating the 24-hour PM_{10} average standard. By operation of law, all three areas were designated moderate PM_{10} nonattainment areas upon enactment of the CAA on November 15, 1990.

State Implementation Plan (SIP) submittals addressing PM_{10} potential nonattainment in Kent and Seattle were submitted by Ecology to EPA in November 1990, followed by the submittal for Tacoma one year later. The principal control strategies in the PM_{10} attainment plans for the three areas included a residential wood smoke control program, a fugitive dust control program, and a prohibition on outdoor burning.

Figure 6.11
Monitoring Data Within 15-Mile Radius (Other Than Beacon Hill Station)

Monitoring Site	Pollutant	Year	Averaging Period	Units	Amount	NAAQS
Tacoma – Pacific	CO	1997-1999	1-hr	ppb	9,900	35,000
			8-hr	ppb	7,000	9,000
		2004-2006	1-hr	ppb	5,433	35,000
			8-hr	ppb	3,833	9,000
Corson Avenue	CO	2000-2002	1-hr	ppb	6,000	35,000
			8-hr	ppb	4,600	9,000
5th & James	CO	1997-1999	1-hr	ppb	7,500	35,000
			8-hr	ppb	4,800	9,000
SeaTac-150th	NO_2	1998-1999	1-hr	ppb	57	100
			Annual	ppb	21.9	53
	PM_{10}	1998-1999	24-hr	µg/m³	28	150
SeaTac-Tyee	NO_2	1998-1999	1-hr	ppb	51	100
			Annual	ppb	14.4	53
	PM_{10}	1998-1999	24-hr	µg/m³	28.5	150
Bellevue-West & Wheeler	PM_{10}	1997-1999	24-hr	µg/m³	38.3	150
Bellevue-Bellevue Way	$PM_{2.5}$	2002-2004	24-hr	µg/m³	18.7	35
			Annual	µg/m³	8.5	12
Corson Avenue	NO_2	2000-2002	1-hr	ppb	62.3	100
			Annual	ppb	20.6	53
South Park Site[1]	$PM_{2.5}$	1999-2001	24-hr	µg/m³	32.5	35
			Annual	µg/m³	13.5	12
East Marginal Way	$PM_{2.5}$	2016-2018	24-hr	µg/m³	31.6	35
			Annual	µg/m³	8.4	12
	$PM_{2.5}$	2010-2012	24-hr	µg/m³	19.5	35
			Annual	µg/m³	9.3	12
	PM_{10}	2005-2007	24-hr	µg/m³	62	150
	SO_2	1997-1999	1-hr	ppb	53	196
		1997-1999	3-hr	ppb	37.7	500
Kent-James & Central	$PM_{2.5}$	2010-2012	24-hr	µg/m³	28.3	35
			Annual	µg/m³	10.8	12
Lake Sammamish	O_3	1997-1999	8-hr	ppb	58	70
		2006-2008		ppb	61	70
		2016-2018		ppb	66	70
10th & Weller	CO	2016-2018	1-hr	ppb	2,019	35,000
			8-hr	ppb	1,633	9,000
	$PM_{2.5}$	2016-2018	24-hr	µg/m³	29	35
			Annual	µg/m³	8.7	12
	NO_2	2016-2018	1-hr	ppb	62.6	100
			Annual	ppb	20.5	53

(Note that the $PM_{2.5}$ annual standard was 15 µg/m³ at that time. All data gathered from USEPA.)

Figure 6.12
Department of Ecology and/or Puget Sound Clean Air Agency Monitors from 1997-2019

Monitor	Active Years	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	SO_2
10th & Weller	2014-2019	X	X			X	
Beacon Hill[1]	1995-2019	X	X	X			
	2003-2006				X		
	2011-2015; 2018-19				X		
	2010-2019					X	
	1996-1999, 2005, 2007-2019						X
5th & James	1990-2001	X					
Corson Avenue	2000-2002	X	X				
SeaTac-150th	1998-1999		X		X		
SeaTac-Tyee	1998-1999		X		X		
Lake Sammamish	1990-2019			X			
Kent – James & Central	2004-2007				X	X	
	1999-2003; 2019					X	
South Park	1990-1998				X		
	1999-2002					X	
East Marginal Way	1990-1999						X
	2010-2019					X	
	2004-2007				X		
Auburn-M Street	2019					X	
4th & Pike	1990-2006	X					
University District	1992-2006	X					
Ecology Site	1994-2003	X					
Bellevue-Sturtevant's	1990-1999	X					
Bellevue-148th	1998-2009	X					
Bellevue-West & Wheeler	1990-1999				X		
Bellevue-Bellevue Way	2000-2004					X	
Tacoma-Alexander Avenue	2005-2007				X		
	1999-2003					X	
	1990-1999						X
Tacoma-27th Street and 54th Avenue	1990-1999				X		X
Tacoma-Pacific	1990-2006	X					
Tacoma-Fire Station	1990-2000				X		

1. The Beacon Hill monitor has been active for CO from 2000-2019, Ozone from 1997-2019; only NO_2 has been active since 1995.

The PM_{10} attainment plan for Kent was fully approved by EPA on July 27, 1993 (58 FR 40059) and the plans for Tacoma and Seattle were fully approved by EPA on October 25, 1995 and October 26, 1995, respectively (60 FR 54599 and 60 FR 54812). The maintenance plan and request for re-designation from Non-Attainment to maintenance for Kent, Seattle, and Tacoma were approved on March 13, 2001 (66 FR 14492). The Second 10-Year Limited Maintenance Plan for PM_{10} in Kent, Seattle, and Tacoma and is the last maintenance plan for these areas. This maintenance plan revision ensures compliance through 2020 and fulfills the second 10-year planning requirement of CAA Section 175A (b).

C. ACTIVE MONITORS SURROUNDING CASE STUDY AIRPORTS

Section 3 of this document identified three airports of similar size to Seattle-Tacoma International Airport that were analyzed as case studies – Boston Logan International Airport, Miami International Airport, and Phoenix Sky Harbor International Airport.

As discussed above, there are currently 6 active monitors within a 15-mile radius of Seattle-Tacoma International Airport. Figures 6.13 through 6.15 detail the active criteria pollutant monitors within the same 15-mile radius of Boston, Miami and Phoenix airports. Figures 6.16 through 6.18 maps the locations of these monitors for each case study airport.

Figure 6.13
Active Area Air Quality Monitors: Boston Logan International Airport

Responsible Agency	Monitor Location	Active Years	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$
Massachusetts Department of Environmental Protection	Boston Kenmore Square	2018-2019					
	Boston Kenmore Square	1999-2019					X
	Boston Kenmore Square	1990-2019		X			
	Dudley Square Roxbury [1]	1999-2019	X	X	X	X	X
	Lynn Water Treatment Plant	2014-2019					X
	Lynn Water Treatment Plant	1993-2019			X		
	Lynn Water Treatment Plant	2019		X			
	Von Hilern Street [2]	2013-2019	X	X			X
	Blue Hill Observatory	2002-2019		X	X		

1. The Dudley Square monitor began measuring each pollutant at different times. SO_2: 2018, $PM_{2.5}$: 2014, PM_{10}: 2005, Ozone: 1999, NO_2: 2000 and CO: 2001.
2. The Von Hilern Street site began measuring $PM_{2.5}$ in 2019.

Figure 6.14
Active Area Air Quality Monitors: Miami Intsernational Airport

Responsible Agency	Monitor Location	Active Years	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$
Miami-Dade County Department of Environmental Resources	Lab Annex	1990-2019	X	X			
	Perimeter Road	2017-2019		X			
	Rosenstiel	1990-2019		X	X		
	Miami Fire Station	2018-2019				X	X
	Palm Springs Fire Station	2005-2019					X
	Pennsuco	2010-2019					
	Perdue	1990-2019			X		

Both Boston and Miami have five and seven active monitors, respectively. Phoenix by contrast has 20 active monitors, some of which have been operated since 1990. Not only is the total number of active monitors in Boston and Miami similar, but the number of monitoring per pollutant is comparable.

Figure 6.15
Active Area Air Quality Monitors: Phoenix Sky Harbor International Airport

Responsible Agency	Monitor Location	Active Years	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	SO_2
Arizona Dept of Environmental Quality	JLG Supersite [1]	1996-2019	X	X	X	X	X	X
Maricopa County	West Phoenix [2]	1990-2019	X	X	X	X	X	
	Central Phoenix [2]	1990-2019	X		X	X		X
	South Phoenix [2]	1999-2019	X	X	X	X	X	
	North Phoenix [2]	1990-2019			X	X	X	
	Diablo	2014-2019	X	X			X	
	Mesa [3]	1990-2019	X		X	X	X	
	Thirty Third	2015-2019		X				
	Tempe [4]	2000-2019			X	X	X	
	South Scottsdale	1990-2019			X	X		
	Durango Complex [5]	1999-2019				X	X	X
	West 43rd	2002-2019				X		
	Gendale [6]	1990-2019			X	X	X	
	West Chandler	2000-2019	X		X	X		
	Falcon Field	1997-2019			X			
Gila River Reservation	St. John's[7]	2003-2019			X	X		
Salt River Reservation	Senior Center Station	2005-2019			X	X	X	
	High School Station [8]	2006-2019			X	X		
	Red Mountain	2005-2019			X			
	Lehi [9]	2005-2019			X	X		

1. The JLG Supersite monitor began measuring each pollutant at different times. SO_2: 2018, $PM_{2.5}$: 2011, PM_{10}: 2004, Ozone: 1996, CO & NO_2: 1999.
2. West Phoenix began measuring $PM_{2.5}$ in 2010. Central Phoenix began measuring PM_{10} in 1997. South Phoenix began measuring $PM_{2.5}$ in 2010. North Phoenix began measuring $PM_{2.5}$ in 2011.
3. The Mesa monitor began measuring $PM_{2.5}$ in 2012.
4. The Tempe monitor began measuring both $PM_{2.5}$ and PM_{10} in 2012.
5. The Durango Complex monitor began measuring $PM_{2.5}$ in 2012 and SO_2 in 2011.
6. Glendale monitor began measuring $PM_{2.5}$ in 2011.
7. The St. John's monitor began measuring PM_{10} in 2013.
8. The High School Station monitor began measuring PM_{10} in 2012.
9. The Lehi Station monitor began measuring PM_{10} in 2018.

The majority of the Phoenix sites measure multiple pollutants for an extended period of time. The Phoenix area has a much more comprehensive monitoring network surrounding its airport than does than airports in Boston, Miami, and Seattle. The following two tables and three figures provide further detail of the active monitoring system surrounding the three airports within a 15-mile radius. All active monitors surrounding Miami and Logan airports were compliant for all criteria pollutants in 2019. The Phoenix area (Maricopa County) is in attainment with all criteria pollutants except for ozone and PM_{10}. Ozone is considered in marginal nonattainment of the 2015 NAAQS and PM_{10} is considered in serious nonattainment (US EPA 2019). Specifically, in 2019, the West 43rd monitor exceeded the PM_{10} 24-hr standard, while six monitors within the 15-mile radius exceeded the 2015 ozone standard.

Figure 6.16
Air Quality Monitoring Station Locations: Boston Logan International Airport

Figure 6.17
Air Quality Monitoring Station Locations: Miami International Airport

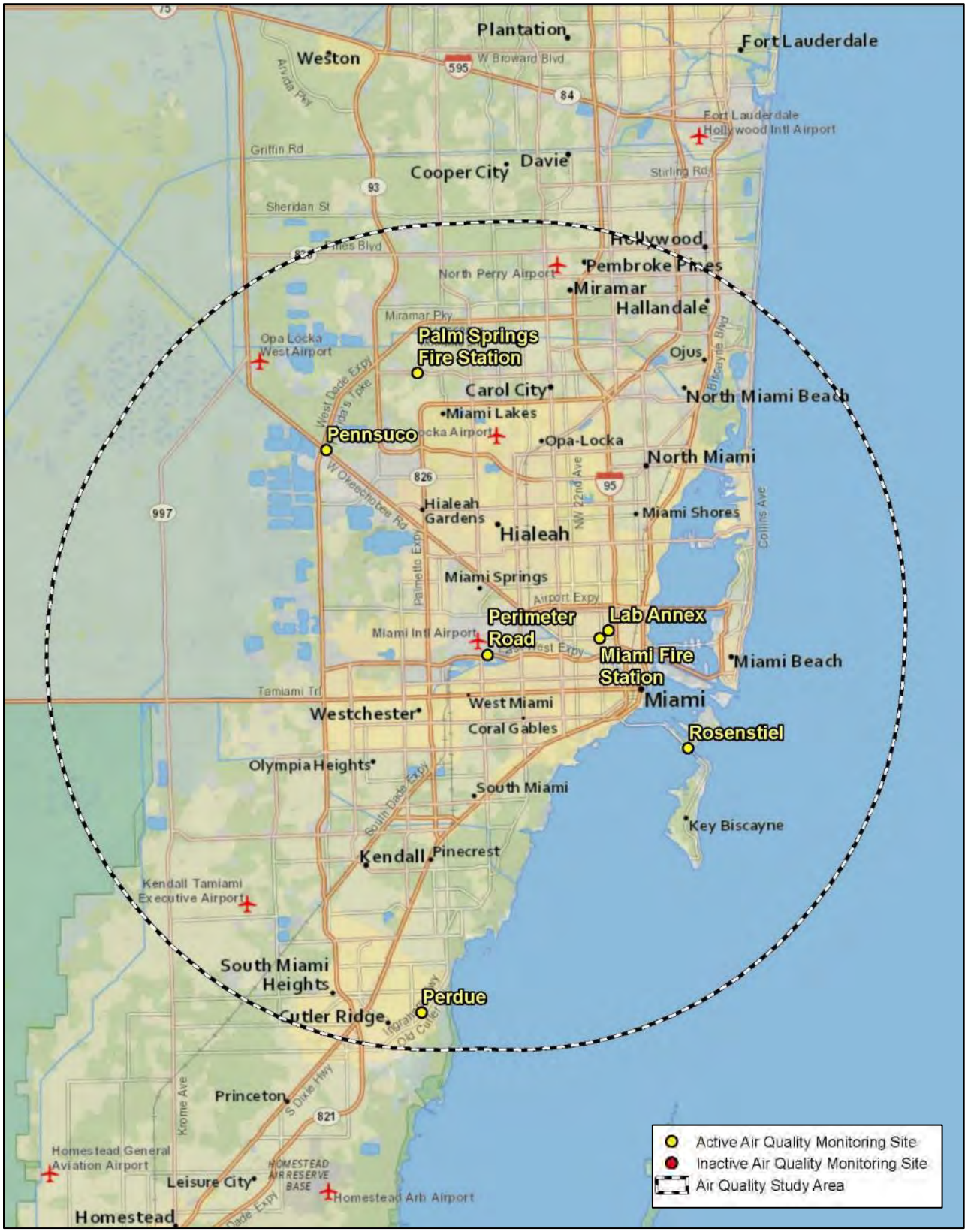
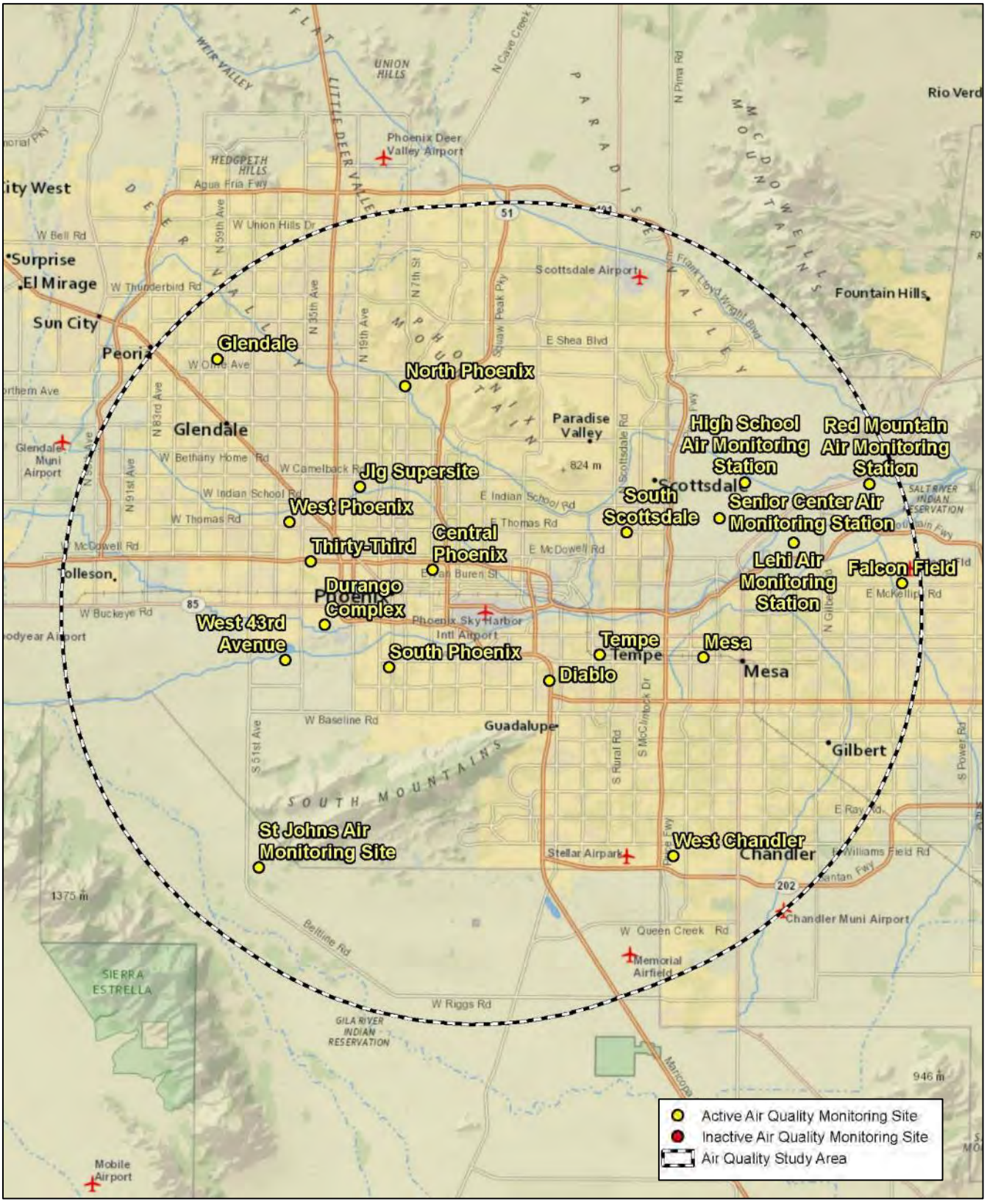


Figure 6.18
Air Quality Monitoring Station Locations: Phoenix Sky Harbor International Airport



D. FEDERAL REFERENCE/EQUIVALENT METHOD AND NAAQS COMPARISON

The EPA requires that all monitors used to evaluate NAAQS compliance must meet federal reference method (FRM) or equivalent method (FEM) standards when sampling. FRM means a method of sampling and analyzing the ambient air for an air pollutant that is specified as a reference method in an appendix to 40CFR § 50.1, or a method that has been designated as a reference method in accordance with part 53 of 40CFR § 50.1. This ensures that all data collection is consist amongst states and agencies.

The EPA has defined FRMs for the measurement of various criteria pollutants, such as CO, O_3, NO_2, PM_{10}, and $PM_{2.5}$. These methods are described in detail in 40 CFR §50. For example, both PM_{10} and $PM_{2.5}$, the FRM is based upon manual sampling techniques where a pre-weighed filter is installed into a sampling device, ambient air is sampled for 24 hours, and then the filter is retrieved, equilibrated and reweighed in order to determine the concentration of particulate on the filter. Only the measurement techniques defined in 40 CFR §50 can be FRMs.

To foster innovation and advance new technologies, EPA also reviews, tests, and approves other FEMs, which are based on different sampling and/or analyzing technologies than FRMs, but are required to provide the same decision making quality when making NAAQS attainment determinations (Gilliam and Hall 2016). All monitors evaluated for this study are FRM or FEM.

E. NATIONAL EMISSION INVENTORIES FROM SEATTLE-TACOMA INTERNATIONAL AIRPORT: 1997 -2017

The EPA compiles comprehensive and detailed air emissions for criteria and hazardous air pollutants called National Emissions Inventories (NEI). The NEI data are developed every three years. Data comprises point, nonpoint, on-road and nonroad sources. Point sources in the NEI include large industrial facilities and electric power plants, airports, and smaller industrial, non-industrial and commercial facilities. NEI on-road sources include emissions from vehicles that use gasoline, diesel, and other fuels. These sources include light duty and heavy duty vehicle emissions from operation on roads, highway ramps, and during idling. All emissions are based on the EPA transportation emissions model known as MOVES. NEI nonroad sources include off-road mobile sources that use gasoline, diesel, and other fuels. Source types include construction equipment, lawn and garden equipment, aircraft ground support equipment, locomotives, and commercial marine vessels. For many nonroad sources, the EPA uses the MOVES-NONROAD model and these sources are included in the EIS nonroad Data Category. Aircraft engine emissions (occurring during landing and takeoff operations) and the ground support and power unit equipment are included in the EIS Point Data Category at airport locations (US EPA 2018).

The estimates from Seattle-Tacoma International Airport's operations were obtained from the Emissions Inventory System through discussion with the Washington Department of Ecology. Figure 6.19 outlines the criteria pollutant emissions associated with Seattle-Tacoma International Airport for each NEI year.

Figure 6.19
NEI Criteria Pollutant Totals from Seattle-Tacoma International Airport

Pollutant	1997	2000	2005	2008	2011	2014	2017
CO	2,111.95	2,272.80	2,500.63	3,242.51	3,318.47	3,045.04	8,066.16
NO_x	1,287.98	1,485.13	1,215.22	2,222.20	2,334.86	2,489.08	3,704.20
VOC	410.90	350.85	232.39	280.39	447.81	479.98	1,177.63
SO_2	122.04	144.57	115.46	191.62	242.97	260.68	506.01
PM_{10}	17.92	19.70	102.41	38.28	47.92	61.93	76.43
$PM_{2.5}$	15.03	16.36	93.98	36.42	47.04	61.07	75.40
CO	2,111.95	2,272.80	2,500.63	3,242.51	3,318.47	3,045.04	8,066.16

In Figure 6.19, 1997 and 2000 $PM_{2.5/10}$ data does not have commercial aircraft emissions as it was not available. Also, the 1997 and 2000 airport pollution emissions were estimated using King County totals and multiplied by the average percentage attributable to the airport from 2005-2017. Even so, there is a large increase for most gaseous pollutants.

Nitrogen oxides are more of a gradual increase over the last 21 years. The increases are likely due, in part, to increased aviation operations and more landing and takeoffs specifically by commercial aircraft. For example, 2014 commercial aviation data suggested 162,713 landing/takeoffs (LTOs) and 2017 was 240,525 LTOs. Also, the model used by the Federal Aviation Administration (FAA) and the EPA when calculating aircraft-related emissions changed after 2014 – therefore, the majority of the increased CO and other pollutants is primarily due to a change in aviation modeling. The Federal Aviation Administration stopped using the Emissions and Dispersion Modeling System (EDMS) and began using the Aviation Environmental Design Tool (AEDT).

F. AVIATION MODEL COMPARISON

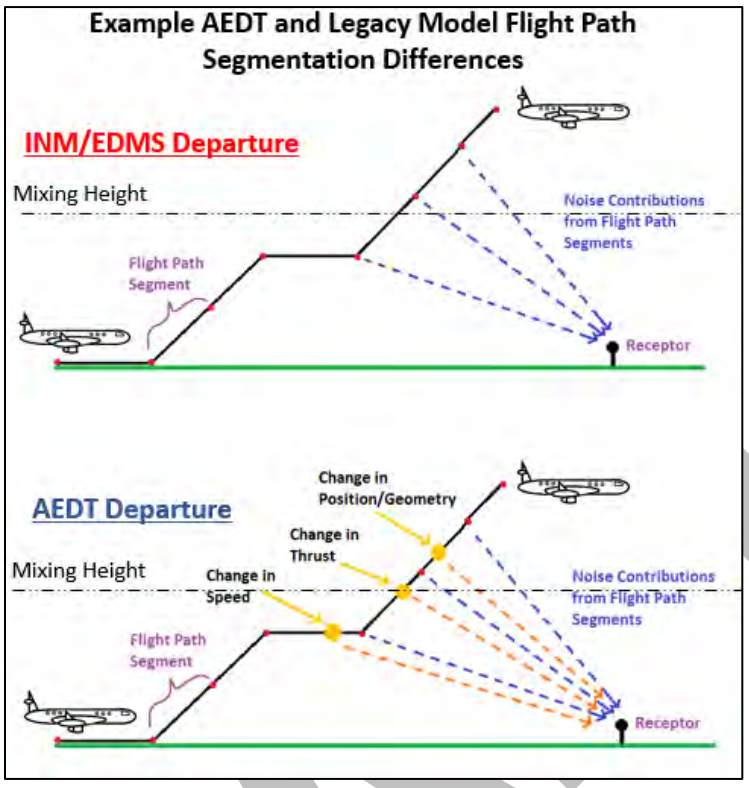
AEDT was developed to replace the Federal Aviation Administration modeling tools as it relates to noise, air emissions and fuel consumption. AEDT incorporated all elements from EDMS and the Integrated Noise Model (INM) into one comprehensive architecture and common interface. Many updates and corrections representing the best available science have been incorporated into AEDT, which will result in differences when comparing results from AEDT with the legacy tools.

During AEDT development extensive work of verification and validation was performed against both the legacy tools and gold standard data such as Cockpit Flight Data Recorder data to ensure AEDT is capturing the aircraft performance and positioning correctly. These types of validation exercises are captured as part of the AEDT documentation to build confidence that AEDT is a more accurate model than legacy tools. Figure 6.20 illustrates flight path and emission calculation point differences between EDMS and AEDT models.

AEDT and the legacy tools model aircraft along a flight path. AEDT and INM/EDMS break up flight paths into smaller pieces, called flight path segments. Each flight path segment contains specific aircraft data including: engine power setting, aircraft state (bank angle, flap setting, etc.), aircraft speed, and position. These values are used to compute noise, fuel burn and emissions.

AEDT flight paths typically have more segments, which have shown to better approximate changes in aircraft states. Aircraft performance modeling improvements also directly impact time in a particular mode (i.e., take-off, climb-out, and approach) and fuel burn. These improvements cause differences in fuel burn and emissions which vary by aircraft. For example, a Boeing 747-200 spends fewer seconds in take-off mode, but ten times longer in climb-out mode per AEDT than EDMS. As a result, the total amount of fuel burned increases tenfold during that mode. Modeled fuel consumption from AEDT correlates better to measured values than EDMS. AEDT is a robust improvement regarding noise and emissions modeling as compared to EMDS.

Figure 6.20
EDMS and AEDT Comparison Flight Paths



G. HAZARDOUS AND TOXIC AIR POLLUTANTS

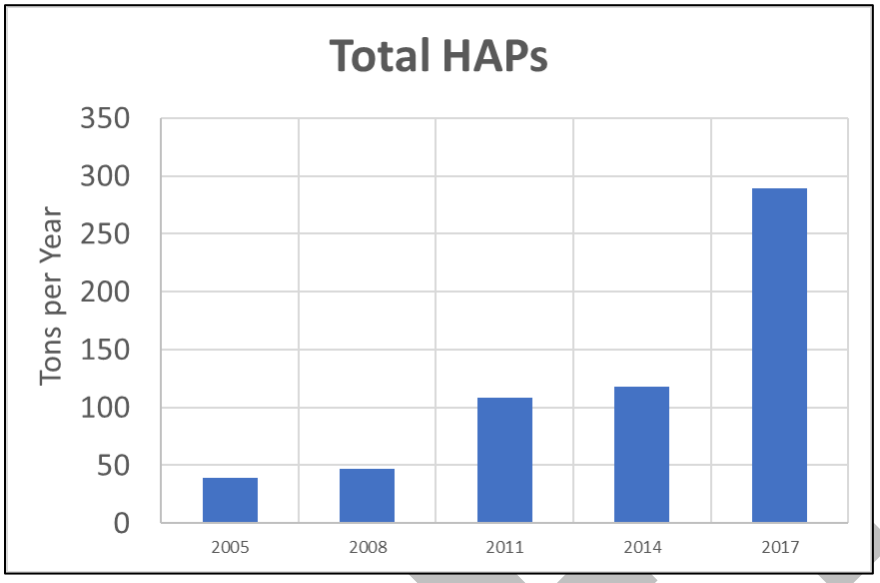
Hazardous Air Pollutants (HAPs) are pollutants known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects and comprised in a list of 187 toxic pollutants per the Clean Air Act. The majority of HAPs originate from stationary sources (e.g., factories, refineries, power plants) and mobile sources (e.g., cars, trucks, buses, airplanes), as well as indoor sources (building materials and cleaning solvents).

All aviation data for HAPs and criteria pollutants is allocated to a specific Source Classification Code (SCC) by the EPA, as follows:

- Military Aircraft (2275001000)
- Commercial Aircraft (2275020000)
- General Aviation – Piston Engine (2275050011)
- General Aviation – Turbine Engine (2275050012)
- Air Taxi – Piston Engine (2275060011)
- Air Taxi – Turbine Engine (2275060012)
- Non-aviation emissions at airports are primarily:
- Ground Support Equipment
- Auxiliary Power Units

NEI data from Seattle-Tacoma International Airport from 2005-2017 is illustrated in Figure 6.21. Note that there is a large increase in 2017. Aviation-related emissions are determined using AEDT for known engine types, while generic emission factors are applied on a ton per LTO basis.

Figure 6.21
Seattle-Tacoma International Airport HAPs Emissions



From 2008-2014 there was steady increase of overall HAPs emissions attributed to the airport, with a substantial increase in 2017. Formaldehyde contributes approximately 126 tons (43.6%) of the total in 2017. This is because the formaldehyde tons/LTO emission factor is an order of magnitude or greater than most other HAPs (Eastern Research Group, Inc. 2019). The overall increase is attributable to the change from EDMS to AEDT along with increased LTOs, primarily commercial aviation, at Seattle-Tacoma International Airport.

H. TOXIC AIR POLLUTANT IMPACT STUDIES

In 2003, the Puget Sound Clean Air Agency conducted a monitoring study for toxic emissions at 6 locations around Seattle. The purpose of the study was to characterize air emissions and to identify those air toxics and sources that may pose the greatest risks to residents of the Puget Sound area. The analysis uses results from a monitoring study conducted in the greater Seattle/King County area.

The study evaluated 17 toxic pollutants including wood smoke and diesel particulate matter (DPM). Two of the monitoring locations selected were Beacon Hill and Georgetown. Beacon Hill represents a typical urban residential area with a mix of urban sources. Georgetown was chosen because it represents potential maximum concentrations near an industrial area as it is impacted by large industries and a regional airport. Additionally, Highway 99 and residential wood burning impacted the site. The other four sites were Lake Sammamish for an urban background site, Maple Leaf for a typical urban residential site, the City of SeaTac for a site that is highly impacted by mobile sources (airport etc.), and Lake Forest Park for an area affected by woodsmoke and mobile sources.

The 2003 study suggests that DPM has a higher potential to a cancer risk than the air toxics measured. Wood smoke has the potential to contribute to the region's cancer risk. Those toxics that are higher are most likely from volatile organic compounds from mobile sources, which the airport is a subset. However, the overall results do not reflect significantly higher pollutant levels at the SeaTac location when compared with other sites. In fact, SeaTac's potential risks appear slightly lower than Beacon Hill.

Formaldehyde and other toxics health risks are similar to the average of six sites. The SeaTac site cancer risk is 67.5 per 1 million and the hazard index (HI) is 0.55. The average is 73.4 per 1 million (70 year lifetime and exposure) and 0.57 HI.

Toxics were again assessed in a PSCAA 2017 Air Quality Data Summary (Puget Sound Clean Air Agency, 2018. The Beacon Hill Washington Department of Ecology monitoring site is one of the 27 EPA National Air Toxics Trends locations. Annual average potential cancer risks were calculated for the air toxics collected from 2000 to 2017 at Beacon Hill. For many air toxics, the analysis of the trends shows a statistically significant decrease in annual average concentrations. While the Washington DOE using the Acceptable Source Impact Levels (ASIL) for stationary source toxics compliance, there is not an explicit standard for non-stationary sources like the airport or motor vehicles.

That being said, a potential exceedance of an ASIL does not necessarily mean that a source is not compliant, but rather that a further health risk assessment is required per DOE regulations. The potential impact from the Seattle-Tacoma International Airport from toxics is not explicitly known, but general trends indicate a significant reduction over the past 10-15 years. The 2018 report for 2017 emissions did, however, suggest that the mean hazard index for non-cancerous toxics were exceeded for one pollutant, acrolein. Acrolein irritates the lungs, eyes, and nose, and is a combustion by-product. Unfortunately, acrolein is one of the most difficult pollutants to monitor, and its measurements have large uncertainty. Therefore, for acrolein, PSCAA did not explore a trend analysis as the results are likely all within the historical uncertainty of the measurement.

I. GREENHOUSE GAS EMISSIONS

The primary natural and synthetic greenhouse gases (GHGs) in the Earth's atmosphere are water vapor, carbon dioxide (CO_2), methane, nitrous oxide, and fluorinated gases. GHGs allow heat from the sun to pass though the upper atmosphere and warm the earth by blocking some of the heat that is radiated from the earth back into space. As GHG concentrations increase in our atmosphere they impact the global climate by further decreasing the amount of heat that is allowed to escape back into space. Many GHGs are naturally occurring in the environment; however, human activity has contributed to increased concentrations of these gases in the atmosphere. Carbon dioxide is emitted from the combustion of fossil fuels (i.e., oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Methane results from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills. Methane is also emitted during the production and transport of coal, natural gas, and oil. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Fluorinated gases, while not abundant in the atmosphere, are powerful GHGs that are emitted from a variety of industrial processes and are often used as substitutes for ozone-depleting substances (e.g., chlorofluorocarbons, hydrochloroflourocarbons, and halons). It should be note that the overwhelming majority of GHGs from airport operations are associated with CO_2 and not the other GHG pollutants. For example, Kerosene-based jet fuel CO_2 emission factors are usually measured in kilograms per gallon, while methane and nitrous oxides are measured in grams per gallons and typically an order lower in magnitude. All subsequent GHG emissions-related discussion will be in reference to CO_2 only.

Contribution from Airport Operations

GHG emissions are a global concern and from aircraft are primarily CO_2 emissions. Though there is no ambient standard for CO_2 emissions, there are reporting requirements and general commitment to reduce emissions in the United States and worldwide.

This report researched at CO_2 emissions from two perspectives. One is from the contribution from a local perspective, where landing and take-off are taken into consideration. The other is from a global perspective where although aircraft flies over other regions of the country, the original source of the CO_2 emissions are from refueling at Seattle-Tacoma International Airport.

The landing/take off emissions, based on EPA emission factors and FAA models such as EDMS and ADET discussed earlier. Total aviation emissions from Seattle-Tacoma International Airport in 2014 were 525,357 tons of CO_2. That amount increased to 1,195,636 tons in 2017. All emissions are associated with only the SCC values described in Section 1.3 and contribute to only the area within 3000 feet of elevation surrounding Seattle-Tacoma International Airport. This is a restriction of the EDMS/AEDT. The increase of CO_2 totals is most likely due to the increase of landing and take-off cycles (165,567 in 2014 and 204,121 in 2017) and a move from EDMS to AEDT.

In 2014, CO_2 other mobile source emissions associated with King County (on-road and non-road light and heavy-duty vehicles and equipment was 11,031,736 tons. Seattle-Tacoma International Airport contributed only approximately 4.55% of the total.

It should be noted that the Airport's contribution covers only the area within airport property and 3,000 feet above its ground, while the County emissions are spread out throughout the various roads and highways of King County. This potentially dilutes the impact, but the Airport's contributions tend to be more concentrated. Therefore, it is possible for the smaller emission totals to potentially have a greater impact on the surrounding areas.

GHG Emissions in King County: 2003-2017

King County developed a report update in 2018 that compared countywide GHG emissions by sectors in 2003, 2008, 2015 and 2017. Total GHG emissions from all sectors increased from 18,719,700 Megagrams of carbon dioxide equivalent ($MgCO_2e$) in 2003 to 20,108,400 $MgCO_2e$ in 2017. However, the peak emissions were seen in 2008 and have decreased since. Emissions from commercial aviation increased from 525,600 MgCO2e in 2003 to 716,800 in 2017. Note that the emission calculation methodology used for aviation in this study was based on EPA emission factors from 2015 and total fuel consumed, which differs from Seattle-Tacoma International Airport specific data developed by the EPA via EDMS/AEDT.

The overwhelming majority of GHG emissions from King County are derived from two sectors, Built Environment and Transportation/Mobile Sources. Built Environment consists of energy consumption such as electricity, natural gas and petroleum. They are broken down into three general categories: residential, commercial and industrial. 61.7% of 2017 emissions totals are derived from these sources. Similarly, the transportation sector comprises on-road vehicles (passenger vehicles, transit and freight), rail, marine vessels, commercial aviation (Seattle-Tacoma International Airport and Boeing Field) and other miscellaneous mobile equipment. Total transportation emissions have stayed relatively constant by percentage since 2003: 36.6% to 35.9% in 2017. As a result, 97.6% of 2017 GHG emissions are associated with these two sectors. Aviation specific emissions in King County have seen a slight up tick in total amount and percentage. The aviation percentage of total emissions is 3.6% in 2017 and approximately 10% of total transportation emissions. By contrast, on-road vehicles makeup approximately 87% of all transportation emissions. The percentage of aviation-related GHG emissions is similar to the worldwide percentage described by the International Civil Aviation Organization (ICAO). The ICAO states that aviation emissions comprise approximately 2% of global GHG emissions.

Global Contribution from Seattle-Tacoma International Airport

In 2007 (and updated on March 17, 2008), the Port of Seattle developed their own CO_2 emission estimates associated with the airport for the 2006 GHG Inventory. It was calculated that the airport through a variety of sources emitted 4.7 million metric tons of CO_2 in 2006. The total was allocated to sources directly controlled by the Port such as hotel/parking lot shuttles and facility power at 1.4%. Eight percent was from publicly controlled sources

like passenger vehicles and employee commuting. The remaining 90.6% of the emissions was derived from aircraft operated by various airlines and tenants. The 2007 report also indicated that over 90% of the aircraft emissions occurred when the planes were operating above 3000 feet or cruising. This consistent with the more recent EPA data. Appendices within the 2007 report identify methods used to calculate the various emission sources. For example, cruising emissions were determined by calculating total fuel dispensed and subtracting off the LTO (less than 3000'). Seattle-Tacoma International Airport utilized only Jet fuel A in 2006 with a conversion rate of 21.095 pounds of CO_2 per gallon dispensed.

Aircraft Emissions Certification and Compliance

Tier 4 and earlier engines manufactured before July 18, 2012 must meet HC, CO, smoke, and NO_x standards prescribed in 40 CFR 87.21. Tier 6 and 8 engines manufactured on or after July 18, 2012 must meet HC, CO, smoke, and NO_x standards prescribed in 40 CFR 87.23.

General certification requirements are contained in title 14 of the Code of Federal regulations. Engine manufacturers must submit compliance reports to EPA. Manufacturers holding U.S. FAA type certificates are required to submit exhaust emission data (NO_x, HC, CO, Smoke and CO_2) to EPA to comply with the terms of the reporting requirements.

J. IMPACTS

Positive Impacts

There are some positive aspects of air quality to report:

- **Air Quality is in Attainment in King County**
  King County meets all applicable standards through the full time period. King County has had a couple areas in maintenance for PM_{10}, but both areas are improving and working toward full attainment.

- **Some Air Monitors Show Improvement in Air Quality**
  Throughout the past 22 years, some air monitors have shown a decline in overall ambient concentrations. The Beacon Hill station shows that CO, NO_2 and SO_2 have decreased since 1997. However, the lowest SO_2 was seen between 2010-2012 (Puget Sound Clean Air Agency 2018). CO has seen a steady decline across the entire region and state since 1997 (Puget Sound Clean Air Agency 2015).

- **Toxic Emissions Showing a Downward Trend**
  The PSCCA 2017 toxics data summary shows a distinct decrease since 2000 for the majority of pollutants. The 2003 study illustrates that the toxics surrounding the town of SeaTac did not demonstrate a significant difference than any of the other five sites that were evaluated. The SeaTac site produced a lower ambient concentration than the average of the six sites for most toxic pollutants.

- **Emissions Reduction Initiatives**
  The airport has installed nearly 300 electric ground support equipment. The goal is to have them available at every gate by 2021 for a total of 561. These vehicles save nearly 1 million gallons of petroleum each year and 10,000 metric tons of GHGs per year. Seattle Tacoma International Airport has also installed pre-conditioned air (PC air) at all gates. PC air was a project that constructed a centralized plant that pumps hot and cold fluids through 15 miles of pipes to each of the airport's 73 jet gates, where a unit then pre-conditions warm or cool air blown into the aircraft. The central plant houses four 300-ton chillers that fill 16 ice storage tanks with ethylene-glycol solution cooled by electricity provided by the airport. Four

secondary pumps circulate the chilled liquid through pipes to the gates for cooling. Alternately, the airport's steam plant heats water that is piped to gates for heating.
A heat exchanger at the gate directs the conditioned air through a telescoping duct on the jet bridges, to a ventilation hose and directly into the aircraft's cabin. The plant has the potential to expand to 100 gates in the future. It is estimated that the PC air saves five million gallons of fuel per year, which equates to 40,000 metric tons of GHGs and 73 tons of NO_x.

- **Sustainable Aviation Fuels**
  The Port of Seattle has a goal to power all flights fueled at Seattle-Tacoma International Airport with a minimum of 10% blend of sustainable aviation fuels (SAF) by 2028. This initiative has been spearheaded by the Port of Seattle Commission as part of the SAF Northwest initiative. The Port has been working with the Washington State Aviation Biofuels Work Group since 2012. In 2017 the Workgroup provided recommendations to the state legislature that identified a statewide clean fuel standard. This standard was introduced as House Bill 1110. On March 12, 2019 the bill was passed by the House of Representatives, which directs DOE to adopt a rule that establishes a Clean Fuels Program. The rule is to limit GHG emissions per unit of transportation fuel to 10% below 2017 levels by 2028 and 20% below 2017 levels by 2035. The current status of the bill is going back and forth amongst the Senate and House.

Neutral Impacts

Despite some positive gain as described above, air quality concerns remain:

- **Neutral Impact #1: Limited Airport-Area Air Quality Monitors**
  As discussed previously in this Section, while regional air quality has been improving over the past several years, there are very few active monitors close to Seattle-Tacoma International Airport. Therefore, it may be necessary to evaluate the need to include more FRM/FEM monitors downwind of Seattle-Tacoma International Airport to ensure all standards are truly being met.

  Over the past 20 years, air quality monitors operated by PSCAA or DOE have come and gone. The primary reason is because of ambient pollutant trends declining over time and the agencies believing that they are no longer necessary because standards are being easily met. However, there are not many active monitors very near the Study Area Cities.

- **Neutral Impact #2: $PM_{2.5}$ is Regulated but not UFPs**
  It is evident through recent studies that UFPs are present and may cause health concerns, they are not currently regulated by the EPA, DOE or PSCAA. PSCAA has indicated that they do not foresee any federal standard within the next few years. The earliest may be 10 or more years out. They indicated that further study is needed as well.

Negative Impacts

Despite some positive gain as described above, air quality concerns remain:

- **Negative Impact #1: Ultrafine Particulate Pollution**
  Ultrafine particulates (UFPs) are defined as less than 0.1 microns in aerodynamic diameter or 100 nanometers. UFPs are not currently regulated in the United States and include combustion sources as well as secondary aerosols formed through atmospheric chemistry reactions. Very high concentrations of UFPs have been reported near and on freeways as well as in proximity to airports. Several studies were reviewed:

- Mobile Observations of Ultrafine Particles (MOV-UP) Study – The University of Washington (UW) conducted a seasonally sampling study from February 2018 through March 2019 to assess UFP concentrations associated with air traffic and other sources. The UW study ("Mobile Observations of Ultrafine Particles", abbreviated as MOV-UP) utilized mobile and stationary sampling methods. Two hybrid vehicles were equipped with a condensation particle counter (CPC, Model 3007) and the P-Trak Model 8525 condensation nuclei particle counter. Mobile monitoring occurred along defined routes ("transects") which were designed to sample in an East-West direction at fixed latitudes north and south of the airport. Because of terrain and roadway considerations, some transects deviate slightly from the target latitude. UW monitored transects 10 miles north (5 transects) and 10 miles south (6 transects) of Seattle Tacoma International Airport. Fixed site monitoring was conducted at four locations, also equipped with the same equipment as described above. The MOV-UP primarily found that UFPs derive from both roadway traffic and aircraft sources, with the highest UFP counts found nearest major roadways (Interstate 5). Total concentrations of UFP alone (10 to 1000 nm) did not distinguish between roadway and aircraft features. However, key differences exist in the particle size distribution and the black carbon concentration for roadway and aircraft features. These differences can help distinguish between the spatial impact of roadway traffic and aircraft UFP emissions using a combination of mobile monitoring and standard statistical methods.

  Fixed-site monitoring confirms that aircraft landing activity is associated with a large fraction of particles in the range of 10-20 nm (ultra UFP). Mobile-derived fuel-based emissions factors (the number of ultra UFP per kilogram of fuel) are consistent with differences in emissions between aircraft and roadway vehicles.

  The MOV-UP study findings demonstrate two clear and consistent spatial features of ultrafine particles independently associated with vehicle traffic and aircraft emissions.

- Boston Logan Airport UFP Study – Tufts University conducted a UFP study related to aviation emissions in Boston surrounding Logan International Airport. The study was sample-based, similar to the University of Washington Study, however their methods were slightly different. Sampling was conducted at residential homes and inside the Central Business District of Boston. The focus was whether aviation-related particle number concentrations (PNC) increased downwind of Logan. Seven residences were sampled in the Chelsea area (4 to 5 kilometers from the airport) and another nine in Boston (5 to 6 kilometers away). During winds from the direction of the airport an increase in outdoor and indoor PNC was evident at all areas in Chelsea and in three of the nine in Boston. The median increase during impact-sector winds compared to other winds was 1.7-fold for both outdoor and indoor PNC. Across all residences during impact-sector and other winds, median outdoor PNC were 19,000 and 10,000 particles/cm^3 in Chelsea and Boston, respectively. The median indoor PNC were 7,000 and 4,000 particles/cm^3, respectively. Overall, the results indicate that aviation-related outdoor PNC infiltrate indoors and result in significantly higher indoor PNC. Results also suggest that aviation-related outdoor PNC do get inside and significantly increase indoor PNC values.

- LAX/ATL UFP Study – The University of Washington measured UFP number and distribution downwind of the Los Angeles International Airport (LAX) and Atlanta Hartsfield-Jackson International Airport (ATL) in 2016 using mobile monitoring along transects similar to the MOV-UP study detailed above. Measurements were also taken at 43 urban neighborhood locations along freeways. The study found a three to five-fold increase in UFP number concentrations in the transects under the approach path to both airports compared to the surrounding area. Additionally, the ultrafine particles observed below the airport descent paths were distinct by being smaller in diameter than particles measured in other neighborhoods and freeways within the same city. Elevated black carbon and NO_2 correlated well with the area airport transects as well. Note that the two UW studies as well as the Tufts study show similar results regarding particle size number measurements and elevated values along airport transects. All studies also suggest further evaluation and study is necessary to truly understand the health effects of aircraft-related UFP.

- Washington Department of Health Literature Review – The Port of Seattle requested the Washington Department of Health to conduct a comprehensive literature review to evaluate UFPs and their impact on health effects. The review indicated that it is difficult to determine the impact of UFP exposure on human health. Animal evidence indicates that UFP exposure is associated with adverse health effects, including neurological effects. There is strong and consistent animal data linking long-term UFP exposure with nervous system effects, and these effects are often correlated with multiple markers of neurotoxicity in animals. While much is known about $PM_{2.5}$ and its health impacts, there is a lot more uncertainty about the number, mass or concentration of UFP constituents within $PM_{2.5}$. UFPs are not evenly distributed in the atmosphere and have unique physical and chemical properties compared to larger particles that lead to differences in how they affect health.

  The Department of Health could not conclude from $PM_{2.5}$-specific human studies whether UFPs are a major contributor to observed neurological and other adverse health effects. Currently toxicological and epidemiological human studies do not provide evidence that UFPs are more problematic than other PM size fractions. Enhanced modeling methods will allow for improvements in estimating the impact of UFPs on human health. The evidence on health effects in humans associated with UFP exposure remains inconclusive or insufficient for most health outcomes.

  The Department suggests that further study is needed to identify toxicity characteristics such as particle number concentration, chemical composition and surface area, in addition to UFP monitoring across the county as part of NAAQS compliance and standardizing methods.

- Los Angeles International Airport UFP Study – University of Southern California – The University of Southern California (USC) Department of Preventative Medicine conducted a short-term UFP exposure study to evaluate potential impacts on walkers in the vicinity of Los Angeles International Airport (LAX). Twenty-two randomly selected non-smoking adults (zero cigarettes in the past month) with mild to moderate asthma participated in the study in Winter 2014 and Summer 2015. Participants were asked to walk for two hours with short resting periods every 15 minutes at two public parks, one outside the high LAX UFP zone. The study suggested UFP numbers were four to five higher than background levels in downwind communities. They concluded that UFP related to airport emissions demonstrated increased acute inflammation. Note that the sample size is very small but does indicate potential adverse health impacts for compromised populations.

- Bay Area Air Quality Management District Study – The Bay Area Air Quality Management District (BAAQMD) is the regulation body surrounding San Francisco and San Jose California. The study began in 2011 and was most recently updated in 2016 where $PM_{0.1}$ was measured from a variety of sources using a TSI model 3031 along with regional dispersion modeling (CMAQ-MADRID) and emission inventory data from 2015. Their findings suggested that approximately 8% of all non-road sources were attributable to nearby airports. During the Winter 2015, all $PM_{0.1}$ sources were determined to emit an average daily amount of 5.809 tons with aircraft comprising 0.021 tons.

- EPA Particulate Matter Integrated Science Assessment (ISA) – The SA is an evaluation and synthesis of policy-relevant science to characterize exposures to ambient PM and associated health and welfare effects. Ambient UFPs originate from two distinct processes: primary emissions and new particle formation. Primary UFPs originate from a large variety of sources, such as transportation (road traffic, ships, and aircraft), power plants, municipal waste incineration, construction and demolition, vegetation fires, domestic biomass burning, cooking, and cigarette smoke. UFP consists mainly of nucleation-mode particles. However, nucleation-mode particles often have short atmospheric lifetimes because they coagulate to form the larger particles that make up the accumulation mode.

  Soluble material can move rapidly from the alveolar surface into the blood, but poorly soluble particles generally remain in the lung for an extended period of time. A number of human studies are available confirming that the majority of poorly soluble UFP deposited in the alveolar region undergo slow clearance and do not rapidly enter circulation. However, animal studies (primarily of rats) show that UFPs cross cell membranes by mechanisms different from larger (~1 µm) particles and that a small fraction of these particles enter capillaries and distribute systemically. Some evidence suggests that a small degree of pulmonary inflammation increases in resulting in a flux of fluid and any associated particles or fibers into pulmonary capillaries.

  Studies examined hospital admissions for respiratory-related diseases, with the majority presenting associations with short-term $PM_{2.5}$ exposure in analyses of all ages. A recent study which examined associations with PM sizes smaller than 2.5 µm, but larger than UFP supports a positive association with respiratory-related emergency department visits observed for $PM_{2.5}$.

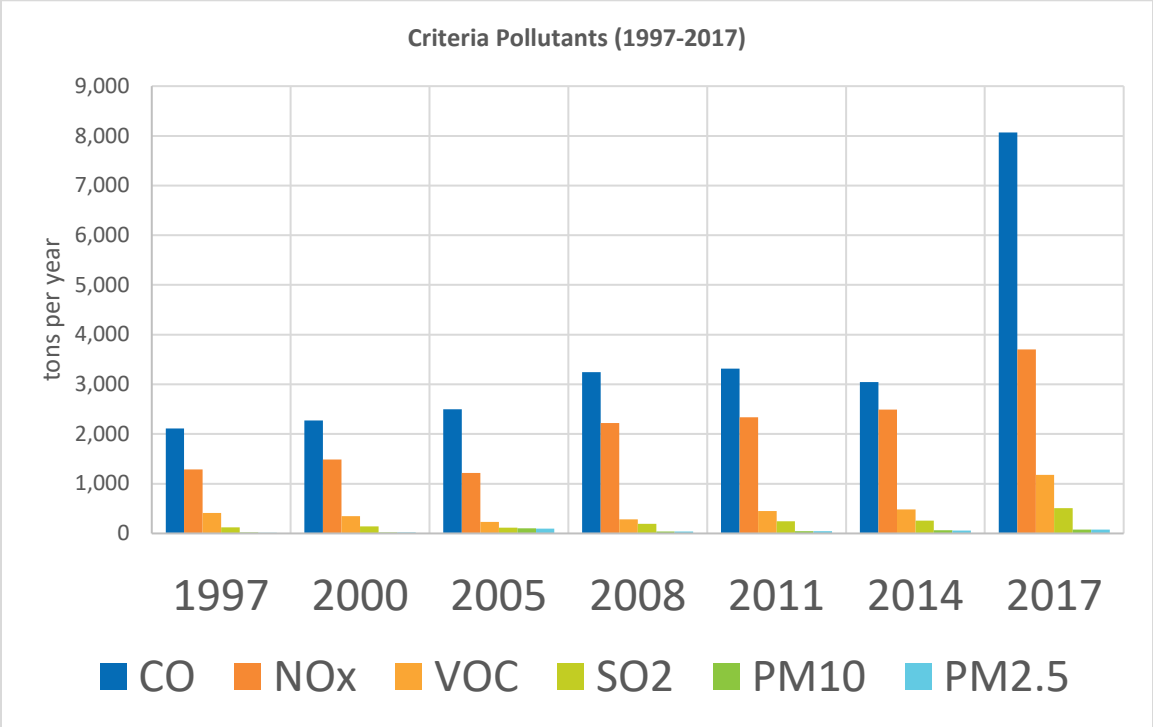
  Short-term UFP exposure may lead to respiratory health effects via a pathway involving respiratory tract inflammation and allergic responses, which are linked to asthma exacerbation. Another pathway involves the activation of sensory nerves in the respiratory tract leading to lung function decrements.

- **Negative Impact #2: Increased Operations Negatively Affect Air Quality**

  Overall Seattle-Tacoma International Airport operations (twice LTO values) have steadily increased from 2011 through 2018 (314,944 to 438,391). Prior to 2010, operations declined from 2000 (from 445,667 to 313,954). Figure 6.22 illustrates those fluctuations since 1997. NEI total emissions, as previously discussed increase or decrease, in part, due to the total airport operations. Note that while the total operations are increasing in recent years the emissions increase is not directly correlated, only partially. This is because engines fuel efficiency has been increasing and the distinctive emissions increase from 2014 to 2017 are also significantly impacted by the change in Federal Aviation Administration model from EDMS to AEDT. While emissions are increasing, general ambient air concentrations at the Beacon Hill monitor (active through the full time period) have mostly declined. This may suggest that airport emissions do not have a great impact compared to other emission sources surrounding that monitor.

Figure 6.22
Seattle-Tacoma International Airport Annual Operations

Figure 6.23
Seattle-Tacoma International Airport NEI Annual Criteria Pollutant Emissions



- **Negative Impact #3: Black Carbon Emissions from Aircraft**

  Particulate emissions, specific $PM_{2.5}$, comprise a series of elements, one of which is black carbon. They are a byproduct of incomplete combustion with a variety of size ranges. Some are visible to the naked eye. The global distribution of black carbon aviation emissions are shown to be higher across the standard airline flight paths throughout the United States and Europe. Most emission inventories of black carbon for jet engines extrapolate data from wind tunnel or staged nonrealistic engine tests. A recent study attempts to use data from in use aircraft as well as a new model to better estimate the global black carbon inventory from aircraft during takeoff, landing, and while cruising. The study concluded that the warming effects of these particles exhibit (by absorbing incoming solar radiation in the atmosphere) are approximately 1/3 as large as the warming effect from the CO_2 emitted from the jet engine combustion itself.

- **Data Gap #1: $PM_{2.5}$ Regulated but not UFPs**

  It is evident through recent studies that UFPs are present and may cause health concerns, they are not currently regulated by the EPA, DoE or PSCAA. PSCAA has indicated that they do not foresee any federal standard within the next few years. The earliest may be 10 or more years out. They indicated that further study is needed as well.

- **Data Gap #2: Lack of Access to EDMS versus AEDT Data for Comparison**

  As illustrated throughout this study, Seattle-Tacoma International Airport aviation emissions drastically increased from 2014 to 2017. The 2017 dataset was the first year where AEDT was instituted. While there is general discussion of changes made from EDMS to AEDT, EPA was unable to provide 2014 data utilizing AEDT to do a complete "apples to apples" comparison.

- **Data Gap #3: 2016 Emissions vs 2017 NEI Emissions**

  A community commenter asked the Consultant Team to address emissions differences between a 2017 Landrum & Brown Air Quality Baseline Report outlining 2016 aviation emissions from the Port of Seattle as part of the Sustainable Airport Master Plan (SAMP) and 2017 EPA NEI emissions data. The 2016 Port emissions is significantly lower than the 2017 NEI emissions with the exception of Ground Support Equipment (GSE). 2016 Port emissions are based on the following:

  - Aircraft emissions: 412,170 operations (from FAA ATADS) broken down into five subcategories. Based on those operations, emissions were calculated utilizing AEDT;
  - All Auxiliary power unit (APU) emissions were established via AEDT default assumptions; and,
  - GSE total emissions were then calculated from known pollutant-specific emission factors, load factors, horsepower and overall usage;

  The 2017 EPA NEI emissions are based on the following:

  - Numerous sources are used as input values including FAA ATADS, state provided data and generic emission factors for unknown engine-types. All known engines types were used as input to AEDT.
  - Data and emission factors are based on LTO cycles rather than operations. EPA used 495,636 operations (247,818 LTOs) based on approximately two 2 LTOs/operations. However, 2017 FAA ATADS data suggests 416,136 operations.
  - All emissions associated with unknown engine types were directly carried over from the 2014 NEI.

  Both datasets implemented AEDT on some level, but there are different input factors as outlined above. However, there is not sufficient evidence to confirm that one method is more accurate than the other. To definitively determine whether one dataset is more representative an in-depth review of all AEDT input parameters is required. The Consultant Team does not have access to that information at this time.

- **Data Gap #4: Follow-Up to UFP Studies**
  The majority of UPF studies reviewed indicated that the next step is to continue data study and determine how health effects are affected by aircraft UFPs. For example, the UW study suggests the need to determine if short-term health responses to roadway traffic and aircraft particles differ. Are there long-term health impacts of exposure to traffic and aircraft ultrafine particles? Will exposures change over time? To fully understand UFPs and their relationship to human health more studies are needed.

- **Data Gap #5: Dated Environmental Impact Statement**
  In September 2006 CH2MHill (now Jacobs Engineering) conducted an air quality analysis as part of the 2007 Seattle-Tacoma International Airport Comprehensive Development Plan NEPA Environmental Assessment. The report states that aviation-related emission estimates in 2006 were based on 207,320 LTOs (414,640 operations) and projected 2024 emissions on 274,895 LTOs (549,790 operations). Both inputs and emission results were established using EDMS. The 2024 operation estimates are reasonable but use of EDMS is outdated. Because of the differences between EDMS and AEDT, it is likely that the 2024 estimates conducted by CH2MHill would be lower.

  Also a conformity analysis was conducted using CAL3QHC for off airport motor vehicles and a CO hot spot analysis was conducted at four intersections surrounding the airport. Modeling compliance with the NAAQS was obtained for the CO 1-hr and 8-hr standards. However, a cumulative assessment was not conducted because of the temporary nature of construction and varying schedules. While monitoring data illustrated NAAQS compliance for other criteria pollutants it did not appear that other facility-wide modeling was conducted beyond the CO hot spot analysis. Because of this, the lack of a cumulative analysis and that AEDT has replaced EMDS, it may be worthwhile to reevaluate the contents of the 2007 report with a newer report to confirm or update emission impacts. The Port of Seattle is in the process of developing an updated SAMP. The Near-Term projects environmental review has been through scoping and as of December 2019, the review period was extended to incorporate feedback during the scoping period. The current schedule estimates that the SAMP Environmental Review final document and decision will be completed by September 2021.

- **Data Gap #6: Toxic Concentration Information**
  Toxic studies that are referenced in this this Section suggest that the overall toxic concentrations are mostly on the decline since 2000. However, the DOE study is based only on the Beacon Hill monitor and the 2003 PSCAA study covers only two years' worth of data at the SeaTac monitor. The PSCAA study suggests that Airport's contribution may not be more impactful than any other sources, but it is uncertain. The lack of confirmed data does not allow for 100% confidence that Seattle-Tacoma International Airport does not have a greater toxic impact on the surrounding communities. Also, the PSCAA study was conducted prior to the installation of the third runway in 2008. Increased toxic monitoring nearer the airport would provide more data to validate or disprove that concentrations from aviation sources don not greatly differ from others.

K. WHAT WE HEARD FROM THE PUBLIC

During this study, the Consultant Team heard comments from the public through public meetings, stakeholder interviews, and monthly Technical Advisory Committee meetings. The following is a summary of this citizen input:

- **Community Data Evaluation**

  Throughout the development of this review of air quality-related data, numerous members of the community provided data for consideration. A question was raised regarding the NEI CO_2 data associated with the airport and the Port of Seattle report from 2006 discussed previously in this Section. The 2006 report identifies approximately 4.7 million metric tons emitted. When compared to the NEI data stating that 525,357 short tons (476,596 metric tons) were emitted from aviation-related activities at the Seattle-Tacoma International Airport in 2014. The report also indicates that 90.6% of the total emissions were derived from fueling estimates and occur during cruising (above 3,000 feet). Because the NEI data only accounts for activity under 3,000' such as landing, take-off and taxiing, it is reasonable to assume that the cruising emissions are excluded or emissions are reduced by approximately 90%. When compared to each other, 2014 NEI data comprises approximately 10.1% of the 2006 totals, which would suggest that the CO_2 emissions under 3,000' are similar for the two years. The Port of Seattle also provided CO_2 estimates for 2017 which suggested a total of 714,010 metric tons from Scope 3 sources (aviation-related sources) and the NEI data from 2017 was 1.08 million metric tons. There is somewhat of a discrepancy, but there is not an underestimation of the NEI data as previous suggested by community members.

  A community member also sent information pertaining to a 2015 New Jersey of Institute of Technology study indicating that emissions and air toxics from airports are "significant and growing". The Consultant Team was unable to obtain a copy of this study after numerous requests from the community member and an internal search. All data reviewed for this study does also suggest that emissions associated with Seattle-Tacoma International Airport are also increasing, but as discussed throughout this report, the general trend of measured concentrations of both criteria and toxic pollutants at the nearest monitors continue to illustrate a downward trend and/or meet appropriate federal standards.

  LTO cycle emission factors were also provided by the community. These data appeared to derive from a few different legitimate sources at the time of publication. They included: EPA Procedures for Emission Inventory Volume IV: Mobile Sources, September 1981; a Seattle-Tacoma International Airport emissions inventory EIS in 1994-95 which employed version 994 of EDMS and a 1991 DOE study for King County.

  All sources were reviewed for comparison between the most recent information and calculation methodologies or models. As discussed earlier, like all other models, EDMS has been improved over time and replaced by AEDT to further its accuracy. Because the NEI data and other Port of Seattle calculation methods are more recent and most representative of the operations of the airport during the time of this study (1997-present) the suggested data sources were deemed less reliable when compared to newer approaches.

- **Ultrafine Particulates and Aircraft Wakes**

  Community members were curious as to whether UFPs that become entrained in the wake of aircraft are pushed down because of a vortex-like effect. The most recent University of Washington MOV-UP report references a 2006 study that evaluated who aircraft emissions within the wake of airplanes tend to descend under induction of vortices. This conserves emissions which leads to higher mean concentrations at ground level, except under moderate or very stable atmospheric conditions. Because of this effect, UFPs from descending aircraft reach the ground within a few minutes nearest the airport and up to 15-20 minutes 15-kilometers downwind. The shorter timeframe doesn't allow the UFPs to coagulate into larger particles. Additionally, the UFPs associated with aircraft tend to be smaller than mobile sources from highways and their affected areas tend to be larger with the potential to affect more people, but at lower concentrations.

- **SO_2 Emissions from Seattle-Tacoma International Airport**

  During a public meeting, the community expressed concern over the amount of SO_2 emissions associated with the airport as they compare to other surrounding SO_2 sources. As previously discussed, the 2017 NEI data suggested that the total annual SO_2 emissions attributable to the airport was 506 short tons (see Table 8). When compared to other King County sources identified in the NEI, Seattle-Tacoma International Airport is a significant contributor of SO_2. The second largest emission source was Ardah Glass, Inc. at 98.6 tons. Additionally, Seattle-Tacoma International Airport was the fifth largest individual source in the State of Washington. The most recent EPA emissions data does bear out Seattle-Tacoma International Airport as being a large emitter of SO_2 within its surrounding area. In should be noted, however, that the region is still within the SO_2 NAAQS. There was also concern about whether compliance correlates to health impact. The NAAQS have been rigorously analyzed regarding human health and is constantly reviewed. The review and determination process includes updates to planning documentation, integrated science assessments, risk and exposure and policy amendments. All primary standards are human health-based as well.

- **Particulate Residue on Plants and Other Surfaces**

  Several community members inquired as to the source of the residue they are seeing on their plants. Aircraft engines emit water vapor, CO_2, small amounts of NO_x, hydrocarbons, carbon monoxide, sulfur gases, and PM/soot. Soot makes up a very small percentage of the overall emissions from aircraft, but 97% of the soot is comprised of black carbon. While it is uncertain what percentage of the residue is directly attributable to the aircraft, it is very likely that most of the residue seen on plants is carbon based soot from the combustion of jet fuel and nearby traffic. It should also be noted that $PM_{2.5}$ that tends to linger in the atmosphere for an extended period of time, travel long distances and have secondary formation. Thus, deposition of soot is not likely to come from solely one source.

Figure 6.24
NAAQS and WHO Guidelines Comparison

Pollutant	Averaging Period	Concentration µg/m³	
		WHO[1]	NAAQS
Ozone (O_3)	8-hr	100	137
Nitrogen Dioxide (NO_2)	1-hr	200	188
	Annual	40	100
Sulfur Dioxide (SO_2)[2]	1-hr	500	196
	3-hr	20	1,300
Carbon Monoxide (CO)	1-hr	N/A	40,000
	8-hr	N/A	10,000
Particulates (as PM_{10})	24-hr	50	150
	Annual	20	N/A
Particulates (as $PM_{2.5}$)	Annual	10	12
	24-hr	25	35
Lead (Pb)	3-month rolling	N/A	0.15

1. Ambient (Outdoor) Air Quality and Health Fact Sheet (World Health Organization 2018).
2. The WHO SO_2 guideline averaging periods are 10 minutes and 24-hr.

- **World Health Organization Guidelines**

  This report has illustrated that the region surrounding Seattle-Tacoma International Airport is in compliance with the NAAQS. However, strictly to provide further context and compare other air pollution guidelines, a recent May 2018 World Health Organization (WHO) document was reviewed. The following data are for informational purposes only and in no way supersedes the NAAQS as it pertains air quality compliance in King County and the surrounding areas. Rather its intent is to provide the reader with an understanding of how some in the international community evaluate human health standards. The following table a comparison between the criteria pollutant standards in the United States and health guidelines according to the WHO.

- **Jet Fuel Odor Concerns**

  Community members were concerned about the potential health effects from jet fuel odor and subsequent inhalation. The New Jersey Department of Health (NJDOH) has a hazardous substance fact sheet that outlines odor thresholds and potential adverse health effects from inhalation of kerosene-based jet fuel. As per NJDOH, the odor threshold is 0.1 ppm meaning the lowest concentration at which an odor can be detected by the human sense of smell. Inhalation of kerosene can irritate the nose, throat and lungs. Higher exposure has the potential to affect the nervous system causing headaches, dizziness, nausea and vomiting. It also the potential through the skin, but requires direct contact. Note that the odor threshold is primarily focused on workers in close proximity to the aircraft, but there is still a potential to affect the general public to a lesser degree.

- **Indoor Air Quality and Absenteeism**

  During a recent public meeting, community members discussed a potential correlation between poor indoor air quality and absenteeism from work and school. Per the EPA there are numerous sources of indoor air pollution such as inadequate ventilation. Pollution sources include: fuel-burning appliances, tobacco products, various building materials, household cleaning supplies or outdoor sources such as radon, pesticides and outdoor air pollution. Outdoor air pollution can infiltrate buildings and homes via open windows and doors as well as poor window seals and cracks. Older houses and building are more susceptible because they are less airtight and often more damaged by age and weather.

  Size distribution also affects what fraction of the ambient air penetrates indoors. $PM_{2.5}$ more easily changes direction, more $PM_{2.5}$ tends to infiltrate indoors compared with $PM_{2.5-10}$, which impacts onto building envelope surfaces more easily. UFP is more likely to diffuse onto building envelope surfaces than $PM_{2.5}$, so a lower proportion of UFP is likely to infiltrate indoors compared with $PM_{2.5}$.

  According to the EPA, recent studies reinforce previous conclusions that Indoor/Outdoor (I/O) relationships are sensitive to particle size, with I/O typically decreasing in the $PM_{2.5-10}$ range. New studies add to the literature base for UFP, where I/O was found to decrease with decreasing particle size. Unlike for larger particles, UFP movement is more influenced by Brownian diffusion, which likely caused more UFP to diffuse to building surfaces instead of being transported indoors. Additional studies added to the characterization of indoor-outdoor relationships for different seasons and times of day. For most studies, I/O was higher during summer than winter and higher during daytime than nighttime.

  Poor indoor air quality can create Sick Building Syndrome. This occurs when occupants of a building experiences acute health and comfort effects that are correlated to time spent in the building. Because of this it can cause to more absenteeism amongst the work force. There is a plausible correlation between outdoor air pollution and increased absenteeism. However, there is nothing that specifically indicates that aviation emissions have a greater impact than any other outdoor source.

L. RECOMMENDATIONS

To address the issues identified in this Section, the following recommendations are proposed.

- **Air Quality Recommendation #1: Current Monitoring Network**
  The current monitoring network surrounding Seattle-Tacoma International Airport is somewhat limited. Over the past 15-20 years various locations have started to be shut down in areas that have shown a steady decline and well within applicable standards. However, there are areas that potential could warrant more monitors nearby the airport. Other networks were also evaluated at three other airports of similar size. These were Boston, Miami and Phoenix. Boston and Miami have a similar number of monitors when compared to Seattle. However, Arizona DEQ and Maricopa County operate a significant number of monitors greater than Seattle. Most of them are measurements of ozone and particulate-based.

- **Air Quality Recommendation #2: Monitoring Guidelines for New Location**
  The location of a new monitoring site is initially dependent on the objective. In this case, the objective is likely to determine most pollutants at the neighborhood or middle scale. Other criteria to evaluate is nearby sources (Seattle-Tacoma International Airport), prevailing wind direction, uniformity land use and nearby population density. Other factors that are involved in site consideration include:

  - Economics – Access/cost to property, installation of power lines, excavation and installation of concrete pads, fencing, other site specific costs;
  - Security – A particular site may not be appropriate for the establishment of an ambient monitoring station simply due to problems with the security of the equipment in a certain area. If the problems cannot be remedied via the use of standard security measures such as lighting, fences, electronic surveillance etc., then attempts should be made to locate the site as near to the identified sector as possible while maintaining adequate security;
  - Logistics – Full knowledge of data collection, including planning, training, scheduling, and staffing;
  - Atmospheric Considerations – Atmospheric considerations may include the spatial and temporal variability of the pollutants and its transport to the monitoring site. Effects of buildings, terrain, and heat sources or sinks on the air trajectories can produce local anomalies of excessive pollutant concentrations. Meteorology must be considered: wind speed, wind direction, wind variability, topography; and,
  - Pollution Considerations – A sampling site or an array of sites for one pollutant may be appropriate for another pollutant species because of the configuration of sources, the local meteorology, or the terrain. Pollutants undergo changes in their compositions between their emission and their detection; therefore, the impact of that change on the measuring system should be considered.

  None of the factors stand on their own, but are dependent in part of each other. Should any new sites be considered all of the above will be accounted for by PSCAA or DOE. At a minimum, criteria set forth in 40 CFR Part 58, Appendix D should be utilized.

  In addition to adding more monitors it may be possible to relocate a current monitor to a more desirable site. That may mean closer to the airport or more directly under the flight path when flying at lower altitudes. The key to relocation is identify the intent of the monitor (i.e. potentially better evaluate impacts within the communities nearest the airport). Along with intent, it is necessary that any relocation effort meets all the site criteria discussed above.

- **Air Quality Recommendation #3: Purple Air Monitors**

  PurpleAir.com is a company that sells particle monitors to individual users which allows them to measure particles ranging from 0.3 microns to 10. Those data are then used to calculate mass concentrations for $PM_{1.0}$, $PM_{2.5}$ and PM_{10}. While these units are helpful to the user and provides Air Quality Index (AQI) at various averaging periods, the data gathered is not consistent with FRM/FEM monitors. AQI values are informative for daily air quality and are correlated to the NAAQS. For example, an AQI rating of 100 corresponds to a concentration equivalent to the federal standard for a specific pollutant and averaging period. The measuring methods of PM and the averaging time of data collected also differ from regulatory monitors.

  As discussed previously in this Section, the Purple Air monitoring network is helpful for AQI and to provide general interpretation of NAAQS correlation. It provides a general understanding of particulate matter surrounding the monitor but does not explicitly mean the area is non-compliant or shows negative impacts. Individual exceedances of even FRM monitors does not mean the area is violating a specific standard. Complete data over a given averaging period must be reviewed by the applicable agency (i.e. PSCAA or DOE), submitted to the EPA and then designated as such. It is recommended that consideration be given to deploying more Purple Air monitors throughout the Study Area Cities (100 to 200 monitors, for example) in areas of concern to get a general sample of air quality trends. A quality assurance program should be part of this effort to ensure the monitors are deployed, placed, and maintained correctly. This, in turn, may assist in indicating which areas should receive future FRM/FEM monitor in the future.

- **Air Quality Recommendation #4: Ultrafine Particles and Health Impacts**

  The most UFP recent studies have demonstrated that there is a correlation to high UFP particle numbers and flight paths. It has also shown that aviation-specific UFPs can be distinguishable from other sources such as highway traffic. There is even a correlation of UFPs to animals experiencing adverse neurological impacts. However, there are very limited study on how UFPs impact human health. The current stance is that further study is necessary to establish a definitive link. If a link can be established that may be the first step toward future regulation.

- **Air Quality Recommendation #5: Aviation Emissions Rise and Impact Decline**

  United States EPA NEI data has shown a general increase over the past decade that correlates well to a rise in airport operations. Additionally, the FAA/EPA modified their model (EDMS to AEDT) to calculate engine-specific emissions, which illustrated a large increase from 2014 to 2017. Although airport-related emissions have be on the rise in recent years, the region and county have demonstrated compliance with all NAAQS and are moving out of maintenance for PM_{10}. Additionally, most of toxic pollutants measured at Beacon Hill have shown a steady decline since 2000. Also, the PSCAA 2003 study demonstrated that measured in the City of SeaTac were comparable to all other monitoring locations evaluated in the study. The overall regional reduction of impacts may suggest that the Airport have a smaller contribution than other sources in the area or, as discussed above, more monitors nearer the six communities would be helpful to gauge a more direct impact from the Airport.

M. THE FUTURE

AS noted previously, technological change is a near-constant, especially in transportation. In 2020, there is an increased interest by almost every automobile manufacturer to create vehicles that no longer rely on conventional internal combustion engines. At present, the near-future appears to be battery-powered vehicles, which will help reduce mobile-source air pollution (ozone and hydrocarbons). However, in the absence of external forces (rebate programs, drastic fuel price spikes, etc.), it will likely take years for these vehicles to reach market penetration to see measurable improvements in air quality.

Other previously noted changes – in aviation technology, a potential new Airport, new modes (Hyperloop), or even new disruptive technology (autonomous cars, flying taxi services, etc.) remain future possibilities but there are no market-ready alternatives (yet). Should any of these potential futures become a reality, an update to this Study would be warranted.

N. SUMMARY

Next to noise, air quality also tends to be a common concern surrounding airports. More stringent air quality standards have improved measurable air quality since the enactment of the National Environmental Policy Act in 1970 This has been accompanied by improvements in aircraft design and powerplant technology that have made today's aircraft more efficient, less polluting, and quieter than those flying decades earlier.

But in the minds of the public, meeting the standards or being in "attainment" is not a true measure of the concerns surrounding air quality. For example, the operation and location of working air quality monitors may not be truly representative of airborne emissions surrounding Seattle-Tacoma International Airport. And emerging research into currently-unregulated pollutants – specifically UFP's – raises further concerns about impacts on human health.

While more study is warranted to understand potential epidemiological impacts of UFP's and other pollutants, improvements to the Study Area's air quality monitoring program is something that can be done almost immediately. Technically being "in compliance" with State and Federal air quality standards may not be an accurate representation of air pollution levels when the devices that sample and monitor the air are either not functioning or are not close to inhabited portions of the Study Area.

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SECTION 7

MOBILITY

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SECTION 7

MOBILITY

A. APPROACH

This analysis explores historical data relating to three mobility topics as they relate to Seattle-Tacoma International Airport for the study period between 1997 to 2019:

- Traffic congestion (travel delay times);
- Parking in residential areas; and,
- Pedestrian access to and around Seattle-Tacoma International Airport.

Mobility changes and potential Airport impacts were reviewed in the six Study Area Cities. Readily-available mobility data (between 1997 and 2019) was reviewed to generate an analysis of existing Airport conditions and potential impacts to the Study Area Cities. This data included information from the Port of Seattle, the Washington Department of Transportation (WsDOT), Sound Transit, King County Metro, and the six Study Area Cities. Historic and current aerial photographs from Google Earth were also utilized to notate infrastructure changes within the study timeline.

For this analysis, "readily available" means data sources received from government agencies, information posted on agency websites, interviews from government representatives, and aerial photography; whereas, news articles and other non-governmental reports were not included.

It is important to note that no new or special transportation studies originated from this analysis (e.g., traffic counts, traffic/parking studies, field surveys, or the like). The "2015 Inventory of Existing Conditions" by Leigh | Fisher provided baseline conditions at Seattle-Tacoma International Airport. In some situations, comparative and analytical data were unavailable for the study time period; whereas, these situations suggest that future studies may be needed. The overall approach of the mobility analysis of the study involved the following steps:

- **Step 1 – Data Collection**
  Collected qualitative and quantitative data ranging from 1997-2019 related to Study Area infrastructure, transit, traffic, roadway reconstruction, regional parking facilities and trends, and pedestrian access and accommodations.
- **Step 2 – System and Service Changes**
  Identified the changes in mobility infrastructure and services from 1997 to 2019 in and around the Airport (e.g., roadways and transit services).
- **Step 3 – Study Area Impacts**
  Identified potential regional and airport-related traffic impacts on the transportation networks, specific to the six surrounding communities.
- **Step 4 – Study Area Impacts**
  Identified the potential regional and Airport-related impacts of transit and parking on the regional network.
- **Step 5 – Data Gaps**
  Identified data gaps and needs related to mobility data.

- **Step 6 – Recommendations**
  Identified future actions to better track, determine, and mitigate Airport mobility impacts on the surrounding six communities included in this Study (Recommendations).

B. AIRPORT MOBILITY INFRASTRUCTURE

The infrastructural changes to Seattle-Tacoma International Airport from 1997 to 2019 were noted that affect the regional transportation network and surrounding communities. This included existing conditions and significant infrastructure changes related to roadway access, passenger and employee parking, and rental car facilities, as well as off-airport parking facilities and passenger volume trends. This information will help establish a baseline for potential impacts on other mobility issues in the vicinity.

Rental Car Facility

In 2010, the Airport broke ground on a new Consolidated Rental Car Facility, which merged airport rental car services to a new facility approximately 1½ miles north of the main terminal along US Highway 99 at South 160th Street. The new 2.1 million-square-foot facility operates 24 hours a day and supports all 14 current rental car companies. Figure 7.1 lists the vehicle rental vendors located at the Consolidated Rental Car Facility.

Figure 7.1
Car Rental Companies at the Consolidated Car Rental Facility

Rental Car Companies	
Alamo	Fox Rent A Car
Avis	Hertz
Budget	National
Dollar Car Rental	Payless
Enterprise	Rent-A-Wreck
E-Z Rent-A-Car	Sixt Rent A Car
Firefly Car Rental	Thrifty Rental Cars

When the rental car operation relocated to the new consolidated facility, approximately 3,000 parking spaces (up to two floors) relocated from the main parking garage (adjacent to the terminal) to this new off-site facility. The vacated spaces in the main garage are now open to public use. On average, passenger shuttle services between the main terminal and car facility serve around 1,500 passengers during peak periods. In review of readily available studies and reports, the Consultant Team was unable to identify customer demand and rental vehicle utilization.

Prior to the construction of the Consolidated Rental Car Facility, rental agencies and the associated vehicles were housed in the main parking garage, customers could lease and obtain their rental vehicles across from the terminal. Now, customers must access the facility via a shuttle service from the main terminal to the remote location. Currently, the Port of Seattle operates two routes using 29 dedicated shuttle buses that bring passengers to and from the terminal to the Consolidated Rental Car Facility. All shuttles drop off and pick up passengers at the Arrivals and Departures Curb. A dedicated, 24-hour shuttle bus service operates 365 days a year, and passengers experience a headway of up to five minutes during peak periods.

The Consolidated Rental Car Facility changed traffic patterns and accessibility. Prior to the construction of the Consolidated Rental Car Facility, rental car movements originated from the Airport's main parking garage with direct access to the Airport Expressway and US Highway 99. From there, vehicles could access State Route 518, Interstate 405, and Interstate Highway (IH) 5. Now, rental car movements originate further north along US Highway 99 and South 160th Street, with more direct access to the regional and local roadway networks. A new

northbound on-ramp from South 160th Street allows rental vehicles to access the northbound lanes on the Airport Expressway to connect to State Route 518.

The Consolidated Rental Car Facility resulted in the following notable changes/additions:

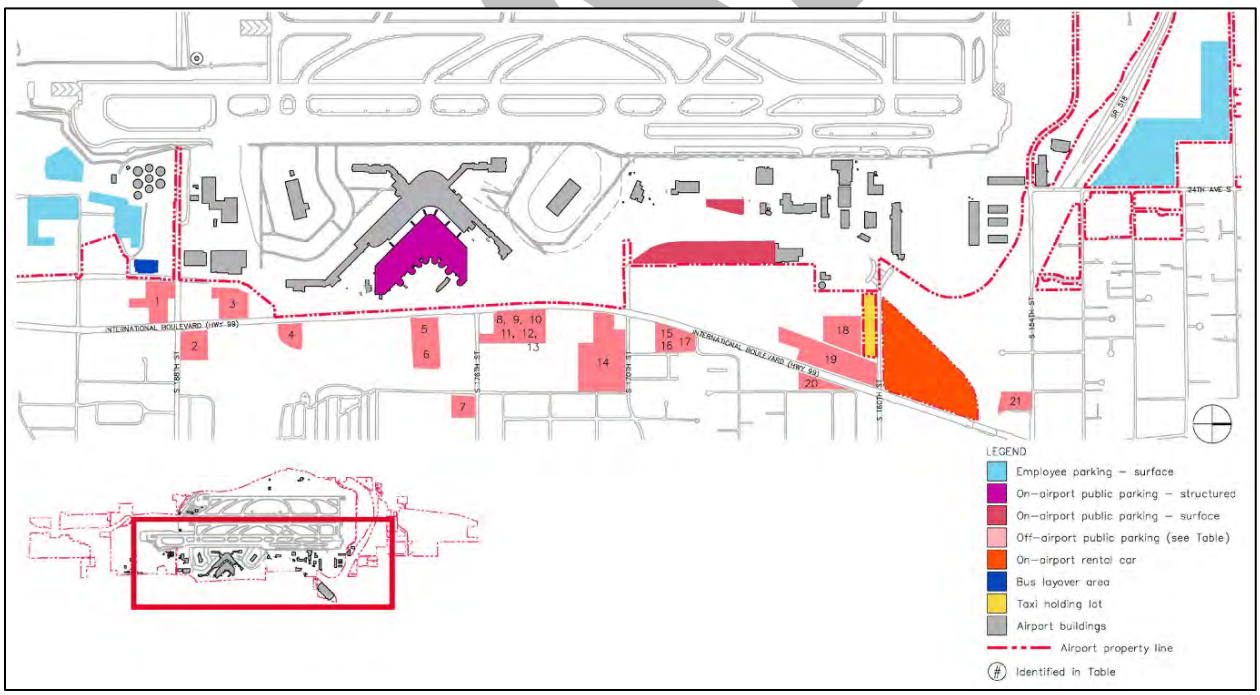
- Rental car operations were relocated from the main parking garage adjacent to the terminal to a remote location 1½ miles to the north;
- The new facility requires customers to take a shuttle bus to the new facility. Before, customers could walk from the terminal to the rental agencies in the adjacent garage; and,
- Rental cars exit and arrive at the new remote facility and utilize US Highway 99/South 160th Street. Before, rental cars used the main parking garage entrances/exits near the terminal (US Highway 99 at South 182nd Street or the southern terminus of the Airport Expressway).

Airport Passenger Parking Lots

Airport passengers and patrons (non-employees) have multiple vehicle parking options to access the terminal, including the Airport's Main Garage and various off-site private parking lots.

Each of these options vary in parking rate and convenience depending on length of stays. The associated fees for these options change depending on the duration of the vehicle's stay. The following subsections summarize the availability and changes to the Airport-related parking facilities. In review of readily available studies and reports, the Consultant Team was unable to identify the Airport's historic parking demand or utilization rates.

Figure 7.2
Existing Airport-Related Parking Facilities as of 2015



Seattle-Tacoma International Airport Main Garage

In 2000, the Port of Seattle expanded Airport passenger parking facilities from 10,000 to 13,000 parking spaces by rehabilitating the main parking garage (located adjacent to the main terminal).

By 2012, passenger parking capacity increased by an additional 3,000 stalls when all rental car operations were shifted to the Consolidated Rental Car Facility. As of 2019, the garage provides approximately 11,000 parking spaces for public parking, with an additional 2,000 spaces reserved for handicap accessible (ADA) stalls, electric vehicle charging stations, employee parking, maintenance vehicles, and out-of-service parking spaces. Of the 2,000 spaces, 766 are dedicated to Airport employee parking. The Port of Seattle also provides 95 parking spaces for over-height vehicles located east of the main garage exit plaza.

The Port of Seattle charges fees to park at the main garage – $5.00 per hour, $32.00 per day, and $149.00 per week. Monthly parking is $375, with an optional discounted corporate daily rate of $22.00. (All rates are inclusive of taxes. The most recent rate increases occurred in July 2019).

In review of readily available studies and reports, the Consultant Team was unable to identify the Airport's historic parking demand or utilization rates or the historical parking fee rates. The modified main parking garage resulted in the following notable changes/additions.

- The garage expansion added 3,000 parking spaces in 2000;
- The new Consolidated Rental Car Facility reallocated approximately 3,000 in the Airport's main garage spaces from rental car companies to other airport users (e.g., passengers, employees, and maintenance); and,
- The Port of Seattle increased the parking fees in July 2019.

Private Airport Parking Lots

The vicinity also has multiple vendors that provide private, off-site parking for airport patrons. Most of these vendor lots provide shuttle service to the terminal. Based on a 2014 inventory, there are approximately 19,069 off-airport parking spaces available in nearby communities of SeaTac, Burien, and Tukwila. Approximately 14,345 of the spaces are open for airport specific parking, and the remaining 4,769 spaces are available for hotel patrons but are periodically available to airport passengers for a fee. Based on a desktop review of vendor websites, private vendor lots charge fees ranging from $11.00 to well above $16.00 per day to park; most vendor parking fees are also subject to state and local sales tax. The nearby off-airport private parking lot facilities are detailed in Figure 7.3, based on the 2014 inventory.

Based on readily available document reviews, the Consultant Team could neither identify historical changes in private parking lot availability nor determine the customer demand and utilization rates over the duration of the study time period.

Airport Cell Phone Lot

A new Cell Phone Lot is located south of South 170th Street between the Airport Expressway's north and southbound lanes (constructed in 2014). This lot is an alternate option for individuals waiting to pick up arriving passengers rather than circulating around the terminal. The lot contains 250 spaces, is free to use, and permits vehicles to idle in the lot for up to 20 minutes. There is a southbound on-ramp to the Airport Expressway near the west end of South 170th Street via Air Cargo Road; whereas there is no direct northbound on-ramp to the Airport Expressway from South 170th Street.

Prior to 2014, the previous Cell-Phone Lot had approximately 100 spaces and was located west of Air Cargo Road and to the north of South 170th Street. Based on review of readily available studies and reports, the Consultant Team was unable to determine the parking utilization rates at the cell-phone lot.

Figure 7.3
Private Off-Airport Parking Lot Inventory (2014)

Vendor	Surface Lot or Garage	Estimated Capacity	Estimated Capacity for Airport	Shuttle Provided?
MVP Airport Parking	Lot	362	362	Y
Doubletree Inn Seattle Airport	Lot	852	2170	Y
WallyPark, Premier Garage	Garage	1,600	1,600	Y
MasterPark, Lot A	Lot	441	441	Y
WallyPark, Self-Park Lot 2	Lot	319	314	Y
WallyPark, Valet-Only	Lot	806	806	Y
Marriott Hotel Seattle Airport	Garage	529	na	Y
Clarion Hotel Seattle Airport	Lot	253	51	Y
Park N Fly Seattle	Lot	293	293	Y
Holiday Inn Seattle Airport	Garage	219	44	Y
Rodeway Inn	Lot	75	15	Y
Jet Motel	Lot	313	63	Y
Sea-Tac Inn & Airport Parking	Lot	116	23	Y
MasterPark, Lot B	Lot	2,237	2,237	Y
Red Roof Inn Seattle	Lot	52	10	Y
MasterPark, Valet Garage	Garage	1,000	1,000	Y
Ramada Inn & Suites SeaTac	Lot	132	26	Y
MPark	Lot	660	na	Y
MasterPark, Lot C	Lot	1,337	1,337	Y
Extra Car Airport Parking	Lot	359	359	Y
Ajax Parking, Lot 1	Lot	185	185	Y
Americas Best Value Inn	Lot	216	43	Y
Skyway Inn Airport Parking	Lot	295	59	Y
SeaTac Park.com	Lot	1,162	1,162	Y
Sandstone Inn Airport Parking	Lot	379	76	N
Super 8 Motel	Lot	295	59	Y
Thrifty Car Rental	Lot	924	924	Y
Sea-Tac Crest Motor Inn	Lot	140	28	Y
Aeroparking	Lot	380	n.a.	Y
E-Z Airport Parking	Lot	453	453	N
ShuttlePark2	Lot	1,051	1,034	Y
Knights Inn SeaTac Airport	Lot	36	na	Y
Ajax Parking, Lot 2	Lot	701	733	Y
Park N Jet, Lot 2	Lot	459	na	Y
Park N Jet, Lot 1	Lot	438	438	Y
	TOTAL SPACES	**19,069**	**14,345**	

Source: Port of Seattle 2014/Inventory of Existing Conditions Seattle-Tacoma International Airport, March 2015 (Leigh Fisher)

The new Cell Phone Lot resulted in the following notable changes/additions:

- The new relocated lot was relocated from Air Cargo Road to South 170th Street between the north and southbound lanes of the Airport Expressway;
- It provided 250 parking spaces, up from 100 spaces at the previous lot; and,
- The new lot is accessible via South 170th Street and a direct off-ramp from the Airport Expressway.

Airport Employee Parking Lots and Permits

As of 2017, Seattle-Tacoma International Airport provided jobs to 19,100 individuals, employed by the Port of Seattle, private vendors, airlines or by various service companies. Approximately 18.1% of these individuals (3,460 persons) reside in one of the Study Area Cities. Based on review of readily available studies and reports, the Consultant Team was unable to identify historic Airport employment trends, employee parking demands, utilization, and changing fees over the course of the study time period.

The Port of Seattle provides on-site parking locations for the Airport's employees at five main areas:

- North Employee Parking Lot (NEPL) – This is a new remote parking lot located north of the Airport runways along 24th Avenue South, providing 4,777 employee parking spaces. The Port of Seattle constructed this parking facility and opened it for use around 2000;
- South Employee Parking Lot (SEPL) – This is a collection of multiple surface lots that contain approximately 1,091 spaces dedicated for employee parking. This collection of lots is located south of the airport along 28th Avenue South between South 188th and 192nd Streets;
- Main Parking Garage – The first floor of the Main Parking Garage (adjacent from the terminal) provides 766 parking spaces dedicated to employee parking;
- At various air cargo areas – The hangers, offices, and operation buildings along Air Cargo Road have several isolated parking lots. The Port of Seattle reports do not include the parking space quantities for these areas; and,
- Main Parking Garage Toll Plaza – There is a small surface lot with 27 employee parking spaces adjacent to the Main Parking Garage Toll Plaza.

Employees that choose to park at one of the Airport's parking facilities must possess a permit and pay an associated fee. Specifically, employees that chose to park at an airport facility have three permit options:

- Standard Monthly Parking Pass ($76.00 per month) – Gives employees unlimited access to the Employee Parking lot and shuttle bus service;
- Carpool Value Pass ($30.00 per month) – Provides limited access to the NEPL and shuttle buses, and only allows permit holders to park in the NEPL up to eight days a month. This permit applies to employees who hold a One Regional Card for All (ORCA) transit card purchased by their employer; and,
- Employee Rider Pass ("R-Pass", $19.00 per month) – Does not allow employees to park in the NEPL but provides access to the employee parking shuttle buses.

Employees can deposit their monthly parking permit payments through an online payment portal, mail, or drop boxes distributed across the Airport property.

To access the remote parking lots, the Port of Seattle maintains a fleet of 16 buses dedicated to shuttling employees from on-and off-site offices/work zones to parking facilities. The shuttles operate 24 hours a day, every day, including holidays. Northbound stops are located at the south tunnel and at the north tunnel. Employees waiting at each stop experience an average headway of 10 minutes. R-Pass Permit holders using the

shuttle service must request a stop along Air Cargo Road. At the time of this analysis there was no information available for previous employee parking rates and pass options.

Airport Expressway

In 2007, the Port of Seattle began construction on the Airport Expressway to enhance circulation between terminal, parking facilities, and major roadways. The Airport Expressway is classified as a Port Arterial (otherwise classified as a limited access freeway) and is the primary roadway access to the terminal from State Route 518. Airport Expressway provides access to Air Cargo Road via South 170th Street; whereas, there is no northbound on-ramp from South 170th Street.

Airport Expressway included the following changes/additions:

- The northbound lanes just north of the main parking garage in the vicinity of South 170th Street were realigned approximately 450 feet to the east, creating a new location for the Cell Phone Parking Lot. This alignment coincided with Sound Transit's light rail extension to the Airport;
- Airport Expressway added a new flyover ramp for northbound vehicles to return south to the main terminal and parking garage. This flyover ramp is just south of South 160th Street; and,
- Airport Expressway enhancements also reconfigured ramps to South 170th Street and added a northbound ramp from South 160th Street which services exiting vehicles from the Consolidated Rental Car Facility.

Before the improvements to the Airport Expressway, those traveling along Air Cargo Road could not directly access State Route 518 via South 160th Street. Furthermore, there was not a continuous roadway option for northbound travelers to return to the terminal or parking garage.

Passenger Volumes and Trends

Since 1997, Seattle-Tacoma International Airport has doubled its total passenger volumes. In 1997, it averaged around 25 million passengers a year, and saw around 3.4 million through passengers (airline passengers that arrive at the airport and connect to another flight). By 2007, the passenger volumes increased by 21%, and through passengers only increased by around 300,000. By 2019, total annual passengers were 49.8 million passengers, with roughly 5 million through passengers.

In 2017, the Port of Seattle conducted a passenger survey to assess transportation mode trends. The results stated that up to 23% of survey participants visiting the Airport take single occupancy vehicles, and 31% take rideshare or a private car service. However, only 10% of survey participants indicated that they take light rail or bus services to the Airport.

Mobility Impacts

The Consultant Team identified the following potential impacts the changes to the Airport infrastructure may have contributed to the Study Area Cities and the Airport itself. These potential impacts were identified based on the analysis and findings in the preceding subsections. (The existence of inconclusive findings is also acknowledged based on the lack of readily available information through the Study process.)

- **Consolidated Rental Car Facility**

  The Consolidated Rental Car Facility changed rental car traffic from the terminal vicinity to South 160th Street and the northern segments of US Highway 99 near State Route 518. This shifted rental vehicle movements to this northern location. The Consolidated Rental Car Facility requires customers to access rental agencies via shuttle bus service that utilizes Air Cargo Road and South 160th Street, adding frequent shuttle bus movements to these roadways. No information could be found to determine the number of vehicle movements in and out of the Consolidated Rental Car Facility or pertaining to the annual volumes of rental car customers at this location. However, the remote rental location does require the continuous operation of a shuttle service between the terminal and the facility, which adds distance and travel time to potential customers arriving at the Airport.

- **Main Garage Expansion**

  The parking garage expansion increased parking capacity at the terminal by 3,000 spaces. Furthermore, the Consolidated Rental Car Facility freed up an additional 3,000 spaces at the garage. The increased parking capacity at the terminal accommodates more vehicles; and thus, promotes additional vehicle traffic on surrounding roadways. Additional study is necessary to determine historical and current parking occupancy and demand for the main parking garage. And additional study is necessary to determine whether parking rates affect Airport patrons' mobility choices and behavior (e.g., transit, rideshare or other modes). The parking garage does generate income from parking fees and additional parking capacity and availably may encourage additional vehicle traffic on internal roadways, thus contributing to traffic congestion at the Airport.

- **Private Airport Parking Lots**

  The privately-operated airport parking lots provide alternative parking choices. These lots reduce the number of personal vehicles entering the Airport, however, they create additional traffic patterns on roadways in the vicinity. Additional study is necessary to determine the vehicle movement patterns around the private airport parking lots, as well as occupancy and demand for each private airport parking lot. However, private parking lots do provide an alternative to the main garage at the Airport and could free up capacity. Concurrently, these facilities capture parking revenues that may otherwise go to the Port of Seattle.

- **Cell Phone Lot**

  The new Cell Phone Lot added capacity by 150 spaces from the previous lot and has a direct off-ramp for southbound traffic to access the lot before reaching the terminal. However, there is not a direct northbound on-ramp from the Cell Phone Lot onto Airport Expressway which requires northbound vehicles to use US Highway 99. The added capacity allows additional vehicles to wait at a central location to pick-up Airport passengers rather than circulating on area roadways. Additional study would be necessary to determine the number of vehicle movements in and out of the Cell Phone Lot, as well as the daily use, duration, and availability of parking spaces.

- **Employee Parking**

  The Port of Seattle constructed and opened the NEPL in 2000. This added parking capacity for Airport employees and added vehicle movements to 24th Avenue South and the adjacent roadways. Furthermore, a shuttle service provided continuous trips between the new employee lot and various drop off locations in and around the Airport. Additional study is necessary to determine the number of vehicle movements in and out of the employee parking lots, the historical and current parking occupancy and demand for the employee parking lots; parking capacity pertaining to future Airport employee projections, or employee parking locations prior to the NEPL's opening in 2000. However, the NEPL and SEPL requires operation of a shuttle bus service, not only contributing to an employee's commute time but also requiring an ongoing capital expense to maintain the service. The Port must also manage its existing own parking permit program.

- **Airport Expressway**
  The roadway modifications to the Airport Expressway included additional ramps on the South 160th and South 170th Street which added additional routes for area vehicles. At the same time, the new ramp on South 160th Street allows vehicles exiting the Consolidated Rental Car Facility to have direct access to the expressway and regional highway connections. The Airport also doubled its passenger volumes since 1997, increasing mobility demands on the regional transportation networks including roadways and transit services. Additional study would be necessary to accurately determine the passenger transportation modes to and from the airport since 1997.

C. GROUND TRANSPORTATION INFRASTRUCTURE

The roadway network infrastructure changes from 1997 to the present were researched to determine what impacts Airport-related traffic may have on the local network. Historic vehicle count data at key intersections and roadways in the Study Area Cities was reviewed, including infrastructure changes to roadways and intersections, and an assessment of the impacts of these changes on the local and regional roadway network. This helps to understand evaluate vehicle flow, congestion, and segments in proximity to the Seattle-Tacoma International Airport and regional network. The same roadway intersections were also included from the 1997 Seattle-Tacoma International Airport Impact Mitigation Study. This section also provides high-level recommendations based on the data collected and observed impacts.

Trendline Analysis

Major roadways evaluated in this analysis are included in Figure 7.4. The Consultant Team focused on improvements to major thoroughfares that affect regional mobility and connections to/from the Airport; whereas, smaller local street improvements were not examined.

Overall, roadway improvements along major arterials appear to have been focused on lane expansion and accommodations for various modes of transit including light rail, bus services, and bus rapid transit as well as pedestrian accommodations. Among these transit-related improvements include the implementation of more high-occupancy vehicle (HOV) lanes dedicated for transit and personal vehicles with at least two passengers, which can create a more reliable transit service and better connect roadways to transit centers. Other transit improvements included the light rail expansion, which helped to connect the airport to the cities of SeaTac, Tukwila, and Seattle.

Roadways have also been constructed/expanded on the Airport property to accommodate new facilities such as the expanded Main Parking Garage, Cell Phone Parking Lot, transit stations, and the Consolidated Rental Car facility. By reconstructing and realigning roadways on the Airport property, the Airport is better connected to the regional transportation network and surrounding communities.

Improvements constructed between 1997 and 2007 primarily focused on major roadway widening, adding local roads adjacent to the Airport, and adding HOV facilities on major arterials to accommodate transit services.

Improvements between 2008 and 2019 T focused on adding more on-and off ramps to state routes, adding connections to critical arterials in the local roadway network, and implementing streetscape improvements to accommodate transit, bicycle, and pedestrian modes. A list of all major roadway improvements is detailed in Figure 7.5.

Most changes occurred on the eastern side of Seattle-Tacoma International Airport, including Military Road South, 28th Avenue South and 24th Avenue South. Another important infrastructure change included the addition of on-and off-ramps around State Route 518 and Des Moines Memorial Drive, creating direct access from a State Route to local roads surrounding the Airport.

Figure 7.4
Key Roadways in the Study Area

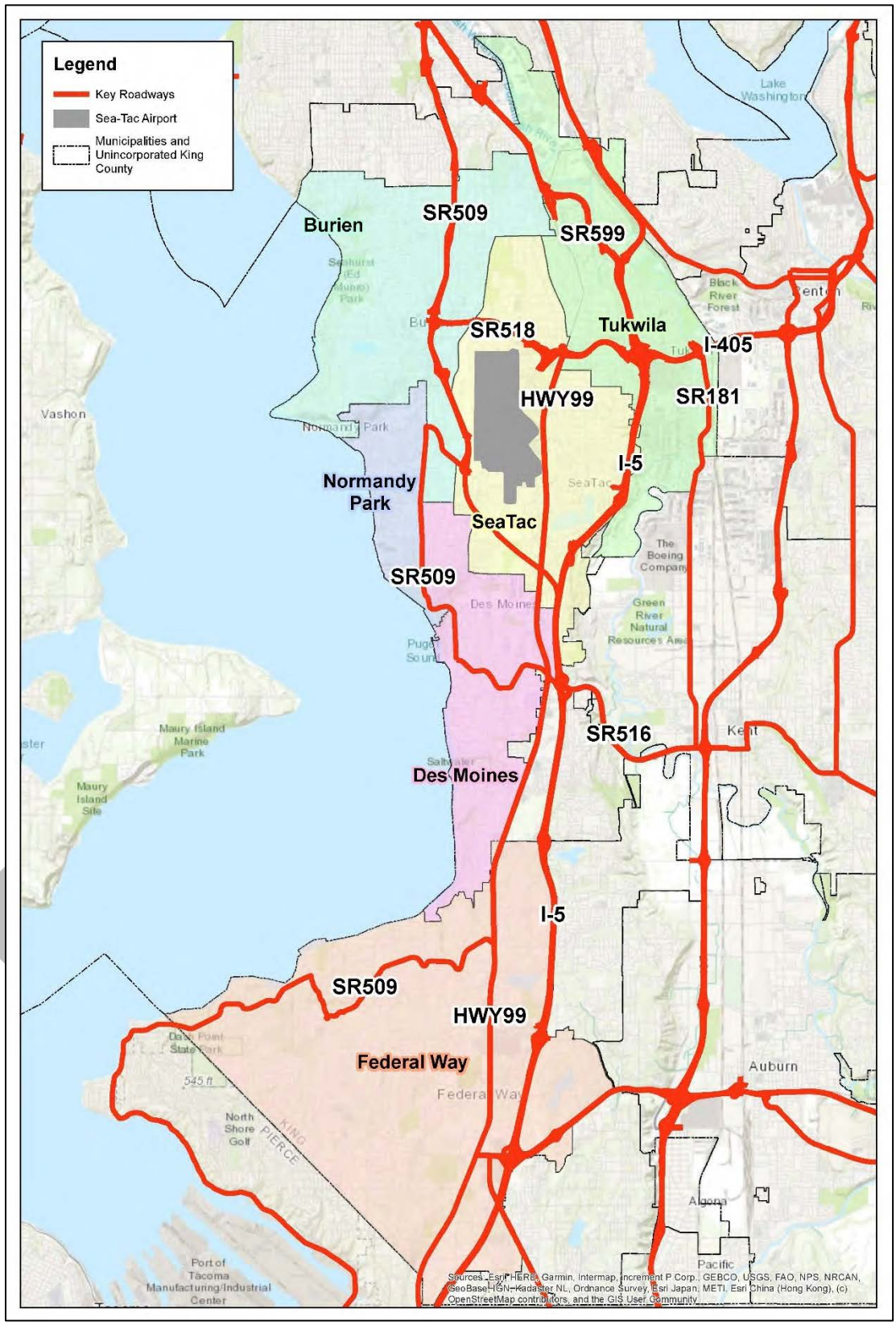


Figure 7.5
Major Roadway Improvements Surrounding Seattle-Tacoma International Airport: 1997-2019

Roadway Project	Details
28th Avenue South	▪ Widened lanes at South 200th Street and 28th Avenue South. ▪ Completed in early 2000's.
US Highway 99	▪ Added HOV lanes in mid-1990's. ▪ Widened roadway between 2005 and 2006 to accommodate sidewalks, landscaping, and pedestrian facilities. Added southbound HOV lanes. ▪ Completed in early 2000's.
IH-5/405 Transit/HOV Bypass	▪ Added an HOV bypass lane at the IH-5 and IH-405 interchange in both the southbound and northbound directions. ▪ Provides by-pass lanes for transit and HOVs through the interchange.
Airport Expressway	▪ Added a new regional expressway reconfiguration, 3 to 5 travel lanes, and northbound on-ramp near the terminal. ▪ Completed around 2007.
Federal Way Transit/ HOV direct on-ramp	▪ Added on-ramp, highway overpass/bridge, and roundabout at 28th Avenue South and South 317th Street. ▪ Provides direct access to IH-5 from the transit center via a HOV lane/ on-ramp.
Des Moines Memorial Drive Ramps	▪ Added a new two-lane off-ramp from eastbound State Route 518 to Des Moines Memorial Drive (improved both freight and vehicle access). ▪ Relocated southbound ramp to create a connection to eastbound State Route 518. ▪ Removed left turn lane and relocated northbound ramp to more easily connect to eastbound State Route 518. ▪ Completed in 2017.
Military Road South Improvements	▪ Improved Military Road South between South 176th Street to South 166th Street. ▪ Reconstructed roadway to accommodate continuous center turn lane, curb, gutter, drainage, lighting, signal timing, underground utilities, and landscaping improvements. ▪ Completed in 2015.
South 154th Street Improvements	▪ Constructed eastbound and westbound sidewalks and bicycle facilities ▪ Reconstructed travel lanes and added new turning lanes ▪ Completed in 2014
28th Avenue South to South 24th Avenue South Connection	▪ Connect 28th Avenue to 24th Avenue South. ▪ Add roadway between South 200th Street to South 208th Street. Consisted of landscaped median, 2 northbound lane, and 2 southbound lanes. ▪ Add northbound and southbound elevated shared pathway. ▪ Completed in 2018.
24th Avenue South	▪ Widened lanes on 24th Avenue South from South 208th Street to South 216th Street. ▪ Provided additional travel lanes, bicycle lanes, curb, gutter, and sidewalks. ▪ Completed in 2014.
South 216th Street	▪ Added a continuous center turn lane, bicycle lanes, transit stops, curb, gutter, and landscaping improvements, and sidewalks. ▪ Completed in 2014.

Traffic Data History 1997 to 2019

Traffic data was reviewed for 1997 to 2019 as available. Data included Annual Average Daily Traffic (AADT) trends on key regional roadways, Vehicles Per Day (vpd) data, Level of Service (LOS), and vehicle delay at critical intersections and segments around the Airport. 1997 data and highlighted intersections detailed in the Table 3.1.3.c. are pulled from the 1997 Seattle-Tacoma Impact Mitigation Study and were used as a baseline for comparing traffic changes.

The Consultant Team reviewed publicly available data from the WsDOT and the 2015 City of SeaTac Transportation Master Plan; whereas, the SeaTac Transportation Master Plan had data that better aligned with the intersections from the 1997 Seattle-Tacoma Impact Mitigation Study. Moreover, the WsDOT data showed traffic volume changes in the region but focused less on the Airport. This was important to acknowledge that traffic has been increasing around the region and potentially independent of the Airport growth and expansion.

After reviewing publicly available WsDOT AADT traffic count data from 2005 to 2018, the Consultant Team discovered that the locations of traffic count meters during this timeframe for intersections, approaches, and ramps were in scattered locations and inconsistent. Historic and current WsDOT AADT traffic section data (as opposed to the traffic count data) were also reviewed to better understand traffic trends on major roadways in the region. WsDOT collects traffic section data using traffic counts located at different "mileposts". Sections along roadways are then created between various mileposts. WsDOT traffic count data includes historic and current traffic data located at specific points along roadways. Roadways containing WsDOT traffic section data reviewed in this section include US Highway 99, State Route 509, State Route 599, State Route 518, State Route 516, State Route 181, IH-5, and IH-405.

- **2005 Baseline**

  The Consultant Team used readily available WsDOT AADT from 2005 as a baseline to compare traffic volume increases on the state roadways around the Airport. As seen in Figure 7.7, most major roadways experienced an AADT of 25,000 to 50,000. Following are observations for notable highways near Seattle-Tacoma International Airport in 2005.

  State Route 509 functioned well, as it saw AADT volumes of around 10,000. IH-5 experienced volumes of approximately 150,000 to 250,000. Roadways containing volumes like these are categorized as "high volume routes". The IH-5/IH-405 Interchange and approaches experienced AADT volumes between 75,000 to 150,000.

- **2018 Comparison**

  In 2018, AADT on major roadways slightly increased. As seen in Figure 7.8, most roadways saw a maximum of 75,000 AADT, with a few exceptions:

  - US Highway 99 and State Route 509 experienced AADT volumes between 25,000 to 50,000.
  - State Route 518 experienced between 50,000 and 75000 AADT.
  - AADT at the exits at State Route 518, and US Highway 99 and State Route 518 approaches to US Highway 99 increased to 50,000 to 75,000.
  - Most of IH-5 in the Study Area experienced 200,000 to 260,000 AADT.
  - IH-405/State Route 518 around the IH-5 and IH-405 interchange saw between 100,000-150,000 AADT, which is also considered as a "high volume route".

Figure 7.6
2009 Average Annual Daily Traffic

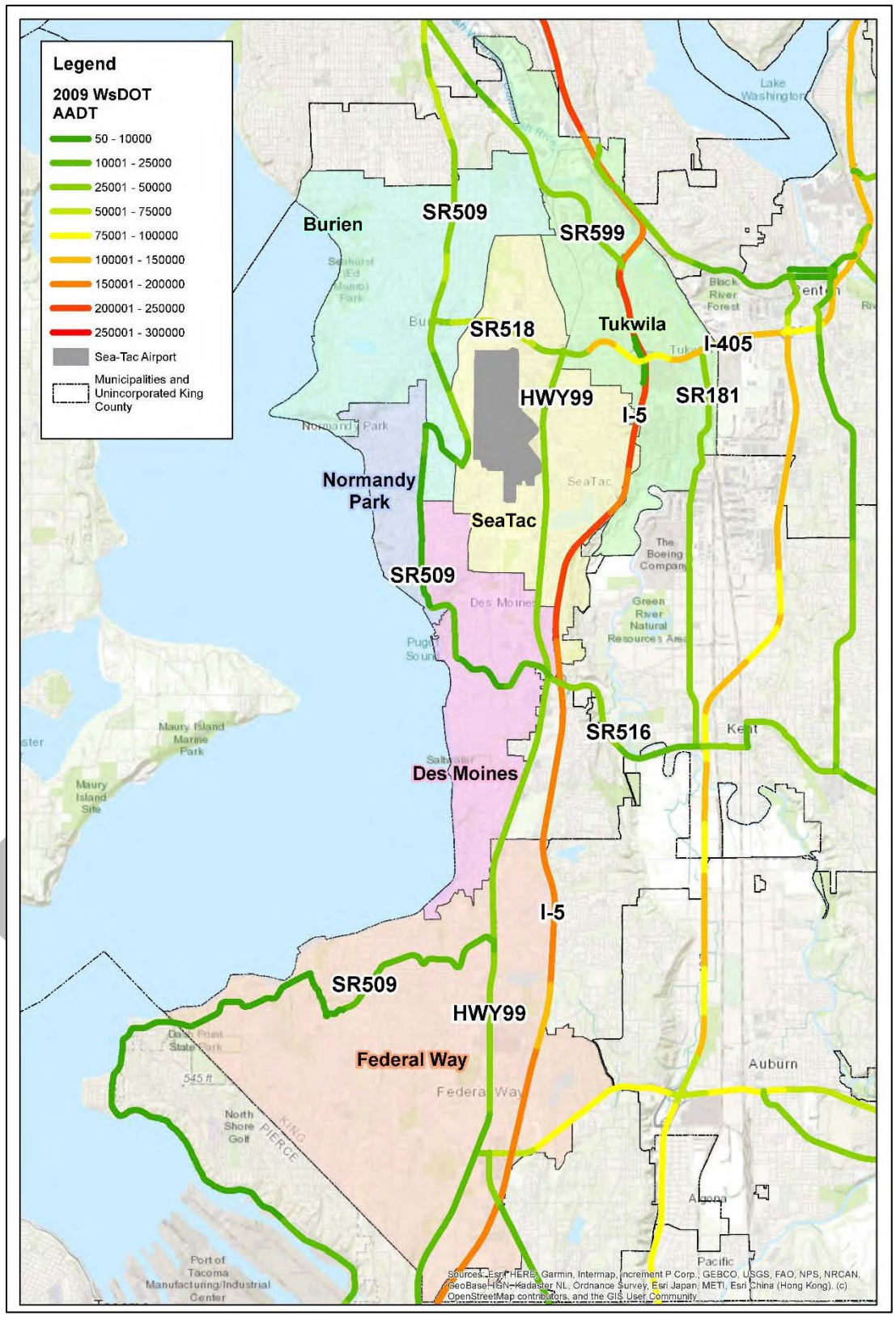
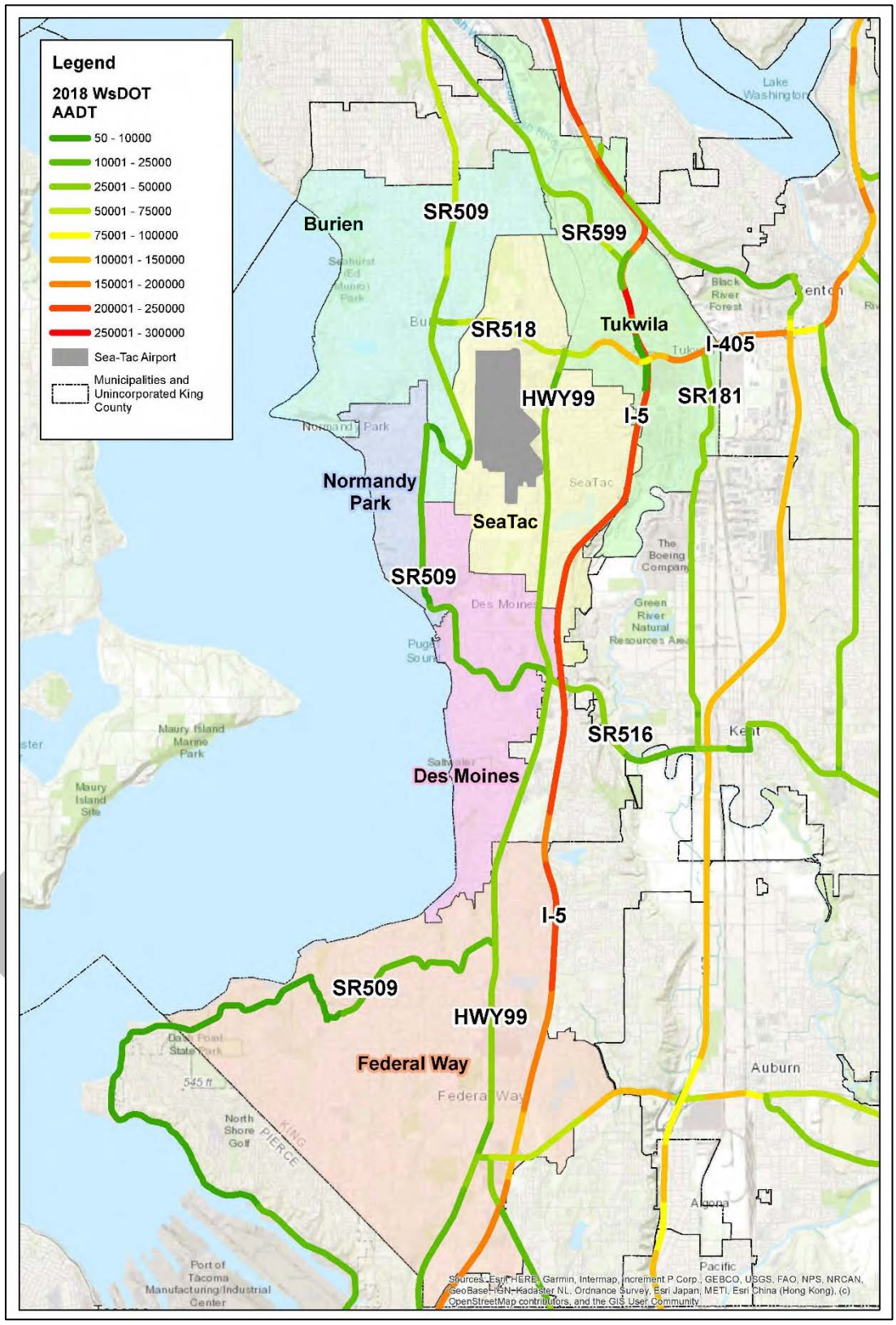


Figure 7.7
2018 Average Annual Daily Traffic



The City of SeaTac Transportation Master Plan also provides observations on traffic congestion data on key arterials in and around the Airport. This Master Plan data focused on the 2011-2013 timeline. The following lists notable observations.

- Between 2011-2013, US Highway 99 between South 150th Street and South 216th Street saw approximately 25,600 vpd;
- Volumes increased to around 30,000 to 35,000 vpd between State Route 518 and South 200th Street;
- US Highway 99 south of South 200th Street experienced lower volumes of around 28,300 vpd;
- On the west side of the Airport, the northern portion of Des Moines Memorial Drive South experienced lower volumes than US Highway 99 during 2011-2013, seeing around 7,000 vpd. The southern section of Des Moines Memorial Drive South (south of State Route 518) saw increased volumes of almost 9,000 vpd, as it is a primary connection to State Route 518 and the City of Burien;
- The northern segment of the Airport Expressway (below State Route 518), saw more than double the amount of traffic volumes of US Highway 99, with about 58,000 vpd. These are like the volumes collected in 2011-2013 on State Route 509 and State Route 518.
- Larger roadways such as IH-5 (south of IH-405 to Military Road) displayed consistent traffic volumes of around 202,000 to 204,000 vpd during 2011-2013. This is more than 50% above the projected AADT seen in the 1997 Baseline Impact Study, which projected that the Airport would experience 130,000 AADT by the year 2020. However, the projection stated in the Baseline Impact Study does not specify what roadways were considered within the "Airport" traffic analysis.

In the above analysis, the most recent traffic data pulls from publicly available local transportation mitigation plans.

Vehicle Delay and Level of Service

Vehicle delay and level of service data provide insight on traffic congestion issues at key locations and roadway segments in a transportation network, as well as highlight areas that experience high or low traffic. A Level of Service (LOS) category is a measurement of speed, travel time, comfort, and delay that helps understand traffic flow and operations within a transportation network. Figure 7.8 provides an overview of the Highway Capacity Manual Level of Service categorization used for the current data. Signalized intersections use average delay per vehicle, whereas unsignalized intersections use average delay per vehicle of the worst approach in an intersection during the peak hour of traffic to determine the Level of Service category.

Figure 7.8
Level of Service Methodology and Description

LOS	Control Delay (per vehicle)	Description
A	10	Free Flow
B	>10-20	Stable flow (slight delays)
C	>20-25	Stable flow (acceptable delays)
D	>35-55	Approaching unstable flow (tolerable delay, occasional wait through more than one signal)
E	>55-80	Unstable flow (intolerable delays)
F	>80	Forced flow (jammed)

Figure 7.9
Study Area Adopted Level of Service Standards

Jurisdiction	Level of Service Standards by Facility or Area
WsDOT	▪ Highway of Statewide Significance (HSS) Facilities – LOS "D" or better in urban areas ▪ HSS Facilities in rural areas – LOS "C" or better
City of Burien	▪ Roadways within Urban Center – LOS "E" ▪ Roadways designated as auto/truck priority routes – LOS "D" ▪ All other roadways – LOS "D"
City of Des Moines	▪ All roadways – LOS "D" or better (based on the AM or PM peak hour) ▪ Selected intersections along major arterials and in the marina District – LOS ""E" or "F"
City of SeaTac	▪ Principal or minor arterials – LOS "E" or better ▪ Collector arterials and lower classification streets – LOS "D" or better
City of Tukwila	▪ Non-residential arterial intersection – LOS "E" ▪ Minor and collector streets in residential areas – LOS "D" ▪ Corridors in the Southcenter area – LOS "E"

The Level of Service analysis completed in the transportation chapter of the 1997 Seattle-Tacoma Impact Mitigation Study were pulled from the 1994 Airport Environmental Impact Statement (EIS). Findings from the 1994 EIS state that entry points surrounding the Airport functioned at a Level of Service "F", which signifies poor traffic conditions. Most of the intersections that displayed poor level of service are located on the eastern side of the Airport. Other intersections located on the western side of the Airport experienced acceptable levels of service (LOS "A" to "B"). The current (2014) Level of Service and delay data used in Figure 7.9 use the methodologies and ranking system from the Highway Capacity Manual from the Transportation Research Board. It reflects PM peak hour data for both signalized and unsignalized intersections. WsDOT, and the cities of Burien, Des Moines, SeaTac, and Tukwila have adopted LOS standards for key arterials in the region and in their communities. The adopted LOS standards for each municipality and WsDOT are listed in Figure 7.8 (above). Setting LOS standards promote roadways that encourage the use of alternative transportation modes, as well as consider the limitations of redesigning and reconstructing roadways.

Figure 7.10 provides a comparison of Operating Level of Service and average delay per vehicle at key intersections and along roadway segments surrounding Seattle-Tacoma International Airport, which also provides an analysis of the change in these traffic measurements since 1997. (The 1997 traffic data pulls from the 1997 Seattle-Tacoma Impact Mitigation Study and the 2014 data is pulled from the City of SeaTac's 2015 Transportation Master Plan.) LOS categorizations represent the existing operations (as of 2014) as defined by the Highway Capacity Manual – they do not represent municipal and state agency adopted level of service standards.

Key intersections and roadways such as IH-5, US Highway 99, State Route 518 and State Route 509 experienced an increase in the traffic data reviewed by the Consultant Team. Des Moines Memorial Drive, Military Road, and 28th Avenue South saw notable increases in average delay between 1997 and 2014. AADT data reviewed from 2009 and 2018 convey that IH-5 and major interchanges in the study area experienced high AADT volumes.

Figure 7.10
Level of Service and Vehicle Delay at Critical Traffic Segments

Intersection Number and Name	1997		2014		Impacts	
	Average Delay (sec./veh.)	Operating LOS	Average Delay (sec./veh.)	Operating LOS	Average Delay Change	LOS Change
SB State Route 509 ramps at State Route 518	10.7	B	- - -	- - -	- - -	na
NB State Route 509 ramps at State Route 518	1.8	A	- - -	- - -	- - -	na
US Highway 99 and South 154th	34.8	D	46	D	32%	Neutral
US Highway 99 and South 160th	21.1	C	28	C	33%	Neutral
US Highway 99 and South 170th	60.8	F	43	D	-29%	Improved
US Highway 99 and South 176th	18.8	C	28	C	49%	Neutral
US Highway 99 and South 180th	15.9	C	- - -	- - -	- - -	na
US Highway 99 and South 188th	247.4	F	68	E	-73%	Improved
US Highway 99 and South 192nd	- - -	F	10	A	- - -	na
US Highway 99 and South 200th	37.7	D	58	E	54%	Worsened
US Highway 99 and State Route 518	49.4	E	11	B	-78%	Improved
24th Avenue South and South 154th/156th	8.1	B	9	A	11%	Improved
Des Moines Memorial Drive South and South 15Sth Street * (2011)	**7.6**	**B**	**33**	**C**	**334%**	**Worsened**
Des Moines Memorial Drive South and South 160th Street	6.8	B	8	A	18%	Improved
NB State Route 509 ramps at South 160th St.	- - -	C	- - -	E	- - -	Worsened
SB SR 509 ramps at South 160th St.	- - -	E	- - -	E	- - -	Neutral
Air Cargo Rd. and South 160th Street	5.1	B	- - -	- - -	- - -	Neutral
Air Cargo Road at SB Airport Expressway Ramps	- - -	D	- - -	- - -	- - -	Neutral
Air Cargo Rd. and South 170th Street	15.8	C	- - -	- - -	- - -	Neutral
NB Airport Exp. and South 170th St.	- - -	C	- - -	- - -	- - -	Neutral
SB SR 509 and South 188th St. (2018)	- - -	A	- - -	E	- - -	Worsened
Des Moines Memorial Drive and South 188th Street (2013)	12.6	B	27	C	114%	Worsened
28th Avenue South and South 188th St.	**12.6**	**B**	**30**	**C**	**138%**	**Worsened**
Military Road and South 188th St. (2013)	27.9	D	30	C	8%	Worsened
SB IH-5 ramps and South 188th St. (2018)	15.0	C	34	C	127%	Neutral
NB IH-5 ramps and South 188th St. (2018)	28.1	D	35	C	25%	Improved
Des Moines Memorial Drive South and South 200th Street (2013)	**9.1**	**B**	**18**	**B**	**98%**	**Neutral**
Des Moines Memorial Drive South and Marine View	8.3	B	- - -	C	- - -	Worsened
28th Avenue South and South 200th	- - -	C	- - -	- - -	- - -	na
Military Road and South 200th Street (2013)	**8.2**	**B**	**56**	**E**	**583%**	**Worsened**
Military Road and NB IH-5 ramps (2013)	- - -	C	18	B	- - -	Improved
28th Avenue South and South 192nd Street (2011)	3.6	A	- - -	- - -	- - -	na
SB IH-5 ramps and State Route 516	27.6	D	- - -	- - -	- - -	na-

Potential Impacts

The Consultant Team identified the following potential impacts the changes to roadway infrastructure and traffic congestion may have contributed to the six surrounding communities (regional) and to Seattle-Tacoma International Airport itself. These potential impacts were identified based on the analysis and findings of the data available from 1997 to 2019, but it is also acknowledged that there are some inconclusive findings due to the lack of readily available information through the study process.

- **General Roadway Infrastructural Changes**

  Since the early 2000s, state agencies and communities within the Study Area have invested in prioritizing infrastructure projects that accommodate bus services and multimodal elements such as sidewalks and bicycle lanes. By investing in transit and multimodal infrastructure, transit becomes a more viable option for passengers and commuters especially for those who live in the study area communities. Providing dedicated lanes for transit creates a more reliable service that can more easily access the region, including significant destinations such as the Airport and Downtown Seattle. Moreover, the increase in HOV lanes create less congestion for bus transit services.

  However, the Study's findings are inconclusive due to the following data gaps:

  - No consolidated database exists that contains information on historical and current capital improvements in the Airport area; whereas, AADT and LOS data are located at multiple sources.
  - No consolidated report or online portal exists that documents completed projects since 1997 related to roadway infrastructure in the study area; whereas, data is located at multiple sources.

- **General Traffic Congestion Changes**

  There is a general regional perception that traffic is congested during peak hours along major roadways. Roadways in the Cities of Des Moines and SeaTac adjacent to Seattle-Tacoma International Airport – such as US Highway 99 – experienced high volumes of vehicles per day from 2011 to 2013. From 2009 to 2018, AADT increased on IH-5 south of the IH-5/IH-405 interchange, as well as along the segment of State Route 509 that parallels Seattle-Tacoma International Airport. Traffic volumes also increased on US Highway 99 between State Route 518 and South 170th Street, this occurred around the time of the completion of the Consolidated Rental Car Facility. From 2009 to 2018, traffic volumes north of State Route 518 in Burien and SeaTac along State Route 509 and State Route 599 increased, whereas volumes around southern Des Moines and Federal Way remained consistent.

  However, the Study's findings are inconclusive due to the following data gaps:

  - No information could be found on LOS and delay data for specific, key intersections in the Study Area.
  - No information could be found containing traffic information and/or reporting mechanism for key intersections in the vicinity of Seattle-Tacoma International Airport.
  - Historical and current AADT data is inconsistent, as traffic count meters have been placed in different locations from the baseline year to present day which could reflect inaccurate counts.

- **Average Vehicle Delay & Level of Service Changes**

  Overall, average vehicle delay and LOS have increased since 1997. The most significant locations (as seen in have exhibited an average of an 85% increase in average vehicle delay. However, LOS tends to increase by only 1 to 2 levels. Des Moines Memorial Drive has experienced a high increase in average vehicle delay, which could be due to the infrastructural changes to on-and off-ramps on State Route 518 at State Route 509 and Des Moines Memorial Drive. Vehicles now have easier access to local roads, therefore creating a local cut-through route that can impact Burien and other surrounding neighborhoods.

However, the Study's findings are inconclusive because no information could be found on LOS and delay data for specific, key intersections in the Study Area for both mid-and current timeframes.

- **Vehicle Circulation**

  Improvements to on-and off-ramps and physical connections to local, minor roads can create less circuitous routes for those traveling by high occupancy vehicles and transit. Instead of using standard on-and off-ramps at major roadway interchanges, transit and carpool vehicles now have the option to use new and/or improved on-and off-ramps that prioritize HOVs. This allows local HOVs and transit to use more local roads to access housing areas, attractions, and/or places of employment.

- **Continuous Center Turn Lanes**

  WsDOT and other communities have been implementing continuous center lanes on major roadways. Adding continuous center lanes along roadways such as at Military Road South can improve congestion as left-turning vehicles do not block traffic in through lanes. Also, adding continuous center lanes promotes slower vehicle speeds as vehicles in opposite lanes usually decelerate for turning vehicles. This could also impact crash rates, as continuous center turn lanes can reduce head-on collisions and act as a temporary dedicated lane for emergency vehicles.

- **Airport Expressway and Air Cargo Road**

  Changes to both the Airport Expressway and Air Cargo Road have generated impacts on vehicle circulation in the micro-roadway network at the Seattle-Tacoma Airport. Those traveling along Air Cargo Road now have direct access to the Cell Phone Parking Lot, 24th Avenue South, Departures Drive, and the Consolidated Rental Car Facility as opposed to using US Highway 99. It also provides shuttles and vehicles with a less circuitous route to access the Main Parking Garage. Employees parking in both the Northern Employee Lot and southern lots have the Airport Expressway as a local road to easily travel between airport facilities.

  However, the Study's findings are inconclusive because no current information could be found on vehicle delay, level of service or AADT for these roadways.

- **Consolidated Rental Car Facility**

  The relocation of the Consolidated Rental Car Facility has an impact on both traffic generation, distribution, and circulation. The relocation of the facility has generated a passenger shuttle, which now connects passengers from the rental car facility to the terminal. Although increased congestion could occur at exit points around the facility, traffic is now diverted from the Main Airport Garage to a more northern location. The proximity of the facility to State Route 509, US Highway 99, and State Route 518 connect vehicles to the regional network more easily than before the relocation from the Main Airport Parking Garage.

  However, the Study's findings are inconclusive due to the following data gaps:

  - No information could be found on passenger shuttle circulation routes.
  - No information could be found on the rental car vehicle use per day, especially during AM and PM peak hour times at Seattle-Tacoma International Airport.

- **Link Light Rail Airport Station**

  The implementation of the Link Light Rail to the Airport/SeaTac, Tukwila, and Angle Lake Stations in 2009 and 2016 provided transit riders with direct, quick access to Seattle-Tacoma International Airport and Downtown Seattle. As opposed to Bus Rapid Transit or other bus services, passengers now have the opportunity to use light rail to travel to and from Seattle-Tacoma International Airport. Although trip generation data is not publicly available, it is important to note that the implementation of these stations most likely provided benefits for traffic congestion in local communities.

However, the Study's findings are inconclusive because no information could be found on direct trip generation from the construction of both stations

- **Rideshare and Shuttle Services**
  With the increase of rideshare services (e.g., Lyft and Uber) and shuttle services at both a local, regional, and national scale, single-occupant vehicles are becoming more prominent at popular pick-up and drop-off points. If rideshare/shuttles do not have a streamlined pick-up and drop-off and wayfinding system, rideshare vehicles can be diverted onto local roads and create congestion at major bottleneck locations along roadways such as Arrivals and Departures Drive.

  However, the Study's findings are inconclusive due to the following data gaps:
  - No information could be found on traffic congestion and/or crash data related to rideshare services.
  - No information could be found on circulation routes and AM and PM peak hour traffic counts for rideshare services a1nd shuttle buses/airporters.

D. TRANSIT INFRASTRUCTURE

The Consultant Team reviewed transit service and infrastructure changes in and around Seattle-Tacoma International Airport from 1997 to 2019. This has increased substantially since 1997 which included light rail, express bus, bus rapid transit, and local bus services.

Service and infrastructure changes related to Sound Transit, King County Metro Bus Rapid Transit (RapidRide) and their associated facilities were noted. Additionally, private transport service to Seattle-Tacoma International Airport was also reviewed.

Current Transit Service

There are multiple public transit options to access Seattle-Tacoma International Airport. Figure 7.11 shows the public transit routes serving the area:

- **King County Metro**
  King County Metro Routes 124, 156, 180, and RapidRide Line A provide transit service directly to or near Seattle-Tacoma International Airport. Routes 156, 180, and RapidRide Line A have stops on US Highway 99 near the Airport entrance; whereas, 180 and RapidRide provide the most frequent bus service, each providing over 110 combined inbound and outbound daily trips. Route 124 provides service directly to the terminal during late night periods (after 1:00 AM). In addition, Route 128 and RapidRide F connect to the Tukwila (light rail) Station and passengers can transfer to light rail or RapidRide Line A to reach the terminal.

- **Sound Transit**
  Sound Transit provides transit service to Seattle-Tacoma International Airport via the Link Light Rail and express bus Routes 560 and 574. The express buses load/unload near the south end of the terminal. Route 574 services Lakewood, Tacoma, Federal Way, and Sea-Tac and Route 560 serves Burien, Renton, and Bellevue. The Link Light Rail has three stations in the service area – the Tukwila Station (1.3 miles north of the Airport), the Airport/SeaTac Station (east of the main parking garage), and Angle Lake (1.2 miles south of the Airport). The Link provides 6-minute headways during peak, weekday commuting hours and 12-minute headways on the weekends. Sound Transit service routes average 72 combined inbound and outbound daily trips.

Figure 7.11
Public Transit Routes

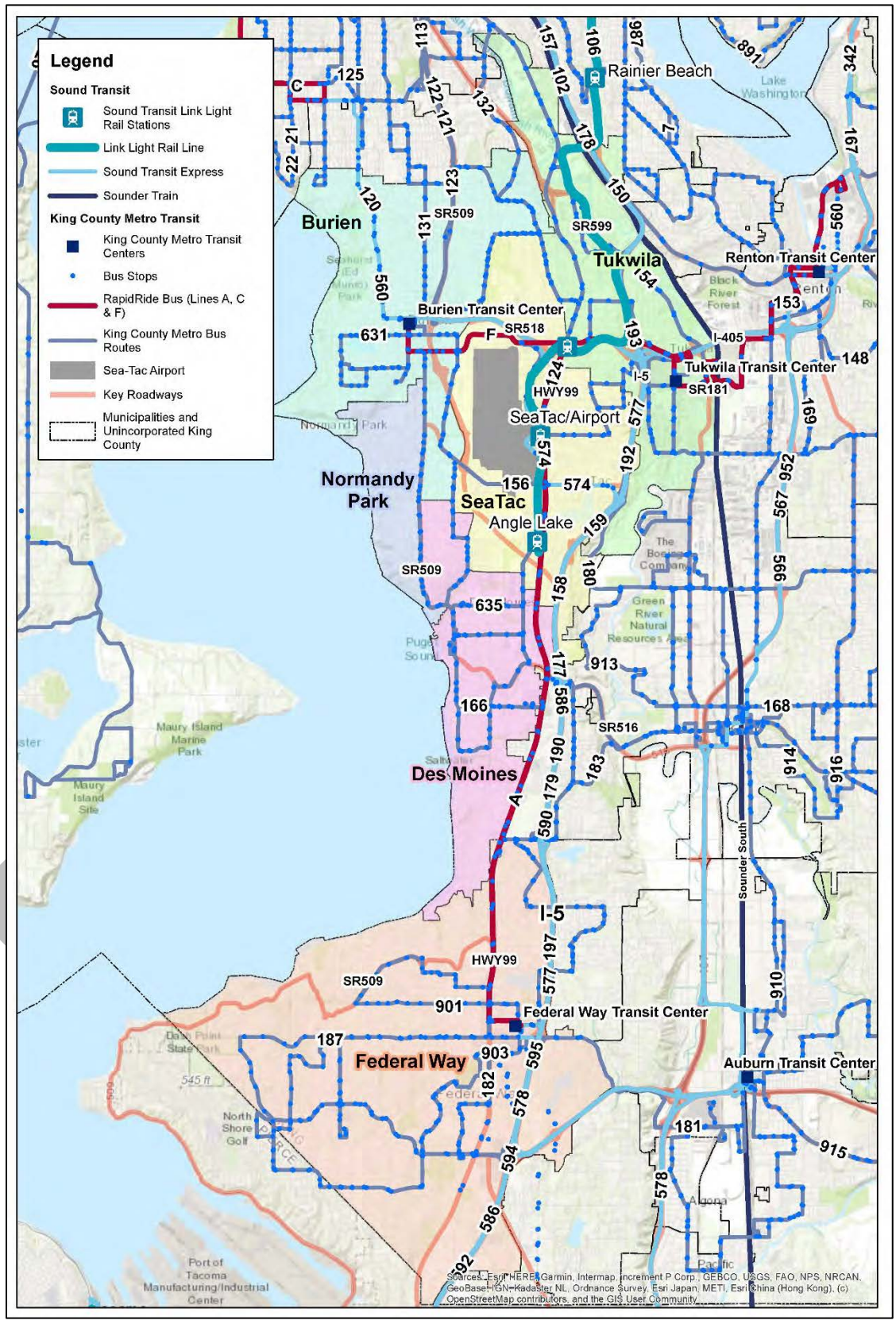


Figure 7.12
King County Metro Routes

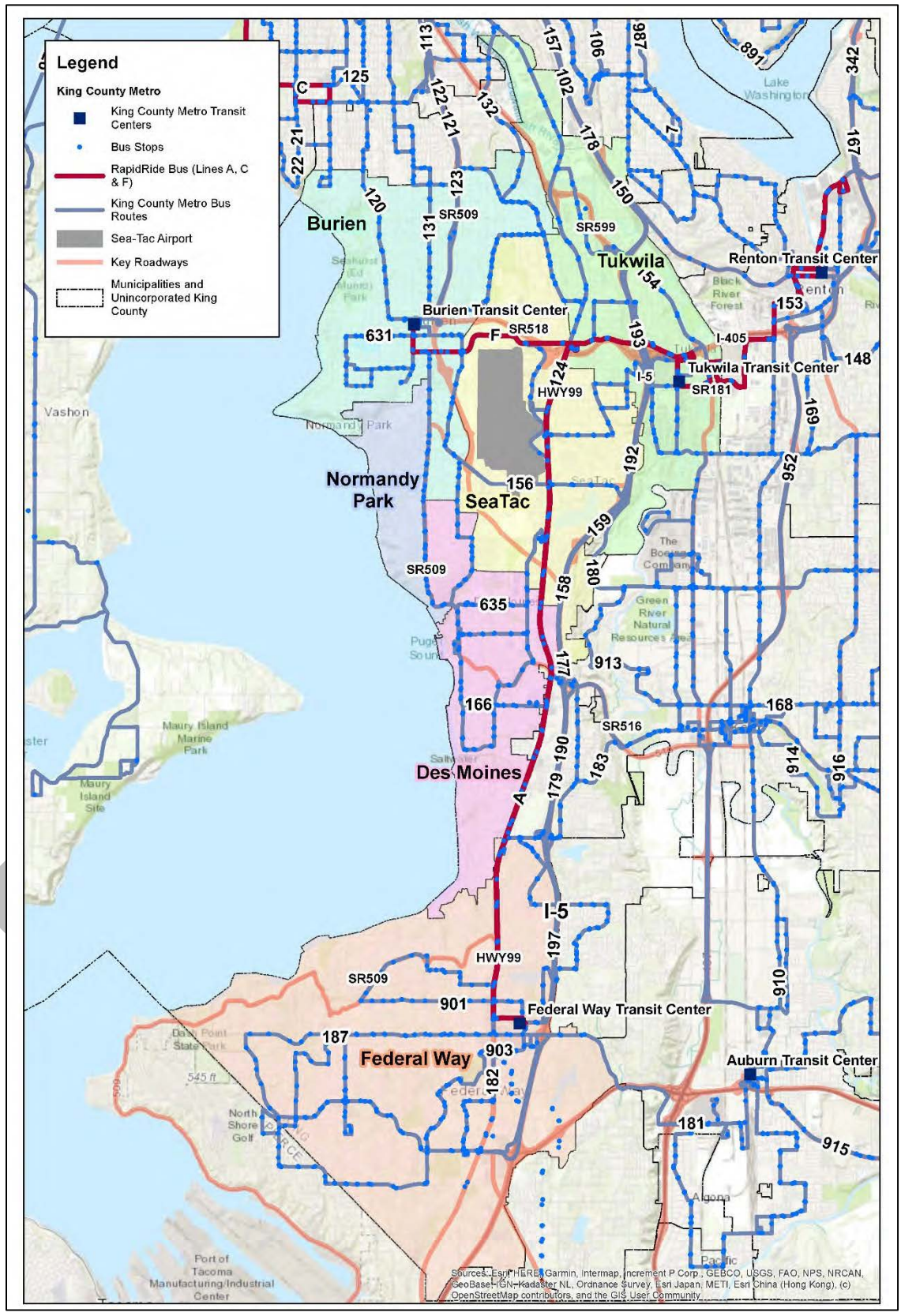
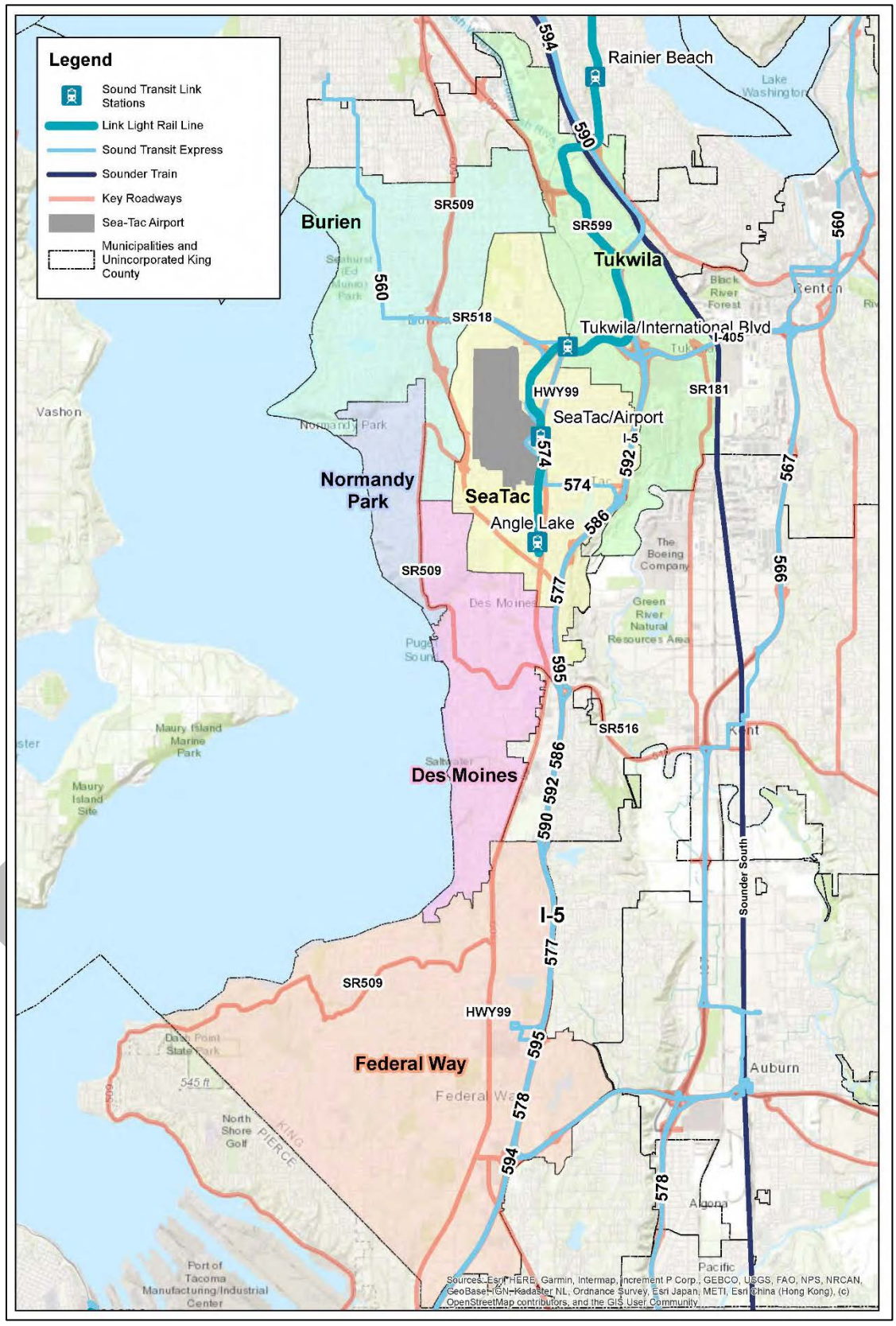


Figure 7.13
Sound Transit Routes



- **Private Transport Services**

  As of 2014, there were 10 regularly scheduled private transport services that provided transportation to the Airport from outline regional designations including communities in Washington, and British Columbia. These private transport services use vans and buses to transport passengers for a fee and utilize designated loading/uploading locations at the Airport. The Port of Seattle documents and reports did not provide detail pertaining to schedule times, frequency, or user fees. Figure 7.14 summarizes the operator names, destinations, and service commencement. Based on review of readily available studies and reports, the Consultant Team was unable to identify passenger demand and utilization for the private transport service operators during the study time period.

Figure 7.14
Private Transport Service Operators

Operator	Destination	Year Started
Bellair Airport Shuttle	Bellair Airport Shuttle Alaska Ferry Terminal, Anacortes, Bellingham. Blaine, CleElum, Ellensburg, Ferndale, La Conner, Marysville, Mt. Vernon, Stanwood, Yakima	1985
Bremerton-Kitsap	Bangor, Bremerton, Gig Harbor, Gorst, Port Orchard, Poulsbo, Purdy, Silverdale, NW Tacoma	1979
Capital Aeroporter	Auburn, Bonney Lake, Centralia, Chehalis, Federal Way, Fife, Kent, Lacey, Lakewood, Olympia, Parkland, Puyallup, Shelton, Steilacom, Tacoma, Tumwater, Union	1972
Ft. Lewis-McChord (services provided by Bremerton-Kitsap & Capital Aeroporter)	Joint Base Lewis McChord	1972/1979
Island Airporter	San Juan Island	2003
Olympic Bus Line (operated by Greyhound Lines)	Port Angeles, Sequim, Port Townsend, Discovery Bay, Kingston	~2010
Quick Shuttle	Vancouver, BC, Canada	1987
Vashon	Vashon Island	1996
Wenatchee Valley	Wenatchee	2012
Whidbey-Sea-Tac	Whidbey Island	2003

Changes to the Transit Service Network

- **Changes from 1997 to 2007**

  The creation of Sound Transit and its associated services were the most significant public transit changes in the study area between 1997 and 2007. In 1996, Sound Transit commenced implementation of the voter-approved transit initiative Sound Move. This transit initiative created a new financing source (taxes) and was the first of a multi-phased plan to expand regional transit service across the Puget Sound urban area and to lessen the dependence on automobile travel.

  Highlights of the first phase included: the design and construction of light rail service from Seattle to Seattle-Tacoma International Airport; the commencement of peak period Sounder commuter rail service and Express Bus Routes; and the design and creation of additional High-Occupancy Vehicle (HOV) lanes and ramps on major roadway corridors.

  Additionally, King County voters approved the Transit Now initiative in 2006 to fund and expand transit service across the urban county. The initiative funded the planning and implementation of King County Metro's bus rapid service RapidRide; though the service became active later in 2010. Based on review of readily available studies and reports, the Consultant Team was unable to identify changes or additions to the King County Metro bus routes serving Seattle-Tacoma International Airport during this time period.

In 1999, Sound Transit implemented 18 Sound Transit Express Bus routes (ST Express) through the Sound Move initiatives. The ST Express provides service to large population and employment centers throughout the Puget Sound urban region. Express bus routes have limited stops between origins and destinations. Figure 7.15 describes the express bus services that directly serve Seattle-Tacoma International Airport.

Figure 7.15
Sound Transit Express Routes Serving Seattle-Tacoma International Airport

Route Number	Description	Year Started
Route 574	Express access from Lakewood to the Airport. Operates all day, Monday through Sunday with stops in Lakewood, Tacoma, Federal Way, and SeaTac.	1999
Route 560	Express access to the Airport from White Center and Bellevue. Operates all day, Monday through Sunday with stops in White Center, Burien, and SeaTac.	Late 1990's
Sound Commuter Rail	Provides rail service between Tacoma and Seattle with a station in Tukwila. Passengers can transfer to other local bus routes at each station. Operates Monday through Friday.	1999

State and local transportation agencies have also performed various HOV enhancements on area highways and arterial streets to improve access to buses and vehicles with at least two passengers. Notable HOV enhancements included:

- The HOV bypass lanes at the IH-5/IH-405 interchange;
- Direct access ramps from the Federal Way Transit Center to IH-5;
- HOV lanes on IH-5/IH-405, and State Route 518 ramps; and,
- HOV lanes on US Highway 99.

- **Changes from 2008 to 2019**

In 2008, voters approved the Sound Transit 2 initiative to further fund and expand transit service in the region. Also, by 2008, the vicinity started to realize King Metro Transit service improvements from the 2006 Transit Now initiative which included RapidRide service. Based on review of readily available studies and reports, the Consultant Team was unable to identify changes or additions to other King County Metro bus routes serving the Airport during this time period.

Sound Transit extended light rail service to the Airport and its vicinity. The study area includes three stations, Tukwila, Airport/SeaTac, and Angle Lake. Trains run at 6 to 24 minute headways; with higher frequencies occurring at weekday AM and PM peak periods.

The Tukwila Station opened in 2009 and is located at State Route 518 and US Highway 99 (1.5 miles from the Airport terminal). The elevated station includes a surface Park & Ride lot and local bus connections.

The Airport/SeaTac Station opened in 2009 and is located on the east side of the main parking garage and along US Highway 99. This is an elevated station with a pedestrian concourse through the main garage and a pedestrian bridge over US Highway 99. There are no Park & Ride facilities at this station. The station provides for local bus connections on US Highway 99.

Angle Lake Station opened in 2016 at US Highway 99 and S 200th Street (1.15 miles from the Airport terminal). The elevated station includes a structured Park & Ride garage. The station provides for local bus connections on US Highway 99.

Sound Transit increased airport express bus frequency on Route 574 to 30-minute headways and Route 560 to 1-hour headways. Sound Transit expanded their bus fleet and included bus frequency on other express bus routes throughout the urban service area.

King County Metro RapidRide is local bus rapid transit (BRT) modes that provide frequent, fixed-route service along major highways and arterials. The stops are designed as stations and spaced further a part to reduce travel delay. The RapidRide service includes level-boarding platforms, off-board fare collection, and transit signal priority signals. In many locations, RapidRide buses use HOV lanes to bypass other vehicle traffic. Two RapidRide routes were added to the study.

- Line A was added to US Highway 99 in 2010 and provides frequent service between the Tukwila (light rail) Station to Federal Way; there are stops near the Airport's US Highway 99 entrance (near South 182nd Street); and,
- Line F was added in 2014 to provide frequent service between Burien and Renton with a stop at the Tukwila (light rail) Station. Transit passengers can transfer to Line A, the light rail, or other local transit routes to access the Airport at the Tukwila Station.

Major changes were also made to the private transport services in and around Seattle-Tacoma International between 1997 and 2019.

- In 2014, the Airport added 22 bus parking positions at the north end of the terminal to accommodate the private transport service vehicles. Prior to this, transport services used the North Charter Lot adjacent to Concourse D; this facility had only 7 parking positions; and,
- The Whidbey-Sea-Tac service was added in 2003 to provide service to Whidbey Island, Washington. Wenatchee Valley service was added in 2014 to provide service to Wenatchee, Washington.

Park & Ride Lots

In the Study Area, there are a total of 18 Park & Ride facilities, which accommodates approximately 7,085 parking spaces. Patrons can park at these facilities to access transit to major destinations including Seattle-Tacoma International Airport. Park & Ride lots do not provide long-term parking options for passengers; whereas patrons may not leave vehicles overnight or continuously over multiple days. Figure 7.16 shows the location of the various Park & Ride lots in the Study Area.

Most of the Study Area transit Park & Ride lots were added within the study time period (1997 to the present) and constructed concurrent with major transit projects (e.g., light rail and express bus service). The Consultant Team reviewed aerial photography to determine the approximate year each Park & Ride lot was established. Jurisdiction and ownership over the Park & Ride lines vary between the transit agencies; whereas, some lots are leased from private entities (e.g., places of worship and retail centers).

In July 2019, the King County Council approved a monthly permit options at the 10 busiest Park & Ride lots in the region. For those who choose to participate in the permit program, will now pay $60.00 to $120.00 per month for guaranteed access to parking between 4AM-10AM, Monday through Friday and specific facilities. Carpool monthly permits will still be free. The only Park & Ride lot located in the study area that will be affected by the new permit program is the Tukwila Park & Ride located at IH-5 and Interurban Avenue South, which will see a permit price of $90.00 per month for those who choose to utilize the program.

Based on review of readily available studies and reports, the Consultant Team was unable to identify the number or frequency of Airport passengers and employees that utilize Park & Ride facilities. Furthermore, the Consultant Team could neither identify capacity changes at each Park & Ride lot since its establishment year or identify whether any previous lot was closed or discontinued.

Figure 7.16
Park & Ride Facilities in the Study Area

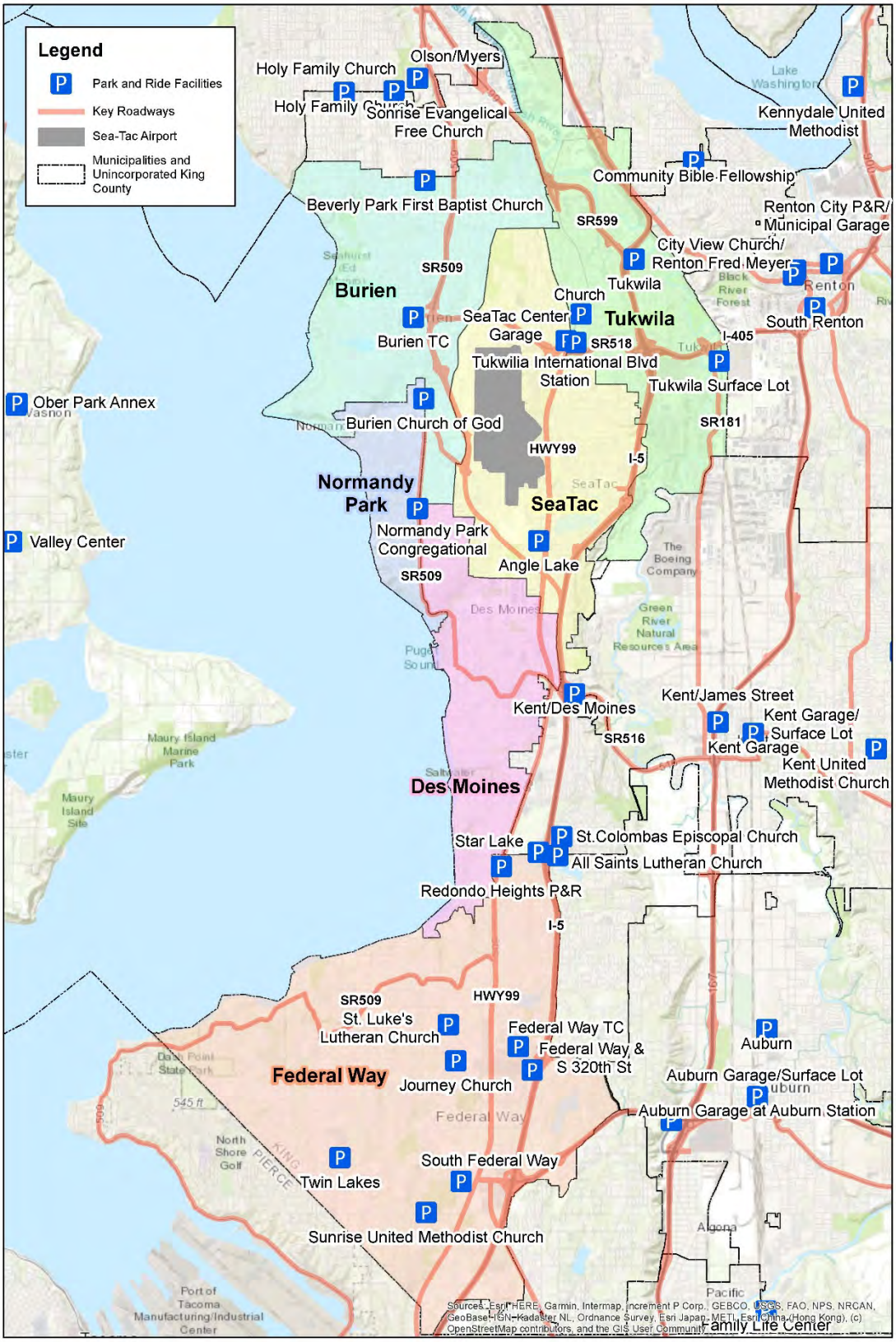


Figure 7.17
Summary of Park & Ride Facilities in the Study Area

Park & Ride Lot	Parking Space Quantity [4]	Year Established [3]	Utilization, 2009 [5]	Utilization, 2012 [5]	Utilization, 2015 [5]	Utilization, 2017 [5]
Pre 1990						
Federal Way/South 320th St	877	Pre 1990	47%	45%	37%	33%
South Federal Way	515	Pre 1990	61%	40%	30%	23%
Tukwila @ Interurban Ave.	255	Pre 1990	99%	98%	100%	100%
1997-2006						
Twin Lakes	600	~2000	14%	16%	19%	16%
Redondo Heights P&R	697	2005	7%	6%	9%	11%
Federal Way Transit Center	877	2006	84%	99%	99%	99%
2007-2016						
Tukwila Transit Center	600	2009	83%	99%	99%	100%
Burien Transit Center	488	2009	81%	59%	72%	65%
Sea-Tac Center Garage	62	2013			95%	89%
Tukwila Surface Lot	390	2014			100%	90%
Angle Lake Station	1090	2016				98%

1) Source: King County Metro and Sound Transit.
2) This table does not include private leased Park & Ride lots within the study area as site data was not readily available.
3) A review of aerial photographs determined the approximate year the Park & Ride lots were established.
4) This table lists the parking quantity as of 2019; whereas, this table does not notate changes and additions to parking quantity since the year established.
5) King County Metro Park & Ride Utilization reports determined the Park & Ride lot utilization rates over the years.

The Park & Ride lots in the study area exhibited the following notable changes/additions:

- The region's transit agencies developed eight new Park & Ride lots in the study area since 1997;
- King County started a paid parking permit option to reserve parking spaces at the Tukwila at Interstate-5 and Interurban Avenue South;
- Five of the Park & Ride lots experienced a decrease in utilization since 2009; whereas, three showed consistent increases;
- Public input revealed concerns about employees at Seattle-Tacoma International Airport utilizing Park & Ride facilities for *de facto* remote employee parking. This was specifically noted at the garage for the light rail station at South 200th Street. There is no current measurement of how many public spaces may be occupied by Airport employees at nearby Park & Ride facilities. This issuer requires further study.

Ridership Trends

The Puget Sound urban region has experienced an increase in transit ridership during the study period as population increased and the various transit agencies added more lines and service options.

- **<u>King County Metro</u>**
  From 2008-2018, King County Metro transit ridership has remained consistent at around 115 million riders per year. 2010 saw a decrease in ridership levels, which saw an annual ridership of around 109.6 million riders. The most recent ridership analysis conducted in 2018 states that the King County Metro System has around 122.5 million riders, which is an 11% increase from 2010.

King County RapidRide services have seen an 87% increase in ridership from 2011 to 2018, ranging from 106,000 to 786,000 riders. Since September 2019, RapidRide lines have already seen approximately 518,000 riders, which is a 42% increase from the previous King County Route 140 that the new RapidRide lines have replaced. Figure 7.18 summarizes the Average Annual Boarding statistics for each of King County Metro routes that provide service to or near the Airport. Most airport area routes have seen an increase in average daily boardings since 2015; whereas, Route 128 has experienced decline.

Figure 7.18
King County Airport Area Route Ridership Statistics

Metro Route	Average Daily Boardings			
	2015	2016	2017	% Change 2015-2019
124 (Night owl times only)	3,100	4,000	4,000	29.0%
128	3,800	3,500	3,500	-7.9%
156	1,100	1,100	1,100	0.0%
180	4,300	4,600	4,400	2.3%
Line A	9,400	9,700	10,200	8.5%
Line F	5,400	5,500	5,600	3.7%

1) Sources: King County Metro System Evaluation Reports 2018, 2017, and 2016.
2) King County ridership reports completed prior to 2016 utilized different metrics other than average daily boardings.

Based on review of readily available studies and reports, the Consultant Team was unable to obtain King County Metro average daily boarding statistics by route for the years before 2015; whereas the previous years used different metrics and were not easily comparable. Second, the Consultant Team was unable to identify the boarding/unloading statistics for the stops at the Airport. Furthermore, the Consultant Team was unable to determine which transit users were Airport passengers, employees, or visitors.

- **Sound Transit**
  The Sound Transit network has seen a 0.4% decrease in weekday boardings from 2018 to 2019. Certain routes/services that have seen an increase in ridership include Link Light Rail, and Paratransit services. From 2009-2018, Link Light rail has seen a 90% increase in total ridership, from 2.5 million to 24.5 million riders. Ridership tends to peak during weekends and summer months, reflecting average daily boardings above 80,000 riders. Figure 7.19 summarizes the Average Annual Boarding statistics for each of Sound Transit's routes that provide service to or near the Airport. Most airport area routes have seen an increase in average daily boardings since 2016; whereas, express bus Route 574 has seen a slight decline.

Based on review of readily available studies and reports, the Consultant Team was unable to obtain Sound Transit average daily boarding statistics by route/light-rail station for the years before 2016. The Airport terminal boarding/unloading statistics for the two express bus routes were also unavailable. Furthermore, the Consultant Team was unable to determine which transit users were Airport passengers, employees, or visitors.

The transit ridership statistics in the study area exhibited the following notable changes/additions:

- **King County Metro**
  Four routes (124, 180, and RapidRide Lines A & F) experienced daily boarding increases since 2015; whereas, Route 128 experienced a decline and Route 156 remained unchanged; and,

- **Sound Transit**
  Each of the three area light rail stations experienced continual ridership increases since 2016. Express Bus Route 560 experienced a minor ridership increase, and Route 574 experienced a minor decline since 2016.

Figure 7.19
Sound Transit Airport Area Route Ridership Statistics

Sound Transit Route	Average Daily Boardings				
	2016 (Q4)	2017 (Q4)	2018 (Q3)	2019 (Q3)	% Change 2016-2019
Sound Transit Express Bus Routes (ridership based on the entire route)					
560	1,687	1,725	1,847	1,928	14.3%
574	2,319	2,270	2,308	2,311	-0.3%
Sound Transit Link Light Rail Stations (ridership based on boardings at the following stations not entire route)					
Tukwila	2,688	2,818	2,964	3,380	25.7%
Airport	5,138	5,072	6,374	6,872	33.7%
Angle Lake	2,810	3,506	3,899	4,339	54.4%

1) Sources: Sound Transit Service Delivery Quarterly Performance Reports 2018 and 2017.
2) Sound Transit ridership reports completed prior to 2017 do not include ridership statistic for each light rail station.

Impacts

The Consultant Team identified the following potential impacts the changes to transit service and infrastructure may have affected the Airport and the six surrounding communities. The analysis and findings in the preceding subsections guided this list of potential impacts. The Consultant Team also acknowledged inconclusive findings based on the lack of readily available information.

- **General Transit and Light Rail Service**
  The transit agencies provide multiple routes to and around the Airport. This reduces traffic congestion to and from the Airport and parking demand at the main garage.

  Sound Transit light rail has three stations in the study area that provides frequent connections to the Airport, Seattle and other regional destinations. The Airport/SeaTac station provides direct transit rider connections to the terminal through the main garage. The station also provides pedestrian connections to US Highway 99. All three stations have experienced annual increases in daily boardings.

  The addition of light rail, express bus, and RapidRide service provides faster modes when compared to standard local bus service. These services exhibit more consistent, and higher levels of passenger boardings. However, the following data gaps were noted:

  - No information could be found to determine how many riders at the Airport/SeaTac station access Seattle-Tacoma International Airport verse other nearby destinations;
  - No information could be found to determine how many light rail riders are Airport passengers verse employees; and,
  - No information could be found to whether the service changes reduced the vehicle trips to the Seattle-Tacoma International Airport.

- **Regional Transit Service Funding**
  Sound Transit and King County Metro both secured voter-approved initiatives that fund transit service expansions across the region. This includes additional bus, light rail, and commuter rail service and associated infrastructure (e.g., stations and Park & Ride lots).

- **RapidRide and Route 180**

  King County Metro commenced bus rapid transit with its RapidRide service. The agency added Line A that runs along US Highway 99 with stops near the Airport entrance and Line F with connections through the Tukwila (light rail) Station). Both lines have experienced an increase in daily boardings. However, the following data gaps were noted:

  - No information could be found on the passenger boardings for the RapidRide Line A stops along US Highway 99 near the terminal;
  - No information could be found to determine how many RapidRide riders are Airport passengers/employees versus through passengers to other destinations; and,
  - No information could be found to whether the service changes reduced the vehicle trips to Seattle-Tacoma International Airport.

- **Sound Transit Express Bus Service**

  Sound Transit operates two express bus routes with stops at the terminal. Route 574 provides service to Lakewood with stops in SeaTac and Federal Way. Route 560 provides service between Burien and Renton. The express bus routes allow for connections to/from the Airport / SeaTac station but do not connect to the other light rail stations. Route 560 experienced increase daily boardings; whereas, Route 574 has seen a slight decline. However, the following data gaps were noted:

  - No information could be found on the passenger boardings for the stops at the terminal;
  - No information could be found to determine how many express bus riders are Airport passengers/employees versus through passengers to other destinations; and,
  - No information could be found to whether the service changes reduced the vehicle trips to the Airport.

- **Private Transport Services**

  The private transport services provide additional customers to the Airport from outlying communities. These private transport service providers also reduce traffic congestion and the need for long-term parking on the Airport property. However, no information could be found on the number of Airport employees that use each Park & Ride lot to access the Airport.

- **HOV Enhancement**

  State and local transportation agencies have installed HOV lanes and direct on ramps for transit service and carpool vehicles. These HOV facilities allow transit and carpool vehicles to bypass other traffic on highways and arterials.

- **Park & Ride Lots**

  The addition and expansion of Park & Ride lots allows more rider access to transit services verse limited routes near low density residential areas. The introduction of the parking permit program for the Tukwila Lot (at IH-5 and Interurban Avenue) created reliable parking for those who chose to participate in the program but could be a negative for occasional transit users and non-permit holders as spaces may become unavailable during peak commuting times.

  They also provide Airport employees additional access to transit service to the Airport. At the same time, Airport employees using the Park & Ride lots may reduce parking availability to other transit riders. However, no information could be found on the number of Airport employees that use each Park & Ride lot to access the Airport.

E. PEDESTRIAN INFRASTRUCTURE

The section below provides an overview of changes to the pedestrian network from 1997 to present day that have impacted access to Seattle-Tacoma International Airport. It notes infrastructural changes related to pedestrian routes near the terminal and to US Highway 99.

Pedestrian Infrastructure

The Port of Seattle has maintained sidewalks from US Highway 99 to the Terminal via Arrivals Drive since before 1997. The intersection at International Drive has a traffic signal, crosswalks, and sidewalks. There is a continuous sidewalk on the south side of Arrivals Drive from US Highway 99 and all along the Terminal entrances.

The two principal changes for pedestrians have been the new light rail station (which also includes a new pedestrian bridge over US Highway 99) and the new remote Consolidated Rental Car Facility (which now requires access via shuttle bus).

The Airport Station of Sound Transit's Link Light Rail system provides additional pedestrian access to the Terminal. These facilities provide pedestrian access for both transit users and pedestrians in the vicinity. There is a pedestrian route from the main terminal, through the Main Parking Garage and connecting to the elevated light rail station platform. There is a pedestrian bridge over US Highway 99 from the elevated light rail station platform to the eastside of the roadway, linking parking facilities, the light rail station, and immediately surrounding land uses to the Terminal. The pedestrian bridge was constructed in 2009.

To access the Consolidated Rental Car Facility, passengers need to use the dedicated shuttle service. Prior to the construction of the facility, passengers walked from the terminal to the connected rental car facility in the Main Parking Garage. With the new remote rental car facility, passengers must use the shuttle service, which drops off at the north and south terminals and picks up at the Consolidated Rental Car Facility Arrivals and Departures Curb. During peak hours, a wait time of five minutes for passengers is average. However, longer wait times have also been experienced. The shuttle bus operates 24 hours a day, every day of the year.

No studies and reports were readily available to determine the number of pedestrians that use the public sidewalks or the light rail station to access the Terminal. Furthermore, the Consultant Team was unable to determine changes in wayfinding and signage that occurred in and around the terminal to assist with pedestrian access between 1997 and the present.

Impacts

- **Pedestrian Access to Transit Routes**
  The existing sidewalk along the terminal to the US Highway 99 and the addition of the Link Light Rail Airport/SeaTac station with pedestrian bridge provide pedestrian access to transit routes on US Highway 99 including King Metro Transit routes 180 and RapidRide Line A. However, no information could be found to determine the number of daily pedestrians utilize the sidewalks front for the terminal and Link Light Rail Airport/SeaTac station and pedestrian bridge to access US Highway 99.

- **Consolidated Rental Car Facility**
  The Consolidated Rental Car Facility's remote location requires the Airport to operate a continuous shuttle service between Facility and the Terminal. The remote location adds distance and travel time for potential customers arriving at the Airport. No Information could be found to determine the peak demand times for the shuttle buses to the Consolidated Rental Car Facility and how well the existing shuttle vehicles are accommodating this demand. Further, no information could be found to determine if the shuttle travel times from the terminal to the remote rental car facility have affected customer demand, or if other factors (such as on-demand rideshare apps like Uber and Lyft, or the option of light rail) are influencing rental car choices.

F. PARKING INFRASTRUCTURE

Early in the project scoping phases there were community concerns that Airport passengers and employees may utilize neighborhood streets for daily and/or long-term parking in lieu of utilizing more formal Airport parking facilities. The Consultant Team examined local parking conditions, local parking requirements and restrictions on public rights-of-way to help determine potential Airport impacts to residential areas.

In 2018, the City of SeaTac completed a Permit Parking Program study that examined on-street parking conditions/impacts in three notable neighborhoods near the Airport. The SeaTac Study identified three neighborhoods in walking proximity to the Airport/SeaTac, Tukwila or Angle Lake light rail stations. The study indicated street parking conditions close to January 2018 (a study day and time was not indicated); no historical data was included to compare changes in street parking availability and utilization. The following summarizes the area conditions and parking utilization for these three areas based on the 2018 SeaTac Permit Parking Program study:

- **McMicken Heights Neighborhood (City of SeaTac)**
  The SeaTac study focused on the residential neighborhood near the Airport/SeaTac station in the general vicinity from US Highway 99 to 35th Avenue South between South 170th Street to South 176th Street. The study area included approximately 600 on-street parking spaces and 9 block faces that do not allow on-street parking. The study found that 78% of the vehicles parked on the street were attributed to residents. The streets closest to the light rail station showed higher occupancy rates, whereas the outlying streets exhibited 0% to 50% utilization. The neighborhood did not exhibit consistent street parking durations; whereas, the parking duration times on each street differed by block (>1 hour to over 9 hours).

- **Tukwila Station Area (City of Tukwila)**
  The SeaTac study focused on the residential area northwest of the Tukwila station with a particular focus on South 152nd Street and 30th Avenue South. The study area included approximately 95 on-street parking spaces and 2 block faces do not allow on-street parking. The study found that, like McMicken Heights, 78% of the vehicles parked on the street were attributed to residents. A segment along South 152nd Street had the highest parking utilization of 50% to 70%; whereas the other street segments have 0% to 50% utilization. Overall all, this area exhibited high parking duration (4 to over 6 hours); whereas, a small segment of South 152nd Street showed no utilization.

- **Angle Lake Station Area (City of SeaTac)**
  The SeaTac study focused on the residential neighborhood near the Angle Lake station in the general vicinity from US Highway 99 to 32nd Avenue South and between South 200th Street and South 204th Street. The area has 280 on-street parking spaces and 2 block faces that do not permit on-street parking. The study found that 75% of the vehicles parked on the street were attributed to residents. All the streets exhibited 0% to 50% street parking utilization. The neighborhood blocks exhibit different parking durations, with the longest parking times occurring on the streets furthest from US Highway 99.

For the other portions of the Study Area, the Consultant Team used professional judgement to identify which of the local six communities were most prone to Seattle-Tacoma International Airport passengers and employees parking in residential neighborhoods. The Consultant Team was unable to identify a consolidated, multi-jurisdictional street parking utilization study for the total Study Area. The cities of Burien, SeaTac, and Tukwila were identified to focus the analysis for the following reasons:

- Adjacency to Seattle-Tacoma International Airport;
- Areas where there are residential street parking locations within a reasonable walking distance (0.5 miles or less) to Seattle-Tacoma International Airport, a light rail station, or RapidRide Lines A or F; and,
- Areas where there are residential street parking locations that could be perceived as faster or more cost effective compared to other transportation-related options (e.g., paid parking garages, taxis).

For areas in neighboring cities that are experiencing a frequently high demand for on-street parking, the Consultant Team was not able to identify the true causes based on review of readily available information. However, based on the parking demand/requirement comparison, projects constructed pursuant to current city standards should not require on-street parking utilization as a means to support their occupants. Further studies are warranted to understand why street parking utilization may be higher in certain areas.

Local Parking Requirements

The Consultant Team reviewed industry parking quantity standards and local development requirements to draw conclusions to whether newer development projects in proximity to the Airport possess adequate parking space quantities to serve their occupants. Specifically, the Consultant Team wanted to identify whether local development requirements created on-site parking scarcities that may influence occupants to use neighborhood streets to meet their parking needs. This would help determine whether street parking activity would be caused by adjacent uses verse other outlying uses including the Airport.

- **Industry Parking Demand Standards**
  The Consultant Team reviewed the Institute of Transportation Engineers (ITE) Parking Generation Manual (Manual) to identify industry standards for parking demand. The Manual is a national standard for evaluating parking demand for specific uses based on case studies and generally applied to suburban settings such as the communities that surround the Airport. The Manual collects data from parking studies nationwide completed by consultants, public agencies, and developers. The Manual provides a benchmark for understanding of "real-life" parking demand.

  This analysis acknowledges that the Manual is merely an indicator of potential parking demand for specific land uses; whereas, the Manual does not reflect local communities' policy decisions to reduce parking capacity to influence alternate modes of transportation (e.g., urban areas, transit-oriented development, etc.).

- **Local Parking Ratio Requirements**
  Local development standards contain minimum required parking ratios for individual land uses (e.g., residential, retail, office, industrial, etc.). Parking requirements are normally imposed as part of a new development project or as part of a change of use in an existing building. Additionally, the cities of Burien, Tukwila, and SeaTac also allow for shared parking arrangements between neighboring properties to address minimum parking requirements. Where local parking requirements exceed ratios listed in the ITE Parking Generation Manual (discussed above), the Consultant Team concluded that there would be enough parking on each development site and would lessen the need for occupants to utilize adjacent streets for parking. In contrast, where the local jurisdiction requires less parking than the ITE Parking Generation Manual, there is potential for properties to not possess enough parking on site to meet occupants' parking demands; thus, creating a need to use nearby street parking or utilize other transportation options. Based on review of readily available information, the Consultant Team was unable to determine whether each cities' minimum parking ratios changed over time since 1997.

- **Parking Demand/Requirement Comparison**
  Figure 7.20 compares local jurisdictions' minimum parking ratio requirements for new development/land uses with the demand ratios listed in the ITE Parking Generation Manual. For the purposes of this analysis, the Consultant Team focused on residential, retail, restaurant, and office since they are the most prevalent land uses in the study area; whereas, hotels were not examined due to the complexity of the parking requirements. The cities of Burien, SeaTac, and Tukwila impose parking ratios that exceed the ITE Parking Generation Manual. This suggests that newly built projects contain excess parking quantity than the typical parking demands, thus, occupants have enough on-site parking and do not need to park on adjacent streets.

Figure 7.20
Minimum Parking Standards

Land Use	Minimum Parking Ratio Requirements by Jurisdictions (1) (2) [parking space per unit or 1,000 square feet (sf) of building area]			
	City of Burien	City of SeaTac	City of Tukwila	ITE Parking Generation Manual
Single-Family	2.0 per unit	2.0 per units	1 to 1.5 per unit	1.33 to 2.17 per unit
Multi-Family	1.8 per unit	1 to 2 per unit (based on unit size)	1 to 1.5 per unit	1.2 per unit (low-rise/suburban setting)
General Retail	3.0 per 1,000 sf	4 per 1,000 sf	3.33 to 5 per 1,000 sf	2.55 per 1,000 sf
Restaurant	7.0 to 13.0 per 1,000 sf	6.66 per 1,000 sf	6.0 per 1,000 sf	9.44 per 1,000 sf
Office	3.0 per 1,000 sf	3.33 per 1,000 sf	3 per 1,000 sf	2.47 per 1,000 sf

1) Sources: City of Burien, SeaTac and Tukwila Municipal Codes (zoning sections) and the ITE Parking Generation Manual.
2) Certain land uses require a range of minimum parking ratios based on structure site or bedroom quantities; see the local zoning code for additional information.
3) Based on readily available information, the Consultant Team was unable to determine changes in the City's parking requirements over the study time period; whereas, the parking ratios in this table represent current requirements.

Local Parking Permit Programs

Cities often regulate on-street parking utilization through local laws and enforcement. Some communities limit the times and durations vehicles can park on public streets. Other communities choose to adopt local parking permit programs to prioritize street parking utilization to individuals living or working in particular neighborhoods or districts. These local policies influence whether individuals will choose to utilize on-street parking in certain areas of the City. The following summarizes the parking policies for each City.

- **City of Burien Parking Regulations**
  The City of Burien relies on the following policies and regulations to manage off-street and on-street parking:
  - Street Parking Laws – The City of Burien prohibits parking on any street or public right-of-way for no more than 24 hours. Violators are subject to a $50 fine and may be subject to vehicle impoundment. The City has the authority to prescribe additional time limits for street parking. Blocks in the downtown area and near the transit center have typical parking time limits; 2-hour parking or 30-minute parking. The City of Burien also uses signs to regulate parking on city streets. Burien employs the following parking limitation signage along various blocks across the city (some areas do not have signage):
  - No Parking at Any Time – This means that street parking is not permitted under any circumstances, at any time in this designated area.
  - No Parking on Certain Days – This restriction may require that on certain days of the month, parking in this zone is not allowed. Temporary no parking zones may be created by the City of Burien for activities such as the Farmer's Market, 4th of July Parade, or construction projects.
  - Loading Zones – This parking zone is restricted for the loading and unloading of products associated with local commercial businesses. However, it is permissible to park briefly to pick up or drop off passengers, but the vehicle must then be parked elsewhere.
  - Parking Permit Program – While the City of Burien does not have a permit parking system for resident and local businesses in place, the City's code does allow the City Manager to implement such a program.

- **City of SeaTac Parking Regulations**
  The City of SeaTac relies on the following policies and regulations to manage off-street and on-street parking:

  - Street Parking Laws – The City of SeaTac limits parking duration in certain areas of the City, most notably the McMicken Heights neighborhoods. Violators are subject to a $50 fine. In other parts of the community, the City imposes parking time limitations or prohibits street-parking altogether.
  - Parking Permit Program/Policies – The SeaTac parking permit program, which was implemented in 2018, not only prioritizes parking for residents and local businesses, but better spreads parking demand in congested areas specifically in the McMicken Heights neighborhood. In this program vehicles registration addresses must be the same as the applicant's residence or business. The first permit is free, while additional permits cost $65 to purchase. It costs $25.00 to reissue a permit. This permit system, along with the City's requirement that vehicles must be moved every 24 hours, discourages long-term airport passenger parking. Currently, the McMicken neighborhood is the only portion of SeaTac subject to parking permits.

- **City of Tukwila Parking Regulations**
  The City of Tukwila relies on the following policies and regulations to manage off-street and on-street parking:

  - Street Parking Laws – The City of Tukwila imposes a city-wide policy that limits on-street parking use to 72 hours; whereas, vehicles must be moved after this time. Violators are subject to a $50.00 fine. In other parts of the community, the City may import on-street parking time limitations or prohibit street-parking altogether.
  - Parking Permit Program/Policies – The City of Tukwila does not have an active residential parking permit program.
  - Transportation Demand Management Policies – In addition, the City of Tukwila has a Transportation Demand Management program that gives residents and commuters resources and incentives to use other, more sustainable modes of transportation. The program provides incentives such as reduced ORCA cards, regional reduced fare permits for seniors and riders with disabilities, carpool and vanpool services, and service areas for microtransit. In addition, with the increase of transit centers in the City, a policy was enacted in the 2015-2019 Update requiring all parking facilities located near transit facilities must accommodate parking demand and prevent spillover parking onto private properties and public streets.

Impacts

The following impacts are noted on the various parking facilities and any related parking issues in the Study Area:

- **Local Parking Requirements Exceed ITE Parking Generation Demands**
  The cities of Burien, SeaTac, and Tukwila impose minimum parking requirements that generally meet or exceed industry standards. This generally suggests that newer development projects have enough parking capacity to address the parking demand for their occupants. The 2018 SeaTac Permit Parking Program study identified specific streets near the Airport/SeaTac and Tukwila light rail stations but also found that most of the vehicles parked on streets were associated with residents. However, no information could be found regarding on-street parking conditions in other parts of Burien, Tukwila, or SeaTac.

- **Notable SeaTac Neighborhoods**
  Pursuant to the 2018 SeaTac Permit Parking Program study, SeaTac's McMicken Heights neighborhood and the areas near the Angle Lake Transit Station experienced consistent on-street parking utilization. These neighborhoods reflected parking utilization rates of 0 to 50%, with observed peak parking demands of 70% to over 85% utilization along popular on-street segments. In McMicken, 78% of the parked cars were attributed to residents and near the Angle Lake Station, 75% of parked cars were attributed to residents. In Tukwila, the residential areas northwest of the light rail station also had high on-street parking utilization; whereas, 78% of the vehicles were attributed to residents. However, no data was available to determine the specific origins of non-residentially associated on-street parking.

- **Shared Parking Allowances**
  The cities of Burien, SeaTac, and Tukwila allow shared parking arrangements amongst neighboring properties to satisfy minimum parking requirements. This allows for on-site parking capacity for private developments (and lessen the need for occupants to utilize on-street parking).

- **Municipal On-Street Parking Restrictions**
  The cities of Burien, SeaTac, and Tukwila impose utilization restrictions for on-street parking in various areas. These restrictions either prohibit on-street parking or impose limits on parking duration. The cities of SeaTac and Burien have a permit program to allow additional on-street parking use for local residents/employees. These restrictions preclude long-term on-street parking use but also grant exceptions to permit holders.

- **Parking Enforcement**
  The cities of Burien, SeaTac, and Tukwila employ parking enforcement for on-street parking. However, no information could be found to determine the number of annual parking violations, the methods/frequency of enforcement activities, or the long-term effectiveness of these practices.

- **Transit Park & Ride Facilities**
  The implementation of new transit centers, stations and Park & Ride lots have an impact on parking demand in the Study Area. In suburban communities, the increase in ridership for alternative modes can generate an increase in demand for parking adjacent to transit facilities, which can create spillover parking into on-street parking and other off-street parking lots in the surrounding communities. Park & Ride facilities provide an alternative option than parking at on-site Airport parking facilities. However, Park & Ride facilities do not allow for overnight parking; thus, is not a viable option for Settle-Tacoma International Airport passengers with overnight travel itineraries. In contrast, Park & Ride facilities are a viable option for Airport employees, although there is some degree of negative reaction on the part of the public when these facilities are used by Airport employees. However, more information is needed in order to determine the extent that Park & Ride facilities impact on-street parking utilization in the cities of Burien, Tukwila, or SeaTac.

G. RECOMMENDATIONS – AIRPORT MOBILITY INFRASTRUCTURE

The following recommendations were drafted to address the known negative impacts generated from the Airport's infrastructural changes and the inconclusions from the analysis.

- **Mobility Recommendation #1: Rental Forecasts**
  The Port of Seattle should work with its staff and rental car vendors to generate annual service demands to ensure the Consolidated Rental Car Facility can accommodate future customer volumes and associated vehicle storage.

- **Mobility Recommendation #2: Parking Data**
  The Port of Seattle should conduct an annual parking demand and occupancy analysis for the main parking garage and employee parking lots to better assess parking demand and plan for supply over time in the Seattle-Tacoma International Airport parking system.

- **Mobility Recommendation #3: Cell Phone Lot Usage**
  The Port of Seattle should conduct an annual survey of the cell-phone lot usage in terms of occupancy and typical vehicle parking duration. The survey should examine whether the cell-phone lot reduces congestion at the arrivals and departures areas in front of the terminal.

- **Mobility Recommendation #4: Private Parking Lot Data**
  The Port of Seattle should create a consolidated list of private parking facilities along with inventory and occupancy data to maintain a record of off-site parking accommodations and how changing supply may increase demand at the main garage. The Port should also identify private lots that may be redeveloped as other non-parking uses in the near and long-term in anticipation of a parking demand shift.

- **Mobility Recommendation #5: Airport Mobility Modes Survey**
  The Port of Seattle should analyze the historical and current passenger mode trends to assess how passengers and employees travel to and from the Airport. The Port should institute annual passenger surveys to forecast and respond to mobility demands.

- **Mobility Recommendation #6: Drop-Off/Pick-Up Zone Study**
  The Port of Seattle should create a data source for drop-off and pick-up zones for airport shuttles to assess congestion and vehicle and pedestrian flow in and around the Airport property.

- **Mobility Recommendation #7: Employee Forecasts**
  The Port of Seattle should work with its staff, vendors, and tenants to generate annual employee forecasts to ensure there are parking and mobility options to accommodate changing employment numbers.

- **Mobility Recommendation #8: Parking Master Plan**
  The Port of Seattle should create a parking master plan based on anticipated passenger volumes and employment forecasts. In doing so, the Port of Seattle should engage area stakeholders (e.g., Airport vendors and employees, surrounding cities, King County Metro, and Sound Transit) in developing the master plan.

H. RECOMMENDATIONS – GROUND TRANSPORTATION

Despite numerous data gaps, the Consultant Team was able to draft a list of recommendations to address the known negative impacts generated from the traffic congestion and roadway infrastructural changes and the inconclusions from the analysis. This list of recommendations is a continuation of the list started on page 165 of this document.

- **Mobility Recommendation #9: Transportation Improvement Program Database**
  The Port of Seattle should work with WsDOT, Sound Transit, King County Metro and local planning and/or local economic and development departments to create a database of all historical and current capital improvements in the Seattle-Tacoma International Airport area to better understand how the physical network changes overtime.

- **Mobility Recommendation #10: Vehicle Origin-Destination Study**
  The Port of Seattle should conduct a vehicle origin-destination study at the Consolidated Rental Car facility to better understand vehicle patterns and movements along the transportation network around the facility as well as understand where vehicles are traveling from to reach the facility. This study should conduct an origin-destination analysis for SOVs, transit, shuttles, and airporters.

- **Mobility Recommendation #11: Targeted Annual Traffic Monitoring**
  The Port of Seattle should work with WsDOT and local traffic engineering departments to create an Airport-specific traffic monitoring system and program. Critical intersections and roadway segments should be identified and monitored on an annual basis to create a consistent and reliable database that monitors congestion over time. The traffic analysis should target specific time frames to include both off-peak and peak seasons, and AM and PM peak time periods. Peak periods may need to be divided into two categories to create a database for passenger/airport peak hours and employee peak hours.

  Future traffic monitoring efforts should include level of service, vehicle delay, vehicle/capacity ratios, and AADT analyses. Intersections that should be included in the annual report are shown in Figure 7.21

Figure 7.21
Intersections Recommended for Annual Monitoring

- IH-5 and IH-405 (on-ramps and off-ramps)
- State Route 509 and State Route 518 (on-ramps and off-ramps)
- Des Moines Memorial Dr S and 8th Ave South
- Des Moines Memorial Drive and 1st Avenue
- South 188th Street and Des Moines Memorial Drive
- South 150th Street and 24th Ave South
- South 152nd Street and 24th Avenue South
- Southcenter Boulevard/South 154th Street and US Highway 99/Tukwila International Boulevard
- South 160th Street and South 158th Street
- South 160th Street and Military Road South
- Military Road South and Tukwila International Boulevard
- South 160th Street and US Highway 99
- 31st Ave South and US Highway 99
- South 170th Street and US Highway 99
- South 176th Street and US Highway 99
- South 188th Street and US Highway 99
- South 200th Street and US Highway 99
- South 160th Street and Air Cargo Road
- South 160th Street and Host Road
- South 170th Street and Air Cargo Road
- South 188th Street and Air Cargo Road
- South 200th Street and Air Cargo Road
- Departures Drive, Arrivals Drive, and Airport Expressway

I. RECOMMENDATIONS: TRANSIT

The following recommendations address the known negative impacts generated from the region's transit service and infrastructure changes and the inconclusions from the analysis.

- **Mobility Recommendation #12: Annual Transit Analysis**
  The Port of Seattle, King County Metro, and Sound Transit should participate in an annual transit analysis on ridership, use, perception, and demand in and around the Airport. This study should result in a database of transit demand in the study area and a means to improve ridership to the Airport. Figure 7.22 lists the following transit stops that should be included in the annual study.

Figure 7.22
Recommended Transit Stops for Annual Transit Analysis

▪ Airport Station	▪ US Highway 99 & South 160th Street
▪ Angle Lake Station	▪ US Highway 99 & South 170th Street
▪ Tukwila International Boulevard Station	▪ US Highway 99 & South 176th Street
▪ Tukwila Amtrak Station	▪ US Highway 99 & South 180th Street
▪ Southcenter Blvd & 62nd Avenue South	▪ US Highway 99 & South 182nd Street
▪ South 180th Street and Southcenter Pkwy	▪ US Highway 99 & South 188th Street
▪ Southcenter Boulevard & Park Place	▪ US Highway 99 & South 195th Street
▪ South 154th Street & 32nd Avenue	▪ US Highway 99 & South 200th Street

- **Mobility Recommendation #13: Airport Passenger and Employee Transit Utilization**
  The Port of Seattle should partner with King County Metro and Sound Transit to identify annual transit utilization of Airport passengers and employees.

- **Mobility Recommendation #14: Park & Ride Utilization**
  The Port of Seattle, King County Metro, or Sound Transit should conduct a detailed analysis of the Park & Ride facilities in the study area to determine how many individuals use the facilities to access the Airport. The analysis could employ the following methods:

- **Mobility Recommendation #15: License Plate Analysis**
  A license plate analysis should be conducted at Park & Ride lots to determine where vehicles originate. A License Plate Analysis uses Registry of Motor Vehicle data to determine where parked vehicles are registered and potential better understand Park & Ride patterns.

- **Mobility Recommendation #16: Origin/Destination Study**
  Similar to the aforementioned license plate analysis, an Origin/Destination Study should be conducted for key transit centers and hubs in the region to determine which users access the Seattle-Tacoma International Airport via transit modes. An Origin/Destination study analyzes travel patterns and average daily traffic in a specific study area along key roadways and points to assess where vehicles are traveling to and from during specific time periods.

J. RECOMMENDATIONS: PEDESTRIAN INFRASTRUCTURE

The following recommendations address the known negative impacts generated from the region's pedestrian service and infrastructure changes and the inconclusions from the analysis.

- **Mobility Recommendation #17: Annual Pedestrian Counts**
  The Port of Seattle, King County Metro, and Sound Transit should participate in an annual pedestrian access analysis to determine the number of individuals that utilize the sidewalk along the front of the terminal and the Link Light Rail Airport/SeaTac station pedestrian bridge to access the Airport.

- **Mobility Recommendation #18: Mobility Barriers**
  The Port of Seattle, King County Metro, Sound Transit, and the City of SeaTac should participate in a study to identify potential mobility barriers for pedestrians traveling between the terminal and US Highway 99 (e.g., lack of wayfindings/signage, crosswalk locations, crosswalk signal timing, etc.).

K. RECOMMENDATIONS: PARKING

The following recommendations were drafted to address the known negative impacts generated from the on-street parking characteristics, change in local policies, and the inconclusions from the analysis.

- **Mobility Recommendation #19: On-Going On-Street Parking Study**
  The cities of Burien, Tukwila, and SeaTac should maintain on-going parking studies with specific emphasis on-street segments adjacent to transit centers, light rail stations, and the Seattle-Tacoma International Airport. The study should monitor supply, utilization, duration, and areas with excessively high use from non-residents. The on-going parking studies may incorporate the following elements.

- **Mobility Recommendation #20: Existing/Baseline Conditions**
  The initial parking studies should document existing conditions of specified off-and on-street parking facilities in the area, in communities including Burien, SeaTac, and Tukwila. Utilization counts should be conducted in these facilities during peak morning, afternoon, and evening peak periods during a typical weekday and weekend.

- **Mobility Recommendation #21: Parking Supply Database**
  The studies should result in a database of existing parking facilities, inventory, and utilization/demand will not only provide insight on parking demand in the area but give the participating communities a database that can be built upon in the future and monitored over time.

- **Mobility Recommendation #22: License Plate Analysis**
  In conjunction with Mobility Recommendation #15 in this Section, the recommended studies should include a License Plate Analysis at key off-street parking facilities and neighborhoods to understand where vehicles originate from in the Study Area. This analysis will highlight who parks in certain on-and off-street facilities, be it residents from the local communities or commuters from surrounding municipalities who use these facilities to park closer to their destination or place of employment.

- **Mobility Recommendation #23: Parking Permit Program Expansion**
  Burien and Tukwila should adopt/expand their parking permit programs to discourage long-term airport passenger and employee parking on residential streets. The permit programs should focus on areas close to light rail and RapidRide stations (within a 10-minute walk, or roughly one-half mile).

- **Mobility Recommendation #24: Parking Limitation Education at the Airport**
  The Port of Seattle should employ an information campaign to educate Airport employees and passengers on the parking restrictions in surrounding communities to discourage on-street parking on surrounding streets for Airport purposes. The Port of Seattle should partner with the cities of Burien, Tukwila and SeaTac to understand local parking restrictions and areas of concern. The Port of Seattle should also post off-airport parking restrictions on the Seattle-Tacoma International Airport webpages, signs in and around the terminal, and employee information sharing.

- **Mobility Recommendation #25: Employee Parking Restrictions**
  The Port of Seattle should adopt a formal policy that prohibits Airport employees from utilizing on-street off-Airport parking during working hours. In doing so, the Port of Seattle should educate employees of the policy and adopt enforcement and associated disciplinary measures for violators.

L. THE FUTURE

There is much speculation on the future of transportation. Every car manufacturer – and many small start-up companies – are spending billions of dollars to reinvent how people get from Point A to Point B. The first disruptive technology appears to be the general acceptance of electrically-powered vehicles – from internal combustion engines with electric assist ("light hybrids") to vehicles completely powered by rechargeable batteries. These hold the promise of lowering emissions, operating quieter, and reducing dependence on petroleum (although electric vehicles also shift energy demand from the pump to the power grid when they require recharging).

There is no set timetable for the adoption of new technologies – from electric cars to autonomous vehicles to flying taxis to Hyperloops. And questions remain regarding Federal and state regulations, insurance issues, affordability, cyber-security, market acceptance, and many others. Adoption of any new disruptive technology is not likely to happen in the near term but may one day offer alternative modes to short and medium-haul flights.

In a similar fashion, the aviation industry is looking to the future with electro-motive engines, battery-powered engines, biofuels, even technologies with no moving parts. These technologies may reduce air emissions, noise output, and lower costs, but they are certainly many more years in the future than electric vehicles.

M. SUMMARY

The Seattle region has grown since the 1997 Study. But what is not clear is how much of the current traffic is attributable to natural, organic regional growth and how much is directly attributable to Seattle-Tacoma International Airport. The necessary data to track and document such attributes does not currently exist. And while drivers who may be stuck in traffic may speculate on the cause, the data does not yet support any single answer.

There are hopeful signs, however, since there are now more transportation choices than there were in 1997. Today, Seattle-Tacoma International Airport is served not only by a network of local and regional roadways, but also by light rail, regional bus, and even bicycle parking. Rental cars have been moved off-site to a Consolidated Rental Car Facility, requiring shuttle bus access, but moving thousands of rental cars away from direct terminal roadway access.

It is likely that the primary mode used to access Seattle-Tacoma International Airport will be some form of private vehicle for the foreseeable future (personal car, rideshare service, taxi), with transit and other modes remaining as small percentages. However, there may be new technologies in the future to bring realistic alternatives that may also have associated reductions in overall traffic congestion.

Therefore, care must be taken to make the necessary infrastructural improvements that meet current and projected demand while concurrently "future-proofing" said improvements to maximize financial efficiency. For example, should Airport parking demand peak or decrease in the future, current (and new) parking facilities could be become the structural framework of future occupiable buildings (retail, hospitality, office, etc.).

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SECTION 8

SURFACE WATER QUALITY

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SECTION 8

SURFACE WATER QUALITY

A. APPROACH

This Section reviews changes in surface water and water quality and potential impacts that the Seattle-Tacoma International Airport has had to the immediate vicinity and in the Study Area Cities. Given the nature of water and streamflows, Seattle-Tacoma International Airport was identified as the point source for water quality impacts. Therefore, the area of impact would be the area of the Airport, and all streams and wetlands downstream that would receive or intercept flows out of the Airport properties. Additionally, the Consultant Team also reviewed the impacts of the developments associated with the 1997 Study which most notably included constructing a third runway to the west of the existing airfield.

The overall approach of the surface water quality analysis of the study involved the following steps:

- Collected qualitative and quantitative water quality data ranging from 1997 to 2019 related to Seattle-Tacoma International Airport stormwater systems that are on-site. This step also includes descriptions of the Industrial Wastewater System (IWS) and Industrial Wastewater Treatment Plant (IWTP), and the Storm Drainage System (SDS) outfalls, which capture runoff from the portions of the existing Airport that do not drain to the IWS;
- Identified the changes to the various stream and wetlands affected by Seattle-Tacoma International Airport developments and operations from 1997 to 2019. This step includes restoration activities on Miller, Walker, and Des Moines creeks, and associated wetlands; and,
- Utilized the United States Geological Survey's (USGS) National Land Cover Database (NLCD), to measure overall land use changes in the study area over the period of study. Specifically, this study was able to use the Land Cover Change Index developed by the USGS, covering years from 2001 through 2016.

B. WATER QUALITY IN ON-SITE STORMWATER

The Consultant Team collected and reviewed readily available data and reports to generate an analysis of water quality conditions at and around Seattle-Tacoma International Airport since 1997, and to identify the potential impacts on water quality to the Study Area Cities.

First, the team compiled and reviewed the airport's National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge Permit and supporting documentation from Port of Seattle. These documents describe the stormwater management system on the site, the monitoring requirements, the state water quality benchmarks, and, importantly, provide a history of the changes and improvements to the system in relation to the NPDES requirements and the developments of the 1997 Master Plan Update which most notably included constructing a third runway to the west of the existing airfield.

Water quality data from 1997 to 2019 was downloaded from the Washington Department of Ecology's (Ecology) Water Quality Permitting and Reporting Information System (PARIS) (Ecology 2020b). This data includes analytical results from the multiple stormwater outfalls within the Air Operations Area (AOA) and surrounding airport industrial support facilities that are reported to Ecology on a quarterly basis. To provide a general summary of the water quality trends time, the Consultant Team selected a subset of seven outfalls with the most continuous data series over the study period, and five water quality parameters that were most frequently sampled (Table

8.1) to graphically present in a series of graphs (Figures 8.2 to 8.19). Graphs depict maximum values reported during a monitoring year, which would reflect exceedances. No new or special water quality studies originated from this analysis. All values were taken from the data provided in the PARIS database (Ecology 2020b). Locations are provided in Figure 8.1.

Figure 8.1
Selected Airport Outfalls and Water Quality Parameters

Outfall Site (current)	Previous Outfall	Receiving Water	Drainage Subbasin Area (acres)	Water Quality Parameters Reviewed in this Report
001	001	Puget Sound	375 acres	Biochemical Oxygen Demand (BOD), Glycols, pH (min., max.), Copper, Zinc, Oil and Grease
SDE4/S1 (combined in 2007)	002, SDE4	Des Moines Creek (East Branch)	172.2 acres (SDE4 only: 159.3 acres)	Copper, Zinc, Turbidity, pH (min., max.)
SDS3/5 (combined in 2007)	005, SDS3	Des Moines Creek (West Branch) via NW Ponds	457.4 acres (SDS3 only: 359.6a acres)	Copper, Zinc, Turbidity, pH (min., max.)
SDN2/3/4 (combined in 2011)	011, SDN4	Miller Creek via Lake Reba	112.87 acres (SDN4 only: 30.6 ares)	Copper, Zinc, Turbidity, pH (min., max.)
SDW1A	na	Miller Creek	70.1 acres	Copper, Zinc, Turbidity, pH (min., max.)
SDW2	na	Walker Creek	37.5 acres	Copper, Zinc, Turbidity, pH (min., max.)

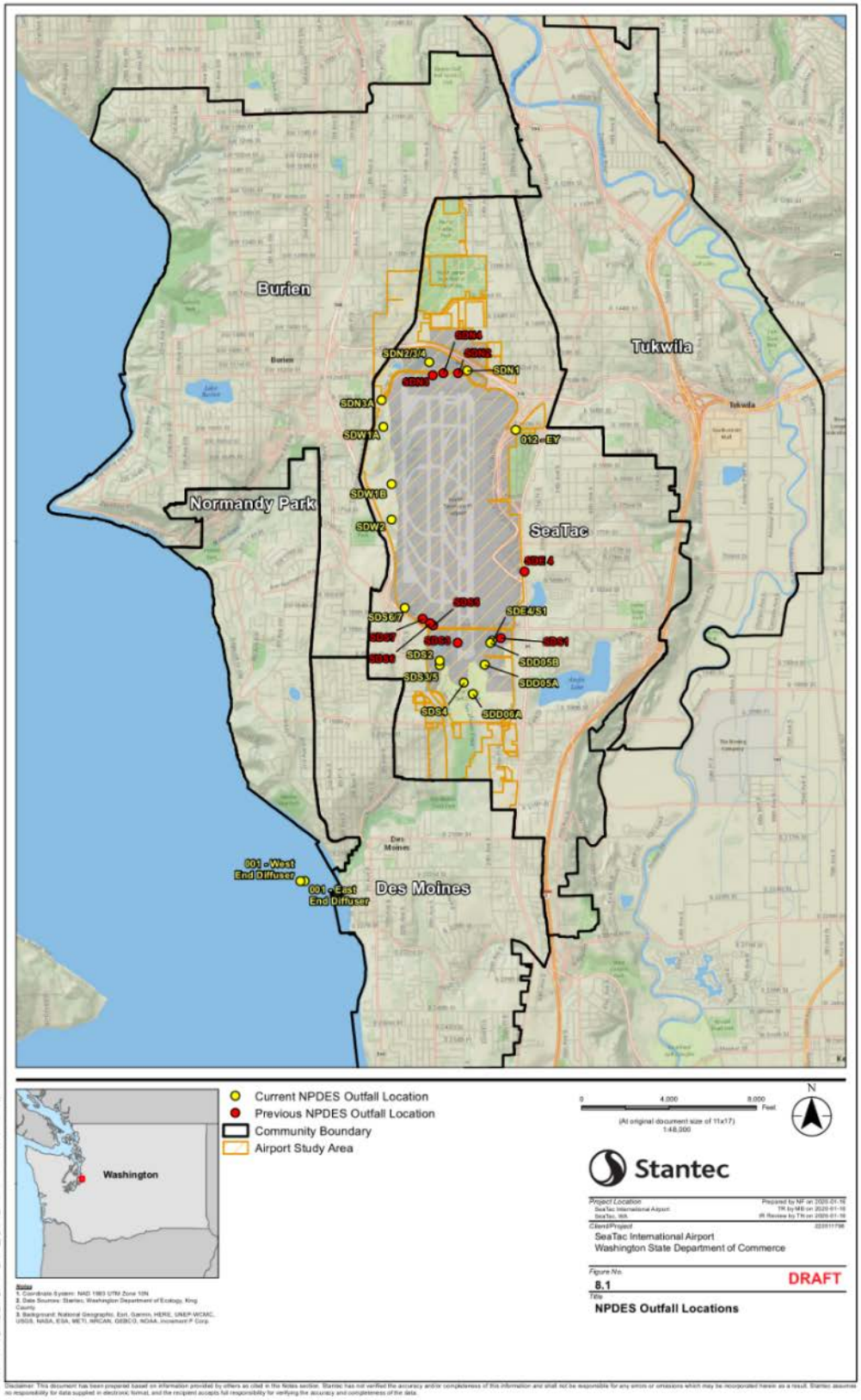
Sources: Port of Seattle 2015a, 2019a

It is important, however, to note that water quality testing limits, sample collection methods, and laboratory analysis methods have changed over the past 22 years, which does present difficulties in assessing trends over such a large period of time. The Consultant Team was able to make adjustment to scalable measurements for Copper and Zinc measurements (i.e., milligrams per liter to micrograms per liter), but a number of the results from the 2008-2009 period appeared to have mislabeled units. In these cases, adjustments were made based on the data ranges immediately preceding or following the questionable data entries.

Some water quality parameters shifted the name of the analysis method that report results at noticeably different ranges, giving the appearance of difference in results across the time period. This was the case for Copper (Cu) results, switching from Total Recoverable Copper to Copper (as Cu) to Total Copper. The same changes occurred for Zinc (Zn). As another example, Outfall 001 tested for Total Glycols from 1997-2008; in 2009, tests instead monitored for propylene glycols and ethylene glycols.

Additionally, some outfalls were consolidated with the issuance of the new NPDES permit. In these cases, the summary results shown in this report use the data from old outfall and the new consolidated outfall together to complete a continuous data set over the 22-year period. For this report's summary analysis, this was limited to three outfalls: SDS3 (SD35), SDN4 (SD234), and SDE4 (SDE4/S1).

Figure 8.2
NPDES Outfall Locations



C. INDUSTRIAL WASTEWATER SYSTEMS

The IWS and IWTP were initially built in 1963/1964, and the system currently manages stormwater from the approximately 375 acres associated with industrial activities. Such activities include aircraft fueling, maintenance operations, and wastewater from other airport related operations., Industrial wastewater may result from any process or activity of industry, manufacturing, trade, or business, and includes (but is not limited to) water used for industrial processes such as pipe integrity pressure testing and vehicle and aircraft wash water; stormwater contaminated with fuel, lubricants, firefighting foam, cleaning agents, and aircraft and ground surface de-icing/anti-icing agents; contaminated construction dewatering waters; excess water from groundwater well construction and monitoring; and leachate from contaminated sludge management (Port of Seattle 2019a). These are all permitted discharges to the IWS. The IWS includes collection and conveyance facilities, biochemical oxygen demand runoff segregation, runoff storage, and the IWTP.

IWS Components and Upgrades

Aircraft maintenance, fueling and deicing operations are restricted to those areas served by the IWS stormwater collection and conveyance system, consisting of 21 miles of piping, 510 manholes and catch basins, two below-grade vaults in the parking garage, and 11 pump stations (Port of Seattle 2015a, 2019a). Each pump station functions as a key structural source control (SSC) Best Management Practice (BMP), diverting runoff from various drainage areas that would otherwise drain to the SDS to the IWS instead. Originally designed for a 10-year, 24-hour storm event, computer modeling of the conveyance system determined that portions of the system might be overloaded during the current stormwater regulation standard of 25-year, 24-hour storm events. In response to this analysis, the Port installed watertight manhole covers in 1997 through 1998 to prevent flooding in areas that would pose a safety problem or may overflow to the storm drainage system (SDS) (Port of Seattle 2016).

The storage of runoff from the IWS collection system is a critical component of the overall system as it allows for temporary containment of flows in excess of the plant's treatment capacity. Three lagoons provide storage capacities of 1.6, 3.3, and 76 million gallons at a maximum normal operating water depth (Port of Seattle 2019). Lagoons 1 and 2 were lined with a polyethylene liner in 1996 and 1997 respectively. In 2002, Lagoon 3 was cleaned, lined, and expanded from 20.2 to 76 million gallons (Port of Seattle 2015a, 2019a).

In preparation for its "all known, available, and reasonable methods of treatment" (AKART) compliance as well as overall plant improvement, the Port began implementing a series of upgrades early as 1995. A total of 36 improvements were made to IWS and IWT from 1996-2009, according to Table E-2 in Port of Seattle (2015a). The total capital cost of these improvements is over $65 million. Among the improvements was the ability to segregate biochemical oxygen demand runoff. While the IWTP is highly effective in treating stormwater pollutants it was less capable of reducing high Biochemical Oxygen Demand (BOD) concentrations caused by aircraft deicing operations. Runoff with high BOD levels must be segregated and pumped off-site to the Valley View Sewer District, which then sends it to King County's South Wastewater Treatment Plant (SWTP) for secondary treatment and discharge. BOD segregation is facilitated by in-stream monitoring for total organic carbon (TOC), which is used as an analytical surrogate for BOD. The real-time data from the influent TOC analyzers allow plant operators to segregate the high concentration runoff to designated lagoons. Effluent TOC meters allow IWTP operators to monitor the concentration and mass loading of treated effluent being sent to the King County's SWTP or directly to Puget Sound via Outfall 001. Since the segregation process became operational in January 2007, the Seattle-Tacoma International Airport has reduced BOD loading to Puget Sound by over 95% while reducing unnecessary use of the sanitary sewer conveyance and treatment capacity and overall energy consumption (Port of Seattle 2015a).

Water Quality Trends for Outfall 001

Water quality data associated with BOD, Glycols, Copper, Zinc, pH (maximum and minimum), and Oil and Grease are shown in Figure 8.3 through Figure 8.9, emptying into Puget Sound from Outfall 001 annually from 1997 through 2019 (from data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651).

As discussed, the segregation of BOD runoff became operational in January 2007. Results of daily maximum BOD measurements are shown to have decreased to maximums generally lower than 100 milligrams per liter (mg/L), as compared to levels before 2007, which ranged from 210 to 13,000 mg/L. Measurements of total glycols (mg/L) show a similar trend, with amounts dropping to less than 100 mg/L after 2007 segregation began.

Levels of copper and zinc have not been measured during the entire 22-year period of study, with samples taken quarterly starting in 2005 -2006. During the period of 2005-2015 under the previous NPDES permit, the two metals remained at relatively lower concentrations and normally did not exceed the daily maximum limits. The copper limit was 83 micrograms per liter (ug/L), and the limit for zinc was 164 ug/L. According to the current NPDES permit requirements (for 2016-2020), heavy metal sampling is not required each year. Priority pollutant sampling was conducted during the wet season and dry season during year three of the permit (2018), but those measurements were not included in the data downloaded from Ecology's PARIS database.

The maximum and minimum levels of pH generally stayed within the 6.0 to 9.0 limits set by the NPDES permit. It appears that only two potential violations of those limits occurred during the study period, once in 2007 (5.8), and the other in 2018 (9.3).

Measurements for Oil and Grease have stayed under the NPDES limit of 15 mg/L, except during 2019, when a daily maximum was measured at 17.35 mg/L. Generally, the levels of Oil and Grease appear to have decreased since 2009 in comparison with levels from 1997 to 2008.

Figure 8.3
Maximum Biochemical Oxygen Demand Measurements sat Outfall 001

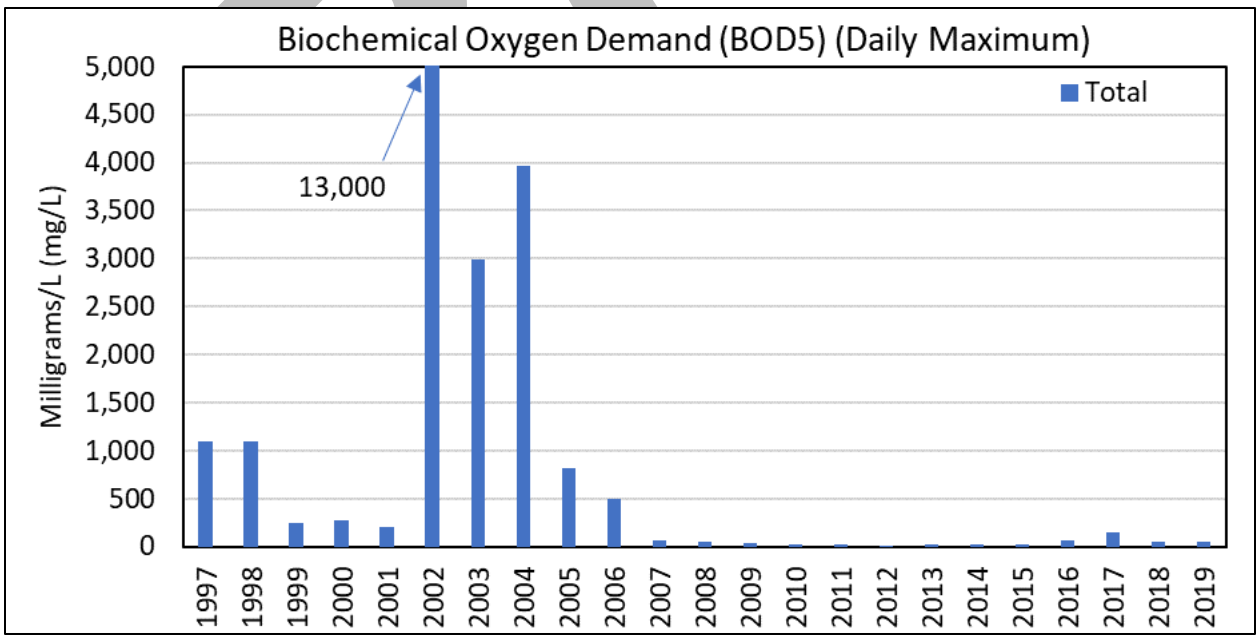


Figure 8.4
Maximum Glycol Measurements at Outfall 001

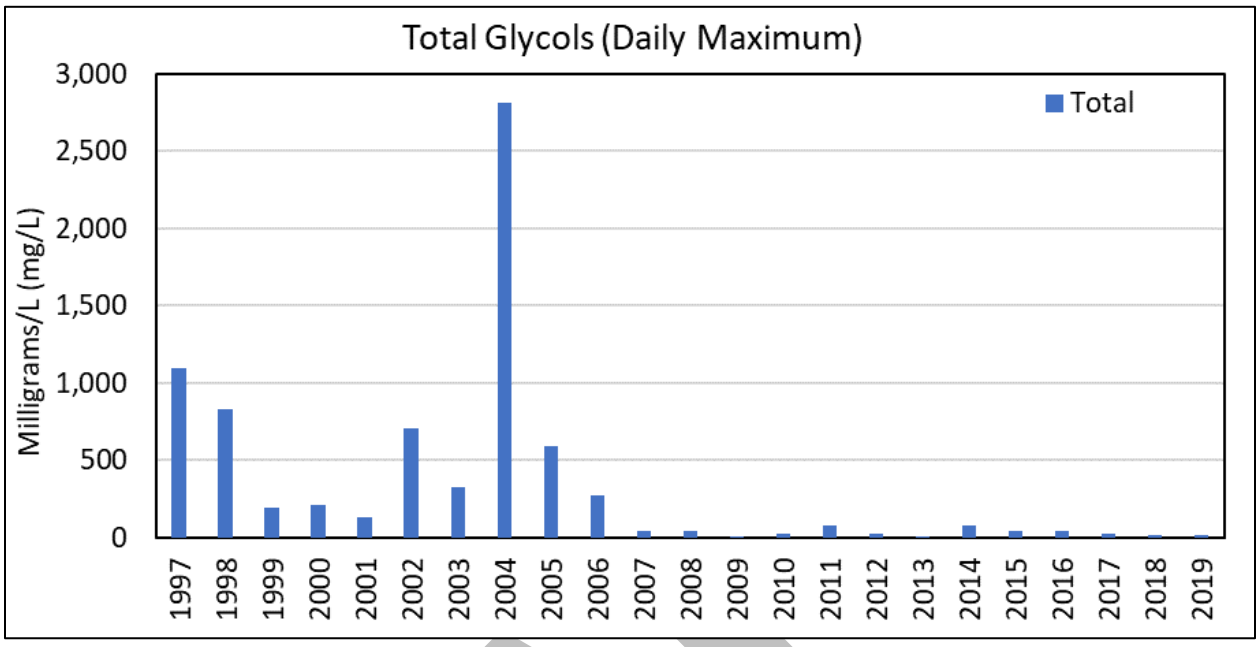


Figure 8.5
Maximum Total Copper Measurements at Outfall 001

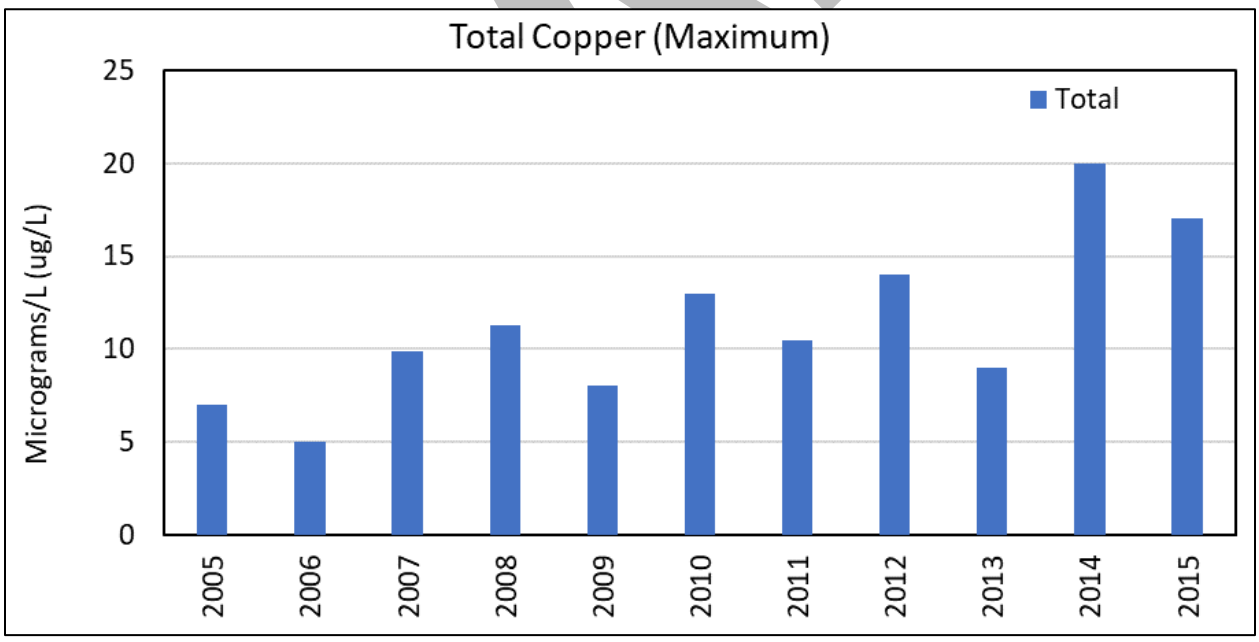


Figure 8.6
Maximum Total Zinc Measurements at Outfall 001

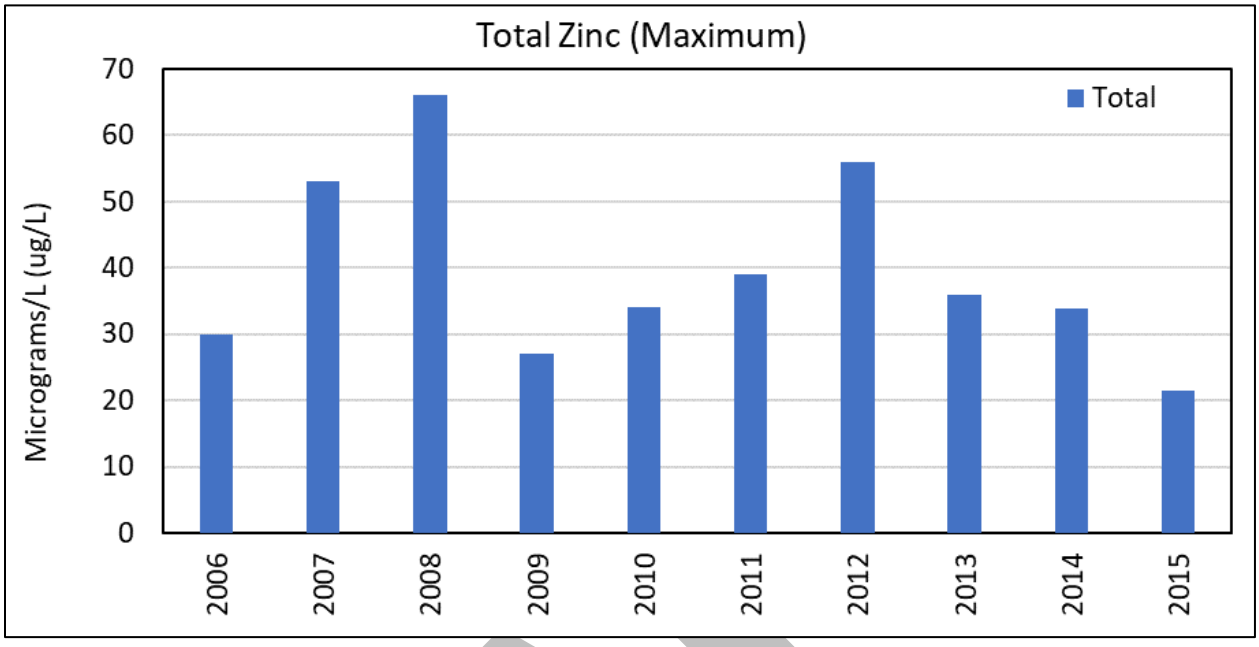


Figure 8.7
Maximum Total pH Measurements at Outfall 001

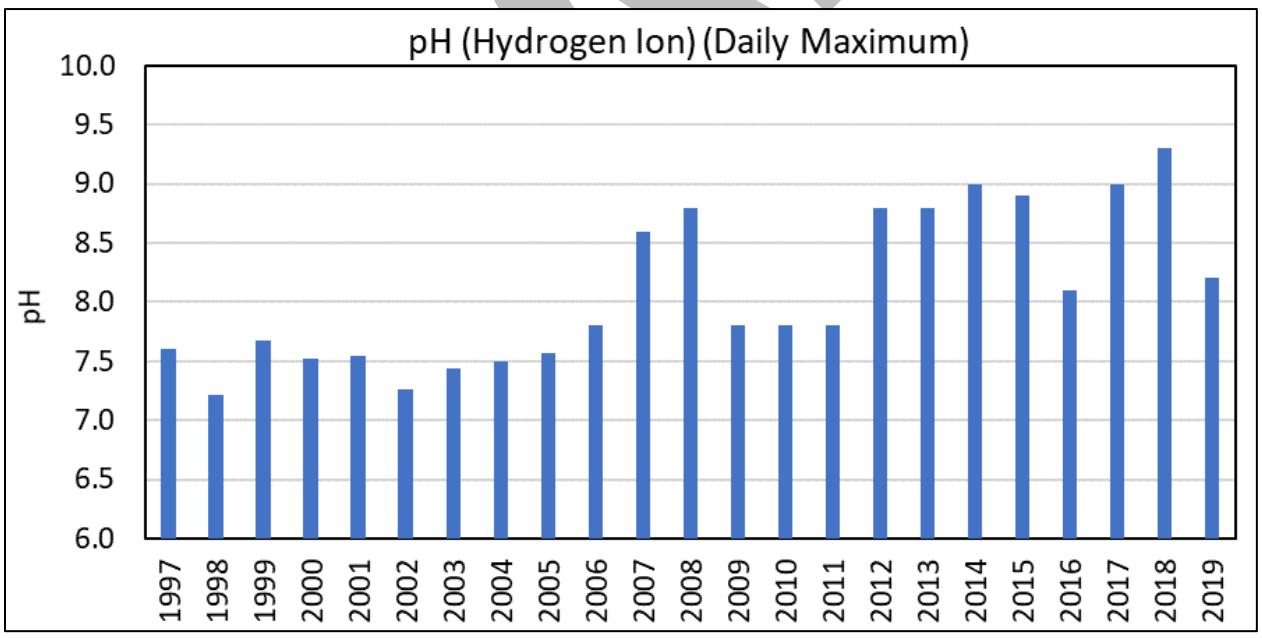


Figure 8.8
Minimum pH Measurements at Outfall 001

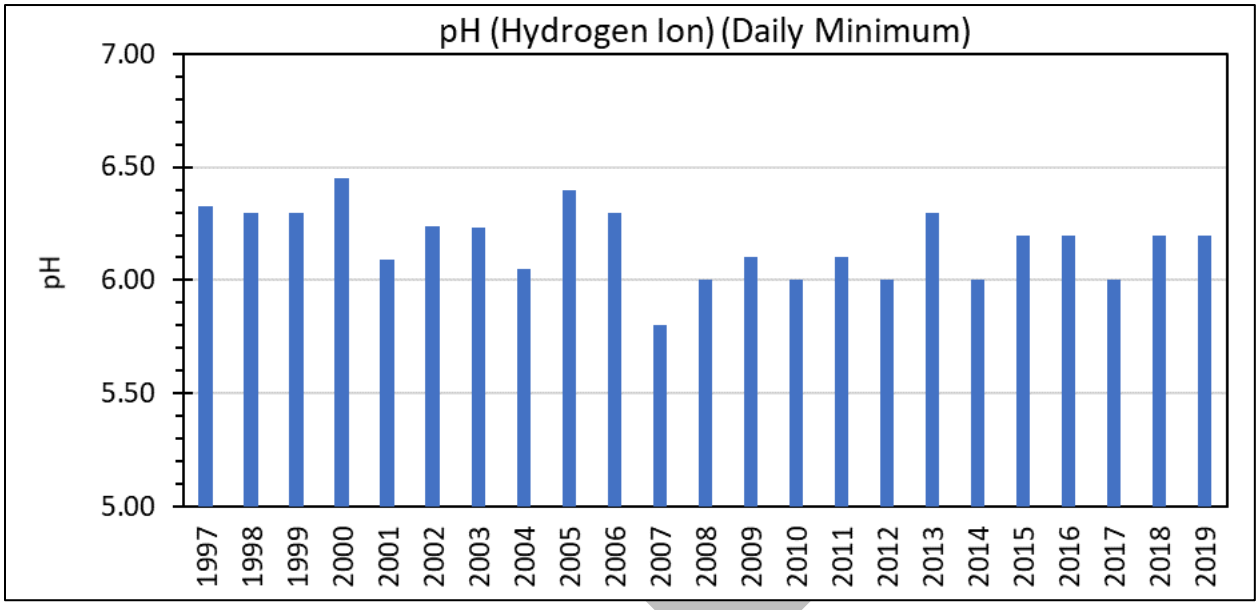
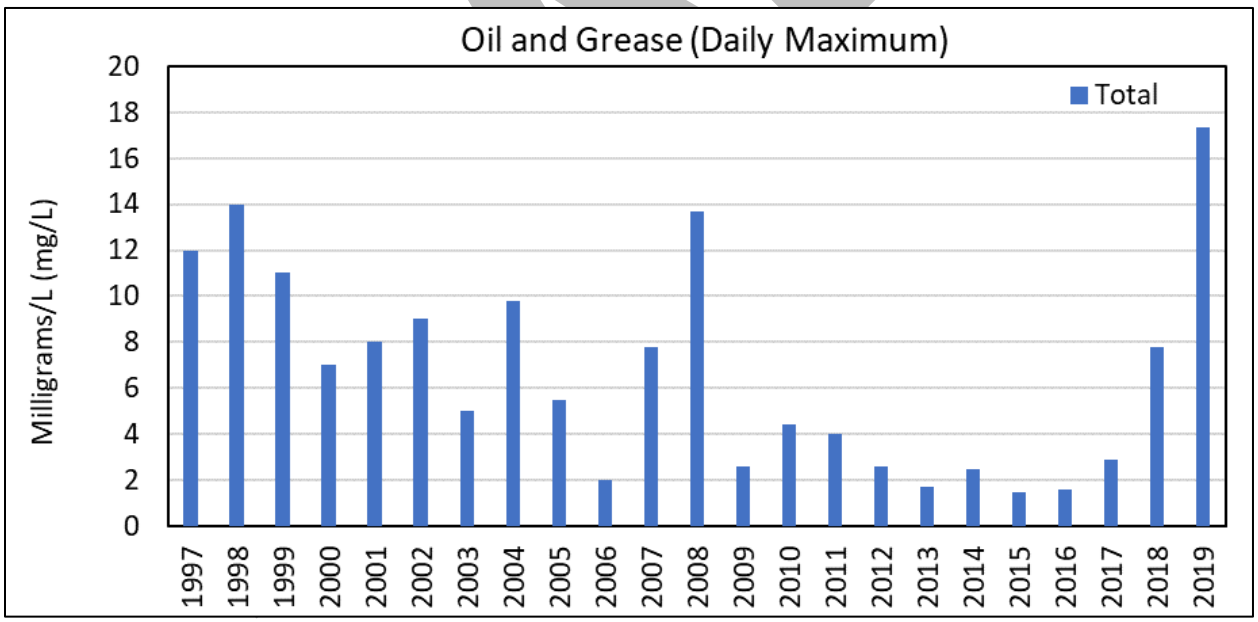


Figure 8.9
Maximum Oil and Grease Measurements at Outfall 001



D. STORM DRAINAGE SYSTEM

The Storm Drainage System (SDS) drains over 1,200 acres. Nearly one-half of this area is impervious, consisting of the airport's runways, taxiways, parking lots, roads, and roofs. Stormwater draining from the SDS makes its way to two different watersheds: Miller Creek (which includes Walker Creek) to the north and west, and Des Moines Creek to the south. Approximately 282 acres (23.5 %) of the SDS area drains to Miller Creek, which represents about 7 % of Miller Creek's total watershed area (Port of Seattle 2015a). Approximately 852 acres (71 %) of the SDS area drains to the south to Des Moines Creek, representing about 21 % of the creek's watershed (Port of Seattle 2015a).

Components and Upgrades

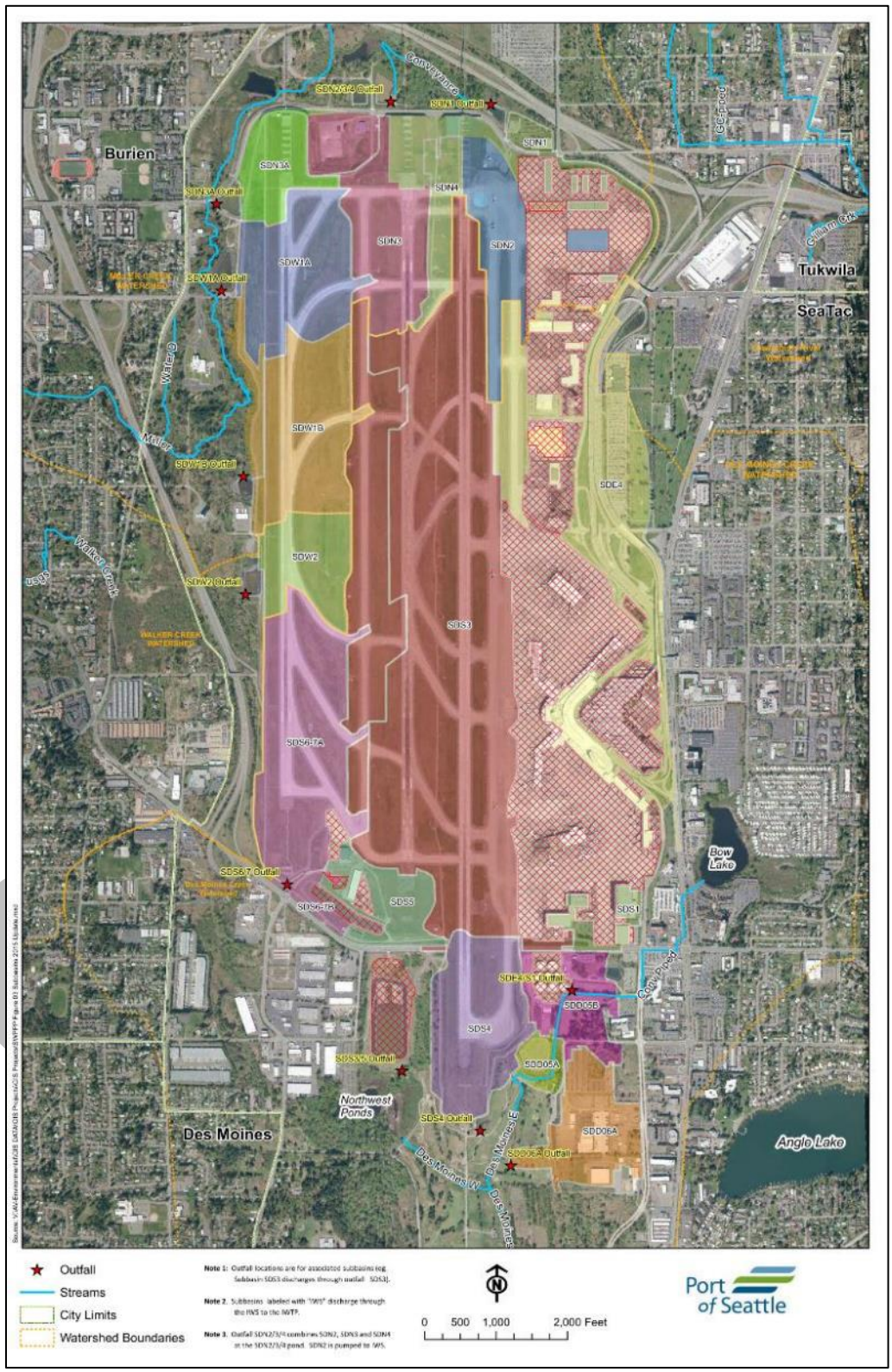
There are five active Seattle-Tacoma International Airport subbasins in the Miller Creek Basin. SDN1 and SDN-2/3/4 discharge to Lake Reba (see Figure 8.10). The SDN-2/3/4 subbasin is located on the north end of the airport and combines the previously separate SDN2, SDN3, and SDN4 subbasins into a single outfall. The three subbasins were combined due to reconstruction of the Pond M (SDN2/3/4) detention facility, which was activated in November 2011 (Port of Seattle 2019a). Seattle-Tacoma International Airport subbasins SDN3-A, SDW1-A, and SDW1-B are located along the western edge of the airport to provide drainage from the third runway. Each drains into Miller Creek. Runoff treatment current in place for these subbasins include Level 2 (duration based) flow control detention pond and filter strips located along the runway provide flow control and treatment (Port of Seattle 2019a).

Walker Creek watershed receives Seattle-Tacoma International Airport discharges stormwater from one subbasin, SDW2 (Figure 8.9). The outfall was activated in November 2008 after commissioning of the third runway. This area receives runoff from the runway, taxiways, and infield areas associated with the west portion of the third runway. BMPs for the subbasin include filter strips adjacent to runways and taxiways provide additional treatment, and a Level 2 detention pond (11.9 acres) for flow control to Walker Creek (Port of Seattle 2019a).

The Des Moines Creek watershed draining Seattle-Tacoma International Airport is divided into an East and West Branch. The West Branch basin is approximately 1,243 acres, with 600 acres within the boundaries of the Seattle-Tacoma International Airport (Port of Seattle 2015a). The West Branch flows into a series of ponds known as the Northwest Ponds, which were enlarged to provide regional detention to control high flows in the middle and lower reaches of Des Moines Creek. The three Seattle-Tacoma International Airport subbasins in Des Moines West Basin (SDS-3/5, SDS-4, and SDS-6/7) all receive runoff from runways, taxiways, and service roads (Figure 8.9). During 2003-2008, these subbasins were improved through the addition of a variety of water quality and flow control BMPs (Port of Seattle 2019a). In addition, a bioretention swale was constructed to provide additional treatment in the SDS-4 subbasin in August 2011.

Des Moines Creek East begins at Bow Lake, one-quarter mile east of Seattle-Tacoma International Airport. The East Branch basin is approximately1,032 acres, with 218 acres within the boundaries of the Seattle-Tacoma International Airport (Port of Seattle 2015a). The creek flows mostly within pipes through the city of SeaTac and along the east side of Seattle-Tacoma International Airport, finally daylighting in the southeast corner of the airport. The SDE-4/S1 subbasin is located along the eastern portion of the airport (Figure 8.9) and combines the SDE4 and the SDS1 subbasins into a single outfall (in August 2007; Port of Seattle 2019a). The SDS1 area receives runoff from aircraft maintenance building rooftops, parking areas, cargo building rooftops, roads, and parking lots. The SDE4 subbasin drains the passenger terminal area on the east side of Seattle-Tacoma International Airport. This area receives runoff from roads, parking lots, terminal area roofs, and taxiways. The combined subbasin has had multiple BMPs implemented to meet basic treatment (AKART) requirements and to provide additional enhanced treatment for dissolved metals. These include a Level 1 flow control extended detention pond, a 600-cartridge media filtration vault which provides enhanced treatment, and a bioswale (Port of Seattle 2019a).

Figure 8.10
Airport Subbasins, Outfall Locations, and Watershed Boundaries



Source: Port of Seattle (2015b) SWPPP.

Water Quality Trends

Over the past two permit cycles (2003-2008, and 2009-2015), the Port of Seattle invested over $80 million in stormwater infrastructure improvements through the construction of AKART BMPS followed by an adaptive management program (Port of Seattle 2015a). As a result, water quality test results required by the current NPDES permit has shown a high attainment of permit effluent limits and low variability in stormwater data over the years. The NPDES Fact Sheet for the current permit (Port of Seattle 2015a) summarized the stormwater data for each of the Seattle-Tacoma International Airport outfalls from April 1, 2009 through March 31, 2013. Overall, stormwater discharges from the SDS were well below NPDES permit limits. The summary noted there were only four permit limit exceedances for turbidity out of 342 samples collected. The permit limit for zinc was only exceeded once out of 334 samples collected, and copper had only four exceedances out of 334 samples collected during that same period.

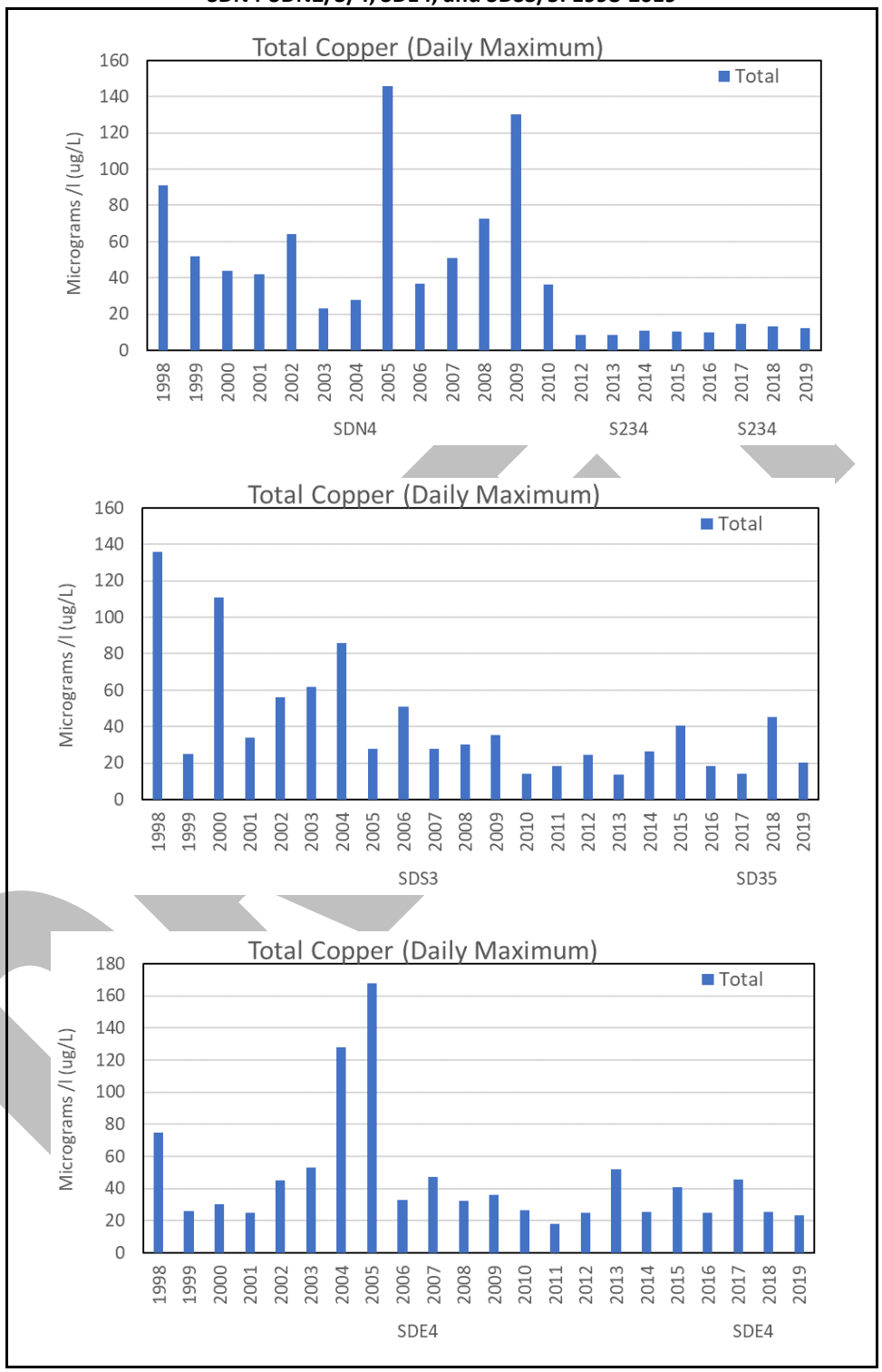
Analysis of the wider 22-year study period examined five water quality parameters: Copper, Zinc, pH (maximum and minimum), and turbidity. Results are shown in Figure 8.11 through Figure 8.20.

The daily maximums of total copper for the outfalls SDS4-SDN2/3/4, SDE4, and SDS3/5 show higher concentrations in the earlier part of the study period, suggesting benchmark exceedances are less common now by comparison (Figure 8.11). Additionally, results from SDN4 still show maximum total copper concentrations would be in exceedance for that site (a limit of 63.6 ug/L) in 2008 and 2009, but maximum concentrations drop in 2010, and again to lower levels in 2011 and beyond. This would coincide with the consolidation of the SDN4 outfall with SDN2 and SDN3, due to the upgrade of the detention facility there, and increased BMPs at that time. Total copper concentrations at the two newer western outfalls have been well below their NPDES limits (59.2 ug/L for SDW1A, and 47.9 ug/L for SDW2) indicating that BMPs on the third runway are appropriate/effective in reducing total copper concentrations, contributions of total copper in stormwater runoff from activities related to the third runway are lower, or that the stormwater system is successful at filtering total copper from the runoff (Figure 8.12).

Similar to trends for total copper, the daily maximums of total zinc for the outfalls SDS4-SDN2/3/4, SDE4, and SDS3/5 show higher concentrations in the earlier part of the study period (Figure 8.13). This is especially true for SDE4; however, SDE4 drains the passenger terminal area and would have the potential for higher levels. The higher maximum concentrations are reduced considerably after 2007, coinciding with the upgrades in BMPs implemented at that time, suggesting their effectiveness. Again, results from SDN4 show maximum concentrations that would be in exceedance for that site (a limit of 117 ug/L) in 2007 and 2009, but maximums drop to 40 ug/L in 2010, and again to lower levels through 2019. This coincides with the consolidation of the SDN4 outfall and the upgrades of BMPs there.

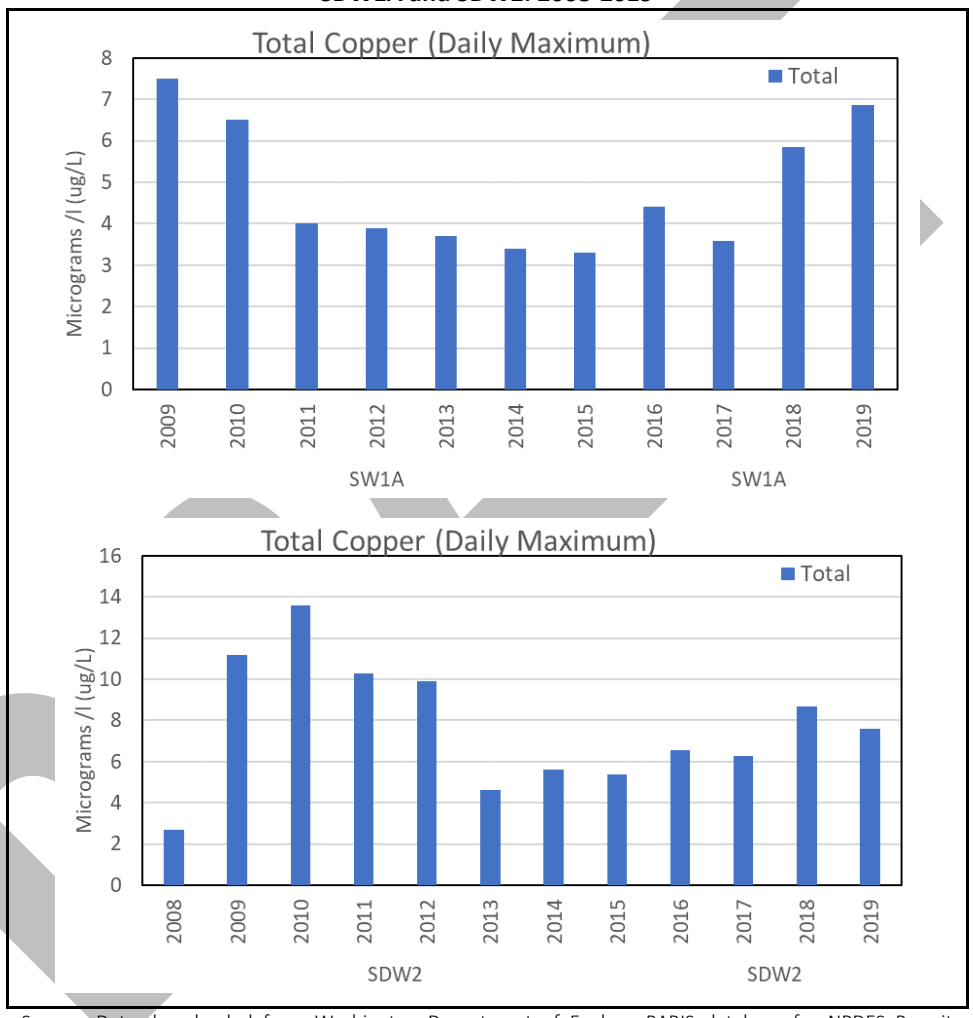
Zinc concentrations at the two newer western outfalls have been well below their NPDES limits (117 ug/L) indicating that either contributions of zinc are low on the third runway, or that the stormwater system is successful at filtering zinc from the runoff (Figure 8.14).

Figure 8.11
Daily Maximum Total Copper Measurements at SDS Outfalls SDN4-SDN2/3/4, SDE4, and SDS3/5: 1998-2019



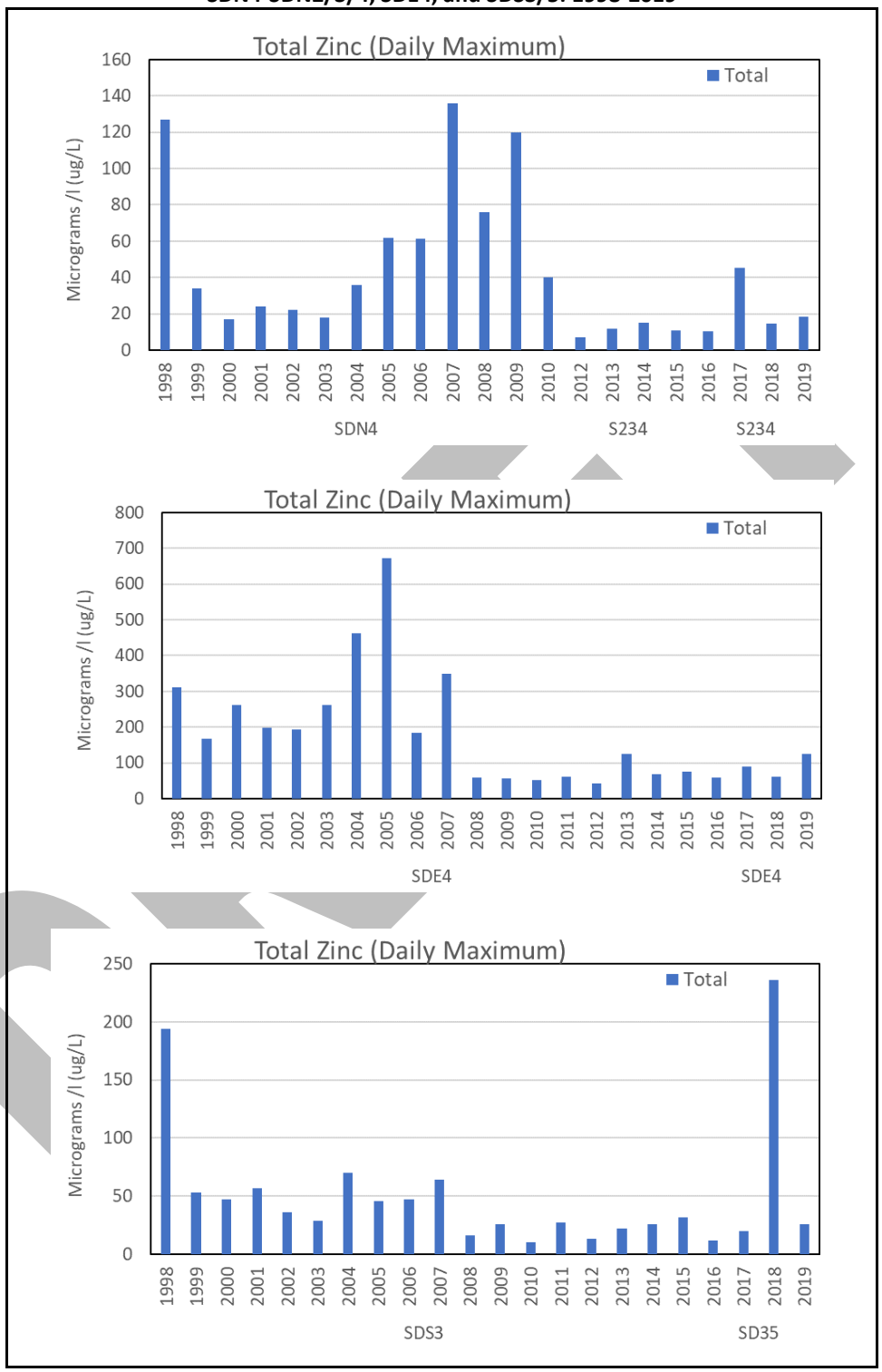
Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

Figure 8.12
Daily Maximum Total Copper Measurements at SDS Outfalls SDW1A and SDW2: 2008-2019



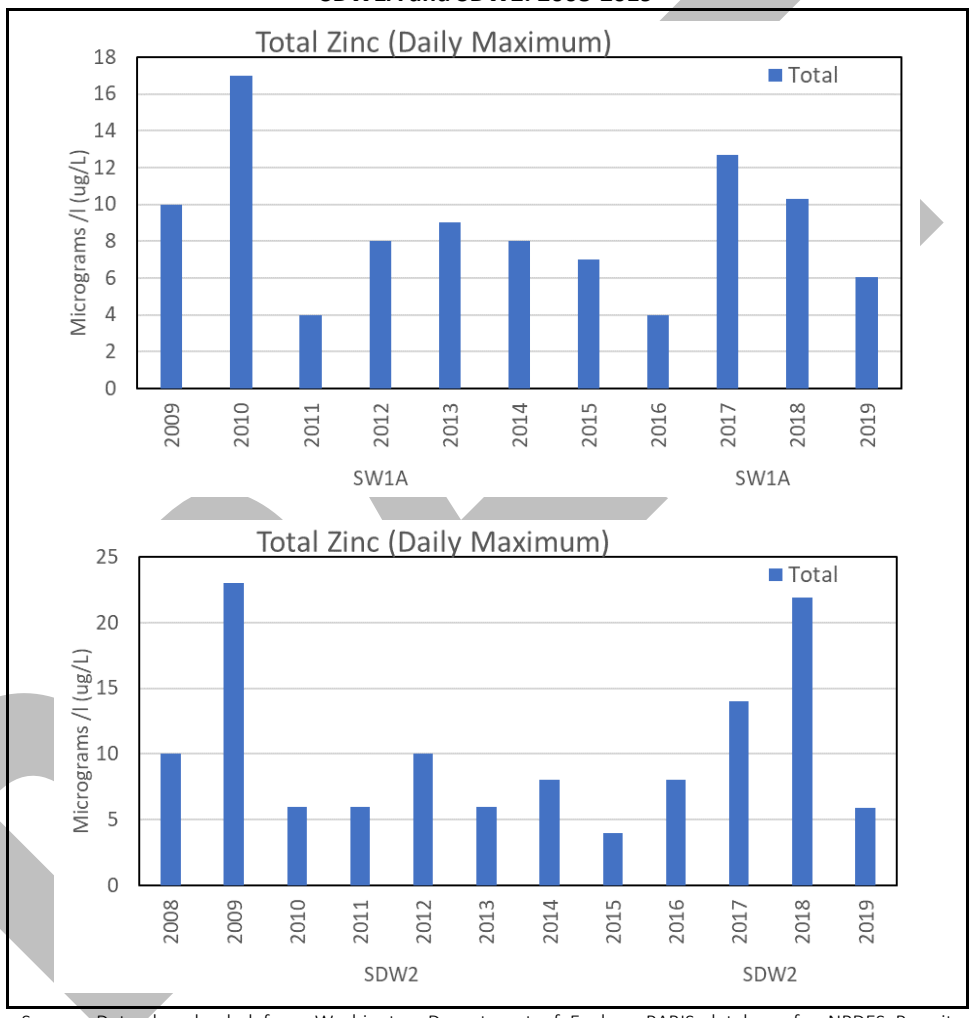
Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

Figure 8.13
Daily Maximum Total Zinc Measurements at SDS Outfalls
SDN4-SDN2/3/4, SDE4, and SDS3/5: 1998-2019



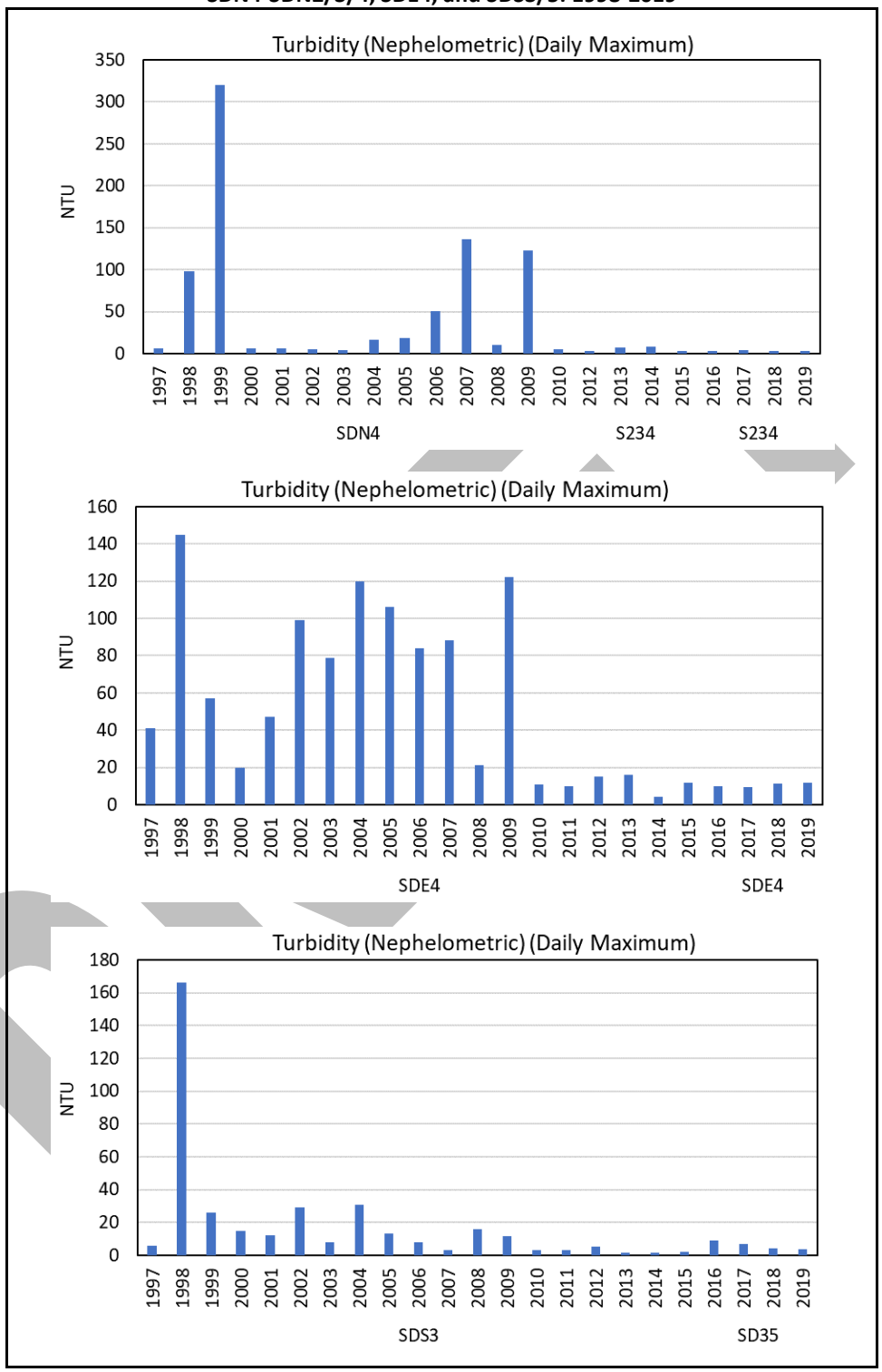
Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

Figure 8.14
Daily Maximum Total Zinc Measurements at SDS Outfalls SDW1A and SDW2: 2008-2019



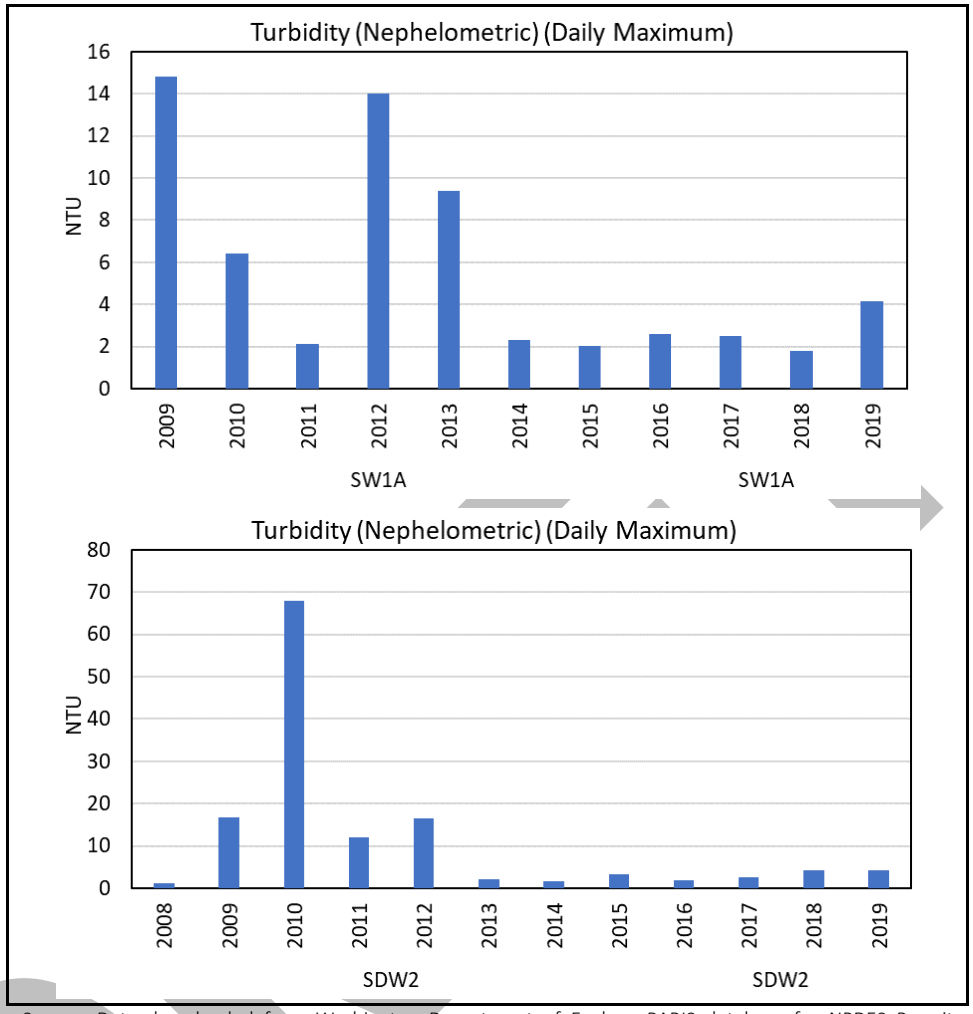
Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

Figure 8.15
Daily Maximum Turbidity Measurements at SDS Outfalls
SDN4-SDN2/3/4, SDE4, and SDS3/5: 1998-2019



Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

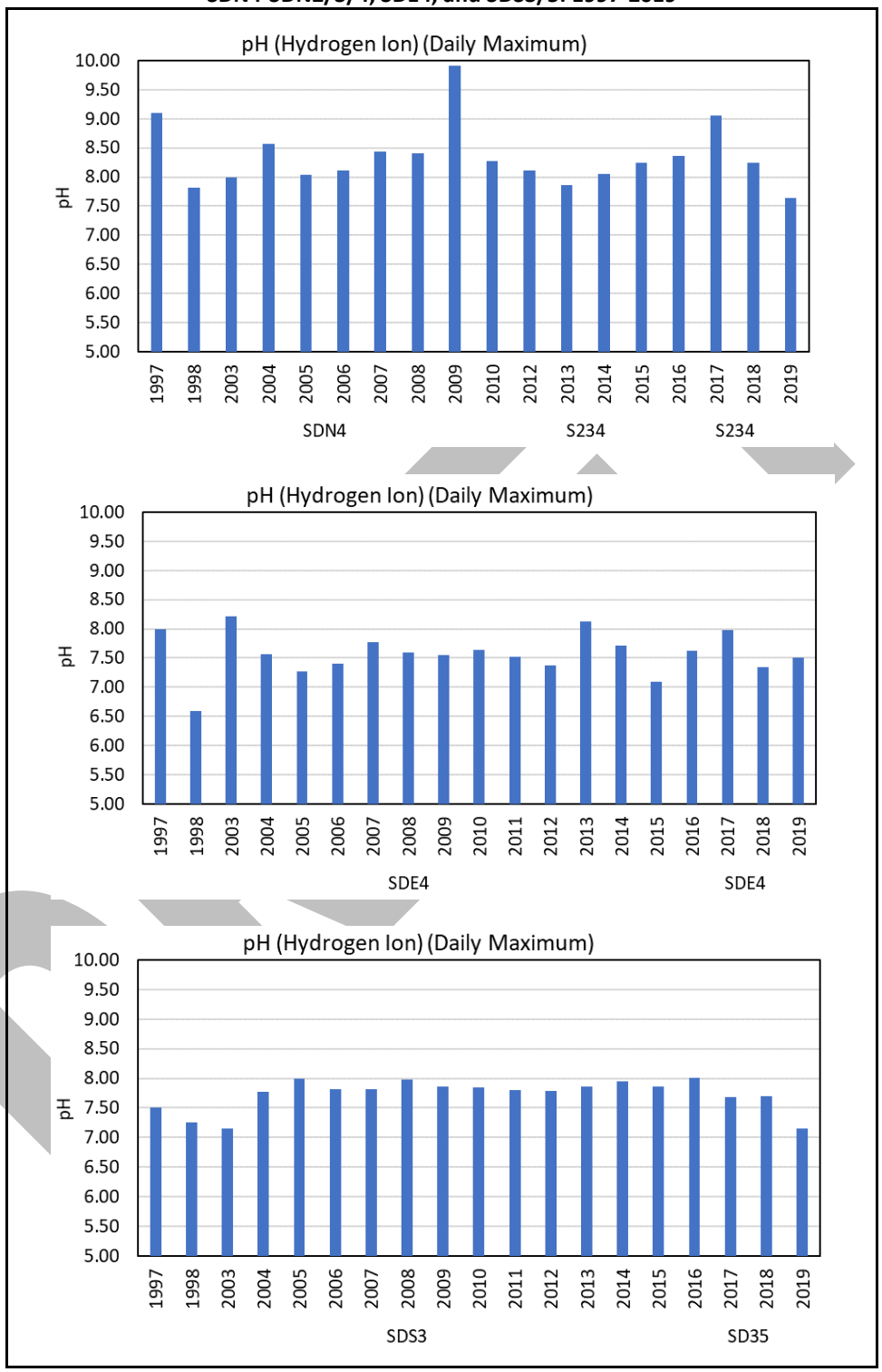
Figure 8.16
Daily Maximum Turbidity Measurements at SDS Outfalls
SDW1A and SDW2: 2008-2019



Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

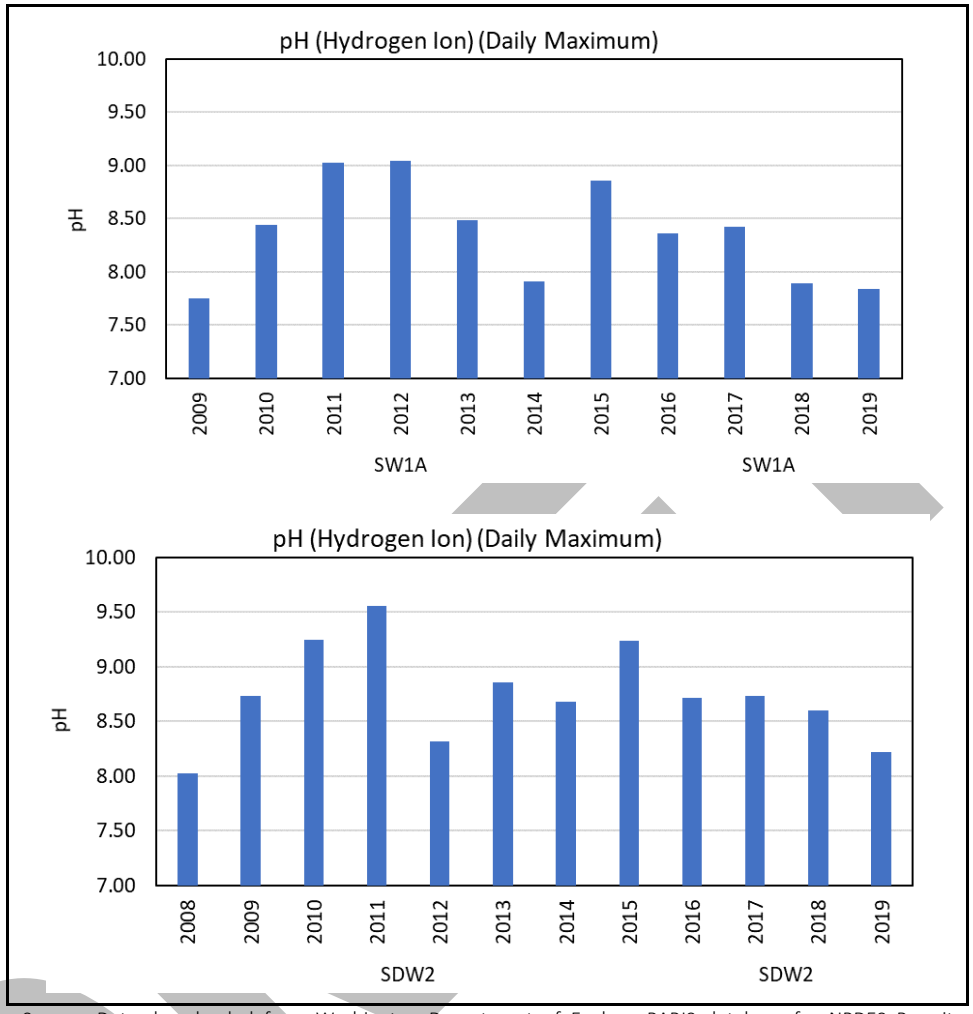
Turbidity limits under the NPDES permit is a daily maximum of 25 NTUs. For SDN4-SDN2/3/4 and SDE4, this limit was exceeded each year up to 2009 (Figure 8.14). For SDN4-SDN2/3/4, this would coincide with the consolidated outfall and the upgraded detention facility. For SDE4, BMP upgrades were brought online in 2007, and there was a substantial maximum turbidity measurement recorded in 2009. Over the past 10 years, however, turbidity levels have remained under the 25 NTU benchmark. Turbidity at the two newer western outfalls have been well below 25 NTUs, except for in 2010 at SDW2 (Figure 8.15). These results indicate that the SDS is successful at controlling turbidity in runoff from Seattle-Tacoma International Airport.

Figure 8.17
Daily Maximum pH Measurements at SDS Outfalls
SDN4-SDN2/3/4, SDE4, and SDS3/5: 1997-2019



Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

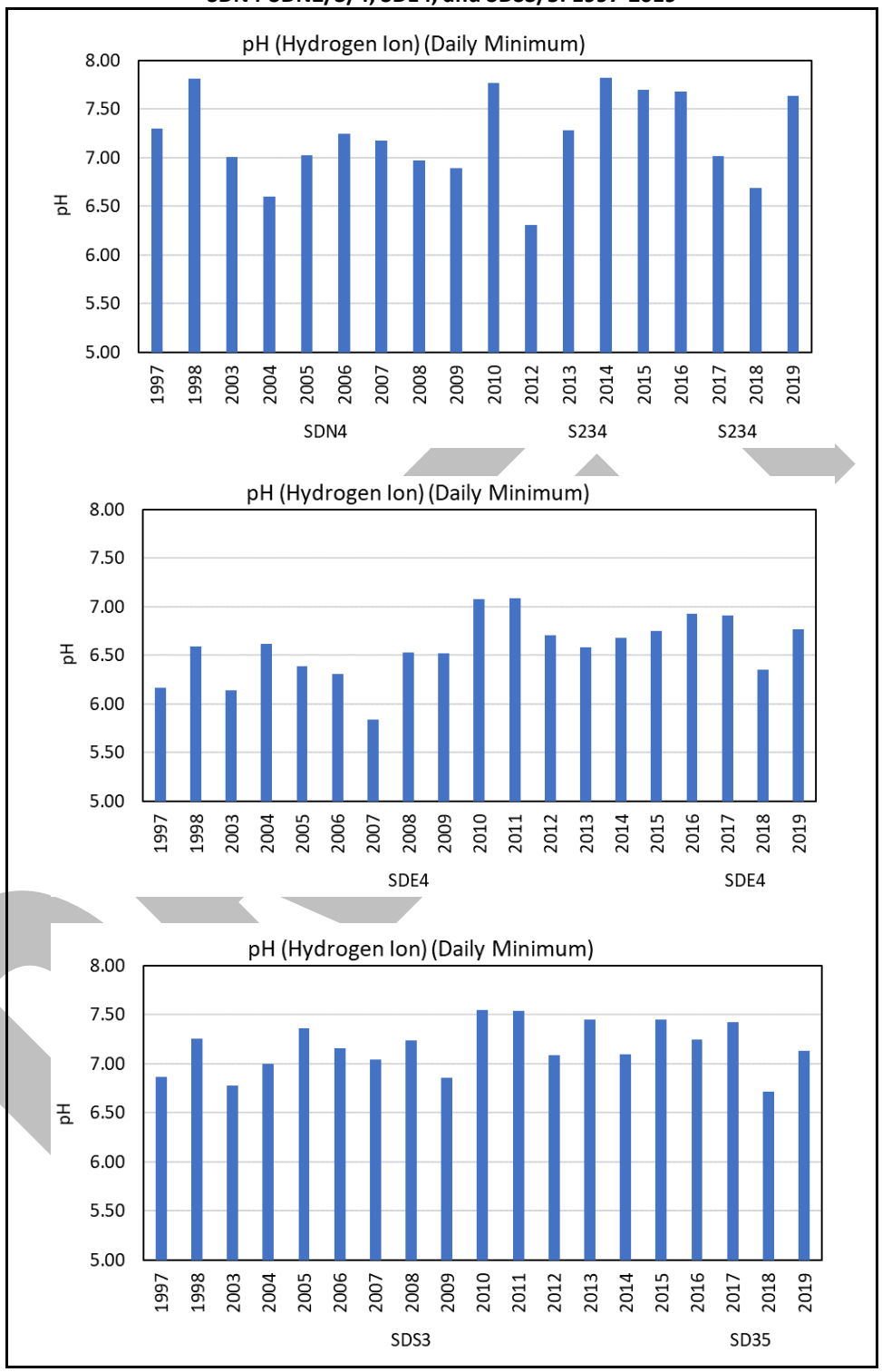
Figure 8.18
Daily Maximum pH Measurements at SDS Outfalls
SDW1A and SDW2: 2008-2019



Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

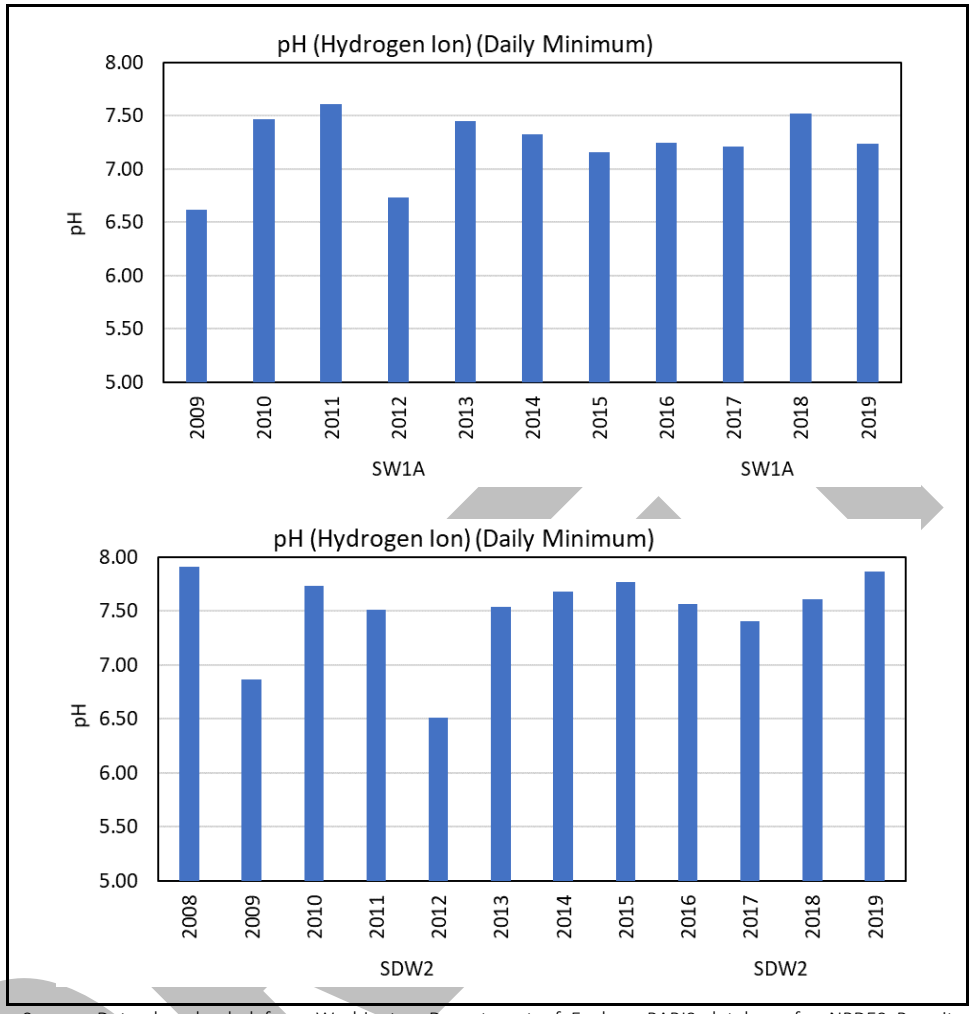
Levels of pH are limited to the range of 6.5-8.5 at the north, south, and east SDS outfalls. Results show that while SDE4 and SDS3/5 have not exceeded the 8.5 maximum, SDN4-SDN2/3/4 has recorded exceedances in four years (Figure 8.16). Daily maximum pH measurements at SDS outfalls SDW1A and SDW2 have slightly different pH limits, ranging from 6.3-9.0. These outfalls have exceeded at pH of 9.0 several times over the study period. The Port conducted a study from November 2011 through May 2012, to identify the potential causes of elevated pH in discharges from the western stormwater ponds and their associated outfalls (SDN3A, SDW1A, SDW1B and SDW2), and to assess if these discharges impacted pH levels in the receiving waters of Miller and Walker creeks. The resulting Stormwater pH Study Final Report (Port of Seattle 2012) concluded that primary productivity within the stormwater ponds was the cause of elevated pH levels at the pond outfalls. The pH data collected in Miller Creek and Walker Creek showed that the pH downstream from the pond discharge locations met the water quality criterion (6.5-8.5 standard units) in both wet and dry weather conditions (Cardno TEC 2014). The Port of Seattle has implemented BMP measures to limit algal blooms in the stormwater ponds to keep pH levels lower.

Figure 8.19
Daily Maximum pH Measurements at SDS Outfalls
SDN4-SDN2/3/4, SDE4, and SDS3/5: 1997-2019



Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651. Note that 1999-2002 were missing from the data downloaded

Figure 8.20
Daily Maximum pH Measurements at SDS Outfalls
SDW1A and SDW2: 2008-2019



Source: Data downloaded from Washington Department of Ecology PARIS database for NPDES Permit WA0024651.

Minimum pH levels at the SDS outfalls are generally above the lower limits. SDN4-SDN2/3/4 recorded pH below 6.5 in 2012, and SDE4 recorded six years of instances with pH minimums. Most were still above a pH of 6.0, indicating minor violations, likely due to heavy rainfall events. The western outfalls were above their pH minimum limit of 6.3 in all years. These results indicate that the SDS is successful at controlling pH levels in runoff from the airport.

E. RECEIVING STREAMS AND WETLANDS

The Consultant Team collected and reviewed readily available reports to corresponding to the changes to the receiving waters of Miller Creek, Walker Creek and Des Moines Creek as a result of airport activities. First, the team compiled reviewed documents and reports, including the airport's Natural Resource Mitigation Plan (NRMP) (Parametrix 2004), the Miller and Walker Creeks Basin Plan (Miller and Walker Creeks Basin Project Management Team 2006), and the most recent mitigation monitoring plans for stream and wetland restorations conducted by the Port of Seattle (Port of Seattle 2019a, 2019b). These documents describe the overall conditions of the stream

watersheds, the impacts that the third runway project had, and give details on the ongoing restoration efforts that the Port of Seattle is conducting within these basins.

The Consultant Team accessed the King County Hydrologic Information Center to assess the availability of water quality data collected on the receiving streams. County water quality data was limited to only a few stations downstream from Seattle-Tacoma International Airport, and most of those stations only collect streamflow, stage, and water temperature on a semi-continual basis. Basic water quality parameters were not regularly collected, and not at every station. If they were collected, typically were at stations established farther downstream toward the mouth of the stream. Water quality parameters were limited to conductivity, turbidity, dissolved oxygen (DO), and pH, and several were only available for limited periods between 2010 to 2016. For instance, station 11f is Des Moines Tributary 0377 at Tyee Weir, the closest station to Seattle-Tacoma International Airport that collects water quality. Station 11f collected discharge, stage, and air temperature from 1995 to present, water temperature and conductivity from 2000 to present, DO and %DO from 2000 to 2015, and turbidity and pH from 2012 to 2013. Because the data sets were limited, both in the available parameters and in the time period collected, and because the locations of that data were too far from the airport outfalls to provide any useful comparison or analysis on potential impacts, this data was not utilized in further analyses.

The Consultant Team also compiled orthoimages of the airport, and each of the surrounding cities to get a visual indication of any changes in land cover or land use. The team further utilized the USGS's Land Cover Change Index, developed from the National Land Cover Database (NLCD), to measure overall land use changes in the study area over the period of study, covering years from 2001 through 2016. The area of land use change from over that period was calculated and tallied for the airport property and for each of the six surrounding cities, and graphical displays were created.

Miller Creek Watershed

Miller Creek is six miles in length and its watershed covers approximately 4,800 acres, which includes portions of Normandy Park, and the Cities of Burien and SeaTac. Flows in Miller Creek originate at three locations:

- The Arbor, Burien, Tub, and Lora Lakes complex;
- Lake Reba; and,
- Seeps located on the west side of Seattle-Tacoma International Airport.

Miller Creek flows south under State Route 518 and through the in-stream Miller Creek Regional Detention Facility, passing Lake Reba and Lora Lake and southwest toward Puget Sound. Approximately 62% of the land use in the Miller Creek Basin is residential, 19% is commercial/industrial, and the remainder is open (parks, cemeteries, or forests/wetlands) (Port of Seattle 2019a).

A part of the Miller Creek watershed, Walker Creek is the major tributary of Miller Creek approximately two miles in length, draining about 900 acres. The creek originates in Wetland 43 west of State Route 509 and the Airport. After exiting its headwater wetland, the stream meanders within the urban environment, through backyards, along road shoulders, and through numerous road and driveway culverts (Parametrix 2004). Walker Creek flows for approximately 1.3 miles southwest and generally parallel to Miller Creek before joining Miller Creek less than 500 ft upstream of Puget Sound. Walker Creek receives stormwater runoff originating from residential and commercial development within the basin, which has likely increased the frequency and magnitude of peak flows. Riparian vegetation is predominantly immature and deciduous, and often non-native, with homeowner landscaping frequently extending to the stream banks (Parametrix 2004).

Prior to the construction of the third runways and other Master Plan Update (MPU) improvements, the natural channel conditions of Miller Creek had been greatly altered due to urban development, especially in reaches above South 160th Street. Most stream reaches featured streambanks extensively armored with riprap or retaining walls, and channels altered by dredging or straightened to protect adjacent properties, or to increase conveyance (Parametrix 2004). With the additional filling of adjacent wetlands due to urban development, Miller Creek lacked connections to adjacent floodplains, floodplain wetlands, or riparian areas. These changes resulted in "a lack of habitat complexity, a lack of woody debris in the channel, a lack of shading from riparian vegetation, the loss of surface water storage, and degraded water quality and biotic integrity in much of the basin" (Parametrix 2004).

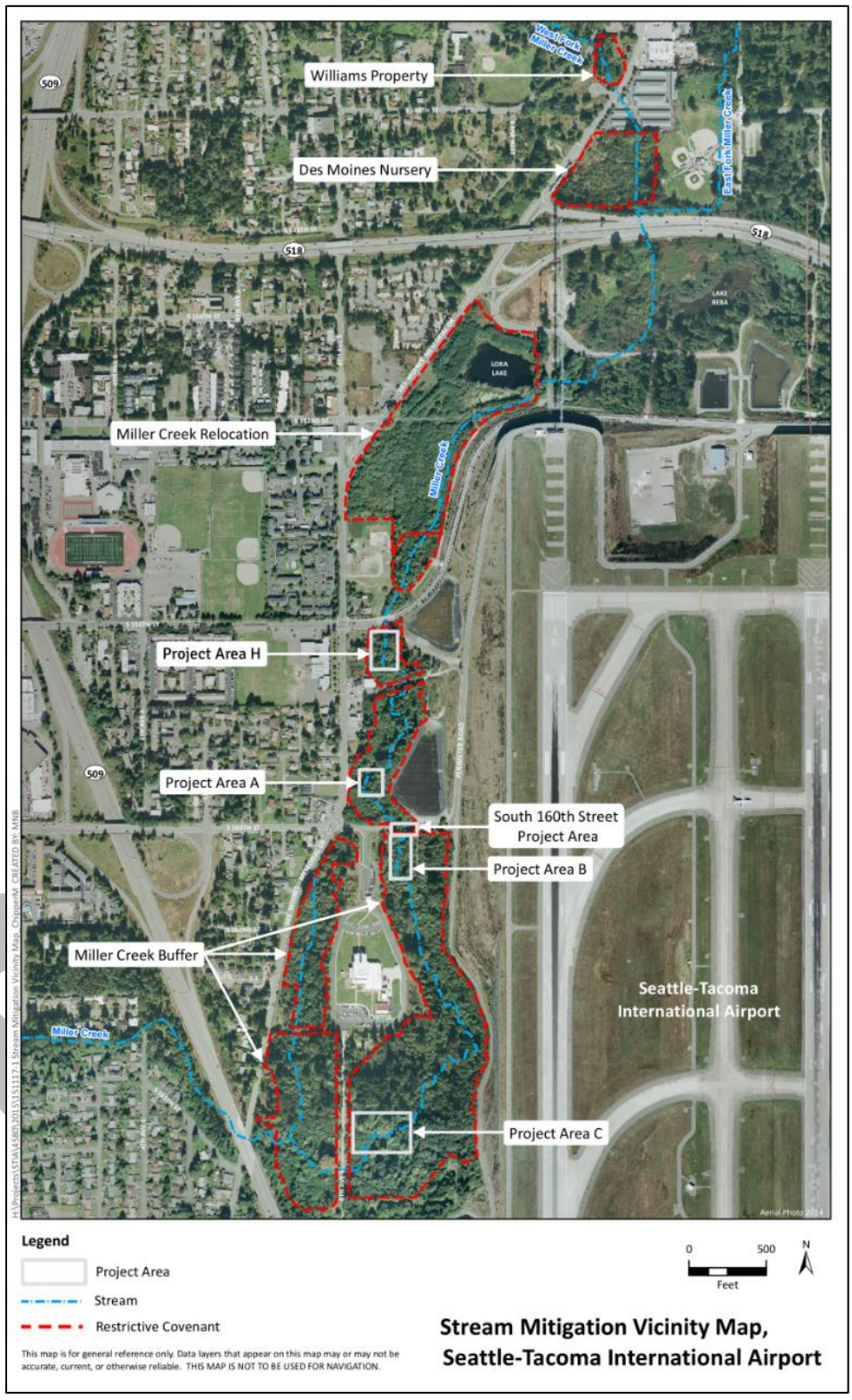
Since Miller and Walker Creeks drain urban watersheds, they are subject to the cumulative impacts of pollution typical of an urban environment supporting an assortment of residential, commercial, and industrial activities. Urban streams receive heavy metals (i.e., copper and zinc), oils, and grease from nearby urban streets, highways, and parking lots; increased levels of phosphorus and nitrogen from fertilization from landscaping; and high levels of fecal coliform from failing residential septic systems (Parametrix 2004). As a result, Miller Creek has been listed under Section 303(d) of the federal Clean Water Act, viewed as a Category 5 (polluted water) water body for bacteria, dissolved oxygen, and temperature (Ecology 2020a). Miller Creek is also listed as a Category 2 Waters of Concern for pH, copper, and zinc. Walker Creek is on the 303(d) list for bacteria and temperature (Ecology 2020a).

Construction activities associated with third runway and other 1997 Master Plan Update improvements impacted approximately 18 acres of wetland and required relocating approximately 1,200 feet of Miller Creek. The Port of Seattle developed the Natural Resources Mitigation Plan (NRMP; Port 2004) to guide compensatory impact mitigation for wetlands, streams, drainage channels, floodplains, as well as stream and wetland buffers in the Miller Creek basin. Components of the mitigation included:

- Miller Creek Relocation, completed in 2006, relocated and enhanced approximately 1,080 linear feet of the Miller Creek stream channel extending from just upstream of South 156th Street to the outlet of Lora Lake. The mitigation also excavated 5.9 acre-feet of floodplain while also creating or restoring approximately 10.5 acres of wetlands at the former Vacca Farm site;
- Miller Creek Buffer, completed in 2006, enhanced existing stream and riparian habitat from the Miller Creek Relocation site downstream to Des Moines Memorial Drive; and
- Des Moines Nursery restoration, completed in 2009, enhanced and restored stream habitat and floodplain connectivity along approximately 480 feet reach of the West Fork Miller Creek just upstream of its confluence with the East Fork Miller Creek at the former 5.33-acre Des Moines Nursery site north of State Route 518.

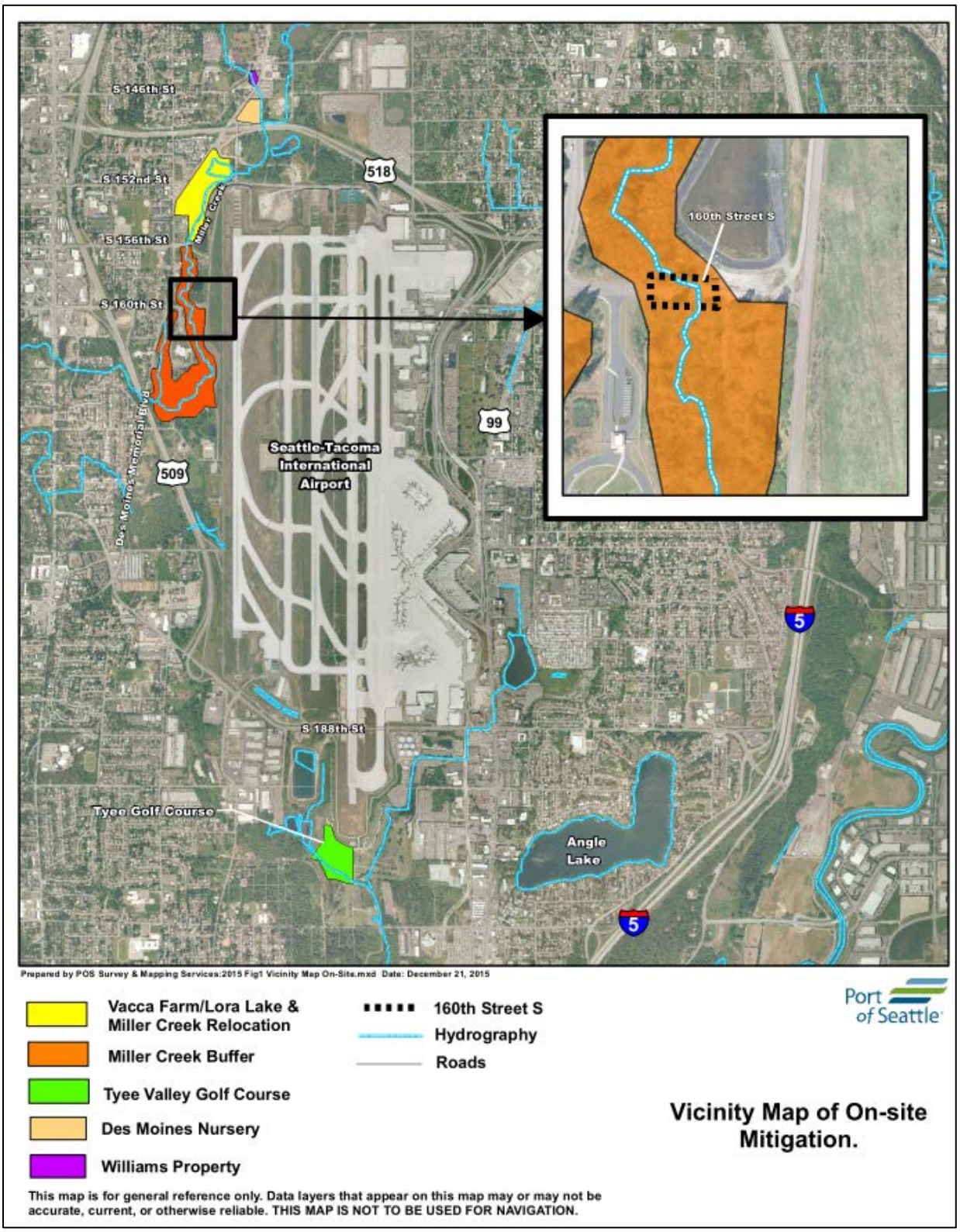
The above information is also depicted in Figures 8.21 and 8.22.

Figure 8.21
Stream and Buffer Mitigation Projects



Source: Port of Seattle (2019b)

Figure 8.22
Location of On-Site Mitigation Projects



Source: Port of Seattle (2019b)

Following construction of the Miller Creek Relocation site, post-construction monitoring efforts from 2007 to 2009 found that the project did not meet design criteria for streamflow velocity and substrate, leading the United States Army Corps of Engineers (USACE) and Washington Department of Ecology (WSDOE) to conclude that the salmonid spawning could not be achieved at the site (Port of Seattle 2019b). In response, the Port of Seattle agreed to additional alternative mitigation actions to provide a functional lift not achieved by the stream relocation as designed and built. These actions included additional gravel augmentation to promote meanders, removing riprap at the downstream end of the new channel, and planting additional woody vegetation to create a closed canopy. It also established two additional restoration sites:

- South 160th Street site, completed in 2012, removed a partial fish passage barrier located within the Miller Creek Buffer Site (Figure 8.21); and,
- Williams Property site, completed in 2012, removed a culvert and ensured bank stability north of State Route 518 and upstream of Des Moines Memorial Boulevard (Figures 8.21 and 8.22).

Additionally, the Des Moines Nursey site is undergoing a change to daylight a tight-lined stream segment just upstream which failed in 2017, discharging a volume of sediment into the Des Moines Nursery site and filling a portion of the stream channel (Port of Seattle 2019c). The site will receive a full restoration in 2020 as part of the City of Burien's West Fork Miller Creek restoration project. A new stream channel will run mostly outside mitigation credit area through an existing stormwater easement, and the abandoned stream channel will be converted to wetland (Port of Seattle 2019c).

Stream mitigation sites are subject to performance standards intended to indicate the ecological function of stream habitat, channel stability, and riparian structure. The NMRP requires a 15-year monitoring period for mitigation. Performance monitoring for the additional Relocation improvements and South 160th St. culvert removal were integrated into ongoing performance monitoring for the Relocation and Miller Creek Buffer sites, respectively. The Williams Property is a distinct project and is being monitored independently for a 10-year monitoring period (Port of Seattle 2019b; 2019c).

Monitoring results from the most recent reporting in 2018 (Port of Seattle 2019b; 2019c) indicate all sites achieved performance standards for all design criteria. Stream habitat complexity has remained stable or increased during the period of monitoring. Channel stability is generally good across all sites with a few localized exceptions. Installed Habitat Logs have remained in place, substrate composition remains dominated by gravel for the period of monitoring, and bank wasting has been minimal. In addition, riparian vegetation has rapidly established and is providing more than 90% cover over the stream at all sites. Likewise, fish passage projects at South 160th Street and Williams Property have stable banks, with Habitat Logs remaining in place, and the establishment of riparian vegetation within the sites.

Des Moines Creek

The Des Moines Creek basin covers approximately 3,600 acres, including most of Seattle-Tacoma International Airport and the Cities of Des Moines, Normandy Park, and SeaTac, and a small portion of the City of Burien. Des Moines Creek originates in two branches:

- Des Moines Creek East begins at Bow Lake, one-quarter mile east of Seattle-Tacoma International Airport. The creek flows mostly within pipes through the City of SeaTac and along the east side of Seattle-Tacoma International Airport, daylighting in the southeast portion of Seattle-Tacoma International Airport. From there, the creek flows through a golf course and the Tyee Detention Facility (constructed by King County in 1989).

- Des Moines Creek West has its origins in the area southwest of the runways, in a highly developed area. The creek flows into the Northwest Ponds, and through the Tyee Valley Golf Course wetland mitigation site. Des Moines Creek East joins with Des Moines Creek West a short distance downstream of Tyee Detention Facility, south of the runways, and then crosses under South 200th Street. Des Moines Creek flows an additional two miles south and west to Puget Sound.

Des Moines Creek also drains an urban watershed and suffers from the cumulative impacts of urban pollution from residential, commercial, and industrial activities.). Land uses in the basin that have likely contributed the majority of nonpoint source pollution include urban development and roadways, land conversion, failing septic systems, and highways (Des Moines Creek Basin Committee 1997). Currently, Des Moines Creek is listed under Section 303(d) of the federal Clean Water Act, viewed as a Category 5 (polluted water) water body for bacteria, copper, dissolved oxygen, and temperature (Ecology 2020a). The East Tributary of Des Moines Creek is also on the 303(d) list for bacteria, copper, and dissolved oxygen (Ecology 2020a).

The Washington State Department of Ecology conducted a study from October 2008 through December 2010 to reassess levels of copper and zinc in Des Moines, Massey, and McSorley Creeks in King County, Washington. Surface water was sampled twice during baseflow and three times during storm events. Analysis included dissolved and total recoverable copper and zinc as well as hardness, turbidity, and total suspended solids. All dissolved copper results taken at baseflow were less than 10% of the acute copper criteria, while zinc was less than 5%. During storm events, no violations of water quality metals criteria were found at 303(d) listed sites. Dissolved copper and zinc in Des Moines Creek decreased from upstream to downstream, while hardness increased. One of the recommendations of the study was to remove Des Moines, Massey, and McSorley Creeks from the 303(d) list for dissolved copper and remove Des Moines and Massey Creeks for dissolved zinc.

Construction activities associated with third runway and other 1997 Master Plan Update (MPU) improvements impacted approximately 3.88 wetlands in the Des Moines Creek basin (Parametrix 2004). The Port proposed to mitigate these impacts through restoration and enhancement projects designed to increase wetland function, enhance aquatic habitat, and improve stream conditions within Des Moines Creek. These mitigation projects included:

- Restore wetland functions to a portion of the Tyee Valley Golf Course by replacing the existing turf grass wetland with a native shrub wetland community;
- Enhance water quality and aquatic habitat and improve stream functions by restoring a forested riparian buffer along an 870-ft of the west branch of Des Moines Creek, also located on the Tyee Valley Golf Course;
- Establish a $150,000 trust fund for restoration projects located in the Des Moines Creek Basin;
- Provide for additional stream enhancement projects and local restoration efforts; and,
- Avoid, minimize, and mitigate potential indirect hydrology impacts to wetlands adjacent to the borrow areas by directing groundwater seepage and surface water runoff to wetlands near Borrow Areas 1 and 3.

The former Tyee Valley Golf Course wetland mitigation site now encompasses 10.53 acres in Des Moines Creek basin along the south runway boundary (Figure 8.21). The site also contains mitigation constructed by the Des Moines Creek Basin Committee (DCBC) that relocated and stabilized the portion west branch Des Moines Creek flowing through the Port mitigation site. The Port integrated the existing mitigation area into its 2011 design and construction, including the monitoring plan. Specific mitigation objectives were also revised as well and now include:

- Establish 5.57 acres of native shrub wetland in a currently degraded wetland; and,
- Improve water quality and aquatic habitat in Des Moines Creek by planting a 100 foot forested buffer along both banks.

The mitigation site is subject to performance standards intended to indicate the ecological function of stream and wetland habitat, channel stability, and riparian structure. The NMRP requires a 15-year monitoring period for mitigation. The Port of Seattle is currently performing maintenance of the site, replacing dead or dying trees, controlling blackberries and noxious weeds, controlling tree density to allow better understory growth and vigor, and enhanced shrub plantings to meet Shrub density performance standards.

Auburn Offsite Wetlands

Construction activities associated with third runway and other 1997 Master Plan Update (MPU) improvements impacted 13.46 acres of wetlands, and the Port implemented a suite of mitigation actions, including creating, restoring, or enhancing 177.77 acres (75.23 mitigation credits) of wetlands and upland buffer (Port of Seattle 2019c). One of those mitigation actions was to replace 18.37 acres of wildlife habitat at an off-site location. Wetland mitigation adjacent to Seattle-Tacoma International Airport is constrained by the need to avoid habitat for avian wildlife which can present a safety hazard for airplanes. Hence, off-site mitigation at Auburn is designed to restore and enhance forested, shrub, emergent, and open water wetland habitat and to provide habitat for avian species, which when present create a flight hazard to airplanes. The mitigation site is located in the City of Auburn, Washington, south of South 277th Street between the Green River and Auburn Way North (outside of the Study Area). Mitigation construction occurred in 2006.

The general mitigation goals for Auburn are:

- Achieve an overall increase in wetland acreage and function at a mitigation ratio of at least 2:1;
- Mitigate lost habitat functions outside of the 10,000 foot aircraft operations safety radius of Seattle-Tacoma International Airport to protect public safety by reducing wildlife hazards to aircraft;
- Create diverse wetland habitats (including forest, shrub, open water, and emergent) as well as upland forested habitat on a large site adjacent to existing habitat corridors along the Green River;
- Enhance wetland functions in the existing degraded wetlands, which are dominated by non-native species, by converting them to diverse, native forested, shrub, and emergent wetlands; and
- Provide long-term protection for the mitigation site by providing a 100-ft forested buffer around the perimeter of the site.

This off-site mitigation created approximately 30 acres of new wetlands, enhance 19.5 acres of existing emergent wetlands, and created approximately 15.9 acres of forest and buffer habitat (Parametrix 2004). The site includes four ponds for waterfowl usage. The Port recently performed a full suite of required vegetation monitoring in 2018, which served as Year 11 in the 15-year monitoring plan (Port of Seattle 2019c). The Port also continues to conduct hydrology monitoring every year, and data indicate site hydrology meets all performance standards, with inundation depths and duration remaining consistent with previous years. Vegetation monitoring efforts found that all shrub and forest zones are achieving for tree density and cover. The assessment stated that the Auburn wetland is a "high-performing site that is meeting all standards for wetland hydrology and most for vegetation cover. Shrub density is lagging in enhanced areas, but this is likely due to the very high alder and cottonwood recruitment, as tree density is more than double the minimum standard in every enhance forest zone. In addition, relative abundance of willow in these zones is high, and willows tend to mature to densities well below planting density due to their large habit." (Port of Seattle 2019c).

National Land Cover Database Cover Change Index

The Multi-Resolution Land Characteristics (MRLC) consortium is a group of Federal agencies that coordinate and generate consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications. This coordination has produced the comprehensive land cover product called the National Land Cover Database (NLCD). The NLCD provides nationwide data on land cover and land cover change for years 2001, 2003, 2006, 2008, 2011, 2013, and 2016. New to the NLCD is the Land Cover Change Index. This index provides a simple and comprehensive way to visualize change from all 7 dates of land cover in a single layer.

Using this database, the study team examined the overall changes to Seattle-Tacoma International Airport and the Study Area Cities from 2001 (the earliest year data is available) to 2016 (the most available current data set). Those results are summarized in Table 8.2 and tabulated in Table 8.3. Visual maps of locations of the changes were overlaid on orthographic images of the airport and each city area from 2002 and 2016 (Figures 8.22 through 8.28). An additional series of side-by-side orthoimages of the airport, and each of the surrounding cities, in 2002, 2009, and 2018 is included as an appendix.

Overall, the area of change from a natural land cover category to an urban or barren land use totaled 1,988 acres from 2001-2016. Federal Way displayed the largest percentage of that total area, at 715.43 acres, or 36% of the total (Figure 8.25). SeaTac had the second highest area of change, at 542.62 acres (Figure 8.27), but nearly 376 acres of this were contributed by changes with the airport properties (Figure 8.22). The airport accounts for 18.9% of the total area of change that occurred from 2001-2016 for the study area of the six cities. The shaded red areas indicating areas of change are largely located around the third runway area, but also show change along the side of the taxiways and other runways, possibly due to clearing and grading of the shoulders for runoff buffers (Figure 8.22). Burien and Des Moines each accounted for 10% of the change in area, and Normandy Park accounted for the least change, with 41.91 acres, or 2% of the Study Area's change.

Figure 8.23
Summary of NLCD Change Index Calculations

Airport	Total Area (acres)	Total Area of Changes* (acres)	% of Change in Study Area	% of Change on Airport
Airport Industrial 1	78.12	6.75	0%	1%
Airport Industrial 2	58.38	5.63	0%	1%
Aviation Business	76.91	12.01	1%	2%
Aviation Commercial	438.45	16.52	1%	3%
Aviation Operations	2,035.11	335.03	17%	62%
Airport Total	**2,686.96**	**375.95**	**18.9%**	**69%**
City	**Total Area (acres)**	**Total Area of Changes* (acres)**	**% of change in study area**	
City of Burien	6,425.30	200.64	10%	
City of Des Moines	4,193.68	197.32	10%	
City of Federal Way	14,379.61	715.43	36%	
City of Normandy Park	1,621.82	41.91	2%	
City of SeaTac	6,572.57	542.62	27%	
City of Tukwila	6,104.92	290.17	15%	
City Total	**39,297.91**	**1,988.10**	**100%**	

*Urban or barren changes

Figure 8.24
NLCD Change Index Calculations by Airport Use Type and City (in acres)

Airport	No Change	Urban Change	Barren Change	Forest-Theme Change	Hay/ Pasture Change	Herbaceous Wetland Change	Water Change	Wetland Within Class Change	Woody Wetland Change
Airport Industrial 1	71.36	6.75							
Airport Industrial 2	52.75	5.40	0.22						
Aviation Business	64.89	12.01							
Aviation Commercial	421.92	16.52							
Aviation Operations	1,700.08	334.14	0.89				0.22	0.22	
Airport Total	**2,311.01**	**374.84**	**1.11**				**0.22**	**0.22**	
City	**No Change**	**Urban Change**	**Barren Change**	**Forest-Theme Change**	**Hay/ Pasture Change**	**Herbaceous Wetland Change**	**Water Change**	**Wetland Within Class Change**	**Woody Wetland Change**
City of Burien	6,224.65	199.98	0.67				2.00		
City of Des Moines	3,996.36	197.32		2.45		13.32	6.92	0.44	
City of Federal Way	13,664.18	712.54	2.89	22.56	1.11	3.81	50.31	0.44	0.22
City of Normandy Park	1,579.91	41.69	0.22			1.26	1.38		
City of SeaTac	6,029.95	540.84	1.78	0.22			2.45	0.22	
City of Tukwila	5,814.75	289.51	0.67	8.23	4.00	3.11	34.51	0.22	
City Total	**37,309.81**	**1,981.87**	**6.22**	**33.45**	**5.12**	**21.51**	**97.57**	**1.33**	**0.22**

Figure 8.25
City of Burien NLCD Change Index: 2001-2016

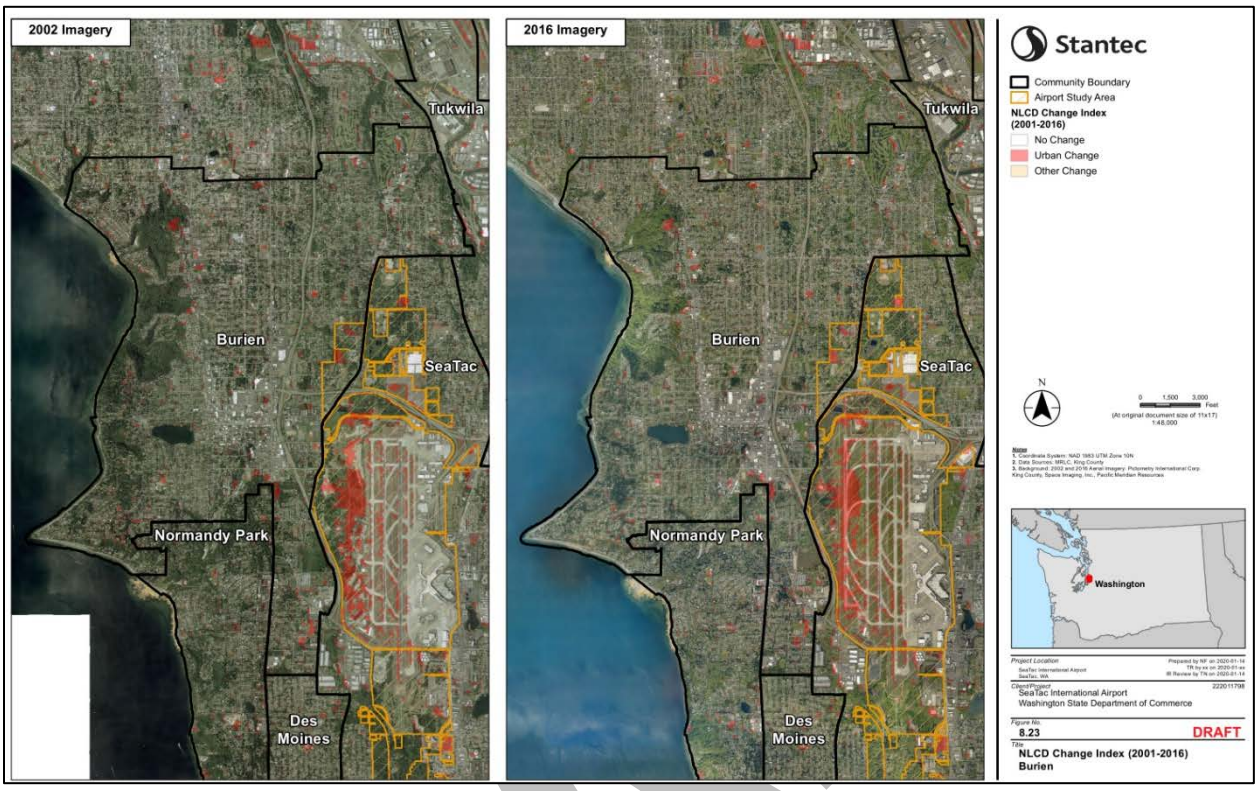


Figure 8.26
City of Des Moines NLCD Change Index: 2001-2016

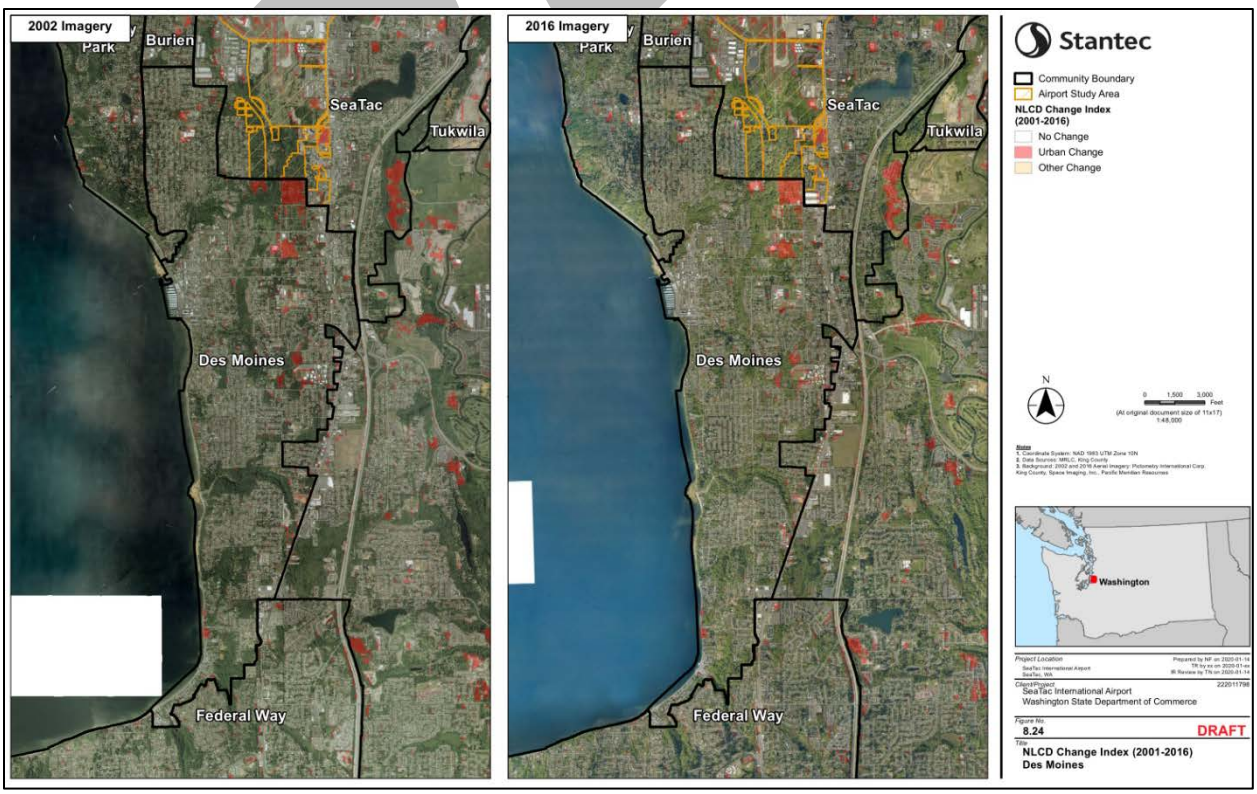


Figure 8.27
City of Federal Way NLCD Change Index: 2001-2016

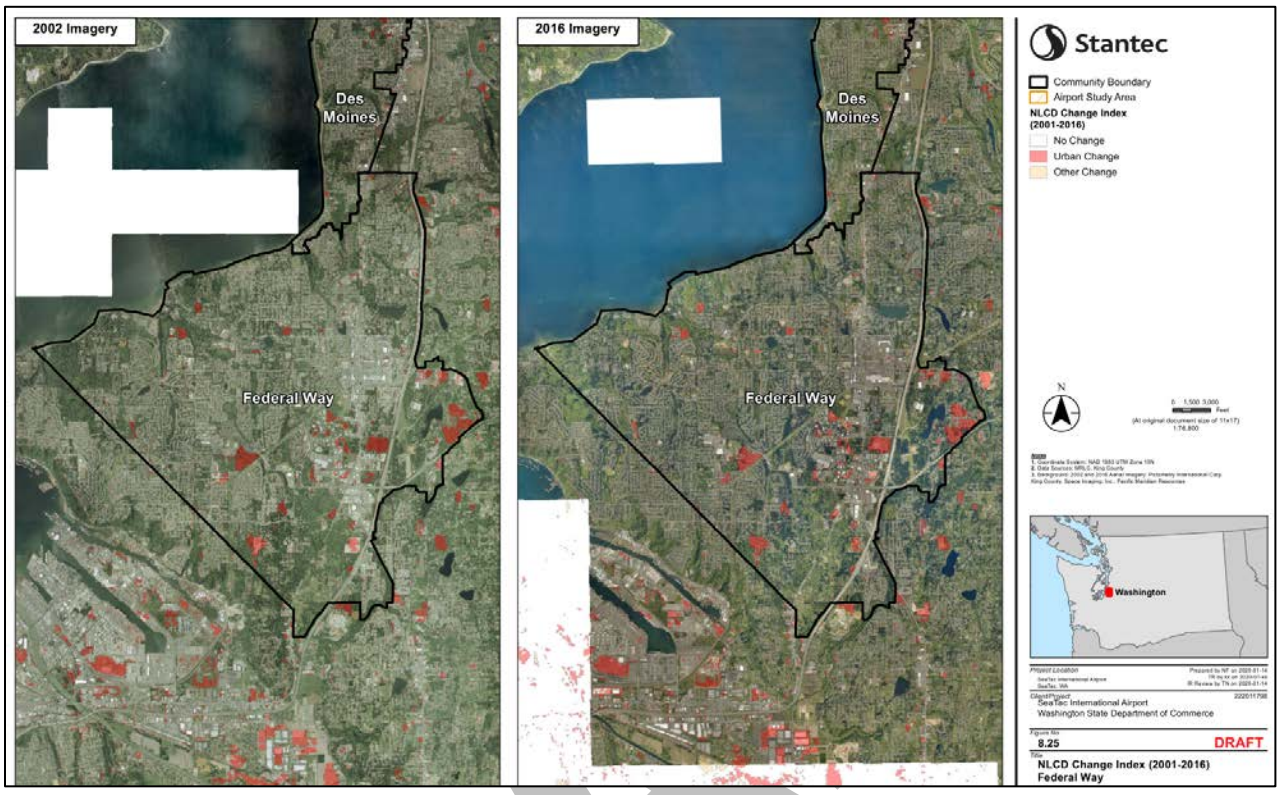


Figure 8.28
City of Normandy Park NLCD Change Index: 2001-2016

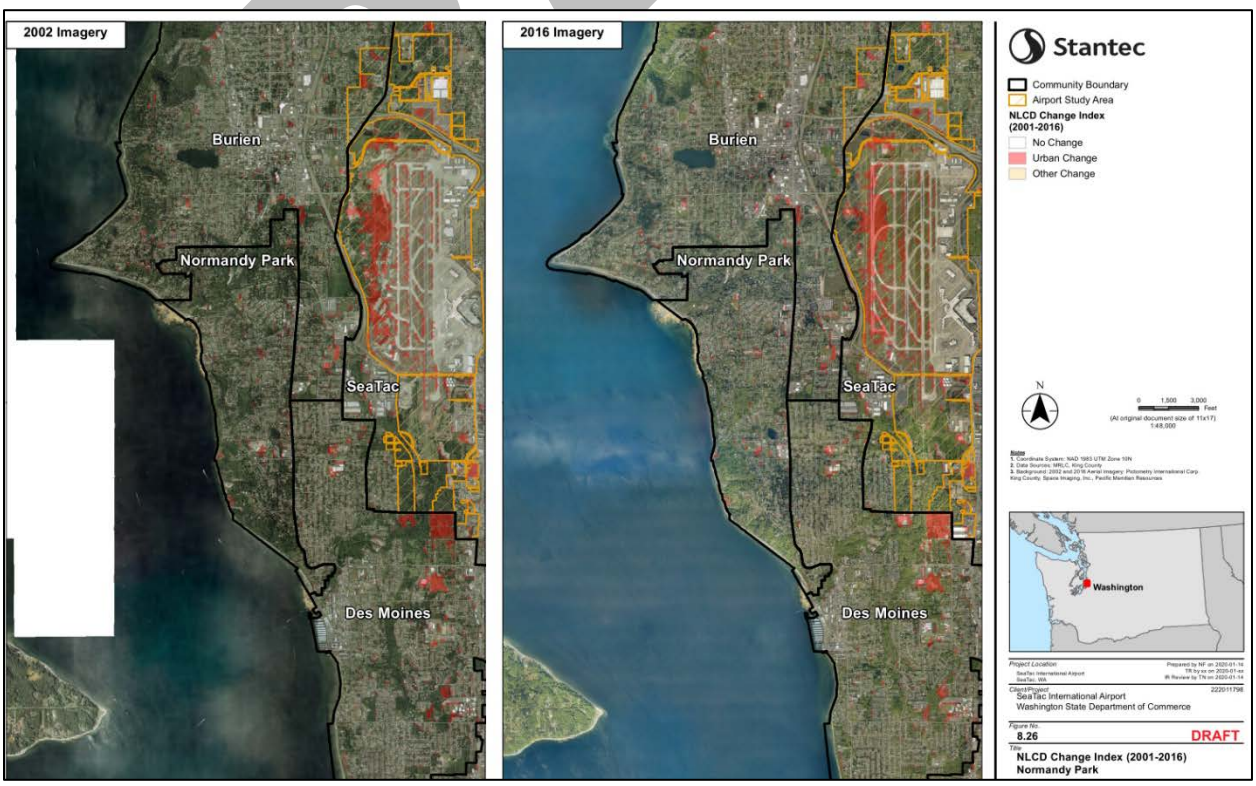


Figure 8.29
City of SeaTac NLCD Change Index: 2001-2016

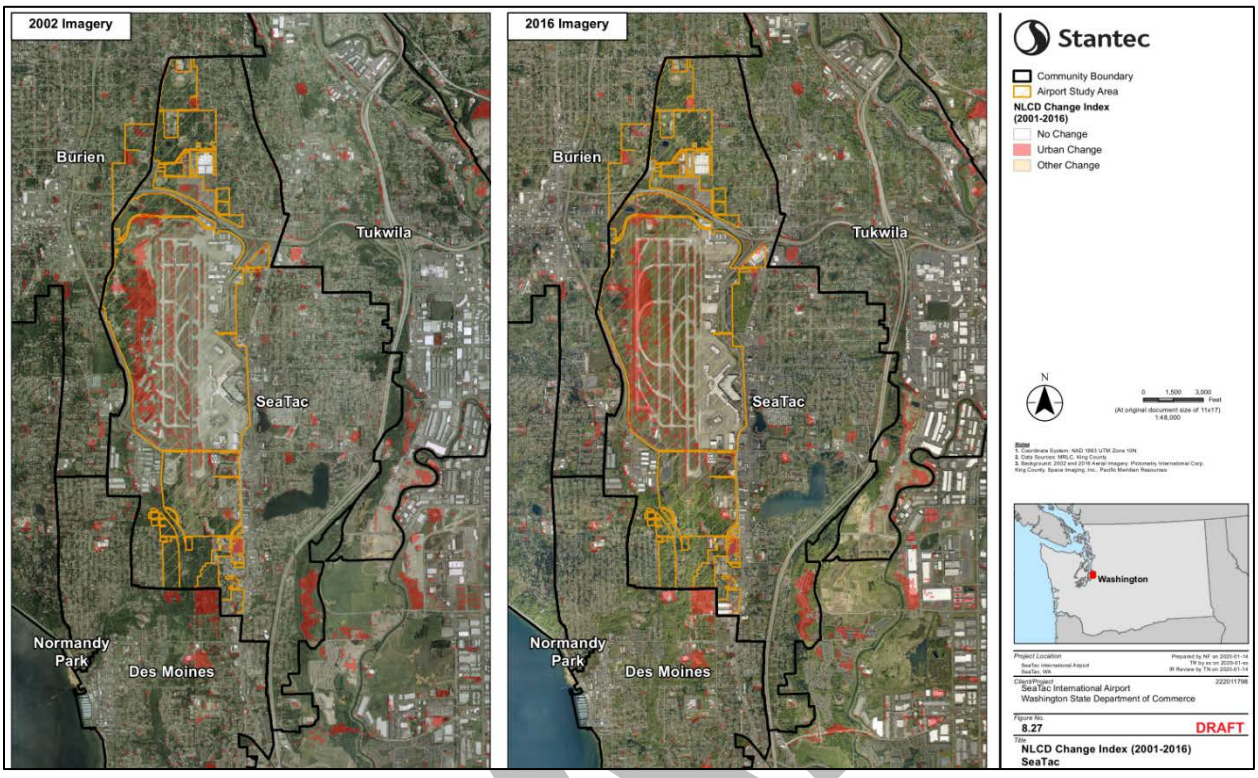
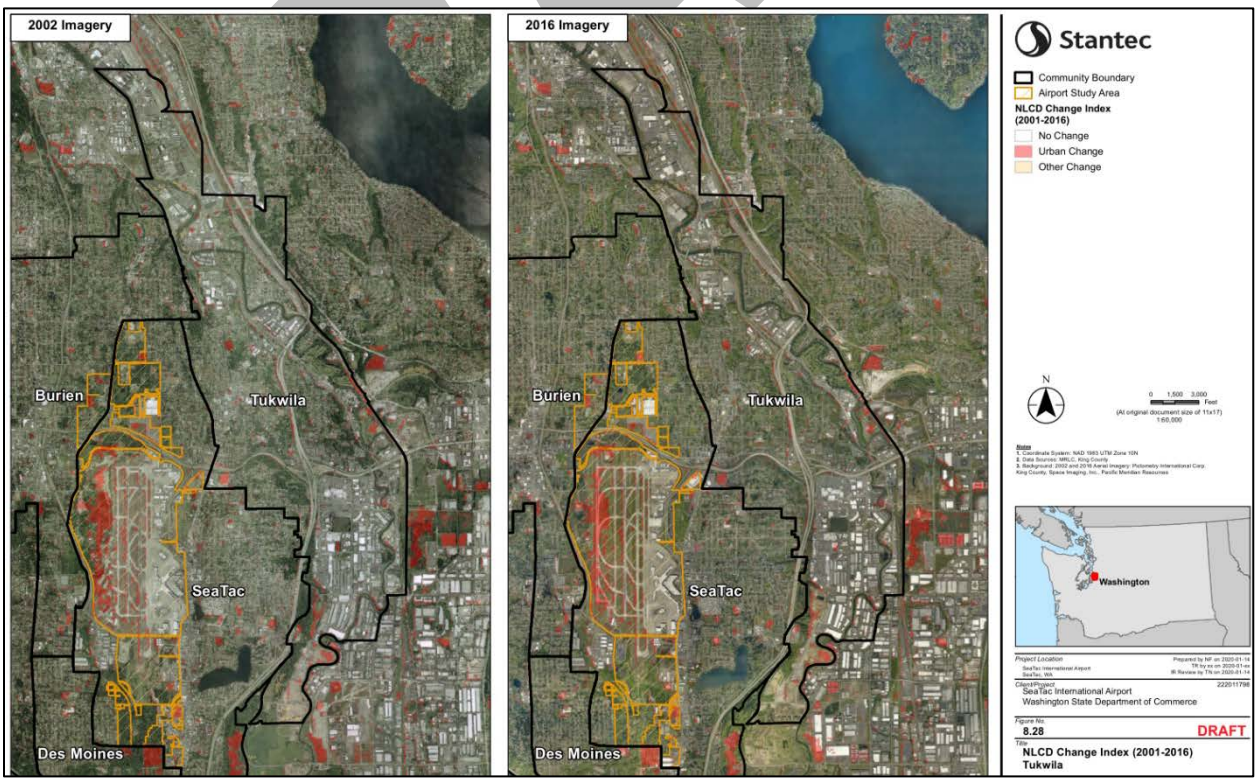


Figure 8.30
City of Tukwila NLCD Change Index: 2001-2016



F. IMPACTS

Positive Impacts

In general, the actions of the Port in the Seattle-Tacoma International Airport and surrounding vicinity have improved water quality and the receiving waters' habitat conditions from what they were before.

The review of the activities and conditions on surface water quality and habitat conditions has found that the Port of Seattle has been responsive to the impacts that Seattle-Tacoma International Airport has had the potential to incur on water quality and aquatic habitats downstream of the airport. To mitigate for these impacts, the Port of Seattle has:

- Constructed 112 acres of wetland near the Airport;
- Enhanced about two miles of stream habitat including the relocation of 1,000 feet Miller Creek's stream channel; and,
- Excavated 60-acre feet of floodplain storage capacity.

To improve fish habitat, stream mitigation has installed 200 pieces of large woody debris, removed two culverts that blocked fish passage, and focused on stabilizing four eroded portions of Miller Creek's stream channel. Additionally, the Port of Seattle supplements streamflow to Miller and Des Moines creeks every summer to ensure adequate water levels for fish. The Port of Seattle has also created and enhanced 65 acres of off-site wetland and wetland buffer adjacent to the Green River in Auburn to mitigate the loss of wetland habitat for waterfowl near the airport.

The Port of Seattle has also upgraded the IWS and SDS stormwater management systems to more efficiently capture and treat stormwater runoff from Seattle-Tacoma International Airport. As part of the Master Plan improvements, the Airport's stormwater management systems were completely retrofitted and upgraded to meet the most stringent environmental standards. Through these improvements, runoff containing high concentrations of deicing fluids are captured, separated, and treated before being discharged to Puget Sound. Review of the available NPDES reported water quality data for BOD levels in their Outfall discharge supports this statement.

Through its Stormwater Pollution Prevention Plan (SWPPP), implementation and regular and frequent NPDES water quality sampling program, metals and other pollutants harmful to salmon and other aquatic organisms have been reduced to safe levels before entering Miller, Walker, and Des Moines creeks. The airport applies a proactive approach and evaluates water quality monitoring results to determine if additional BMPs are necessary to prevent permit limit exceedances. As a result, stormwater discharges from the Airport are well below permit limits with low variability in comparison to other airports and industrial stormwater. Review of the available NPDES reported water quality data supports this statement.

Neutral Impacts

There are no known neutral impacts on the surface water system.

Negative Impacts

The required mitigation in response to Master Plan improvements, plus the near-constant monitoring of stormwater runoff water quality required by the NPDES permitting program and adjustments to stormwater management in response to water quality results leave little in the way of negative impacts to surface water quality and habitat in the immediate area.

While effluent levels are usually below the State water quality criteria, Seattle-Tacoma International Airport is still a contributor of pollutants, and occasionally exceeds those criteria, despite its best management practices and treatments. As fish habitat continues to improve in the receiving streams, such violations, even short-term ones, could affect salmon present. With instances of pre-spawning mortality already recorded in Miller and Walker Creeks (Peter et al. 2018; Goehring 2019), Des Moines Creek (Scholz et al. 2011), and throughout the Puget Sound region (Feist et al. 2011; 2017), it is important to understand the impacts any pollution can have on salmon populations.

G. ANALYSIS AND RECOMMENDATIONS

The analysis of NPDES water quality data from the PARIS database revealed that, for the parameters examined in this Study, runoff from the six Seattle-Tacoma International Airport outfalls selected in this Study have shown a reduction in concentration levels, and met the State's water quality criteria once the systems' retrofit and upgrades had been completed.

The following recommendations are proposed to improve the protection of the surface water system and associated habitats:

- **Surface Water Quality Recommendation #1 – Correct Potential Errors and Data Gaps**
  This Study found potential errors in the data (discrepancies in the labeling of measurement units) and found periodic changes in sampling methodology from NPDES permit periods that may or may not be completely comparable over the 22 years examined (1997 to 2019). If there is a need for a more complete analysis of these NPDES water quality results for all outfalls and all parameters over the 22-year time period, then an additional study with the focus on these datasets will be required.

- **Surface Water Quality Recommendation #2 – Improve Receiving Stream Data**
  This Study found a lack of continuous water quality data on the receiving streams within close downstream proximity to the outfalls. Water quality measurements were limited to basic parameters and were collected sporadically across the study period. Measurements were not taken in a way as to be comparable to Seattle-Tacoma International Airport outfall measurements, as that was not the intent of either the County or Port programs. If there is a concern for the effect of Seattle-Tacoma International Airport outfall impacts on downstream receiving waters, then it would be advisable to establish more permanent monitoring stations downstream of those outfalls, and collect a suite of water quality parameters that are collected at outfalls on a schedule that coincides, so as to make results more comparable.

  Studies conducted by Dr. E.P. Kolodziej at the University of Washington-Tacoma have been focusing on water quality analysis work in Miller Creek for several years, using high resolution mass spectrometry methods to examine what chemicals are present in runoff that may cause salmonid pre-spawning mortality events (Peter et al. 2018). While Dr. Kolodziej explained that their work did sample above and below the area where airport runoff enters the creek, but their analyses have focused on tire rubber compounds and roadway runoff (Personal communication, September 24, 2019). Airport operations were not part of their study at the time, and they did not have any direct airport runoff samples to make a clear comparison relative to the highway runoff from State Route 509, although he did state that "we do know the highway." This would present an opportunity to research the potential impacts of Seattle-Tacoma International Airport runoff on the issues of pre-spawning mortality in Miller and Walker Creeks. Therefore, it is recommended that additional measures, sources, and data be collected to fully determine the impacts that may be experience by receiving streams in the Study Area.

- **Surface Water Quality Recommendation #3 – Further Study of Air Pollution Impacts on Surface Water**
  The Consultant Team heard concerns from community members about the effect of fine air particles as a source of pollution on the soils and waters surrounding Seattle-Tacoma International Airport. However, no known studies have researched that issue to date. The University of Washington recently conducted a study assessing ultrafine particle (UFP) concentrations within 10 miles of the airport in the directions of aircraft flight (UW-DEOHS 2019). The study was able to detect and distinguish traffic and aircraft emissions. One of the identified gaps was in developing a better understanding of the toxicity of traffic- and aircraft-related UFPs. Studying the toxicity would help identify potential sources of heavy metals and other pollutants that may settle on surrounding surfaces, including standing waters of ponds, lakes, and wetlands. Similar studies have been conducted at airports in California (Boyle 1996), Greece (Massas et al. 2018), and India (Ray et al. 2012). Therefore, it is recommended that additional studies be undertaken to research and evaluate the potential impacts of air pollution and ultrafine particulate matter on surface water systems and habitats.

H. THE FUTURE

Ongoing growth and urbanization are concerns for any developed region's surface water systems and habitats. As the Seattle region, King County, and the Study Area continue to grow, the potential exists to stress these systems through increases in air pollution and polluted stormwater runoff. There are hopeful signs, should electric vehicles eventually comprise a majority of vehicles on the area's roadways. That will have an associated decrease in mobile source pollution.

The preservation of key habitats, headwaters, wetlands, and coastlines is also an ongoing challenge as the area continues to grow. The Port of Seattle and the Study Area Cities should continue to take these issues into account for future master plans.

I. SUMMARY

The Consultant Team investigated 22 years of data from numerous sources to determine what impacts the operation and growth of Seattle-Tacoma International Airport may have on the Study Area Cities. The data suggests that the Port of Seattle has improved water quality and the receiving waters' habitat conditions.

There are some areas of concern on the part of the public, but these have been largely limited to the impact that air pollution has on the surface water systems. That concern, coupled with some areas of data gaps or inconsistencies suggests that existing studies, modelling and sampling could be improved to address these concerns.

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SECTION 9

GROUNDWATER & SOIL QUALITY

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SECTION 9

GROUNDWATER & SOIL QUALITY

A. INTRODUCTION

This section presents available geologic, soil, and groundwater data at and in the general vicinity of Seattle-Tacoma International Airport between 1997 to 2019, identifies changes in soil and groundwater quality during this time frame, and provides an evaluation of those identified changes due to potential impacts from airport operations and/or the results of remediation conducted by the airport on soil and groundwater conditions.

Specifically, the Consultant Team reviewed available Airport and off-Airport groundwater and soil analytical data for the noted time frame (focusing on the years of 1997, 2009, and 2019 or as close to those years as the data sets allow), looking for trends in analytical concentrations over time and evaluating whether chemical concentrations increased, decreased, or remained stable. If concentrations increased, the analysis included an evaluation whether the impacts were caused directly by Airport operations, attributed to other non-Airport point sources, and/or caused by percolation of contaminants from stormwater runoff (airport or general urban runoff) percolating into soil and groundwater. If concentrations decreased, the analysis included an evaluation regarding the effectiveness of the airport's subsurface remediation efforts, related natural attenuation, and the Airport's stormwater treatment system.

This section describes the data collected and reviewed by the Consultant Team including:

- Technical reports provided by the Port of Seattle
- Databases, technical studies and GIS information provided by the Study Area Cities;
- Geologic/hydrogeologic framework at the Airport and within the Study Area;
- Airport-related sites/sources of contamination and primary chemicals of interest (COIs);
- The Agreed Order between the Washington Department of Ecology (Ecology) and the Port of Seattle;
- Groundwater analytical data and remediation conducted at the Airport sites;
- Non-Airport-related sites/sources of contamination and groundwater analytical data at those non-Airport-related sites.

This section also provides an evaluation regarding potential groundwater impacts at off-Airport sites and if they originated from Airport operations; whether Airport-related groundwater impacts have migrated off-property; and preliminarily addresses concerned citizens issues of black soot observed on their private property. The section closes with the identification of any data gaps and provides recommendations for specific follow-up analysis.

B. DATA COLLECTION PROCESS

To obtain Seattle-Tacoma International Airport and Study Area data, and in particular, data on known impacted Airport and non-Airport sites within the Study Area, the Consultant Team requested and/or obtained information from the following sources:

- The Port of Seattle public website and documents provided by the Port of Seattle;
- City of Burien public website and documents provided by the City;
- City of Des Moines public website and documents provided by the City;
- City of Federal Way public website and documents provided by the City;
- City of Normandy Park public website and documents provided by the City;
- City of SeaTac public website and documents provided by the City;
- City of Tukwila public website and documents provided by the City;
- Ecology Toxic Cleanup Program (TCP) public website: lists and individual site details for sites within the TCP: Spills and Cleanups; Active and Inactive Underground Storage Tanks (USTs), and Leaking Underground Storage Tanks (LUSTs);
- Washington Department of Ecology's Permitting and Reporting Information System (PARIS) public database containing water quality permits, inspections, enforcement actions and discharge monitoring reports (DMRs) for both federal National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge Permits;
- Washington Department of Ecology's Environmental Information Management (EIM) public database containing groundwater and soil analytical data (which also contains King County data);
- Information from concerned citizens acquired during the two project Public Meetings;
- Online searches for Seattle-Tacoma International Airport-specific or other Airport-vicinity soil studies/technical articles; and,
- A subcontract with Environmental Data Resources (EDR) to conduct online data searches to identify impacted, potentially impacted, or suspected impacted sites at Seattle-Tacoma International Airport and properties within a one-mile radius of Seattle-Tacoma International Airport.

For this portion of the project (Soil and Groundwater Quality), the Port provided the pertinent documents:

- 1996 Seattle-Tacoma International Airport Master Plan Final EIS;
- 1997 Seattle-Tacoma International Airport Master Plan Final Supplemental EIS;
- 2007 Seattle-Tacoma International Airport Comprehensive Development Plan (CDP) Final EIS;
- 2008 Seattle-Tacoma International Airport Groundwater Study; and,
- 2015 Seattle-Tacoma International Airport Groundwater Study Update (Annual Groundwater Sampling 2011-2015).

The Study Area Cities provided available GIS shape files, databases, and environmental technical reports from their files. They predominantly had periodic surface water quality data, stream quality reports, and critical areas maps but did not have groundwater or soil analytical data.

The Study Area Cities and the Port of Seattle referred the Consultant Team to the King County Hydrologic Information Center and Industrial Wastewater Permit websites and to Ecology's PARIS website. Although these particular websites have large amounts of surface water and stormwater analytical data but not groundwater or soil analytical data, review of these websites proved valuable to help identify primary chemicals of concern that could impact soil and/or groundwater.

Supplementing city and agency databases/information and the Port-supplied reports listed above, the additional documents were obtained and reviewed by the Consultant Team:

- 2003 State Route 509: Corridor Completion/IH-5/South Access Road Final EIS;
- 2018 Seattle-Tacoma International Airport Sustainable Airport Master Plan (SAMP) – Technical Memorandum No. 8, Environmental Overview; and
- 2019 Request for Ecology's Opinion Regarding Completed Remedial Action, Former Continental-Olympic-United Fuel Farm Area, Facility/Site #2294, VCP #NW2300, Seattle-Tacoma International Airport.

Study Area Topographic/Soil/Geologic Framework

Information for this subsection was obtained from the 2007 CDP Final EIS (prepared by CH2MHill, now Jacobs) and from the 2008 Seattle-Tacoma International Airport Groundwater Study prepared by Aspect Consulting (Aspect).

Ground surface elevations at Seattle-Tacoma International Airport range from approximately 360 to 440 feet above mean sea level (AMSL) with most of the runway and the Airport's Aircraft Operations and Maintenance Area (AOMA; terminal/gates/passenger concourses, various airline hangars, and former aircraft fueling operations predominantly located along the east-central to southeast portions of the airport property) elevations are approximately 400 feet AMSL. Beyond the airport boundaries, ground surface elevations remain at approximately 400 to 440 feet AMSL north of the airport (north of State Route 518), drop to approximately 200 feet AMSL to the east (approaching IH-5), drop to the west (down to 0 feet AMSL at Puget Sound), and drop to the south (ranging between 200 to 300 feet AMSL but with lower elevations along Des Moines Creek). Overall, ground surfaces drop to the west (towards Puget Sound).

A surface soil map is provided in Figure 9.1 and a surface geologic map is provided in Figure 9.2 (reproduced from Figure 4-1 of Aspect's Groundwater Study). As shown on both figures, much (if not all) of the airport property is graded and/or artificial fill with pavement in the AOMA and building areas, and along the aircraft taxiways/runways with bare ground in between the paved taxiways/runways. Native surface soils in the vicinity of the airport (to depths of approximately 20 inches) belong to the Alderwood Association which are moderately well-drained soils in undulating to hilly topography positions. From depths of 20 to 40 inches, soils are dense, very slow permeable glacial till (consistent with local geologic conditions).

The Study Area is situated in the Puget Sound Lowland with the Vashon Stade of the regionwide Fraser period glaciation dominating the landscape and geologic framework. The Fraser glaciation locally occurred between approximately 13,000 and 15,000 years ago. Sediments deposited prior to the Vashon glaciation are collectively referred to as "pre-Fraser".

As shown on Figure 9.2, the Study Area is primarily comprised of Vashon Stade glacial Vashon Till (Qvt; dense to very dense, sub-rounded to well-rounded clasts in a massive, silt- or sand-rich matrix with sporadic clay lenses) and lesser amounts of overlying Recessional outwash deposits (Qvr; stratified, moderately- to well-sorted sand and gravel with lenses of silty sand and silt) and underlying Advance outwash deposits (well-bedded sand and gravel nearly devoid or silt or clay). In general, the dense to very dense Vashon Till (in particular, the fine-grained silt and clay fractions) retards migration of potential contamination in the subsurface.

Figure 9.1
Surface Soil Map

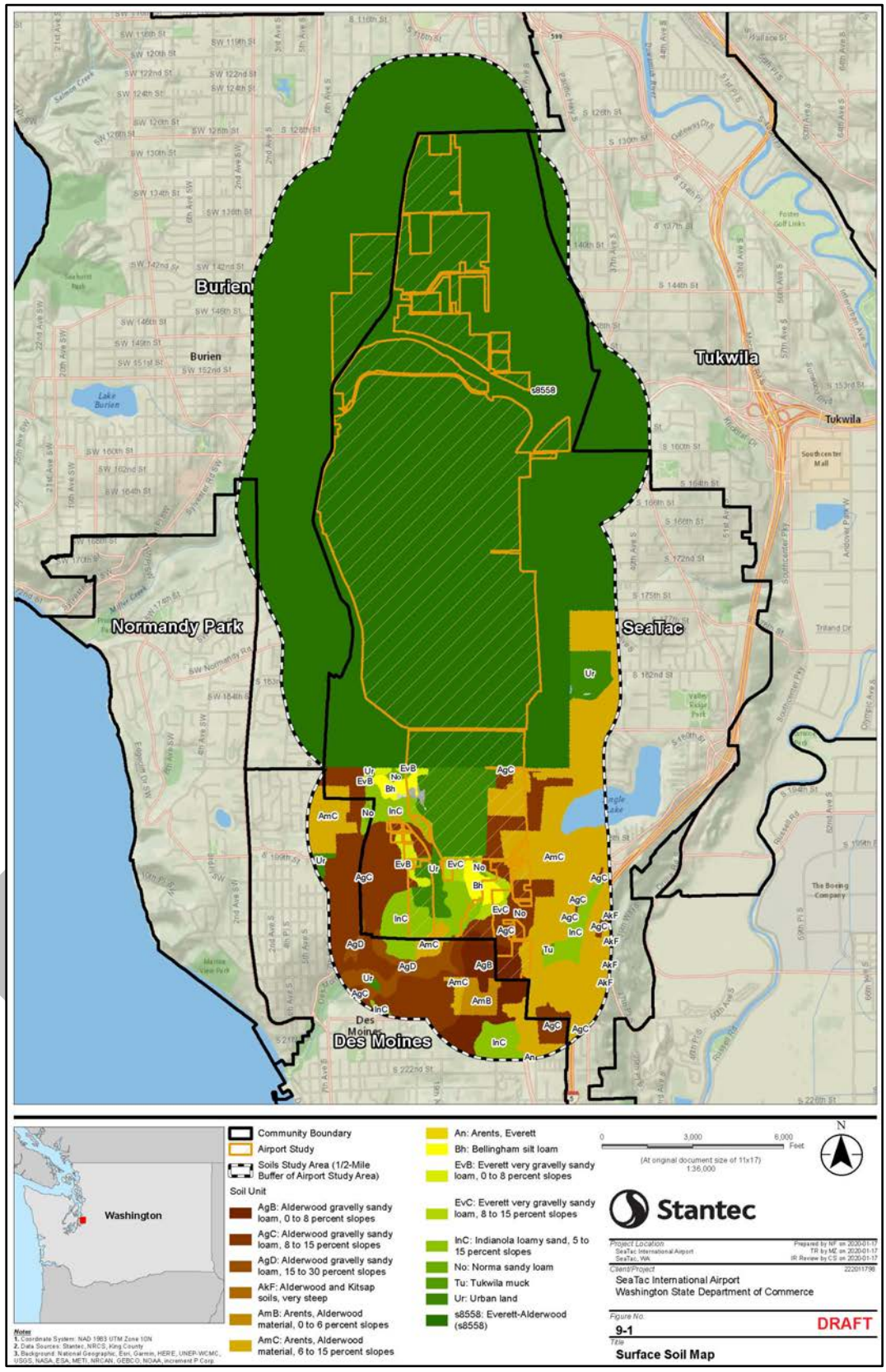
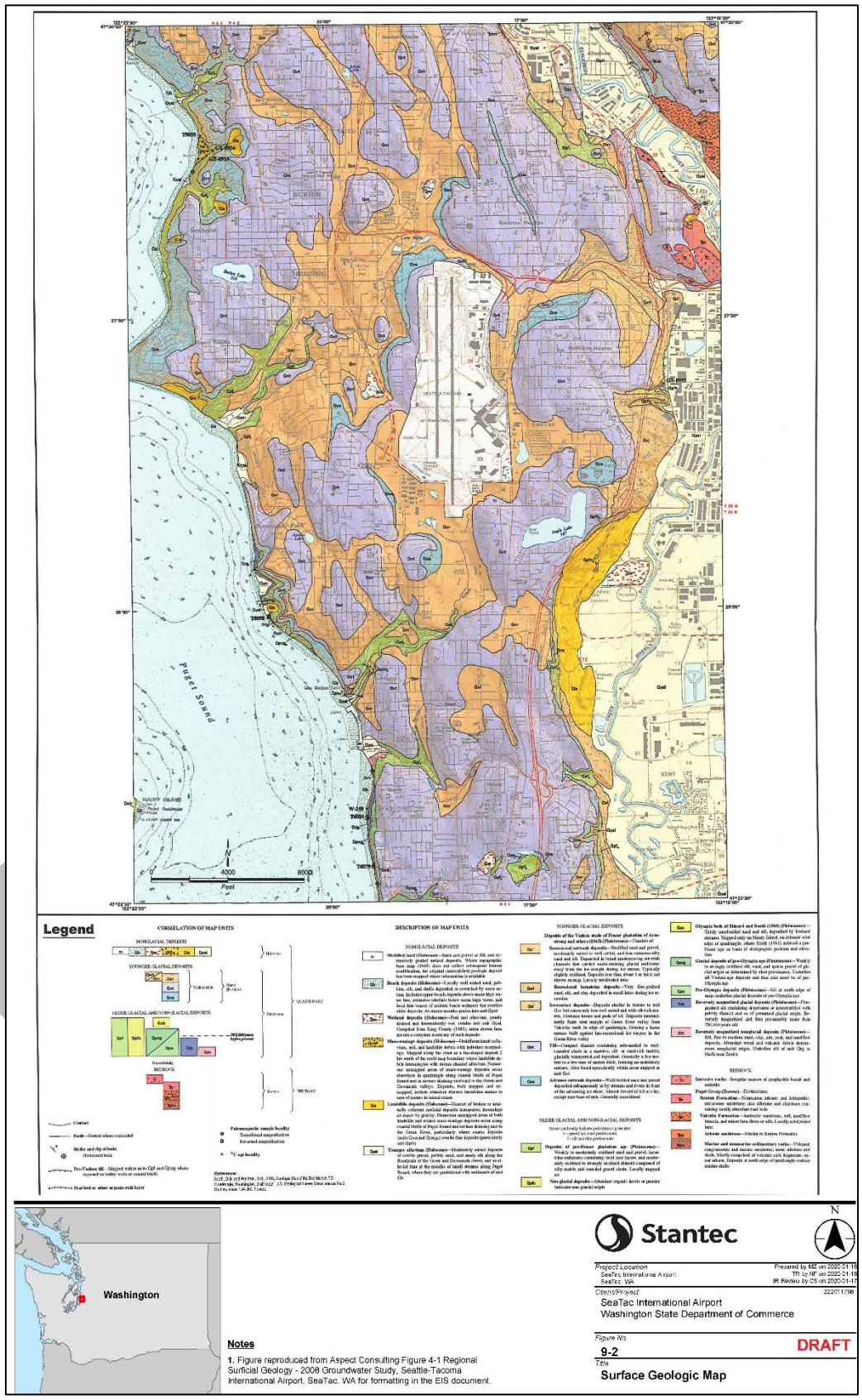


Figure 9.2
Surface Geologic Map



Except for grading activities/new development/redeveloped areas at Seattle-Tacoma International Airport and beyond the airport boundaries (but still within the Study Area) where new artificial fill or wetlands have been generated or created, the topographic/soil/geologic framework has not changed from 1997 to the present time.

Agreed Order #97tc-N122, Environmental Database, and Groundwater Study

In 1995, discussions between Ecology and the Port began regarding an airport-wide groundwater monitoring program which resulted in the initiation of the Airport's Groundwater Study. Part of the requirements of the Groundwater Study tasked the Port of Seattle to compile and convert existing hardcopy data into a computer database. Compilation of this preliminary database began in 1995 with work being performed by Black & Veatch (Tacoma, WA).

In 1996, the Port of Seattle determined the need for the overall management of environmental data which led to their Environmental Management Information System (EMIS). Earthsoft's EQUIS environmental data management software was initially used (1997 to 2000), then moving to a customized Microsoft-based database program (2001 to the present). The Consultant Team understands that this is a proprietary Port-generated and Port-owned database.

By 1997, preparation of the Agreed Order between Ecology and the Port of Seattle was in progress. Agreed Order #97TC-N122 was finalized May 25, 1999 with the requirement that the Groundwater Study was be completed to the satisfaction of and acceptance by Ecology. Primary tasks required by the Groundwater Study included: a detailed geologic and hydrogeologic characterization of the airport and the nearby vicinity of the airport; identification of water-bearing units; groundwater quality; identification and extent of chemical impacts in groundwater at the airport's AOMA; and groundwater modeling to predict future contaminant migration.

In 2003, Aspect submitted a preliminary Groundwater Study that was finalized in 2008 (dated July 25, 2008). The 2008 Groundwater Study addressed the required items and included summaries of soil and groundwater remediation conducted by the Port. The 2008 Groundwater Study was deemed complete and was accepted by Ecology in their letter dated September 17, 2008.

As part of continuing work, Ecology required an additional 5years of groundwater monitoring and sampling at the AOMA groundwater wells with the analysis of 8 key parameters. Based on the results of the 5 years of monitoring and sampling, either additional monitoring and sampling would be required (in the event that chemical concentrations in groundwater remained above Ecology's Model Toxic Control Act [MTCA] cleanup levels [CULs] and/or showed increasing trends) or no further monitoring and sampling would be required (in the event that chemical concentrations in groundwater were below CULs).

As documented at the end of five years of monitoring and sampling in 2015, no further monitoring or sampling was deemed necessary.

Study Area Geologic/Hydrologic Units and Water Supply Wells

Information in this subsection was primarily obtained from Aspect's 2008 Seattle-Tacoma International Airport Groundwater Study which provided a detailed breakdown of the Seattle-Tacoma International Airport and the Study Area's geologic and hydrogeologic units. Aspect used the Port's EMIS to complete their detailed hydrogeologic characterization, built a complete geologic/hydrologic conceptual site model (CSM), and performed hydrogeologic computer modeling to estimate impacted groundwater plume migration rates. The hydrogeologic characterization and CSM were for the Study Area as a whole, whereas the computer modeling focused on Seattle-Tacoma International Airport.

Aspect took prior geologic/hydrologic designations and broke them down into smaller, identifiable units based on Study Area's detailed boring logs, well construction details, groundwater levels, permeability, and other criteria. Coarse-grained, permeable units (aquifers) were given a "C" prefix and fine-grained, very low to impermeable units were given a "F" prefix (aquitards). The units were then assigned numeric suffix with the shallow or uppermost units given a "0" designation and increasing numbers with increasing depth. The upper glacially unconsolidated layers have been designated C0 and F0 with deeper units identified C1, F1, C2, F2, C3, F3, etc.

In summary, the uppermost groundwater in the Study Area (in particular, beneath Seattle-Tacoma International Airport) is a perched unconfined zone with several thin discontinuous water-bearing zones present from ground surface to depths of approximately 40 feet below ground surface (BGS); it is identified as Unit "C0". Beneath perched groundwater zone Unit C0, the next three water-bearing zones (with increasing depth) are Units C1 (represented by Qva, Vashon advance outwash), C2, and C3 which are individually separated by very low to impermeable F1 (represented by Qvt, Vashon Till), F2, and F3 units. Figure 9.3 (reproduced from Table 4-1 of Aspect's Groundwater Study) shows the identified units within the Study Area and beneath Seattle-Tacoma International Airport.

As documented in the 2008 Groundwater Study, impacted groundwater beneath the airport's AOMA has been detected in shallow perched groundwater Unit C0 and in the next lower water-bearing zone Unit C1/Qva. Impacts have not been detected in the deeper water-bearing zone, Unit C2.

There are six (6) water supply well locations within the Study Area and within approximately 2 miles of the Seattle-Tacoma International Airport boundary; however, none are located on the Airport itself. From north to south, the well locations are identified as follows:

- Riverton Heights Wells (a cluster of two wells);
- Washington Memorial Park Well;
- Tyee Well and Old Tyee Golf Course Well (two wells);
- Des Moines Well;
- Angle Lake Well; and,
- King County Water District #54 Well Field (a cluster of three wells).

The locations of these water supply wells relative to the Airport's AOMA where contamination has been detected are shown on Figure 9-3 (reproduced from Figure 6-1 of Aspect's Groundwater Study). The AOMA location is shown within the dashed redline area and buffer zones surrounding the AOMA are shown in different colors: 0.25-mile buffer in orange and 1-mile buffer in yellow. Well screen intervals and the identification of the water-bearing units for these wells are shown on Table 9-2 (reproduced from Table 6-1 of Aspect's Groundwater Study). Most of these wells are screened and completed at much greater depths than impacted groundwater at the airport.

Results of the groundwater modeling show that impacts are essentially restricted to the AOMA. Three small areas extend a short distance beyond the AOMA but still well within the 0.25-buffer and within the airport boundary. Two small lobes extend a short distance west of the AOMA (beneath the easternmost runway) and one small area is immediately north of the AOMA.

Figure 9.3
Summary of Study Area Geologic and Hydrologic Units

Geologic Group	Geologic Unit Name	Geologic Unit Abbr.[1]	Geologic & Sedimentologic Characteristics	Hydro-Stratigraphic Unit		Model Condition	South King Co. Groundwater Mgmt. Plan Unit	USGS[2]
Post-Glacial Deposits	Fill	Fill	All man-placed fill and extensively graded areas.	C0/F0	Order is variable	Perched Water Bearing Zones and Aquitards[3]	Qal and Qvr	m
	Topsoil	Qts	Topsoil.	C0				
	Recent Alluvium	Qal	Sand and gravel deposited by streams and rivers.	C0				Qyal
	Recent Lacustrine Deposits	Ql	Clay, silt, and peat deposited in lakes, ponds and wetlands.	F0				
Fraser Glacial Deposits (Vashon Drift)	Recessional Lacustrine Deposits	Qvrl	Silt and clay deposited in quiet water recessional glacial environments including lakes, ponds, floodplains, and kettles.	F0				Qvrl
	Recessional Outwash	Qvr	Sandy to gravelly recessional glacial stream and river deposits.	C0				Qvr
	All deposits above are normally consolidated. All deposits below are glacially overconsolidated.							
	Weathered Vashon Glacial Till	Qvtw	Weathered till.	F1		Aquitard[3]	Qvt	Qvt
	Vashon Glacial Till	Qvt	Glacial lodgement till composed of poorly-sorted clay, silt, sand and gravel. Includes interbeds of outwash and glaciolacustrine sediments.					
	Vashon Advance Outwash	Qva	Pro-glacial outwash composed primarily of silty sand, sand, and sand-gravel mixtures. (Known in the Seattle area as Esperance Sand.)	C1		Aquifer	Qva "Shallow Aquifer"	Qva
Pre-Fraser Glacial & Non-Glacial Deposits	Transition Beds	Qtb	Includes both Vashon glaciolacustrine silt and clay deposits (Lawton Clay) and pre-Fraser fine-grained non-glacial deposits.	F2		Aquitard	Qvl and Qf(1)	Qpf
	Pre-Fraser Fine-Grained Deposits	Qpff	Undifferentiated pre-Fraser fine-grained deposits.					
	Pre-Fraser Coarse-Grained Deposits	Qpfc	Uppermost extensive coarse-grained deposit below Vashon Drift. Chiefly sand and gravel. Likely includes Olympia non-glacial beds, Possession glacial outwash, and Whidbey non-glacial deposits. Includes a discontinuous fine-grained interbed (C2F).	C2		Aquifer	Qc(3) "Intermediate Aquifer"	Qpfc
				C2F				Qpf
				C2				Qpfc
	Pre-Fraser Fine-Grained Deposits	Qpff	Older undifferentiated fine-grained deposits.	F3		Aquitard	Qf(3)	Qpf
	Pre-Fraser Coarse-Grained Deposits	Qpfc	Older undifferentiated coarse-grained deposits.	C3		Aquifer	Qc(4) "Deep Aquifer"	Qpfc
	Pre-Fraser Fine-Grained Deposits	Qpff	Older undifferentiated fine-grained deposits.	F4		Aquitard	Qf(4)	Qpf
	Pre-Fraser Coarse-Grained Deposits	Qpfc	Older undifferentiated coarse-grained deposits.	C4		Aquifer		Qpfc
	Pre-Fraser Fine-Grained Deposits	Qpff	Older undifferentiated fine-grained deposits.	F5		Aquitard		Qpf
	Pre-Fraser Coarse-Grained Deposits	Qpfc	Older undifferentiated coarse-grained deposits.	C5		Aquifer		Qpfc
	Pre-Fraser Fine-Grained Deposits	Qpff	Older undifferentiated fine-grained deposits.	F6		Aquitard		Qpf
	Pre-Fraser Coarse-Grained Deposits	Qpfc	Older undifferentiated coarse-grained deposits.	C6		Aquifer		Qpfc
Bedrock	Tertiary Bedrock	Br	Siltstone, sandstone and shale with minor coal seams. Includes basaltic and andesitic intrusives.	Br		Aquitard	Tbr	Ti, Tpr, Tpt, Tpta, and Tptm

Notes:

1. The Geologic Unit Abbreviations are those used in this report.
2. USGS designations are those used in the *Geologic Map of the Des Moines 7.5' Quadrangle, Washington* (Booth and Waldron, 2002).
3. The hydrostratigraphic units C0, F0, and F1 were combined into a single layer for the groundwater model.

Figure 9.4
Water Supply Well Construction Details

Owner's Well Name	EMIS Name	EMIS Database Identifier	X Coord. (feet)	Y Coord. (feet)	Ground Surface Elevation (feet)	Screened Interval (feet bgs)	Screened Hydrostratigraphic Unit	Approximate Annual Pumpage[1] (million gallons)	Model Pumpage Rate (cubic feet/day)
City of Seattle, Highline Well Field									
Boulevard Park	23N4E16D3	A_PW205	13695	29774	358	216 - 295	C2	157[2]	57,501
Riverton Heights No. 1	23N4E21C1	A_PW261	14685	23323	436	275 - 355	C2	448[2,3]	164,079
Riverton Heights No. 2	23N4E21C12	A_PW264	14653	23779	431	280 - 385	C2		
Highline Water District									
Des Moines	22N4E8A2	A_PW128	10907	3121	197	312-358	C4	168	61,530
Angle Lake	22N4E9A4	A_PW145	16597	2620	334	412.5 - 481.7	C4	106	38,822
Tyee Well	22N4E4F4	A_PW108	14155	6255	242	93 - 149	C2	196[4]	71,785
King County Water District No. 54									
No. 4	22N4E8K7	A_PW138	10706	-273	166	305 - 328	F5-C5	33	12,086
No. 5	22N4E8K8	A_PW139	10823	-287	148	212.6 - 218 223 - 234.3	C3	85	31,131
No. 6	22N4E8K11	A_PW132	10247	123	141	336 - 351	C5	33	12,086
Port of Seattle									
Old Tyee Golf Course Well[5]	22N4E4F1	A_PW106	14340	5950	238	72 - 160 190 - 243 511 - 541	C2-F3, F3-C3, & C5	162[6]	66,657
Washington Memorial Park									
Well No. 2[5]	23N4E28H2	A_PW337	17050	17520	382	127 - 136	C1	42[7]	15,382

Notes:
1. Based on data obtainec from purveyors except where noted
2. Average for 1990 through 1994 water years
3. Data only available for the combined extraction from Riverton Heights No. 1 and No. 2
4. Well placed in production during 2004. Pumpage based on water right certificate 2191-A (Robinson and Noble, 1998
5. Wells used only for irrigation
6. Groundwater use not metered. Pumpage based on water right certificate 2369-A dated October 18, 195
7. Groundwater use not metered. Pumpage based on water right certificate 3929-A dated June 21, 1961

C. AIRPORT SOURCES OF CONTAMINATION AND LOCATIONS

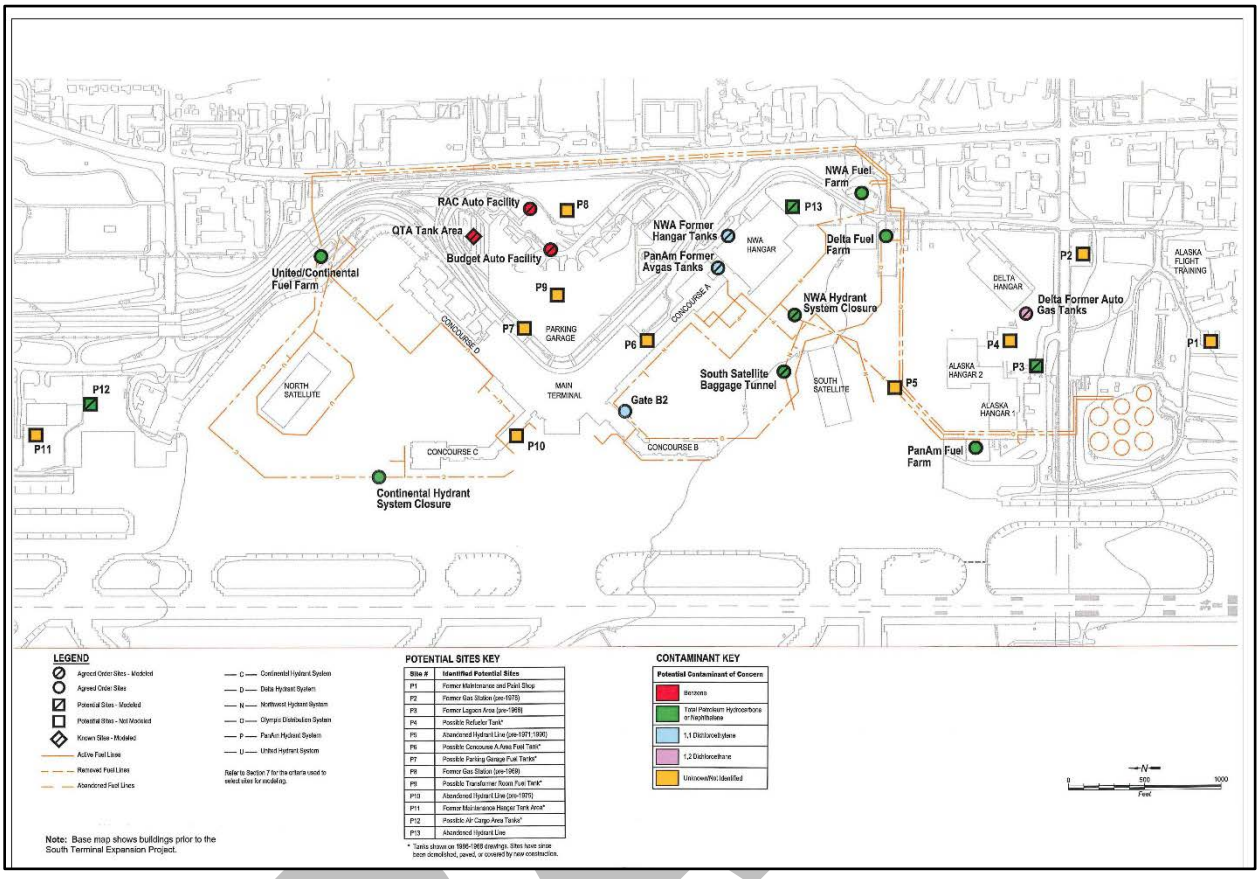
As identified in the Agreed Order #97TC-N122 and as summarized in Aspect's 2008 Groundwater Study, there are 13 contaminated sites at Seattle-Tacoma International Airport that have been investigated as required by Ecology. These 13 sites (listed below) are located within the Airport's AOMA and shown on Figure 9.5 (reproduced from Figure 6-1 of Aspect's Groundwater Study). Figure 9.5 also shows the primary contaminant at each of the 13 sites.

- **Budget Auto Facility**
  Automotive gasoline release from former UST; impacted soil and groundwater in Unit C1 (no perched zone C0 present); central portion of AOMA adjacent to Seattle-Tacoma International Airport's parking structure.

- **Concourse B/Gate B**
  Jet A fuel release near jet fuel hydrant pipelines; impacted soil and groundwater in Unit C1 (no perched zone C0 present); north-central portion of AOMA.

- **Continental Airlines Hydrant System**
  Jet A fuel release along the length of a hydrant pipeline with extent of impacts limited to several locations along the pipeline (specific hydrant valve pits, low drain points, and a high point vent; impacted soil only; northwest portion of AOMA. No Further Action (NFA) granted by Ecology after investigation and based on site-specific total petroleum hydrocarbons (TPH) as Jet A fuel soil cleanup level.

Figure 9.5
Known and Suspected Impacted Sites at Seattle-Tacoma International Airport



- **Delta Airlines Auto Gas Tank Cluster**
  Gasoline and volatile organic compound (VOC) releases from a former 5-tank UST cluster; impacted soil, shallow perched groundwater (Unit C0), and minor impacts to deeper groundwater (Unit C1); southeast portion of AOMA.

- **Delta Airlines Fuel Farm**
  Jet Fuel releases from former USTs; impacted soil and shallow perched groundwater (Unit C0); southeast portion of AOMA.

- **Northwest Airlines Hangar Tanks**
  Mineral spirits & oil releases from five (5) former USTs located in four separate excavations; impacted soil, shallow perched groundwater (Unit C0), and deeper groundwater (Unit C1 at approximately 60 feet BGS); southeast portion of AOMA.

- **Northwest Airlines Fuel Farm**
  Former jet fuel UST tank farm (14 former USTs); impacted soil, shallow perched groundwater, and deeper groundwater (Units C0 and C1); southeast portion of AOMA.

- **Northwest Airlines Hydrant Systems**
  Two former hydrant fuel delivery loop systems (an older loop identified as "abandoned" and unused as of 1976, and a second loop identified as "closed" and taken out of service in 1997); impacted soil, perched groundwater, and deeper groundwater (Units C0 and C1); south-central to southwest portions of AOMA.

- **South Satellite Baggage Tunnel**
  Associated with the "closed" Northwest Airlines hydrant loop described above; impacted soil and deeper groundwater (no perched groundwater identified); southwest portion of AOMA.

- **Pan Am Airlines Avgas (Aviation Gas) Tanks**
  Up to 10 former USTs (four USTs primarily containing Jet A fuel but originally containing Aviation Gas [lending the name for this location], and six USTs containing automotive gas, ethylene glycol, kerosene, diesel, mineral spirits, and waste oil); impacted soil, shallow perched groundwater, and deeper groundwater (Units C0 and C1); central portion of AOMA.

- **Pan Am Airlines Fuel Farm**
  Two constructed-in-place Jet A fuel concrete USTs, partially removed with concrete pavement beneath the former USTs and in two sidewalls left in place to support the adjacent roadway; impacted soil but with only minor impacts to deeper groundwater (Unit C1 at approximately 50 feet BGS) in one well; no perched groundwater at this location; southwest portion of AOMA.

- **Consolidated Rental Car Facility**
  Three former gasoline USTs and dispensing pumps near Seattle-Tacoma International Airport parking facility toll booths that were used by Hertz, Avis, and National rental car agencies; impacted soil and deeper groundwater (Unit C1 at approximately 45 feet BGS); no perched groundwater at this location; east-central portion of AOMA.

- **United Air Lines (UAL) Fuel Farm/Continental Airlines Fuel Farm**
  A total of 8 former USTs at these two nearby facilities (three at UAL containing waste Jet A fuel and glycol deicers, and five at Continental containing Jet A fuel and waste jet fuel); impacted soil and perched shallow groundwater (Unit C0 at approximately 30 feet BGS); northeast portion of AOMA.

Additional information and status for the 13 Agreed Order sites at the Airport are provided in Figure 9.6 (reproduced from Table 6-1 of Aspect's Groundwater Study). Numerous soil borings and groundwater monitoring wells have been drilled at each of these 13 areas.

In addition to the 13 Agreed Order sites, there is another rental car former fueling and vehicle wash area that was located at the north end of the Seattle-Tacoma International Airport parking garage structure. This area has been identified as the Rental Car Quick Turn Around (QTA) Tank Area where five fuel USTs and nine dispenser islands were formerly located and where impacted soil and slightly impacted deeper groundwater (Unit C1) have been detected (no mention of the presence of perched shallow groundwater at this location).

There are also up to 13 other Airport potential sources of contamination within the AOMA. These other sites range from former gas stations, possible other fuel tanks scattered around the AOMA, a maintenance hangar fuel tank, possible hydrant lines, and a former maintenance and paint shop. Additional information is provided in Figure 9.7 (reproduced from Table 6-2 of Aspect's Groundwater Study). These sites were shown on old airport drawings.

Figure 9.6
Summary of Known Impacted Sites at Seattle-Tacoma International Airport

Site (Sites Listed in Ecology Agreed Order)	Release Observation Date	Release Source	Contaminant Type	Affected Media (Confirmed)				Investigation Summary	Remediation Summary	Current Project Status (Project Lead)
				Soil	Perched Groundwater	Regional Groundwater (Qva or C1 aquifer)	Free Product			
Budget Auto Facility	1990	Underground gasoline lines	Petroleum - gasoline	Yes	No (perched groundwater not identified)	Yes	Yes	Gasoline line failure resulted in soil and groundwater contamination. Several site studies have been conducted since 1990. Groundwater compliance monitoring is ongoing.	Free product recovery and vapor extraction, followed in 1997 by soil vapor extraction system with product wicking to remove additional free product. Vapor extraction was discontinued in 2002 and system removed in June 2004 due to low contaminant recovery rates.	Active. Ongoing remediation and groundwater monitoring. (Budget)
Concourse B/ Gate B-2	1991	Underground aircraft fuel hydrant system (suspected)	Petroleum - Jet A	Yes	No (perched groundwater not identified)	Yes (minimal)	No	Contamination related to fuel system releases, initially identified in 1991. Site environmental investigations conducted 1991-1993, and 1998.	Periodic monitoring demonstrated stable, non mobile conditions. Excavation of impacted soil during 2001-2004 capital construction.	Closed (Port of Seattle)
Continental Airlines Hydrant System	1994	Underground aircraft fuel hydrant system	Petroleum - Jet A	Yes	No	No	No	Investigations conducted in 1994 and 1999 identified petroleum in shallow soil at some locations along the hydrant line, but no soil impact at depth.	None appropriate.	Closed. Continental obtained an Ecology NFA, 10/10/03.
Delta Airlines Auto Gas Tank Cluster	1987	Underground storage tanks	Petroleum - gasoline; solvent	Yes	Yes	Yes (minimal)	Yes (in tank-area perched groundwater zone)	Site investigation in 1987 and 1995. Groundwater monitoring through 1998.	Tanks removed in 1992. Significant excavation of impacted soil during 2000-2001 capital construction removed all impacted soil and tank area perching zone.	Inactive, anticipate monitoring or closure pending completion of MTCA Ground Water Study. (Delta)
Delta Airlines Fuel Farm	1989	Underground storage tanks; fuel farm operations	Petroleum - Jet A	Yes	Yes	No	Yes (in perched groundwater zone)	Site investigation in 1989 and 1995. Groundwater monitoring through 1997.	Tanks removed and system closed in compliance with closure regulations in 1999. Significant excavation of impacted soil during 2001-2004 capital construction.	Closed. Delta obtained an Ecology NFA, 3/20/04.
Northwest Airlines Former Hangar Tanks	1990	Underground storage tanks	Petroleum, Solvent	Yes	Yes	Yes	Yes (in perched groundwater zone)	Several site studies of the area around the former tanks have been conducted since 1990. Groundwater monitored through 2001.	Tanks removed in 1990. Vapor extraction conducted in 1995, and bioventing performed in 2000-2001 for free product removal. Significant excavation of impacted soil during 2001-2004 capital construction.	Inactive, anticipate monitoring or closure pending completion of MTCA Ground Water Study. (Northwest)
Northwest Airlines Fuel Farm	1985 (earliest observation)	Underground storage tanks; fuel farm operations	Petroleum - Jet A	Yes	Yes	Yes (minimal)	No	Various studies since 1985 have identified petroleum impacted soil associated with facility operations and releases from nearby hydrant lines.	Tanks removed and system closed in compliance with closure regulations in 1998. Bioventing in tank backfill area 1999-2000. Significant excavation of impacted soil during 2001-2004 capital construction.	Inactive, anticipate monitoring or closure pending completion of MTCA Ground Water Study. (Northwest)
Northwest Airlines Hydrant System Closure (See a, b & c below)	---	---	---	---	---	---	---	---	---	---
(a) Northwest "Abandoned" Hydrant System, removed from service 1976	1981 (earliest observation)	Underground aircraft fuel hydrant system	Petroleum - Jet A	Yes	Yes	Yes	No	Several early studies. System closure investigation completed in 1998.	System closed in compliance with closure regulations in 1998. Significant excavation of impacted soil during 2001-2004 capital construction.	Inactive, anticipate monitoring or closure pending completion of MTCA Ground Water Study. (Northwest)
(b) Northwest "Closed" Hydrant System, removed from service 1997	1985 (earliest observation)	Underground aircraft fuel hydrant system	Petroleum - Jet A	Yes	Yes	Yes	Yes	Several early studies. System closure investigation completed in 1997. Also see South Satellite.	System closed in compliance with closure regulations in 1997. Significant excavation of impacted soil during 2001-2004 capital construction. Also see South Satellite.	Inactive, anticipate monitoring or closure pending completion of MTCA Ground Water Study. (Northwest. See also South Satellite.)
(c) Northwest Airlines South Satellite Baggage Tunnel (Included in Northwest Airlines "Closed" Hydrant System, above)	1992	Underground aircraft fuel hydrant system	Petroleum - Jet A	Yes	No (perched groundwater not identified)	Yes	Yes	Various studies since 1992 have identified petroleum soil associated with releases from hydrant lines.	Closure of hydrant system occurred in 1997. Free product recovery and some specific excavation has occurred in areas of specific releases.	Active. Groundwater monitoring. (Northwest)
Pan Am Airlines "Avgas" Tanks Site	1991	Underground storage tanks	Petroleum - Jet A	Yes	Yes	Yes	Yes	Several site investigations characterizing releases from tanks, have been conducted since 1991.	Tanks removed in 1992 and 2001. Free product recovery thorugh 1996. Significant excavation of impacted soil during 2001-2004 capital construction.	Inactive, anticipate monitoring or closure pending completion of MTCA Ground Water Study.
Pan Am Airlines Fuel Farm	1990	Underground storage tanks; fuel farm operations	Petroleum - Jet A	Yes	No (perched groundwater not identified)	Yes (minimal)	No	Investigation conducted in 1991 and 1993. Semiannual monitoring groundwater monitoring conducted through 1998.	Tanks and soil removed in 1990. Facility closed in compliance with closure regulations in 1993. Some impacted soil remains in place due to site access conditions.	Closed in accordance with Ecology agreement (pre-dates VCP NFA.) (Port)
RAC Auto Facility	1993	Tanks and associated operations	Petroleum - gasoline	Yes	Yes	Yes	Yes	Several site investigations characterizing soil and groundwater conditions conducted since 1993. Ongoing groundwater monitoring.	Tanks and some impacted soil removed.	Active. Ongoing groundwater monitoring. (RAC)
United Airlines Fuel Farm/ Continental Airlines Fuel Farm	1988	Underground storage tanks; fuel farm operations	Petroleum - Jet A	Yes	Yes	No	Yes	Numerous site studies of contaminaiton associated with fuel farm operations have been conducted since 1988. Additional investigation phases are planned. Groundwater compliance monitoring is ongoing.	Past site remediation includes tank removal, soil excavatrion, free product recovery and vapor extraction.	Active. Ongoing groundwater monitoring. Additional remediation planned. (United, Continental, Olympic Pipeline Company, Port of Seattle)

Figure 9.7
Summary of Suspected Impacted Sites at Seattle-Tacoma International Airport

The following are sites identifed as having the potential for environmental impacts based on historical operations. Generally, operations at these sites were discontinued prior to the development of current environmental regulations. Sites P1 - P12 were identified in the original Potential Sites List, 12/99. Data generated since 12/99 results in the addition of one new potential site, P13, and the exclusion of eight of the original sites, as noted below.

Site #	Identified Potential Sites	Description	New Data	In Model	Rationale	Reference
P1	Former Maintenance and Paint Shop	Potential historical release of minor amounts of maintenance materials.	Yes	No	Recent data indicates no significant impacts.	*Environmental Assessment, Former Maintenance and Paint Shop* , Aspect Consulting, 6/03
P2	Former Gas Station	Gas station demolished about 1978. Three gasoline tanks were removed and two oil tanks were filled with gravel and sealed.	Yes	No	Construction related tank removal indicated minor soil contamination.	Onsite POS observations during construction by others. Report status unknown.
P3	Former Lagoon Area	Former oil "lagoon" or "sump" demolished in 1966 construction.	Yes	Yes	New soil data will be used to predict potential groundwater concentrations, using MTCA. Groundwater Study model will use predicted values.	*Former South End Oil Lagoon Site/ Summary of Construction Data Review* , Lovely Consulting, Inc., 9/02.
P4	Possible Refueler Tank	3 - 20,000 gallon fuel tanks shown on 1966-8 drawings. No information on tanks status.	Yes	No	Construction related tank removal indicated minor soil contamination.	*Tank Removal Report, Alaska Airlines Maintenance Hangar Area,* Maul Foster & Alongi, 1/03
P5	Abandoned Hydrant Line	Segment of hydrant line abandoned pre-1990 between former fuel farm and Concourse A.	Yes	No	Recent data indicates no significant impacts.	*Draft Pan Am Fuel Hydrant System Investigation System Report* , Landau Associates, 1/03
P6	Possible Concourse A Area Fuel Tank	500 gallon fuel tank shown on 1966-8 drawings. No information on tank status.	Yes	No	Construction excavations found no tank or indication of former tank presence.	Onsite POS observations during POS construction. No tank or contamination present. No report.
P7	Possible Parking Garage Fuel Tanks	2 - 4,000 gallon fuel tanks shown on 1966-8 drawings. Tanks reportedly filled in place.	No	Yes	Model will rely on data from nearby contaminated sites (Budget and RAC) to predict fate and transport.	---
P8	Former Gas Station	Gas station removed in 1969.	Yes - area	No	Nearby construction excavations found no indication of former tank impact. Also in area with known sites, on which model can rely.	Onsite POS observations of adjacent area during POS construction. No contamination present. No report.
P9	Possible Transformer Room Fuel Tank	Fuel tank shown on 1966-8 drawings. No information on tank status.	No	Yes	Model will rely on data from nearby contaminated sites (Budget and RAC) to predict fate and transport.	---
P10	Abandoned Hydrant Line	Segment of hydrant line abandoned pre-1975 near Concourse C.	Yes	No	Recent data indicates no significant impacts.	*Subsurface Investigation Report United Airlines Fuel Hydrant System* , Enviro-Sciences, Inc., 8/02. Ecology NFA 11/22/05
P11	Former Maintenance Hangar Tank Area	1968 drawing indicates 7 fuel/oil USTs and two drywells in the vicinity of demolished hangar. No information on status.	Yes	No	Construction excavations found no tank or indication of former tank presence.	Onsite POS observations during POS construction. No tank or contamination present. No report.
P12	Possible Air Cargo Area Tanks	1968 drawing indicates 2,000 gallon fuel tank and pump and a 500 gallon gas tank. No information on status.	No	Yes	Typical tank site conditions will be used in model.	---
P13	Abandoned Hydrant Line	Segment of hydrant line abandoned pre-1975 between NWA former fuel farm and NWA former hangar.	Yes	Yes	New soil data will be used to predict potential groundwater concentrations, using MTCA. Groundwater Study model will use predicted values.	*Northwest Airlines Former Fuel Hydrant System, Summary of Construction Data Review* , Lovely, 1/03

Airport-Related Chemicals of Interest

Former and ongoing Airport operations include, but are not limited to: aircraft maintenance and repair; airport services support-vehicle maintenance and repair; aircraft and airport services support-vehicle fueling; fueling system maintenance and repairs; aircraft de-icing (as needed during the winter months); aircraft washing; telecommunication system maintenance and repair; airport pavement maintenance and repair; stormwater system maintenance and repair; and temporary storage of wastes generated or associated with these operations.

Based on operations, the following primary chemicals of concern (COIs) have been identified at Seattle-Tacoma International Airport:

- Various Total Petroleum Hydrocarbons (TPH): aviation gas (Avgas); Jet F fuel (Jet A); gasoline (TPHg/gasoline range organics [GRO]); as diesel (TPHd/diesel range organics [DRO]; as oil (TPHo/oil range organics); and mineral spirits;
- Fuel-related aromatic hydrocarbons (volatile organic compounds [VOCs]): benzene, toluene, ethylbenzene, and total xylenes (collectively known as BTEX);
- Gasoline-related additives (VOCs and metallic) normally associated with gasoline: methyl-tertiary-butyl-ether (MTBE); tertiary-amyl-methyl-ether (TAME); tertiary butyl alcohol (TBA); ethyl-tertiary-butyl-ether (ETBE); ethylene dibromide (EDB); ethylene dichloride (EDC, also known as 1,2-dichloroethane [1,2-DCA]), and lead;
- Semi-VOCs associated with fuels and oils: Naphthalene, 1-methyl naphthalene, and 2-methyl naphthalene;
- Metals associated with aircraft and vehicle bodies, and batteries: lead, aluminum, iron, magnesium, vanadium, lithium, copper, zinc, mercury, and chromium; and, to a lesser extent
- Deicing compounds (VOCs; ethylene glycol and propylene glycol) and Solvents (chlorinated VOCs: 1, 1-dichloroethene (1,1-DCE) and/or its breakdown products such as cis-1,2-DCE, trans-1,2-DCE, 1,1-DCA, or vinyl chloride.

Based on compounds detected in normal urban stormwater runoff, the Airport's NPDES permit monitoring requirements, and/or on long-term surface water quality exceedances detected in Miller and Des Moines Creeks, the following compounds are also considered COIs (and previously listed above):

- Copper and zinc (metals), and
- Ethylene glycol and propylene glycol (VOCs).

D. AIRPORT ANALYTICAL DATA, ECOLOGY COMMUNICATION, AND REMEDIATION

As discussed above in Subsections F and G, numerous soil borings and groundwater monitoring wells have been drilled at AOMA-impacted sites with vertical and lateral extent of impacts defined to non-detected concentrations or sufficiently well-defined as required and accepted by Ecology. A summary table of Unit C1 groundwater sample data showing the number of detected and non-detected compounds at the various AOMA sites is provided herein as Figure 9.8 (reproduced from Table 6-4 of Aspect's Groundwater Study).

As shown in Figure 9.8, most of the detected compounds belong to one of following categories (listed in order of decreasing frequency):

- TPH – gasoline and diesel range (detected at 9 of the 10 areas);
- BTEX (detected at 5 of the 10 areas);
- Chlorinated Solvents (detected at 2 of the 10 areas); and
- Naphthalene (detected in 1 of the 10 areas).

Comparison of the detected compounds/categories matches well to the identified COIs based on Airport operations. Other COIs were not detected. Statistical information in Figure 9.8 shows the actual numbers and percentages of groundwater samples and wells where compounds exceeded Ecology's Model Toxic Control Act (MTCA) cleanup levels (CULs).

In accordance with Ecology's September 17, 2008 letter, the Airport was mandated to conduct 5 years of annual groundwater monitoring and sampling for 8 key parameters at the AOMA sites. The key parameters included: TPHg, TPHd, TPHo, TPH as Jet A fuel, benzene, naphthalene, 1,1-DCE, and 1,2-DCA. Five years of groundwater monitoring and sampling were conducted: 2011 through 2015.

At the end of 5 years, groundwater concentrations showed decreased impacts and conformed to MTCA CULs. On behalf of the Port, SLR (Bothell, WA) prepared an update to the Groundwater Study. Their report (dated July 20, 2015) was submitted to Ecology, stating that further monitoring or sampling was no longer necessary and requesting that specific wells be abandoned. A copy of SLR's report is provided in Appendix C. In an email dated February 24, 2016, Ecology approved the requested well abandonments.

As documented in prior environmental reports and as shown on Table 9-3, remediation has been conducted at the AOMA sites in an effort to clean up the sites and to remove the sources of contamination (i.e., the UST systems and the impacted soil). Remediation was performed using the following methods:

- Soil excavation to depths extending to and beyond shallow perched groundwater;
- Soil vapor extraction;
- Bioventing; and,
- Free Product removal.

Figure 9.8
Summary of Groundwater Impacts at Seattle-Tacoma International Airport

		# Non-Detects	# Detects	% Detects	# Samples Exceeding MTCA Cleanup Levels[1]	% Samples Exceed MTCA Cleanup Levels[1]	# Wells Exceeding MTCA Cleanup Levels[1]	% Wells Sampled Exceeding MTCA Cleanup Levels[1]
Budget Auto Facility								
TPH	Total Petroleum Hydrocarbons - Oil Range	0	1	100%	1	100%	1	13%
TPH	Total Petroleum Hydrocarbons - Gasoline Range	26	61	70%	52	60%	7	88%
VOCs	Benzene	26	58	69%	57	68%	7	88%
VOCs	Ethylbenzene	34	50	60%	19	23%	4	50%
VOCs	Toluene	27	57	68%	25	30%	5	63%
VOCs	Total Xylenes	19	37	66%	1	2%	1	13%
Delta Auto Gas Cluster Tanks								
VOCs	1,2-DCA	21	2	9%	2	9%	2	33%
VOCs	Dichloromethane	19	4	17%	2	9%	2	33%
Gate B-2 Site								
TPH	Total Petroleum Hydrocarbons - Diesel Range	10	6	38%	4	25%	3	50%
TPH	Total Petroleum Hydrocarbons - Oil	0	1	100%	1	100%	1	17%
VOCs	1,1-DCE	13	1	7%	1	7%	1	17%
NWA Fuel Farm								
TPH	Total Petroleum Hydrocarbons - Diesel Range	71	53	43%	34	27%	4	67%
NWA Hangar Tanks								
TPH	Total Petroleum Hydrocarbons - Diesel Range	12	2	14%	1	7%	1	25%
VOCs	Vinyl Chloride	36	4	10%	4	10%	1	20%
VOCs	1,1-DCE	12	29	71%	29	71%	4	80%
VOCs	Carbon Tetrachloride	38	2	5%	2	5%	2	40%
VOCs	1,2-DCA	32	8	20%	8	20%	1	20%
VOCs	1,1,2-TCA	36	4	10%	4	10%	1	20%
VOCs	Benzene	40	1	2%	1	2%	1	20%
VOCs	Tetrachloroethene	37	3	8%	3	8%	3	60%
VOCs	Trichloroethylene	34	6	15%	1	3%	1	20%
VOCs	Dichloromethane	34	6	15%	3	8%	1	20%
VOCs	cis-1,2-dichloroethene	15	19	56%	7	21%	1	20%
VOCs	1,1-DCA	1	41	98%	4	10%	1	20%
South Satellite Baggage Tunnel / Northwest Airlines Hydrant System Closure								
SVOC	Naphthalene	5	5	50%	0	0%	0	0%
TPH	Total Petroleum Hydrocarbons - Diesel Range	49	59	55%	37	34%	9	90%
VOCs	Benzene	107	7	6%	1	1%	1	13%
PANAM Avgas Tanks								
SVOC	Naphthalene	38	8	17%	0	0%	0	0%
TPH	Total Petroleum Hydrocarbons - Diesel Range	75	22	23%	16	16%	8	73%
TPH	Total Petroleum Hydrocarbons - Gasoline Range	9	28	76%	12	32%	6	67%
VOCs	1,2-dibromo-3-chloropropane	39	1	3%	1	3%	1	14%
VOCs	1,1-DCE	27	13	33%	13	33%	2	29%
VOCs	Carbon Tetrachloride	39	1	3%	1	3%	1	14%
VOCs	Tetrachloroethene	34	6	15%	6	15%	4	57%
PANAM Fuel Farm								
TPH	Total Petroleum Hydrocarbons - Diesel Range	43	13	23%	4	7%	1	25%
RAC Auto Facility								
TPH	Total Petroleum Hydrocarbons - Gasoline Range	39	46	54%	41	48%	9	64%
VOCs	Benzene	40	45	53%	44	52%	13	93%
VOCs	Ethylbenzene	36	49	58%	15	18%	4	29%
VOCs	Toluene	36	49	58%	16	19%	4	29%
QTA Tank Area								
TPH	Total Petroleum Hydrocarbons - Diesel Range	0	8	100%	6	75%	4	67%
TPH	Total Petroleum Hydrocarbons - Gasoline Range	0	8	100%	7	88%	6	100%
VOCs	Benzene	1	7	88%	7	88%	6	100%
VOCs	Ethylbenzene	1	7	88%	5	63%	4	67%
VOCs	Toluene	1	7	88%	6	75%	5	83%
VOCs	Total Xylenes	1	7	88%	1	13%	1	17%
United/Continental Fuel Farms		Only 1 well completed in Qva Aquifer						
Continental Airlines Hydrant System Closure		No wells completed in Qva Aquifer						
Delta Airlines Fuel Farm		No wells completed in Qva Aquifer						

[1]MTCA Method A Cleanup Levels used for TPH; All other analytes are evaluated against MTCA Method B Cleanup Levels.

All of these methods are typically and extensively used in the environmental industry to cleanup impacted sites and have been successfully implemented at Seattle-Tacoma International Airport. Most of the heavily-impacted materials have been removed, allowing remaining impacts to naturally attenuate over time with decreased levels of impacts. As noted above, demonstration of reduced impacts at Seattle-Tacoma International Airport is evident in the results of the 2011 to 2015 annual groundwater monitoring and sampling events during which groundwater impacts decreased primarily to non-detect or less than MTCA CULs.

One impacted Airport site immediately north of the AOMA and not part of the Agreed Order is the Former Continental-Olympic-United Fuel Farm. As detailed in SLR's March 2019 technical report, the Consultant Team understands that the airport is not the Responsible Party (RP) for this site but the RP is the Continental-Olympic-United Fuel Facility Environmental Committee (FFEC) whose current project manager is a United representative. SLR's March 2019 technical report documents pre-2011 remediation consisting of soil over-excavation, free product recovery wells, soil vapor extraction, and air sparging (again, all widely-used remediation methods). From 2011 to 2016, a dual-phase extraction system operated. 2017 groundwater analytical data reveal overall decreased chemical concentrations in groundwater but with several wells showing persistent impacts. It appears that discussions between FFEC and Ecology with the acceptable solution is to implement institutional controls for these remaining residual impacts.

E. NON-AIRPORT-RELATED, STUDY AREA SOURCES OF CONTAMINATION

To identify off-Airport, non-airport-related Study Area sources of contamination and impacted sites, the Consultant Team subcontracted to Environmental Data Resources (EDR of Shelton, CT) to search multiple federal, state, local, and tribal databases/lists of known and suspect impacted sites. The environmental industry standard for such database searches normally covers a one-mile radius from a particular site or parcel of land.

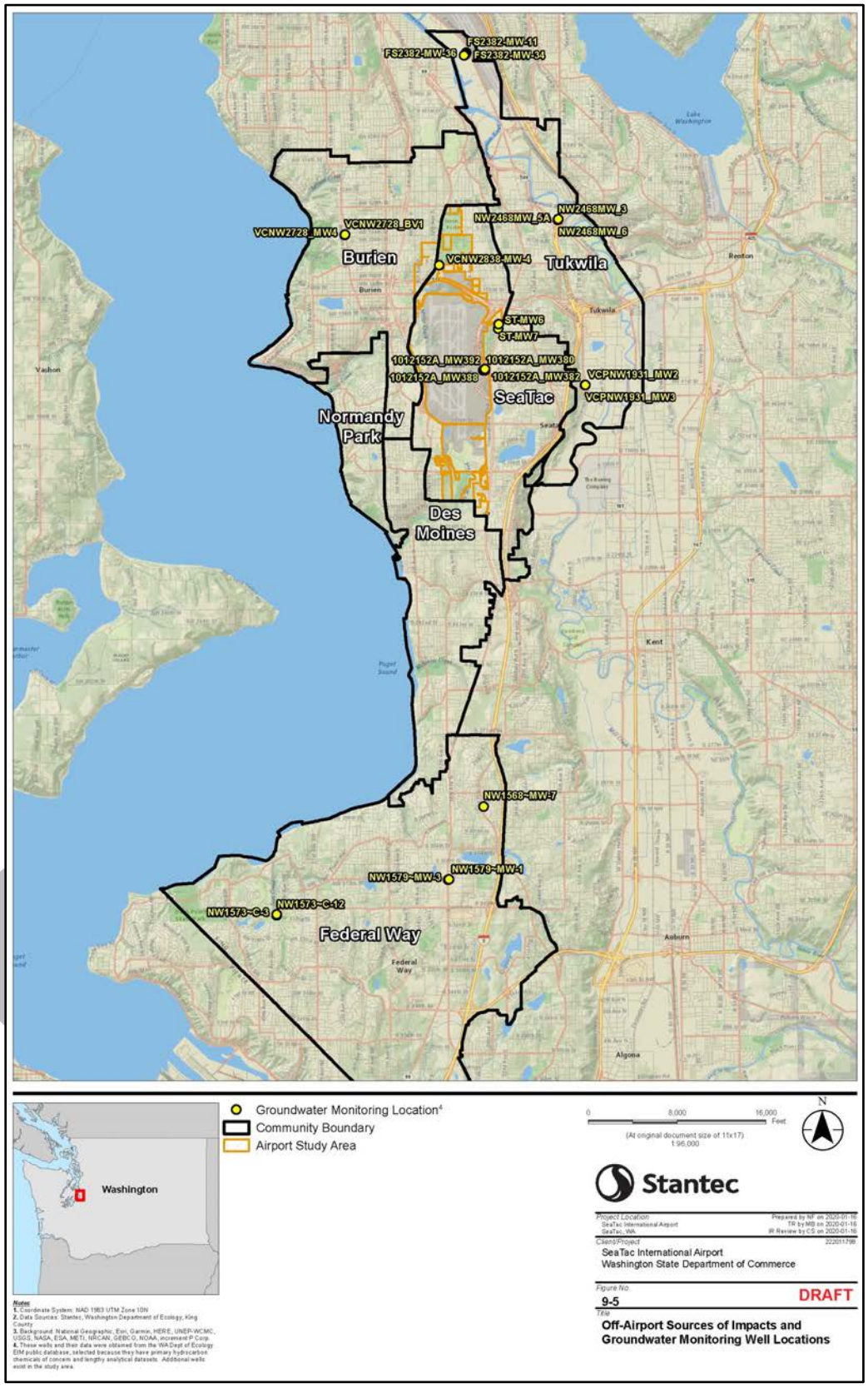
For this project, the Consultant Team adhered to the one-mile radius coverage as measured from the Seattle-Tacoma International Airport boundary. This research also updates similar database reviews conducted by Shapiro and Associates in 1995, a copy of whose April 1995 database report titled "Environmental Site Assessment" was included as Appendix L of the Port's 1996 Seattle-Tacoma International Airport Master Plan Final EIS.

As detailed in EDR's October 2019 report, there are numerous sites within a one-half mile radius of the Airport boundary that are primarily tribal- and state-listed UST or LUST sites, sites with documented or suspect spills or releases, and hazardous waste generators (small or large-quantity generators but not meaning that a release has occurred). There are also several active and former dry cleaner sites with documented or suspect releases.

Non-Airport-Related, Known Contaminated Sites

Based on review of the EDR report and Ecology's TCP public website, the Consultant Team went into Ecology's EIM public database and downloaded soil and groundwater analytical data for impacted sites within the Study Area. Using the airport's COIs as a guide, the Consultant Team filtered the database to identify sites that could have similar COIs (potentially indicating impacts originating from the airport) and then re-filtered the data to identify sites that had multiple years of analytical data (10 years or greater) that could be graphed in order to observe historical data trends. The COIs included: TPHg/GRO, TPHd/DRO, benzene, naphthalene, copper, zinc, and 1,1-DCE.

Figure 9.9
Off-Airport Sources of Impacts and Groundwater Well Monitoring Locations



As shown on Figure 9-5, a total of 10 sites (with their groundwater wells) were identified. The sites are listed below based on Ecology's database nomenclature; the Consultant Team then used Google EarthPro™ to further identify the site name or use; and then its approximate location within a given jurisdiction city.

- FS2382 = Jorgensen Forge industrial property (northern Tukwila);
- NW2468 = Peterson's Diesel Fueling (central to east-central Tukwila);
- ST-MW-7/ST-MW-6 = Master Park Lot C (eastern SeaTac; close to Airport). This site is further identified by Ecology as SeaTac Development (Facility Site #38258847; Cleanup Site #5994) with numerous environmental reports and technical documents on Ecology's TCP website. This site was operated by various business, "some of which utilized fuel products and USTs. Scarsella Bros. Inc. once owned the property and operated a construction yard on the property until the 1970s. This site is not related to the Seattle-Tacoma International Airport or Sea-Tac Ground Water Study." (reference: Ecology's Site Summary Page, SeaTac Development; public website accessed by the Consultant Team on January 17, 2020);
- 1012152A = on airport property; this is Continental-Olympic-United FFEC site described above;
- VCPNW1931 = Ashley Furniture Warehouse (former UST) (southern Tukwila);
- NW1568 = former Chevron Station #9-8473 (northeastern Federal Way);
- NW1579 = Chevron Station #9-8538 (northeastern Federal Way);
- NW1573 = Chevron Station #9-9624 (northwestern Federal Way);
- VCNW2728 = ARCO Station #0409 (central to west-central Burien); and
- VCNW2838 = AA Asphalt SeaTac Yard (northern Seatac).

The 10 properties listed above have/have had known releases that are directly linked to their own particular USTs/former USTs with no discernable connection to airport groundwater data or airport operations. Graphs of the available groundwater data are provided in Appendix E. Most of the groundwater data show decreasing concentrations. In fact, VCPNW1931 received a No Further Action (NFA) determination from Ecology dated January 28, 2014.

Evaluation of soil quality at these sites was not possible as soil borings are typically not drilled multiple times at the same locations. At impacted sites, soil borings are drilled in a lateral, "step-out" manner to assess the lateral and vertical extent of impacts originating from a point source.

One additional well-known and well-documented source of regional soil impacts is the former Asarco Tacoma Smelter. According to Ecology's Site Summary Page, "For almost 100 years, the Asarco Company operated a copper smelter in Tacoma. Air pollution from the smelter settled on the surface soil over more than 1,000 square miles of the Puget Sound basin. Arsenic, lead, and other heavy metals are still in the soil as a result of this pollution." (public website accessed by the Consultant Team on January 17, 2020).

F. WHAT WE HEARD FROM THE PUBLIC

During both project Public Meetings, one citizen raised concern regarding polluted soil in his daughter's garden with the soil believed to have been impacted by air pollution originated from nearby overhead aircraft emissions.

The Consultant Team understands that the citizen has been working with the University of Arizona (UA) and, due to increasing concern of air and soil pollution, this citizen collected or was provided with samples of "filters, soil, plant material, teeth and bone chip". The Consultant Team further understands that the samples were analyzed for a series of metals using industry-standard inductively coupled plasma mass spectrometry (ICP-MS) test methods with the results reported and provided back to the citizen by UA.

The Consultant Team is uncertain of sample collection methods, sample handling procedures, sample locations, and has not reviewed the results in detail. However, with sample collection/handling/location information, these data could be independently reviewed by a qualified third-party entity.

G. RECOMMENDATIONS

Following a review of documents and websites associated with groundwater and soil quality (see References. Following), the Consultant Team has identified no significant data gaps regarding soil or groundwater quality. To date, Seattle-Tacoma International Airport has conducted subsurface investigations in accordance with Ecology's regulations under Ecology's direction and supervision, and the airport has performed remediation to cleanup impacted soil and groundwater to the satisfaction of and acceptance by Ecology. The Consultant Team is unaware of any non-Ecology-mandatory performed by the Port of Seattle.

As a "good neighbor" courtesy and for the long-term protection of groundwater, the following recommendations are offered.

- **Groundwater Recommendation #1 – Conduct Independent Testing of "Black Soot"**
  The Consultant Team heard numerous concerns from Study Area citizens regarding particulate matter and "black soot" that settles on horizontal surfaces (rooftops, cars, decks, pools, etc.), as well as impacts to gardens and landscaping. Therefore, it is recommended that this material be tested by an independent third-party laboratory to determine the chemical composition of the material in question and potential sources.

- **Groundwater Recommendation #2 – Conduct Ongoing Monitoring and Sampling**
  To assure the quality of groundwater, it is suggested that the Port of Seattle (or its consultants) conduct ongoing groundwater monitoring, sampling, and analysis in several remaining AOMA Unit C1 groundwater monitoring wells for key indicator parameters. This could be done on a periodic basis – such as every three years – as an ongoing check on Airport groundwater quality, and the results entered into the Port of Seattle's EMIS. On the same approximate three-year cycle, the results could be reviewed with groundwater data from the Study Area municipal water wells.

- **Groundwater Recommendation #3 – Coordinate with Study Area Comprehensive Plans**
  Natural systems such as groundwater and soils do not begin or end at City or Airport borders. It is recommended that the Port of Seattle cooperatively work with surrounding communities to ensure the ongoing health and preservation of groundwater and soil areas. Similarly, it is recommended that as Study Area Cities update their individual specific comprehensive plans that they coordinate these efforts with the Port of Seattle to ensure all parties are adopting plans and policies that do not harm that local and regional environment.

H. THE FUTURE

As with surface water, ongoing growth and urbanization are concerns for the integrity of any developed region's groundwater and soil systems and habitats. As the region and the Study Area continue to grow, care must be taken to ensure these systems are not impacted.

The increasing reliance on Low-Impact Design (LID) and sustainable and green building practices – for both residential and commercial applications – holds promise that increasing urbanization does not have to come at the cost of natural systems. And improvements to the natural environment should also have parallel benefits to human health, property values, and other quality of life metrics.

I. SUMMARY

Many of the sites of concern occur on Airport property. The Port of Seattle is appropriately monitoring and addressing these areas of interest. Similarly, there are some off-Airport sites of concern – some of which are due to other sources (such as industrial or dry cleaner operations.)

Citizens in the Study Area also raised concerns about impacts to homes, gardens, and landscaping. While those impacts could not be independently verified, there should be follow-up monitoring and/or testing to ensure that there are no areas of concern that have not yet been reported.

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SECTION 10

LIGHT

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SECTION 10

LIGHT

A. APPROACH

This Section researches any potential impacts for light intrusion and other nighttime luminance issues that might be associated with the operation of Seattle-Tacoma International Airport. The existing and previous conditions relating to light in the Study Area were researched between 1997 and 2019. Unlike the previous sections (such as noise, air quality, mobility, etc.), concerns regarding light are not common metrics tracked by the Port of Seattle or other local agencies. There are few data sets that provide annual, comparable evaluation of electric light conditions throughout a large geographic area, such as the communities surrounding the Seattle-Tacoma International Airport. However, satellite composite imaging of nighttime light emissions (sometimes called sky glow) is one data set that provides the ability to compare electric light conditions over the course of many years. Beginning in 2012, satellite composite imaging deployed sensing technologies that provide adequate resolution to support the review of electric lighting at night, over a large-scale area.

Review of this data set over many years will provide a means of reviewing the changes and intensity of developments that incorporate electric lighting systems. To provide comparisons, the Consultant Team evaluated the nighttime light emissions in the Central Puget Sound as well as the City of Seattle and the Study Area.

Review of Data Sources and Methodology

Through the evaluation of Nighttime Light Emissions over time, patterns and intensity of development emerge.

Evaluation of Nighttime Light Emissions provides an insight into the changes of lighting installations over a large area. While there is not a single factor that contributes to nighttime light emissions, the primary contribution is created by two aspects of electric lighting systems:

- Light directly entering the atmosphere from light sources; and,
- Light reflected off of illuminated surfaces, such as roadways or parking lots, that enter the atmosphere.

The National Oceanic and Atmospheric Administration (NOAA), Earth Observation Group and the Colorado School of Mines maintain satellite data. To identify the changes in light conditions at Seattle-Tacoma International Airport, as well as the surrounding communities, between 1998 and 2018, this report utilized this data, processed in the online tool (lighttrends.lightpollutionmap.info, supported by the ERA-Planet GEOEssential project, of the GFZ German Research Centre for Geoscience)

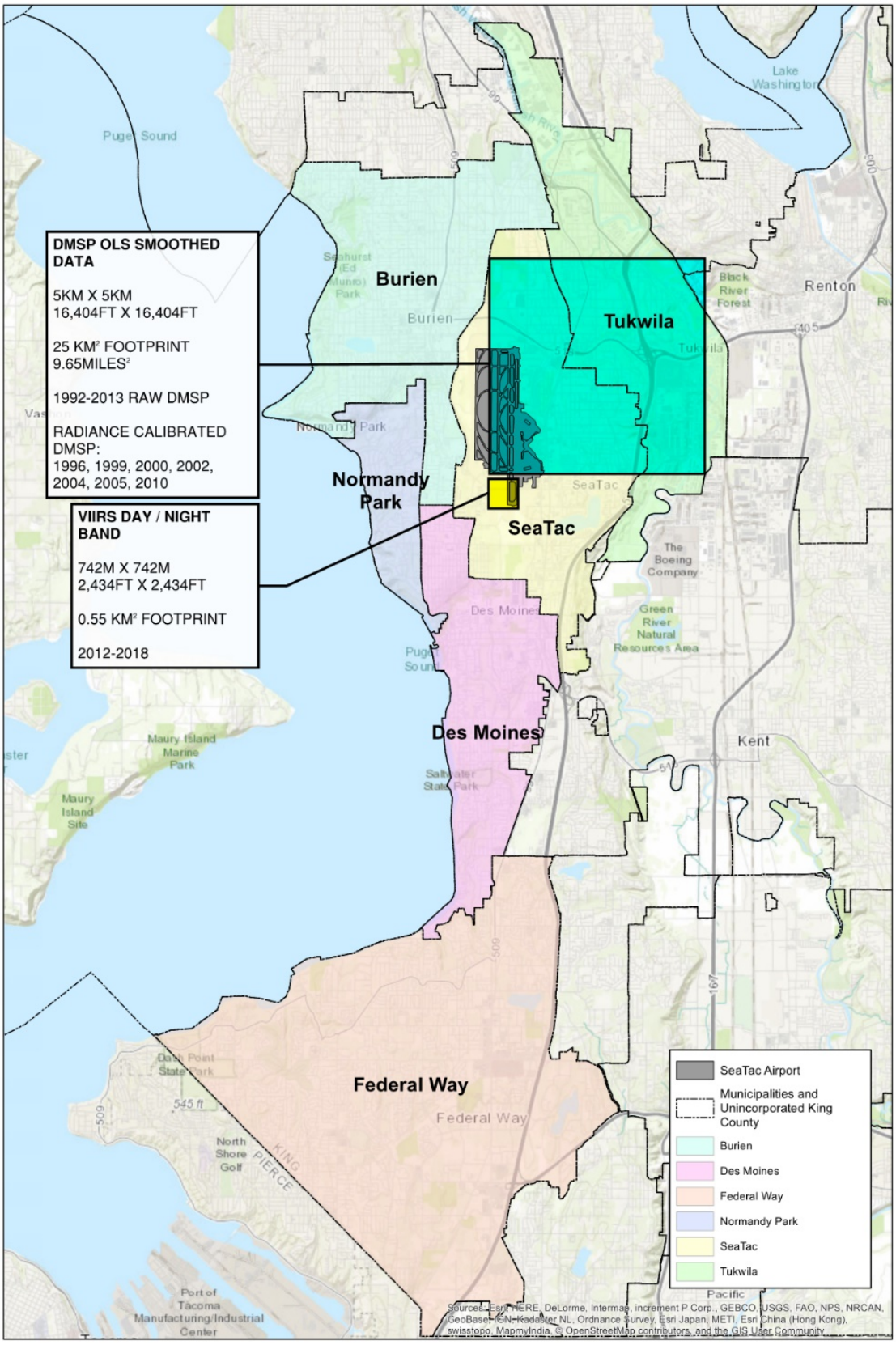
From 1992 to 2013, data comes from the Operational Linescan System of the Defense Meteorological Satellite Program (DMSP) satellites.

- Qualitative: Baseline annual data not calibrated;
- Radiometrically calibrated data produced for select years: 1999 and 2010 Reviewed; and,
- Low Resolution data provides information for region only.

From 2012 to the present, data comes from the Day/Night Band of the Visible Infrared Imaging Radiometer Suite instrument (VIIRS DNB):

- Quantitative: Calibrated Digital Measurements; and,
- Measured spectral range is greater than human vision, including infrared wavelengths.

Figure 10.1
DMSP and VIIRS Data-Point Resolution, shown on Airport and Study Area Maps



Variations in Data

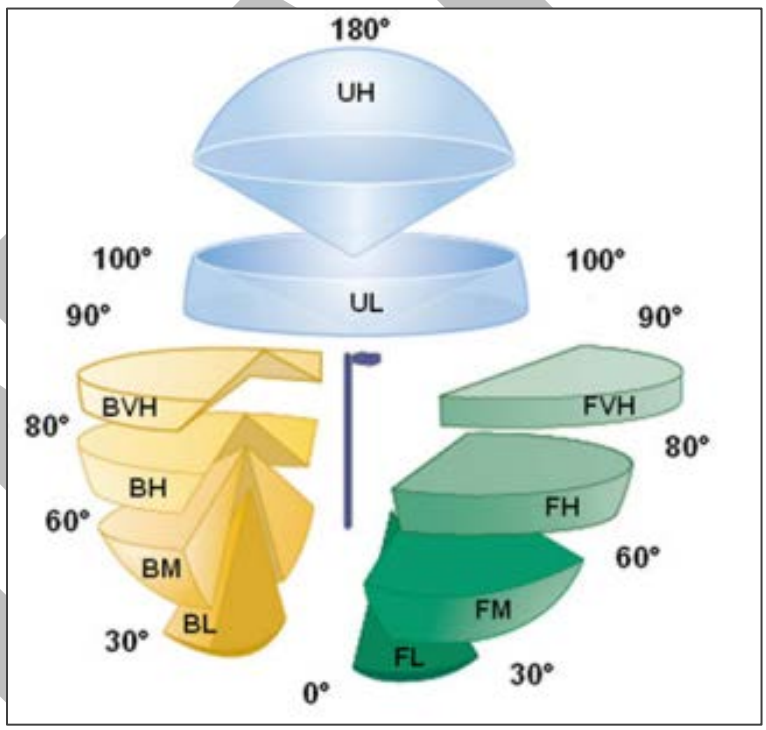
Variations in Nighttime Light Emissions may vary from 15% to 20% due to a variety of factors. These factors are:

- Imaging Angle;
- Time of Night;
- Seasonal Vegetation;
- Atmospheric Conditions – Aerosol;
- Changes in Sample Area for Composites;
- Changes Imaging Sensor;
- The Presence or Absence of Moonlight;
- Temporary Electric Lighting;
- Electrical Blackouts and Disasters; and,
- Actual Changes in Permanently Installed Lighting.

Sources of Light Emissions: Electric Light Sources

Light fixture classifications identify fixtures that may create more skyglow. Fixtures with higher values in the UH and UL categories are the most offensive, followed by those in the BVH, BH, FVH and FH regions. The other categories are primarily aimed down and only reflected light from them adds to skyglow.

Figure 10.2
Illustration of Light Fixture Classification System: Backlight, Uplight, Glare (BUG) Ratings

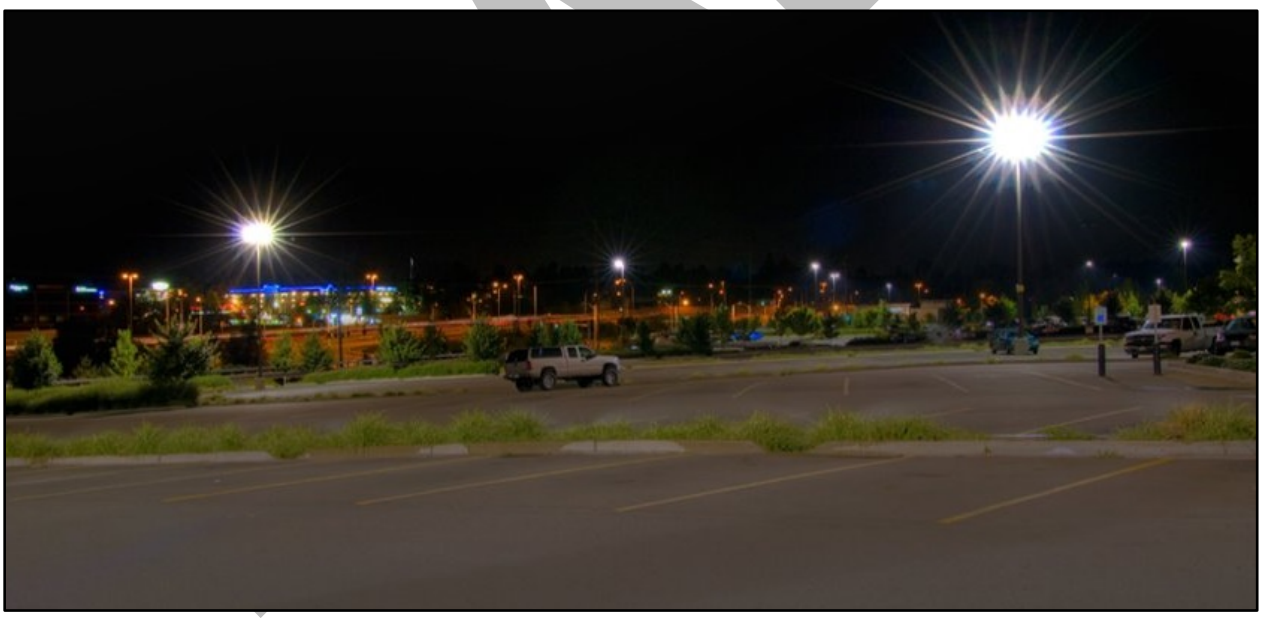


Sources of Light Emissions: Illuminated Surfaces

Lighting Controls can reduce light levels when spaces are not occupied. As seen in Figure 10.3, reflected light from illuminated surfaces enters the atmosphere as skyglow (evaluated in this Study as nighttime light emissions). Figure 10.4 shows the same parking lot as unoccupied, but with lighting controls to lower light level during unoccupied periods to reduce energy use and light pollution.

Figure 10.3
Illustration of Fully Occupied and Fully Illuminated Parking Lot at Northgate Mall
(photo by Stantec)

Figure 10.4
Illustration of Unoccupied and Fully Illuminated Parking Lot (Northgate Mall)
(photo by Stantec)



B. OVERVIEW OF CHANGES IN LIGHT EMISSIONS

Nighttime light emissions for the following geographic areas were:

- Seattle-Tacoma International Airport..... 1.30% Increase per year;
- Neighboring Communities ..... 0.51% Increase per year;
- Central Puget Sound Region ..... 0.31% Increase per year; and.
- City of Seattle..... -1.33% Decrease per year.

Figure 10.5
Areas of Review for Nighttime Light Emissions

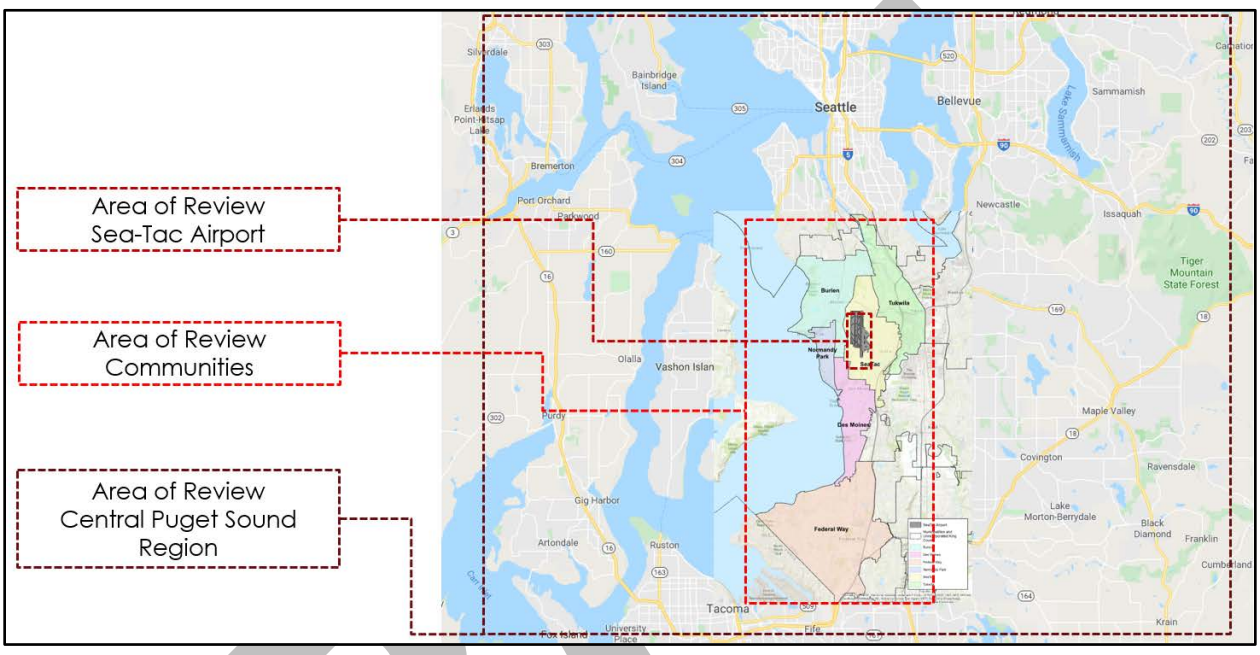


Figure 10.6
Review of Nighttime Light Emissions: 2012 - 2018

Location	Average nW/cm² sr 2012-2018	% Annual Change 2012-2018
Seattle-Tacoma International Airport	51 – 58	1.30% Increase
Neighboring Communities	18.5 – 19.5	0.51% Increase
Central Puget Sound Region	9.7 – 9.9	0.31% Increase
City of Seattle	29 – 27	-1.33% Decrease

Figure 10.7
Measured Nighttime Light Emissions at Seattle-Tacoma International Airport

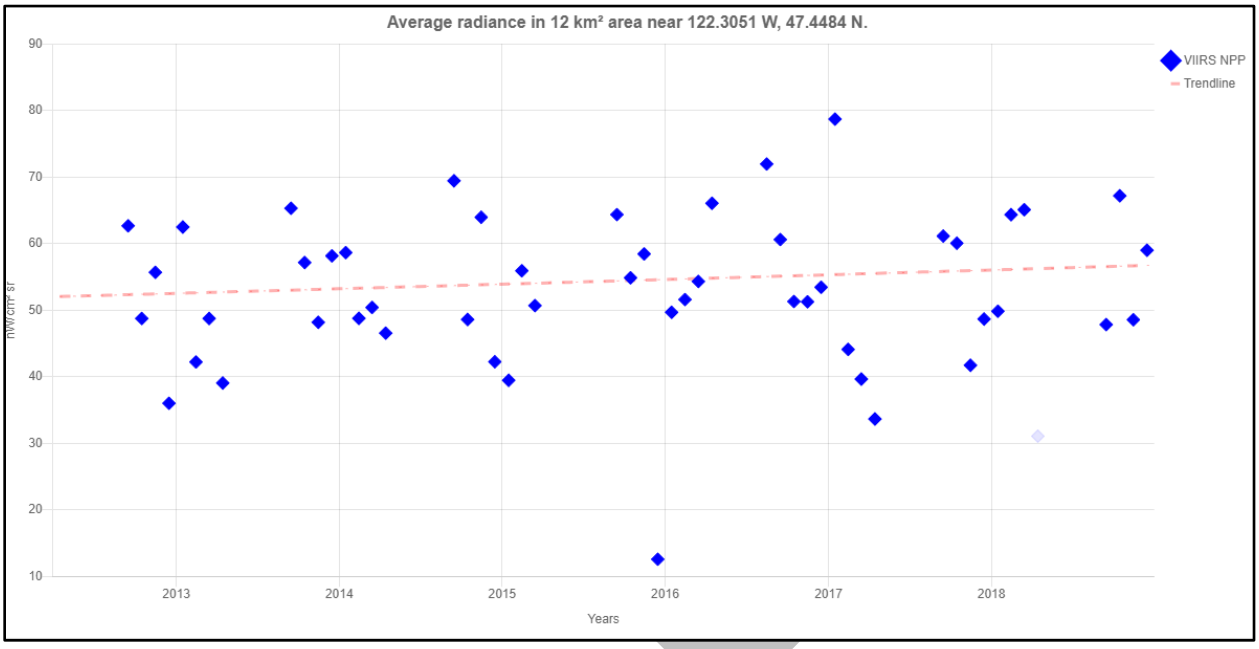


Figure 10.8
Measured Nighttime Light Emissions in Study Area Communities (0.51% Increase per Year)

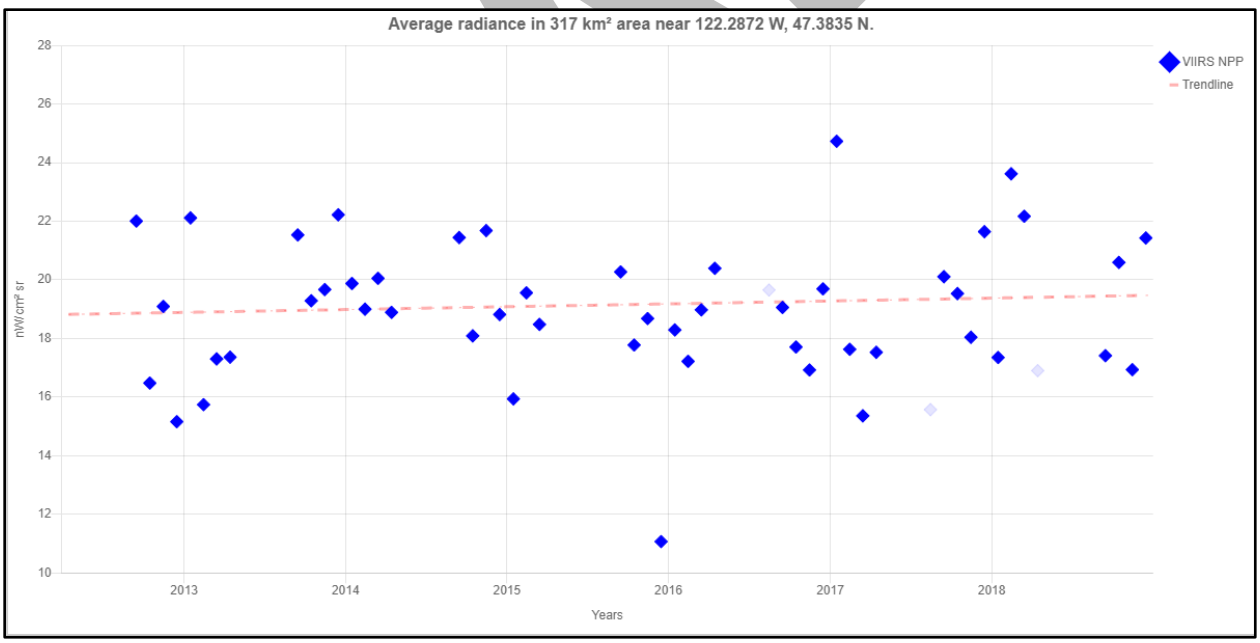


Figure 10.9
Nighttime Light Emissions in Central Puget Sound Region (0.31% Increase per Year)

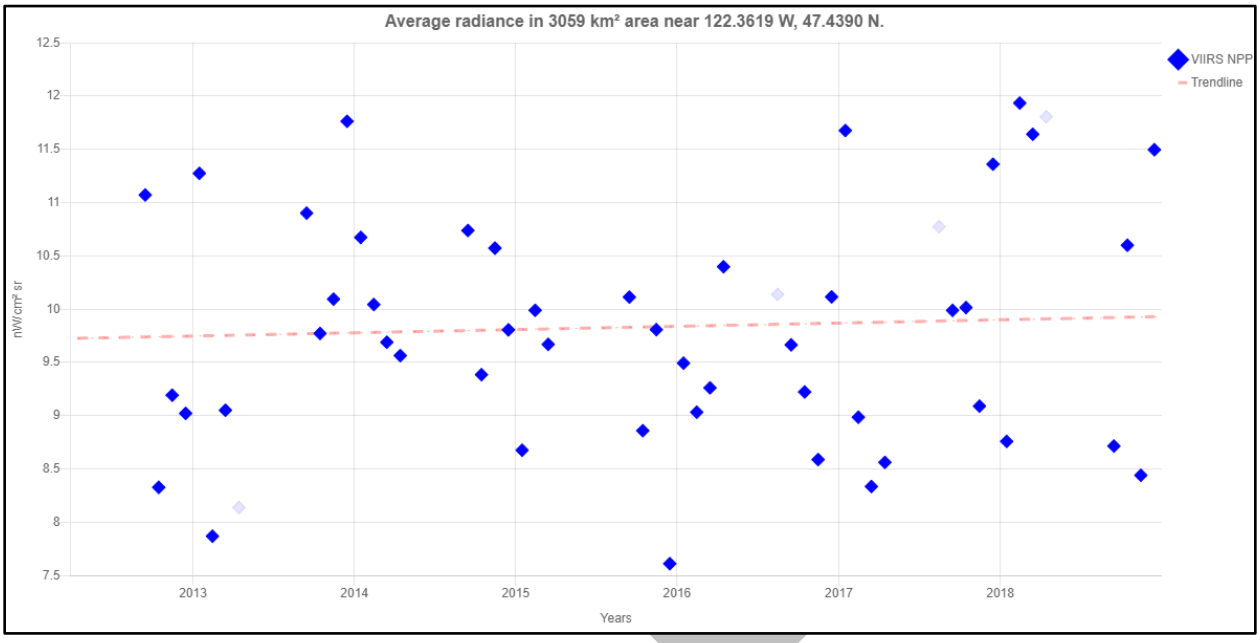
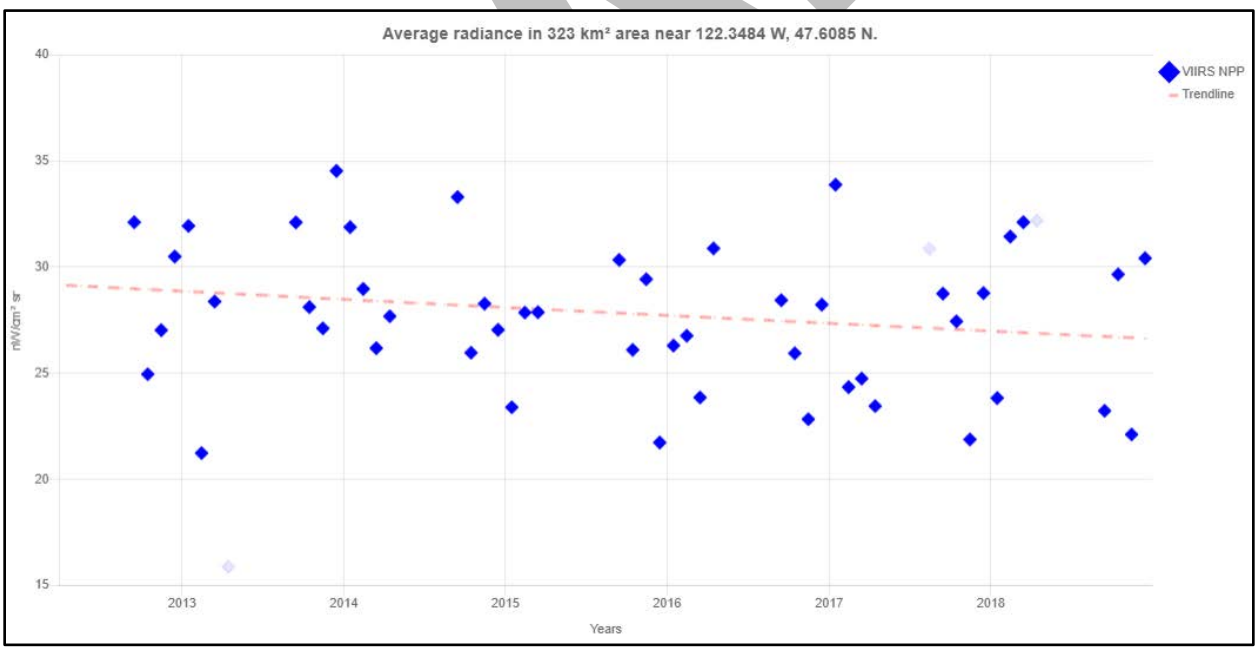


Figure 10.10
Nighttime Light Emissions in the City of Seattle (-1.33% Decrease per Year)



Nighttime Light Emissions

While the widespread adoption of LED street lighting between 2012 and 2018 decreased nighttime light emissions, when illumination levels and areas of development are held constant. However, increased development and the addition of new electric light installations will result in increased level of nighttime light emissions.

Field Observations

To identify the visibility of the Seattle-Tacoma International Airport from the surrounding communities, the Consultant Team conducted sixty (60) field observations from locations with direct visibility of the Seattle-Tacoma International Airport. Of all the lighting infratructure at the Seattle-Tacoma International Airport, two (2) locations created high luminance conditions within the adjacent residential communities.

- **Consolidated Rental Car Facility**
  Visibility of the Consolidated Rental Car Facility from adjacent residential locations is illustrated in Figure 10.11 through Figure 10.13. From these locations, consistent glare potential is present due the visibility of car headlights emanating from the interior of the Consolidated Rental Car Facility. Additionally, high brightness interior lighting and pole mounted exterior lighting present direct visibility of light sources.

- **High Mast Lighting Near North Loop Road and Cargo Facilities**
  The high mast area lighting located within the Seattle-Tacoma International Airport cargo area, adjacent to the North Loop Road presents uncontrolled visibility of light sources. These fixtures utilize high intensity light sources and are aimed nearly horizontally. As a result, no part of the housing conceals the light source from view and these fixtures present direct visibility of the light source to locations adjacent to the North Loop Road (see Figure 10.14 through Figure 10.17).

Figure 10.11
Description of Field Observations

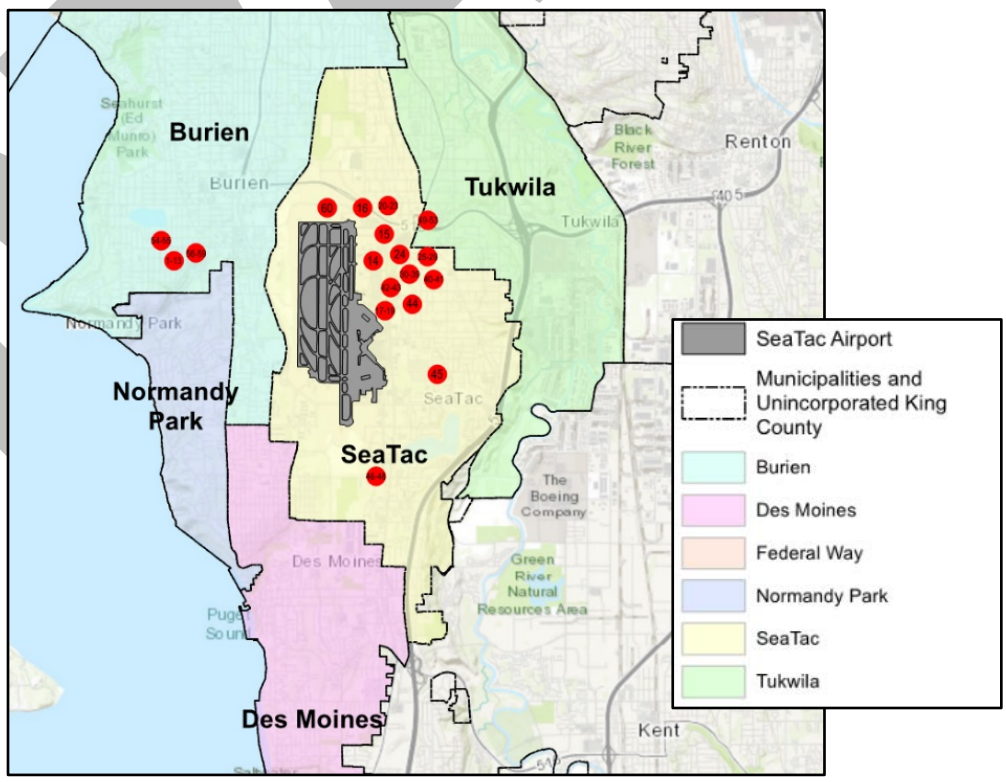


Figure 10.12
View to Consolidated Rental Car Facility (South 164th Street & 32nd Avenue South, Facing North)
(photo by Stantec)

Figure 10.13
View to Consolidated Rental Car Facility (South 164th Street & 32nd Avenue South, Facing North)
(photo by Stantec)

Figure 10.14
View to Consolidated Rental Car Facility (South 164th Street & 32nd Avenue South, Facing Northwest)
(photo by Stantec)

Figure 10.15
View from North Loop Road (Southwest 162nd Street & 9th Avenue Southwest, Facing East)
(photo by Stantec)

Figure 10.16
View from North Loop Road (Southwest 162nd Street & 9th Avenue Southwest, Facing East)
(photo by Stantec)

Figure 10.17
Airport Expressway (Facing East)
(photo by Stantec)

Figure 10.1*8*
Air Cargo Road (Facing West)
(photo by Stantec)

Terminal Apron Lighting

The Seattle-Tacoma International Airport terminal apron lighting is undergoing upgrades in which LED sources replace less efficient high intensity discharge light sources. Not only do these fixtures reduce energy use, they also conceal the visibility of the light source. This results in increased visual comfort for Airport users, as well as the surrounding communities. To further reduce skyglow, controls could be implemented to lower or turn off these sources when gates are not in use because they are instant "on" sources and do not require a warm-up time the way the current sources do.

Figure 10.19 shows the typical apron lighting fixture found at Seattle-Tacoma International Airport.

Figure 10.20 shows the difference between metal halide light sources with limited control of uplight and glare potential (left side) and usage of LED sources which minimize uplight and glare potential (right side). Figure 10.19 shows the difference at Vancouver International Airport.

Figure 10.19
Typical Apron Light Fixture (Illustrative Purposes Only)

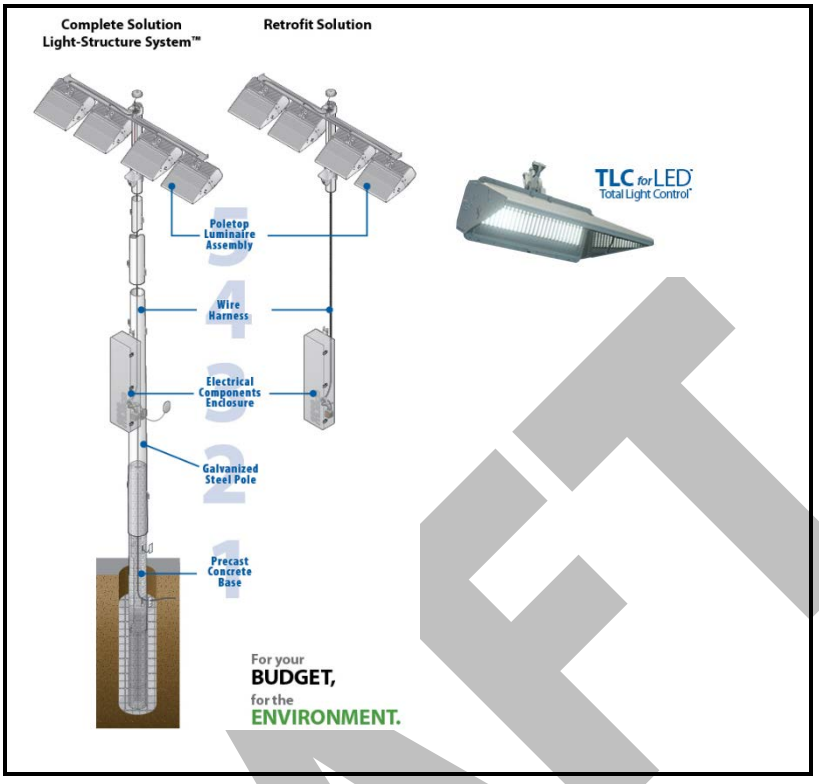
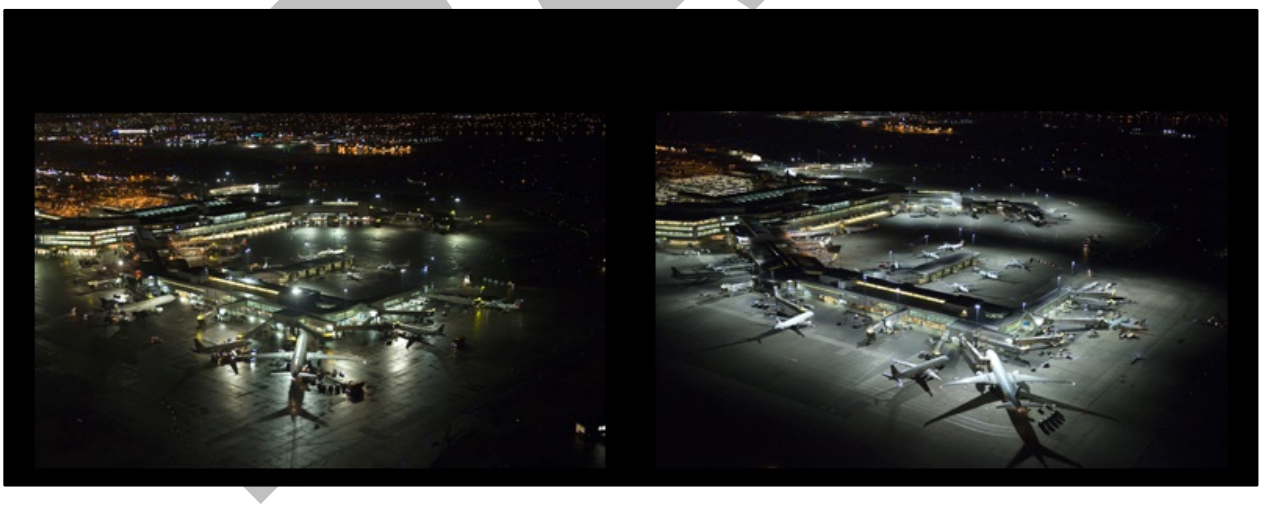


Figure 10.19
Metal Halide versus LED Light Sources at Vancouver International Airport (Illustrative Purposes Only)



C. IMPACTS

Positive Impacts

Seattle-Tacoma International Airport is replacing the older-generation of lighting (metal halide) with energy efficient LED fixtures. LED is much more controllable than older-style lights, which often create glare and skyglow. LED lights use less energy, have a higher degree of controllability, and can reduce or eliminate glare and night-sky disruption in surrounding neighborhoods.

As mentioned previously, the new LED fixture could also include controls to lower or turn off these sources when gates are not in use (since they do not require a warm-up period to reach the required level of brightness.

Neutral Impacts

There are no known neutral impacts from the lighting in and around Seattle-Tacoma International Airport. This was also not an issue that mentioned by Study Area citizens as a significant concern, both in the past (to 1997) and currently.

Negative Impacts

Glare and increased skyglow are concerns with standard metal halide lighting, but Seattle-Tacoma International Airport is taking steps to replace these aging fixtures. Replacement with new LED fixtures also saves energy.

As noted above, Airport lighting was not an issue mentioned by Study Area citizens as a significant concern, both in the past (to 1997) and currently.

D. FINDINGS AND RECOMMENDATIONS

In reviewing the available data relating to lighting in the Study Area, the Consultant Team offers the following findings:

- Seattle-Tacoma International Tac Airport shows the highest evaluated average nighttime light emission (ranging from 51 to 58 nW/cm^2 sr) and the greatest average annual increases of 1.30%;
- The neighboring communities had a significantly lower average nighttime light emission (ranging from 18.5 to 19.5 nW/cm^2 sr) and lower rate of annual increase of 0.51%;
- The Central Puget Sound Region showed lower average nighttime light emissions (ranging from 9.7 to 9.9 nW/cm^2 sr) and lower annual increase 0.31%;
- The City of Seattle showed greater average nighttime light emissions, than the neighboring communities (ranging from 29 – 27 nW/cm^2 sr); however, in the City of Seattle from 2012 to 2018, nighttime light emissions did not increase – they actually decreased by -1.33% annually; and, ;
- Lighting was not a primary concern raised by citizens in the Study Area at either of the Public Workshops or through the series of stakeholder interviews.

Based on this analysis, the Consultant Team offers the following recommendations:

- **Lighting Recommendation #1: Update Airport High Mast Lighting**
  To reduce glare potential, Seattle-Tacoma International Airport should replace the high mast flood lighting with LED sources similar to those used around the terminal aprons, at locations in the Cargo Area and adjacent to North Loop Road. This may be phased in over a period of time – no longer than 5 years is suggested.

- **Lighting Recommendation #2: Adoption of Study Area Lighting Standards**
  Seattle-Tacoma International Airport and the Study Area Cities should consider implementing coordinated Lighting Guidelines for development of community friendly infrastructure. The lighting installations for off-site parking, transit, and the Consolidated Rental Car Facility are currently not aligned with industry standards for similar developments within neighborhoods or residential communities. To better support the communities that are directly adjacent to such infrastructure, the Study Area Cities (notably the City of SeaTac) should consider the adoption of Community Lighting Standards which would establish guidelines for future developments and renovations of existing facilities.

E. THE FUTURE

It is conceivable that lighting technology will continue to evolve and offer more energy efficient technologies. These have the benefit of saving energy, saving money, and generating less heat than previous lighting standards. Lighting improvements may also extend to mobile sources (cars, trucks, aircraft) which will give operators a better degree of control and energy savings. "Smarter" lighting will also be able to detect appropriate movement to illuminate when needed or on an intricate complex schedule.

Improved lighting will also enhance areas like US Highway 99, which experiences the highest degree of pedestrian activity immediately adjacent to Seattle-Tacoma International Airport. Conversely, sensitive areas (residential neighborhoods, wildlife habitats, the Puget Sound coastline, etc.) will be better served by the current and future generations of lighting technology.

F. SUMMARY

This Section has identified some areas in need of improvement, but generally Airport-area lighting has not been a primary issue with area residents. Seattle-Tacoma International Airport is taking steps to replace older-style lighting which has benefits to both the Port of Seattle (energy efficiency) and the Study Area (reduced glare and skyglow).

This Study projects that there would be a benefit throughout the Study Area for the Port of Seattle and the Study Area Cities to collaborate on a standardize set of lighting guidelines to help guide future growth.

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SECTION 11

PUBLIC SAFETY

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SECTION 11

PUBLIC SAFETY

A. PROLOGUE TO SECTIONS 11, 12 & 13

Sections 11, 12 and 13 address conditions associated with quality of life in the Study Area Cities, and how they may have changed over the past two decades.

The term "quality of life" is a qualitative and often subjective metric. It can encompass a wide variety of quantitative and subjective indices – from financial security, job satisfaction, family life, to health and safety and overall personal happiness. And it's meaning and components and vary from person to person.

The Federal Aviation Administration offers guidance regarding the study of quality of life conditions associated with their operations, including:

- Effects on health and safety risks to children;
- Socio-economic impacts such as moving homes or businesses;
- Dividing or disrupting established communities;
- Changing surface transportation patterns;
- Disrupting orderly, planned development; and,
- Creating a notable change in employment.

Whereas its objective is to identify and analyze potential impacts and to ensure that the needs and conditions of people affected by certain actions are fully taken into account and that suitable mitigation measures are identified as needed. The approach deemed most applicable for studying these impacts was modeled after the Environmental and Social Management System (ESMS) methodology.

In the context of this analysis, based in part on the availability of information, Figure 11.1 details the categories of quality of life conditions and indicators investigated in the 2020 Study.

Figure 11.1
Quality of Life Conditions and Indicators

Public Safety (Section 11)	Public Health (Section 12)	Other Socio-Economic Metrics (Section 13)
▪ Violent Crimes ▪ Property Crimes ▪ Motor Vehicular Theft ▪ Human Trafficking ▪ Illegal Drug Trafficking	▪ Leading Causes of Death ▪ Injury and Violence-Related Mortality ▪ Health Risk Factors and Chronic Disease ▪ Life Expectancy (at Birth) ▪ Maternal and Child Health ▪ Access to Care and Preventative Services	▪ Demographics ▪ Education ▪ Housing ▪ Economic and Land Use Development ▪ City Tax Revenue Trends

Analysis Approach

The objective of the 2020 Study was to identify and quantify impacts associated with airport operations across several different social and economic data points between 1997 and 2019. Particular attention was paid to conditions during three specific time periods – 1997, 2009, 2019, and trends which may have emerged between them. This was accomplished through completion of the following steps:

1. Review of the 1997 Seattle-Tacoma International Airport Impact Mitigation Study (the 1997 Study);
2. Investigation of verifiable sources and identification of any relationships or variations between the Study Area Cities and larger geographies including King County, Seattle Metropolitan Statistical Area (MSA), State of Washington, and United States;
3. Identification of "vulnerabilities" within population groups and markets, which may or may not be exacerbated or enhanced by the presence of the Seattle-Tacoma International Airport and its operations;
4. Correlation of findings from this work with similar analyses of related indicators including environmental, air quality, transportation, and others; and,
5. Preparation of possible strategies or recommendations for more effectively monitoring conditions and mitigating adverse impacts

1997 Study Findings

As noted previously, the 1997 Study was undertaken to identify potential impacts resulting from construction of the then-proposed Third Runway; and the source of information was the Final Environmental Impact Statement for the Proposed Master Plan Update, dated February 1996. However, the 2020 Study was for the purpose of identifying current and ongoing conditions surrounding the Seattle-Tacoma International Airport and establishing a baseline of impacts for the six communities. The four key findings of 1997 Study were as follows.

1. **Proximity to the Airport has (varying levels of) value**
   The 1997 Study concluded, "There is an inequity regarding the benefit of the Airport to its immediate neighbors." It found that while Seattle-Tacoma International Airport had a benefit to the region and State, those benefits were not experienced locally in the 1997 Study Area. This finding was largely based on the assumption that, "approximately 5% of the persons utilizing the Airport (at that time) lived in the area most impacted, while the remaining 95% of Airport passengers and employees came from elsewhere in the region." Adverse impacts affecting the 5% in closest proximity of Seattle-Tacoma International Airport (which were projected to worsen) included: higher service costs; lower land values and correspondingly lower property tax revenue; higher concentrations of rental properties; and lower income. The causes of these circumstances were largely attributed to noise, visual blight, pollution and traffic congestion, which ultimately influenced land use patterns and product development that attracted and supported a lower socio-economic profile. This is more fully explained in the context of the second finding below.

2. **Social service demands will increase**
   With regard to elevated levels of service costs, specifically within the Study Area, the 1997 Study forecast the following eventuality after expansion of the Airport facilities: "In general, communities closer to the Airport will experience a relative 'depression' of residential property values, which will result from a cascading effect on the area's population mix." The 1997 Study postulated that single-family homes (that were for sale) would remain on the market for a protracted period, and eventually be converted to rental properties. These rental properties would have a lower average household income and utilize more social services than other areas, further decreasing property values and tax revenues will increasing the demand for social services.

3. **Direct and indirect impacts will be adverse and favorable**
   The 1997 Study also outlining secondary and tertiary impacts, also known as indirect and induced impacts. (Induced impacts are jobs, income and business activity generated by multiplier effects from inter-industry linkages to direct and indirect impact companies.) The 1997 Study projected that depressed residential property values in the Cities immediately proximate to Seattle-Tacoma International Airport, and most affected by approach and departure flight tracks, would see single-family

land uses change to rental, increasing to a more transient population. This could also lead to corresponding commercial business development response to a new consumer market (transient), resistance by the rental community to support municipal and school bond issuances; and fiscal imbalances resulting from increases in service costs, reductions in property tax revenues, and less consumer spending. The 1997 Study also identified specific impacts including the necessity to relocate eight schools in Burien, Des Moines and Unincorporated King County because of environmental impacts, noise, and vibration; and, install sound abatement insulation and establish navigation easements, in twenty-six other schools in the Highline School District. Impacts identified in the 1997 Study as beneficial to the subject cities included: economic activity associated with construction jobs resulting from Airport expansion projects; time savings for travelers because of additional air facilities; off-airport economic activity associated with and supporting air travel and its expansion activities; and other multiplier impacts reflected in increases in employment, income and spending associated with expansion activities.

4. **Forecasted growth will exceed the Airport's capacity limits**

   The 1997 Study noted that the growth of Seattle-Tacoma International Airport could exceed its capacity, resulting in increased airport delays. The then-proposed third runway would increase the Airport's capacity to handle arrivals (since it was, at that time, proposed only for use for arrival aircraft during inclement weather). The 1997 Study, however, did not predict was the full-time use of the then-proposed third runway, further increasing the Airport's capacity. The Federal Aviation Administration recommended an Annual Service Volume (ASV) of 380,000 operations by the Year 2000 with the third runway. Even though opening of the third runway was delayed until 2009, the Year 2000 operations at Seattle-Tacoma International Airport were 445,621 – almost 20% more operations with just two runways. In 2009, annual operations with the new runway dipped to 317,873 – due to the decreased use of air taxis and impact of the Great Recession. By 2019, Airport annual operations recovered to 412,916 – still above the projection by the Federal Aviation Administration. In 2019, Seattle-Tacoma International Airport was the eighth busiest US airport.

While the 2020 Study agrees that most, if not all, of the circumstances cited above (favorable and adverse) have, and continue to affect the Study Area Cities to varying degrees, there is a divergence with regard to certain assumptions, as well as the cause of certain impacts.

For example, the 1997 Study assumed that, "approximately 5% of the persons utilizing the Airport (at that time) lived in the area most impacted, while the remaining 95% of Airport passengers and employees came from elsewhere in the region." Since then, a report prepared by corporate relocation siting professionals noted the value of proximity being within 30 miles of an airport, but not directly adjacent to the airport, was most acceptable and advantageous.

There are also some individuals and businesses that associate some level of value, regardless of adverse impacts, with locating in one of the second or third ring communities from the Airport. An analysis of drive-times and distance between the Study Area Cities found that Federal Way is located approximately 20 miles to the south, while the furthest-most boundary of Tukwila is located nearly the same distance to the north. Residents and employees from these two communities experience both the convenience of and impacts from proximity to Seattle-Tacoma International Airport.

In terms of whether individuals that reside within the Study Area Cities rely on a disproportionate share of public services, the results of analyses presented herein are consistent with this conclusion. However, the 2020 Study attributes this to a variety of factors including:

- Concentrations of certain ethnic groups with a higher propensity to suffer from certain illnesses;
- Lower income levels, and
- Environmental conditions.

The 1997 Study implied a nexus between apartment dwellers and high social service usage. However, the 1997 Study could not predict the widespread and national impact of the Great Recession, widely considered to be the period between mid-2008 and 2012. This impacted an increasing number of individuals, in every major market of the United States, including Seattle. Since the Great Recession, an increasing percentage of homeowners began to demonstrate a preference for renting rather than owning, regardless of income. While renting was once a necessity, it has become a choice driving by demographic shifts including:

- Smaller household sizes due to an aging populace ("empty-nesters") who also seek reduced maintenance requirements;
- Millennials waiting longer to marry and have children;
- Younger employees who favor an abbreviated tenure with any one company;
- A heightened value on leisure time; and,
- Decreased trust in the stability of the mortgage market.

These realities have translated into a surge in development of attached residential product types, both ownership and rental, at a range of price points. Therefore, while the 2020 Study agrees that the majority of individuals most in need of social services rent rather than own their home, housing tenure alone, without regard for income and ethnicity, does not have a direct correlation with service levels. The 2020 Study finds that most, if not all apartment dwellers are:

- Not necessarily highly transitory;
- Do not uniformly have a lower socio-economic profile; and,
- Do not exhibit limited support for school bond issuances.

It is also no longer true that rental properties produce less revenue for municipalities. Trends in the profile of renters of multi-family projects have also been observed among those who rent single-family homes. A growing number of Real Estate Investment Trusts (REITs) have begun to assemble portfolios of single-family homes for professionals with substantial incomes, who prefer renting to owning. In short, the consumer expectations and profiles of renters in 2020 is not the same as it was in 1997.

A significant conclusion in the 1997 Study that is consistent with deductions presented herein, relates to social and economic impacts resulting from Airport facilities reaching certain thresholds or capacity levels. Where they differ, however, is the timeframe within which these thresholds were exceeded. While the 1997 Study had to rely on forecasted data, this 2020 Study was able to analyze data based on tangible occurrences. As stated above, the Airport was expected to reach capacity by 2000 based on anticipated enplanements, and potential operational and cargo activity. This expectation was based on figures presented in the Master Plan Update (Volume 5) that predicted enplanements between 1997 and 2008, without construction of the Third Runway, would reach 7,466,415 for an average of 622,200 additional passengers each year; and enplanements between 2009 and 2018, with construction of the Third Runway, would reach 18,622,008, for an average of 1,862,200 additional passengers each year. Using information made available from the Port of Seattle, actual growth between 1997 and 2018 totaled 25,119,407 passengers, or about 1,141,791 additional passengers each year. While the original forecast projected a 68% overall increase in passengers, the actual increase was closer to 101%.

This finding is significant for a variety of reasons, not the least of which is how impacts may be exceeding levels originally anticipated in the 1997 Study. Although the EIS that was the source of the 1997 Study assumed there would be "no socio-economic impacts resulting from construction of the Third Runway since the same level of passenger enplanements, aircraft operations and cargo movements would occur whether or not facilities at the Airport were expanded", the Study itself concluded that "a consequence of reaching or exceeding its capacity threshold would be additional stresses on socio-economic conditions to a degree they would require mitigation." Since those levels have been exceeded, it is reasonable to conclude that those socio-economic stresses are now being realized.

The 1997 Study did not address the disproportionately higher cost of development, primarily in those Cities located closest to Seattle-Tacoma International Airport. While the 1997 Study addressed the need for alternative and enhanced building materials to provide adequate insulation and protections from noise and vibration from air traffic, it did so primarily with regards to school facilities and residential structures. The 2020 Study arrived at a similar conclusion regarding commercial buildings. Markets that are disproportionately more expensive to develop in, whether due to onerous regulations, elevated land prices, or higher construction costs, if not able to command comparatively higher rental rates or purchase prices, are at an economic disadvantage. When these disparities exist, many communities feel compelled to offer monetary incentives, which, while necessary, effectively diminish the magnitude of return to the municipality.

B. PUBLIC SAFETY INDICATORS

Public safety refers to the welfare and protection of the general public, usually expressed as a governmental responsibility. It is as much a person's sense of safety as it is a community's relationship with police and the justice systems. To this end, it includes how people treat one another; as well as which policies, social conditions, and systems may make some neighborhoods safer than others. At its core, public safety is a measure of community vitality, economy and health outcomes.

The focus of this Section is to present information related to select indicators of public safety in the Study Area Cities and comparative geographies, between 1997 and 2019; as well as isolate possible impacts from Airport operations that may have contributed to adverse circumstances.

Public Safety Indicators

The scope of work for this study identified statistics related to the following indicators as appropriate measures of public safety in the Study Area Cities:

- Violent crimes
- Property crimes
- Motor vehicle theft
- Human trafficking
- Illegal drug trafficking

The discussion that follows includes a description and analyses of: each of the above indicators; positive, neutral and negative public safety impacts; comments received from individuals and representatives involved in the study process, along with clarifying responses; and recommendations for ongoing investigation, as well as possible strategies to mitigate adverse influences.

C. TRENDLINE ANALYSES

The CAP Index (provided by the firm that provides crime forecasts for USA Today) is a measure of the likelihood of becoming a crime victim. A score of 100 is the average crime risk for the entire country. The CAP Index notes that risk of becoming a crime victim is four times greater in areas outside most big city airports than the national average for all locations. The most common crimes in neighborhoods outside of airports and central train stations are thefts, assaults, and robberies, while travelers are relatively secure inside the airport boundaries. While airports and train stations may feel safe because of a greater presence of police and security people, this can lead to a false sense of security outside them.

Lewis Yablonsky, emeritus professor of criminology at California State University-Northridge has written that "Neighborhoods closest to the airport are often poor and possess a higher likelihood of crime." As an example, Professor Yablonsky cites a CAP Index Study that found the area outside Philadelphia International Airport which has the greatest crime risk of any area outside an airport in the 25 most populous metropolitan regions. However, the same study ranked Seattle-Tacoma International Airport 20th out of 29 with a CAP index score of 301, and rail stations outside and serving the airport 7th out of 26, with a score of 680. The CAP score is based on an analysis of data for violent, personal and vehicular crime in the Study Area Cities and King County.

Violent Crime

Violent crime includes all types of personal crime (rape, sexual assault, robbery, assault and murder) where a victim is harmed by or threatened with violence. Figure 11.2 details the violent crime events in the Study Area Cities from 1997 through 2018 ("violent crime" including all types of personal crime). The trend has been fairly erratic in terms of increases and decreases, yet consistent in that Tukwila has continually reported the highest number of violent crimes, while Federal Way and Normandy Park have reported the fewest.

Figure 11.2

Study Area Violent Crime Rate per 100,000 Population: 1997-2018
(**bold** and yellow highlighted cell equals peak occurrence per city)

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila
1997	551	**709**	423	168	660	1,032
1998	667	810	**532**	112	**806**	1,024
1999	871	401	451	100	589	950
2000	643	328	402	71	604	751
2001	726	326	377	172	602	836
2002	573	262	310	63	469	854
2003	617	368	358	47	463	**1,154**
2004	543	391	339	63	506	1,013
2005	511	397	382	47	510	1,144
2006	573	332	392	16	545	1,031
2007	615	405	342	62	616	936
2008	603	400	381	47	622	1,044
2009	534	394	438	31	518	966
2010	687	280	364	46	439	806
2011	659	299	270	47	457	979
2012	**778**	304	322	778	560	1,016
2013	355	319	316	355	617	830
2014	511	388	386	**511**	637	818
2015	408	439	416	75	622	803
2016	498	451	485	45	543	870
2017	420	447	455	105	471	834
2018	426	511	502	165	453	803

Source: FBI: Uniform Crime Reporting (UCR) Program, Washington Association of Sheriffs and Police Chiefs, and Ricker I Cunningham.

In terms of how incidents of violent crime in the Study Area Cities compared to other geographies in 1997, occurrences in all but Normandy Park (168) were higher than the number for King County (213). Similarly, compared to figures for the State of Washington during this same year, incidents in all but Normandy Park (168) and Federal Way (423) were higher than the number for the State (440).

This trend continued in 2009 when violent crime activity in the Study Area Cities with the exception of Normandy Park (31), exceeded that of the County (379) and State (329).

In 2018, the last year for which this type of information was available, the number of violent crimes in the Study Area Cities continued to exceed figures for King County (429), with the exception of Burien (426) and Normandy Park (165), and State (350) and Nation (2017 – 390). During this time, Washington ranked in about the 4th percentile nationwide.

The Pew Research Center also notes the following about crime in the US:

- Violent crime in the US has fallen sharply over the past quarter century. The FBI has reported the violent crime fell 51% between 1993 and 2018;
- Property crime has declined significantly over the long term, decreasing by 54% between 1993 and 2018;
- Public perceptions about crime in the US often do not align with the data. Opinion surveys regularly find that Americans believe crime is up nationally, even when the data shows it is down;
- There are large geographic variations in crime rates. FBI data shows significant differences from state to state and city to city. For example, in 2018, there were more than 800 violent crimes per 100,000 residents in Alaska and New Mexico. Maine, New Hampshire and Vermont had rates below 200 violent crimes per 100,000 residents. And while Chicago has drawn widespread attention for its murder totals in recent years, its murder rate in 2018 was less than half of the rates in St. Louis and Baltimore. The FBI notes that various factors might influence a particular area's crime rate, including its population density and economic conditions; and,
- Most crimes are not reported to police, and most reported crimes are not solved. The Bureau of Justice Statistics found that in 2018, only 43% of violent crimes were reported to police. And in the much more common category of property crime, only about a third (34%) were reported. There are a variety of reasons crime might not be reported, including a feeling that police 'would not or could not do anything to help" or that the crime is "a personal issue or too trivial to report."

The Pew Research Center's finding of under-reported crimes is significant. While local, County and State authorities do a good job of reporting statistics, these number may, in fact, be under-counting the actual incident by a factor of 2 to 3.

Property Crimes

Property crimes (residential and commercial, burglary and vandalism) include many common crimes relating to theft or destruction of someone else's property. They can range from lower level offenses (shoplifting or vandalism) to higher-level felonies (armed robbery and arson).

Most property crimes include a spectrum of degrees depending on factors including the amount stolen and use of force or arms in theft-related cases, and actual or potential bodily injury ion property destruction crimes such as arson.

The 1997 Study reported that "Tukwila, because of increases in surface traffic on Pacific Highway South (SH 99), generated a business environment that gave rise to anti-social and criminal behavior and (therefore) required an expansion of Tukwila's public safety personnel and facilities." The 1997 Study also predicted an increase in public safety requirements for all five of the impacted cities, with the greatest needs experienced in Burien, Des Moines and Tukwila.

Based on an analysis of property crime data between 1997 and 2018, published by the FBI and State of Washington Association of Sheriffs and Police Chiefs and presented in Figure 11.2, incidents of property crimes have actually remained relatively steady. This was particularly true in Burien where property crimes continued to increase during the Great Recession (mid-2018 through 2012) and peaked in 2012; and Des Moines where property crimes started falling in 2000 and did not begin to rise again until 2016.

Similar to violent crimes, rates of property crimes in Tukwila have consistently exceeded that of the other Study Area Cities, followed by Burien, Federal Way and SeaTac that have continued to fluctuate between second and fourth place. Unlike violent crimes, Tukwila has maintained a significantly higher rate than its next closest community.

Figure 11.3 details all types of property crime (residential and commercial, burglary and vandalism) in the Study Area from 1997 to 2018.

Figure 11.3
Study Area Property Crime Rate per 100,000 Population: 1997-2018
(**bold** and yellow highlighted cell equals peak occurrence per city)

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila
1997	7,055	**7,033**	6,910	2,570	7,759	20,584
1998	**8,127**	6,352	6,872	2,747	8,135	20,431
1999	8,008	4,862	5,960	2,161	7,598	21,209
2000	7,770	3,342	5,350	2,431	6,389	17,106
2001	6,530	3,437	6,169	2,217	6,362	15,995
2002	6,659	3,156	6,101	2,095	5,626	14,765
2003	6,056	3,476	6,048	1,655	6,135	16,955
2004	6,365	4,356	6,210	2,734	6,840	18,978
2005	6,507	4,799	**7,469**	2,631	**8,653**	**21,264**
2006	6,074	4,139	6,131	2,042	7,965	18,608
2007	5,510	3,072	5,757	2,067	6,892	17,003
2008	4,713	3,723	5,366	2,584	5,877	16,366
2009	4,913	3,192	5,382	2,143	5,621	19,123
2010	6,325	3,299	5,274	2,783	4,894	15,319
2011	6,954	3,477	4,689	3,325	5,401	14,861
2012	7,461	3,947	5,551	**7,461**	6,329	16,064
2013	5,243	3,833	5,594	5,243	5,628	16,752
2014	4,723	3,732	5,968	4,723	5,348	16,575
2015	5,034	3,880	5,658	2,659	5,193	17,741
2016	5,200	5,044	6,430	2,896	5,778	16,402
2017	4,140	4,420	5,567	2,881	5,213	13,571
2018	3,684	4,104	4,712	2,853	5,208	17,561

Source: FBI: Uniform Crime Reporting (UCR) Program, Washington Association of Sheriffs and Police Chiefs, and Ricker I Cunningham.

In terms of how incidents of property crime in the Study Area Cities compared to other geographies in 1997, occurrences in all of the Study Area Cities were higher than the number for King County (4,288) and the State of Washington (5,499).

This trend was altered in 2009 when property crime activity in all of the Study Area Cities was lower than that in the County (7,061). Property crime in the Cities compared to the State was slightly different where all but, Des Moines and Normandy Park, were higher than and State (3,670).

In 2018, the last year for which this type of information was available, the number of property crimes in the Study Area Cities continued the trend reflected in 2009 when figures for King County (6,372) exceed rates that of the Cities. City figures compared to State figures (4,450) in this year were higher in only three cities, Federal Way (4,712), SeaTac (5,208) and Tukwila (17,561).

As with violent crime, the actual incidents of property crime may be going under-reported, but there are no reliable figures to estimate more realistic figures.

Vehicular Crimes

Vehicular crimes (theft and vandalism) include:

- Driving without a license (including with a suspended or revoked license);
- Leaving the scene of an accident;
- Reckless driving; and,
- Engaging in a speed contest with another driver.

The Consultant Team had heard from the public that, on average, one vehicle per day is stolen from the garage at the Consolidated Rental Car Facility. However, motor vehicle thefts in Tukwila have historically exceeded those in the City of SeaTac, which many attribute to the Southcenter Mall in Tukwila which is widely considered a magnet for vehicular theft and other crimes of opportunity.

As presented in Figure 11.4, while motor vehicle theft and vandalism activity seemed to stabilize during the Great Recession, it generally increased in the following years, with the largest increases realized in Normandy Park, Burien and SeaTac. As with violent and property crime rates, the rate of motor vehicle thefts has consistently been the highest in Tukwila, with the next highest rates in either the City of SeaTac or Burien, depending on the year. Again, Normandy Park, nearly consistently maintained the lowest rate among the Study Area Cities, except during the period 2011 and 2014 when rates their spiked.

Figure 11.4
Study Area Vehicular Crime Rate per 100,000 Population: 1997-2018
(**bold** and yellow highlighted cell equals peak occurrence per city)

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila
1997	1,265	1,165	967	225	1,711	2,777
1998	1,581	1,269	1,089	294	2,037	2,785
1999	1,514	1,056	1,076	313	2,012	3,066
2000	1,427	882	1,020	384	1,671	2,858
2001	1,704	794	1,395	531	1,977	2,698
2002	1,654	936	1,407	328	1,646	2,742
2003	1,413	992	1,450	268	1,781	3,121
2004	1,274	1,321	1,352	375	1,814	3,686
2005	**1,939**	**1,430**	**1,908**	266	**2,699**	**4,738**
2006	1,622	1,265	1,419	249	2,211	3,650
2007	1,263	785	1,118	280	2,002	3,707
2008	807	720	963	78	1,173	2,373
2009	726	562	666	62	1,043	2,084
2010	1,126	580	830	138	1,111	2,376
2011	1,439	634	738	189	1,588	2,211
2012	1,714	727	868	**1,714**	1,549	1,962
2013	1,052	717	824	1,052	1,244	2,044
2014	980	795	907	980	1,295	2,184
2015	1,117	608	841	149	1,288	2,446
2016	1,332	1,053	1,167	194	1,625	2,805
2017	1,071	778	996	299	1,633	2,106
2018	1,049	793	832	315	1,517	2,949

Source: FBI: Uniform Crime Reporting (UCR) Program, Washington Association of Sheriffs and Police Chiefs, and Ricker I Cunningham.

According to Well Being in the Nation Network, in 2017, 12 per 100,000 motor vehicle accidents resulted in mortality in the United Sates. In 2017, the State of Washington was in about the 4th percentile nationwide.

In terms of how incidents of motor vehicular theft in the Study Area Cities compared to other geographies, in 1997, occurrences in all but Normandy Park (225) were higher than the number for King County (462) and the State of Washington (566). The 2009 trend for property crimes wherein figures for all of the Study Area Cities, except Normandy Park (62), were lower than the King County figure (1,013) was replicated for motor vehicle thefts. In 2018, the last year for which this type of information was available, the number of motor vehicular thefts in the Study Area Cities were again lower that figures for King County (590) and the State (367), in all SeaTac (1,517) and Tukwila (2,949).

Crime Indices

A crime index is an indication of the relative risk of a crime occurring and is measured against the overall risk at a national level. In order to verify the accuracy of the findings presented here, crime indices information was obtained from ESRI, which conducts advanced analysis of census-related data and the Washington Association of Sheriffs and Police Chiefs. These are presented in Figure 11.5 below.

Figure 11.5
Study Area Crime Indices: 1997-2018

xxx above average (over 100) xxx below average (100 or less)

Index Type	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila
Total Crime	187	149	199	87	227	576
Personal Crime	125	95	97	24	152	244
Property Crime	196	157	214	96	238	626
Motor Vehicle Theft	508	341	381	105	653	977
Personal Crime	187	149	199	87	227	576

Source: ESRI Crime Summary Report, and Washington Association of Sheriffs and Police Chiefs

Values above 100 indicate the area has an above average risk of occurring compared to the US. Values below 100 indicate the area has a below average risk of occurring compared to the US. The Crime Indexes provides an assessment of the relative risk of seven major crime types: murder, rape, robbery, assault, burglary, larceny, and motor vehicle theft. It is modeled using data from the FBI Uniform Crime Report and demographic data from the US Census and Applied Geographic Solutions (AGS).

As shown, the total crime index among the Study Area Cities was highest in Tukwila (576) and lowest in Normandy Park (87). Tukwila and Normandy Park held the highest and lowest positions in all of the other categories, as well. Worth noting, however, is Burien's index for motor vehicle theft which was more than 2.5 times higher than its index for either property or personal crime.

Human Trafficking

Human trafficking involves the use of force, fraud, or coercion to obtain some type of labor or commercial sex act. Human trafficking an umbrella term that includes both sex trafficking and labor trafficking. Of all human trafficking incidents, 85% is sex trafficking and 15% is labor trafficking.

In the US, the Victims of Trafficking and Violence Victim Protection Act features the following definition of human trafficking:

- Sex trafficking where a commercial sex act is mandated by force, fraud or coercion, or,
- Where the person is forced to perform the act is not at least 18 years old; or,

- The harboring, recruitment, transportation, provision or obtaining an individual for labor or services through using fraud, force, or coercion for the purpose to subject the individual to involuntary solitude, debt bondage, slavery or peonage.

As of the date of this report, no verifiable data was available at the municipal level for either human or drug trafficking. However, given pending legislation related to human trafficking, and a request by State legislators involved with this effort, information related to best practices for mitigating associated impacts may be available in the near-future.

According to a 2011 Department of Justice report ("Characteristics of Suspected Human Trafficking Incidents, 2008–2010"), 82% of suspected incidents were classified as sex trafficking, and nearly half involved victims under the age of 18. Approximately 10% were classified as labor trafficking. 83% of victims in confirmed sex-trafficking incidents were identified as US citizens, while most confirmed labor trafficking victims were identified as undocumented immigrants (67%) or legal immigrants (28%).

Trafficking in persons is estimated to be one of the top-grossing criminal industries in the world (behind illegal drugs and arms trafficking). According to the International Labor Office, human trafficking in the US increased by more than 57% between 2012 and 2017, followed by modest decline in 2018.

The Polaris Project is widely considered the main source for human trafficking statistics, an organization that primarily relies on state level data. According to Polaris, human trafficking is $32 billion dollar a year criminal industry that denies freedom to 24.9 million people around the world.

The cause of human trafficking involves many complex societal problems: poverty, justice, rule of law, human rights, social inclusion. Prostitution is considered the primary driver for the prevalence of human trafficking in places like Washington DC and Nevada. Sex trafficking may occur in a variety of location types:

- Residential brothels;
- Online escort services (where services are provided at various locations, from homes to hotels);
- Hostess clubs
- Massage businesses;
- Strip clubs and,
- Street prostitution.

Underlying much of the prostitution industry and illegal massage parlors is the fact that many of the women supposedly working there are being held against their will.

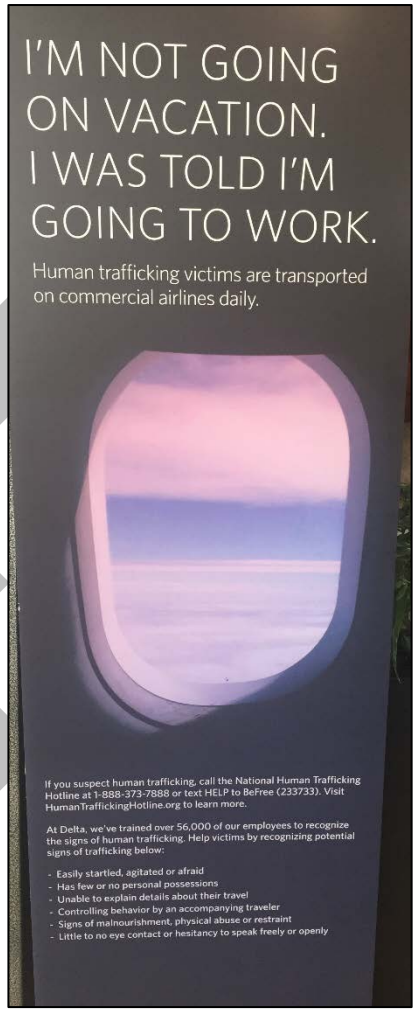
Sex traffickers usually prey upon people with a history of mental, physical and sexual abuse. The Internet has been found to be the major strategic tool used to recruit sex trafficking victims. Online predators may seek out vulnerable girls and boys and lure them into the sex industry with misleading marketing information. Recent studies show that minors are the most vulnerable population to become sex slaves. In these same reports, among those individuals trafficked from other countries, some include legally documented students and temporary workers who typically fill labor needs in the hospitality, landscaping, construction, food service and agricultural industries, who are the subject of vulnerabilities in visa programs. Most of the victims that suffer from sex trafficking came from Mexico, Central America and the Caribbean and only 11% were born in the US.

Other vulnerable groups include homeless and runaways. The National Runaway Switchboard reported in 2009, that one-third of runaway youths in the US are lured into prostitution within 48 hours of being on the street.

Another group include individuals from Latin American countries who are victims of unemployment, natural disasters, drug abuse, etc. who then take risky job opportunities, end up in deceitful romantic relations, or a perception of the American Dream fueled by mass media. A fourth vulnerable group evolved over the last decade, resulting from the opioid crisis.

In conclusion, poverty, lack of education, immigration policy, environmental conditions, fractured families and a lack of good job opportunities are the not the causes of human trafficking, they are forces that cause vulnerabilities in individuals that makes it easier for traffickers to exploit them.

Figure 11.6
Anti-Trafficking Poster at Sea-Tac Airport
(photo by Stantec)



Within the commercial sex trade, there are two approaches to soliciting clients:

- Outcall where the traffickers deliver victims to the buyer's hotel room or their home; and,
- In call when customers cycle in and out of a hotel room while the trafficker extends the victim's stay.

In the US, human trafficking tends to occur around international travel hubs with large immigration populations. Those being trafficked include young children, teenagers, men and women and can be domestic citizens or foreign nations.

Almost all of the top 25 cities for human trafficking prevalence are large metropolises, and many are major tourist destinations and/or have international airports. The exception is New York City, which has the twenty-second-lowest rate of human trafficking in the country. Cities where human trafficking is less common tend to be smaller cities.

According to the National Human Trafficking Hotline, among the top 100 largest cities in the United States, Seattle ranked 25th for the most cumulative reported cases of human trafficking cases between 2007 and 2016, as measured in numbers of cases per 100,000 population.

In 2018, Washington's position had risen to 18th, with 1.3 cases per 100,000 population. Washington State ranks somewhere between 10 and 18 for sex trafficking with 1.3 cases per capita and the Seattle MSA was 25th among other major markets at 26 cases per capita.

While a growing problem throughout the world, human trafficking is considered solvable by governments, nonprofits and communities around the country and world. Today, laws against trafficking exist primarily at the federal and state levels. Over half of the states now criminalize human trafficking, though the penalties are not as tough as they are under federal laws. Related efforts focus on regulating the tourism industry to prevent the facilitation of sex tourism.

Victims of Trafficking and Violence Protection (TVP) Act of 2000 allowed for greater statutory maximum sentences for traffickers, provided resources for protection of and assistance for victims of trafficking, and created avenues for interagency cooperation. It also allows many trafficking victims to remain in the US and apply for permanent residency under a T-1 visa. (This study did not confirm if these allowances have continued to apply during the current presidential administration.)

Previously, trafficked individuals who were often in the country illegally were treated as criminals. According to the section on Severe Forms of Trafficking in Person, the definition extends to include any "commercial sex act in which the person induced to perform such act has not attained 18 years of age." This means that any minor engaged in prostitution is a victim of human trafficking, regardless of citizenship or whether or not movement has taken place. The original TVP of 2000 has been reauthorized three times, the most recent being the William Wilberforce Trafficking Victims Protection Reauthorization Act of 2008.

In addition to the TVP, a federal hotline, the National Human Trafficking Resource Center Hotline run by the Polaris Project has been established. Twenty-five states have mandated certain types of businesses post the hotline number, while three states have established their own hotline.

Safe Harbor laws have been adopted in fifteen states, protecting victims of human trafficking from legal prosecution of crimes committed while under the influence of the trafficker. In addition to protection from prosecution, they provide services such as counseling and housing, and protect them from their exploiters. Victims of trafficking are also protected under federal law but can still be charged under state law. The federal Stop Exploitation Through Trafficking Act of 2013 is a law that encourages states to pass safe harbor laws. It elevated the status of the National Human Trafficking Hotline and opened up the Job Corps program to sex trafficking victims.

There is no data that definitively prove that Seattle-Tacoma International Airport is directly responsible for incidents of human trafficking in the Study Area. There are extenuating circumstances that may contribute to incidents of human trafficking in the Study Area including:

- Over 5,000 hotel rooms, principally in the Cities of SeaTac and Tukwila;
- Easy access from major highways (including IH-5 and IH-405);
- Easy access via light rail and transit; and,
- Proliferation of online sources which require no in-person contact (web camera sites).

Illegal Drug Trafficking

Illegal drug trafficking is a global illicit trade involving the cultivation, manufacture, distribution and sale of substances which are subject to drug prohibition laws. The United Nations Office on Drugs and Crime (UNODC) is continuously monitoring and researching global illicit drug markets in order to gain a more comprehensive understanding of their dynamics.

Like human trafficking, illegal drug trafficking is a criminal enterprise that involves the manufacture, distribution, and sale of substances which are prohibited by law. In some cases, it also involves the illegal manufacture of prescription drugs, but not to the standards set by pharmaceutical companies. The latter is evidenced by the illegal manufacture of drugs sold as various opioids.

There have been changes in attitudes to some drugs that were considered illegal in 1997. For instance, the medicinal and recreational use of marijuana and CBD oil has been legalized in many states. Washington State was the first US state to legalize the recreational use of marijuana (December 2012) and had previously legalize medical marijuana in 1998. Therefore, crime statistics involving marijuana would be expected to significantly decrease between 1997 and 2019.

However, there has been a rise of "synthetic marijuana", often sold at convenience stores and gas stations under a variety of names (K2, bath salts, etc.). These products often contain unknown and dangerous chemicals and there have been incidents of serious injury and death as a result of their use. While they do not technically represent the sale of a prohibited substance, they have been a concern in various portions of the US.

There is no known correlation between Seattle-Tacoma International Airport and illegal drug trafficking in the Study Area. Additional study would be required to determine the causes for various drug trafficking offenses.

D. IMPACTS

Positive Impacts

Positive aspects of public safety impacting the Study Area Cities include:

- Incidents of motor vehicle thefts have generally declined in the Study Area over the past two decades; and,
- Among the three major criminal categories investigated in the 2020 Study (violent, property and motor vehicle theft), 2018 figures were lower than 1997 figures in the Study Area Cities except Normandy Park, and Tukwila relative.

Neutral Impacts

Aspects of public safety that are neither favorable or adverse, impacting the Study Area Cities, include:

- Despite reports of, on average, one vehicle per day being stolen from the garage at the rental car facility, motor vehicle thefts in Tukwila have historically exceeded those in SeaTac.
- The number of motor vehicle thefts in all of the Study Area Cities, except Normandy Park, were lower than those for King County in 2009 and again in 2018, with the exception of SeaTac and Tukwila.
- Property crime rates in Tukwila that have historically exceeded those in all of the other Study Area Cities, are considered more attributable to the presence of the Southcenter Mall than the Airport. .

Negative Impacts

Negative aspects of public safety impacting the Study Area Cities include:

- Violence rates among the Study Area Cities have increased in all but Tukwila and SeaTac since 2016;
- Figures for violent crime in the Study Area Cities in 1997 were higher than the number for King County (213) in 1997 and 2009, with the exception of Normandy Park, as well as in 2018 with the exception of Burien and Normandy Park; and,
- Figures for property crime in the Study Area Cities were higher than the number for King County and the State of Washington in 1997. In 2009, they were lower in the Cities, but higher than state figures in all but Des Moines and Normandy Park. In 2018, the city figures were again lower than county figures, but higher than state figures in Federal Way, SeaTac and Tukwila.

Data Gaps

Information regarding the indicators for which there was either a lack of data, incomplete data, or data that was unavailable at the municipal level includes:

- Motor vehicle vandalism data at either the County or municipal level;
- Crime indices for either County or State level;
- Human trafficking data at either the County or municipal level; and,
- Illegal drug trafficking data either the County or municipal level.

E. WHAT WE HEARD FROM THE PUBLIC

During this study, the Consultant Team heard comments from the public during community meetings, stakeholder interviews, and monthly Technical Advisory Committee meetings. The following is a brief summary of this citizen input by topic area:

- **Violent Crime Activity in the Study Area Cities is Disproportionate**
  Some community members expressed a belief that crimes including vandalism, breaking and entering, and violent crimes against persons were disproportionately higher throughout the Study Area. Others offered the opinion that this was a circumstance shared by all airport communities nationwide, and not just a bi-product of being located proximate to Seattle-Tacoma International Airport. A Burien resident thought that while crime seem oppressive at times, they believed property crimes had declined, while violent crimes had increased. Based on analyses presented herein, the rate of violent crimes in Burien have remained relatively constant since 2015. The rate of motor vehicle thefts, however, did decline by 11% between 2017 and 2018.

- **Property Crime Activity in the Study Area Cities is Disproportionate**
  Some community members expressed concern regarding luggage theft directly from baggage claim carousels. This was predicated on the fact that several pieces of luggage were reportedly found on lawns in the neighborhoods around Seattle-Tacoma International Airport. This assumption could not be confirmed nor disputed since crime statistics were not available at the neighborhood level for the years identified.

- **Motor Vehicle Theft and Related Activity in the Study Area Cities is Disproportionate**
  Some community members thought that soft targets in the vicinity of the Airport (parking garages, rental car center, hotels, mall) contributed to the frequency of motor vehicle thefts, while others thought these land uses attracted all three types of crime. Others thought that most of the crime in Des Moines happened along the Pacific Highway (drugs, loitering, potential car thefts) and in large part due to transients. In SeaTac and Des Moines, some residents said there was a "tremendous amount of crime including shootings and stabbings" compared to the other cities. This assumption could not be confirmed nor disputed since crime statistics were not available at the neighborhood level for the years identified; and no information regarding crimes by transients was available, or types of violent crimes.

- **Airport Parking in Residential Areas**
  There were some reports from the public of Airport users (travelers and employees) parking on nearby residential streets to avoid paying parking fees. This problem was largely reported within the City of SeaTac which has the highest concentration of neighborhoods within walking distance of Seattle-Tacoma International Airport. The City of SeaTac enacted a pilot parking permit program in the summer of 2019 to address this issue, but it was discovered that illegal Airport parking was not as big of an issue as reported by members of the community. There may, indeed, be incidents of Airport users parking illegally in nearby neighborhoods, but no data could be found to support this as a widespread problem.

- **Crime in General**
  A Des Moines resident said there was more over-flow crime on the north side of their city, primarily due to concentrations of low-income residents. This assumption could not be confirmed nor disputed since crime statistics were not available at an area-specific level.

  Other community members thought crime statistics did not portray an accurate picture because "people get tired of reporting crimes when there are no consequences." There was no available data to confirm or dispute this assumption.

Numerous community members expressed their belief that crime was largely an indirect impact associated with the type of land uses (apartments, hotels) concentrated around Seattle-Tacoma International Airport. In terms of Airport hotels, the assumption widely held by members of the community who shared their thoughts was that these hotels supported drug sales, prostitution, and sex trafficking; rather than supporting business travelers. In addition to land uses, the presence of public transit, particularly light rail, was blamed for attracting transients and driving up crime rates. The findings of the CAP Study which investigated socio-economic conditions around several of the nation's largest airports, seems to support the idea that the majority of neighborhoods around US airports are generally less safe. However, the authors of the study attribute it to higher concentrations of lower income households, rather than specific land uses.

- **Homelessness is a Regional Problem and is Pervasive Near the Airport**

  A heightened level of homelessness because of the Airport was a concern raised by several community members. For whatever reason, they assumed that homeless individuals come from other locations, whether traveling by plane, bus or vehicle; and that they eventually find themselves concentrated in the vicinity of the Airport. While homelessness was not a specific indicator identified in the context of this Study, the following information was uncovered during this investigation. Specifically, an article that originally appeared in The Seattle Times in March 2016, addressed several myths about homelessness in the Seattle Metro Area. Therein, and as presented in Figure 11.7 below, based on 2014 data collected from homeless service providers, the author's found that King County was the origin of the highest number of homeless individuals.

Figure 11.7
Homeless Population Census: 2014

Index Type	Number	Percent of Total
King County	33,846	86%
Elsewhere in Washington	2,354	6%
Outside of Washington	3,316	8%
Inaccuracies	33,846	86%

Source: The Seattle Times

What this information suggests is that rather than new residents relocating to Seattle from another community, and then either unable to find or afford housing, the vast majority of the area's homeless population are existing residents who find themselves homeless. Reasons attributed to the steep increase in local homelessness included rising rents, population growth, and cuts in aid from state and federal government sources.

A report on local Seattle television outlets in December 2019 attributed part of the homeless problem to fewer apartment owners willing to accept housing vouchers. The Seattle MSA is a booming housing market and many apartment owners feel they are taking a financial loss by leasing properties under market value. Therefore, many homeless have previously been apartments – many for years – before losing their leases. And many of these residents have full-time jobs, which do not provide enough income to pay for local apartment options. The local media described it as a "houseless" problem, rather than "homeless".

According to Barbara Poppe, advisor to then-Mayor of Seattle Ed Murray:

> "Conditions in Seattle mirror those in other major metropolitan areas where about 80% of clients seeking homeless services are local, and 90% from somewhere in the same state."

Among those groups that originally resided somewhere else in Washington, or outside the state, they had reportedly move to Seattle because of available homeless services. Nationally, the only other locations that provide more housing units and shelter beds than Seattle are New York City and Los Angeles.

It is also important to note that homelessness is occurring in areas often considered affluent areas. Homelessness has been an increasing problem in Honolulu, San Diego, Dallas and Los Angeles. Commonalities include a generally favorable annual climate and rising home and apartment prices. Homelessness is a national concern and requires a multi-lateral approach, including livable wages, available and affordable housing stock, and other challenges.

F. RECOMMENDATIONS

To address the principal issues identified in this Section, the following recommendations are proposed.

- **Public Safety Recommendation #1 – Expand the Study Area**
  Assuming the State determines it valuable to continue this 2019 Study, consider both expanding the Study Area to include investigations in communities located north of Seattle-Tacoma International Airport (across all of the indicators identified herein); and allocating appropriate resources to conduct more detailed analyses of criminal incidents on a neighborhood and area-specific basis (at least in the City of SeaTac and other communities located within a specified distance of the Airport.

  In this regard, supplement data analysis with preparation of "heat maps" that demonstrate more exact locations where certain types of crimes are occurring.

- **Public Safety Recommendation #2 – Consider an Airport Impact Overlay District**
  This concept will be picked up again in a later Section, but as it relates to Public Safety, consider establishing an Airport Impact Overlay District that both shares in revenues and expenses associated with Airport-related operations. The boundaries could be determined after a second level study (assuming there is one), in order to ensure that communities most, or even partially impacted, are included. Reparation levels could be graduated by distance and | or impact level, however, this concept will depend significantly on the ability to isolate monetary advantages and disadvantages to the Study Area Cities from Airport-related activities, as well as the Port's willingness to recognize the value of agreements with all of the communities, as opposed to single agreements with only a few.

- **Public Safety Recommendation #3 – Pursue Multiple Approaches to Assist Victims of Sex Trafficking**
  Possible roadways to identify victims and get them help include educating doctors and other medical professionals about what to look for, as well as employees in the airline and hospitality industries. Individuals in both of these arenas should be receive the Trafficking Education Network that can make them better equipped to respond to human trafficking. Finally, the Coalition Against Trafficking in Women (CATW) influences the shaping of US policy against trafficking.

- **Public Safety Recommendation #4 – Consider CPTED Principles in Portions of the Study Area**
  Crime Prevention Through Environmental Design (CPTED) is a design principle intended to deter criminal activity through a variety of design strategies. These include designs that encourage more pedestrian activity, street-level retail with upper-level apartments that overlook the street ("eyes on the street"), and other principles that create a diverse mixed-use environment where residents have a sense of ownership in the success of the "neighborhood". Areas that could benefit from CPTED principles include US Highway 99 in the Cities of SeaTac, Des Moines, and Federal Way, and First Avenue South in Burien. CPTED principles also help to diversify a community's land uses and economic base.

G. THE FUTURE

Advances in technology will continue to be deployed to combat criminal activity and to improve public safety for residents, employees, and visitors alike. Current and future technologies include:

- **Facial Recognition and Artificial Intelligence**
  Cameras are ubiquitous in many major metropolitan areas across the US and internationally. In some cities, the number of cameras in downtown areas are in the hundreds of thousands – more images than any police department could hope to monitor in real time. Facial recognition software helps identify persons of interest and track their travel through an area. Coupled with artificial intelligence (AI), facial recognition has been a powerful police tool. While not perfect, it appears to be the preferred method for urban policing.

- **"Voluntary" Surveillance**
  "Voluntary" surveillance refers to the growing network of home video cameras and video doorbells that capture criminal activity in real-time. Many police departments link to the various doorbell cameras in their neighborhoods in an effort to prevent a variety of crimes – from package theft ("porch pirates") to vehicle theft to burglary and more. Residents willingly install these systems at their own cost, creating an ever-expanding network of residential and commercial video cameras.

- **Community "Policing"**
  This not only refers to a more visible police presence in some high-risk areas, it also refers to encouraging more engaged residents in neighborhoods. Programs such as First Night and National Night Out encourage community cohesion, building stronger neighborhoods, a result in areas that "self-police". Neighbors know who is supposed to be on their street, are aware if someone is not responding to calls and visits, and generally look out for the welfare of their street or neighborhoods. Another way to encourage this is to allow for a variety of housing types and residents in an area so "eyes on the street" are maximized. (Neighborhoods near a highway interchange are vulnerable to quick-strike burglaries, but if there are empty nesters/retirees in the area during the day, the chances of mid-day break-ins can decrease.)

The best crime prevention technologies are those the prevent crime from occurring in the first place. This includes summer job programs for teens, evening recreational leagues, internships and employment opportunities, family counseling for domestic/spousal abuse concerns, and other seemingly basic but necessary programs. Funding is often a concern and may be a challenge to offer these programs in certain areas.

It is also important that crimes are reported to local, County, and State law enforcement authorities. As stated earlier in this Section, many crimes go unreported for a variety of reasons. But if local law enforcement agencies are not aware that crime is being committed, preventative measures cannot be effectively enacted. An illusion of safety might hide many unreported crimes.

H. SUMMARY

National statistics show a higher incidence of certain types of crime in the vicinity of airports, including robbery, theft and vehicular crime. These statistics are predicated on external factors, including poorer neighborhoods and easy access via highways or transit. However, there are no statistics in the Study Area that point to a direct causation between Seattle-Tacoma International Airport and criminal activity.

Reported crime during the study period (1997 to 2019) has varied per city in the Study Area. Figure 11.8 shows the peak year for reported violent crimes, property crimes, and property theft for each Study Area City. Violent crime peaks were erratic across the Study Area. Both property crimes and vehicular thefts generally peaked in the late 1990's to mid-2000's – except for Normandy Park which saw its property crime and vehicular theft rates peak in 2012.

Figure 11.8
Study Area Peak Years for Reported Crime Rates per 100,000 Population: 1997-2018

Crime	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila
Violent crime	2012	1997	1998	2014	1998	2003
Property crime	1998	1997	2005	2012	2005	2005
Vehicular crime	2005	2005	2005	2012	2005	2005

Overall, the rates of reported violent and property crimes are higher than that for King County and the State of Washington (rates per 100,000 population). Normandy Park was the only Study Area City with rates lower than the County and the State. The same trend was noted for vehicular crime, with Normandy Park being lower than the County and State rates per 100,000 population.

Information for human trafficking and illegal drug trafficking were not readily available at the local level, so it was not possible to assess whether these crimes are more or less frequent in the Study Area.

There appears to be a coincidence of certain types of crimes occurring around attractive targets. Any large concentration of vehicles – in a parking garage, at a shopping mall, or any large parking lot – will be an attractive target to a car thief. Homes and business near highway entrance ramps provide an easy exit route for burglars. Dark and hidden entryways are easy targets for break-ins. But none of these conditions in and of themselves cause the crime to occur. Seattle-Tacoma International Airport may be an attractive target, but it does not cause crime, just as Costco or Southcenter Mall do not cause purse-snatching or car theft.

Additional studies and new methods of data reporting will help identify patterns of criminal activity. These are recommended as part of future follow-up studies.

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SECTION 12

PUBLIC HEALTH

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SECTION 12

PUBLIC HEALTH

A. INTRODUCTION

Public health is the science of protecting and improving the health of people and their communities. Work in this area is achieved by:

- Promoting healthy lifestyles;
- Researching disease and injury prevention; and
- Detecting, preventing and responding to infectious diseases.

Overall, public health is concerned with protecting the health of entire populations, as small as a local neighborhood, or as big as an entire country or region of the world. As such, many experts agree that an assessment of public health must include traditional measures of mortality, as well as disabilities engendered by diseases; or, in other words, consideration of epidemiological risk factors for disease that are influenced by social conditions such as the neighborhood and communities where people most at risk reside.

The focus of Section 12 is to present information related to select indicators of public health in the Study Area Cities and comparative geographies, between 1997 and 2019; as well as isolate possible impacts from Seattle-Tacoma International Airport operations that may have contributed to adverse circumstances.

Indicators

The scope of work for this study identified statistics related to the following indicators as appropriate measures of public health in the Subject Area Cities: morbidity and mortality, hearing and auditory dysfunction, respiratory disease, cardiovascular disease, neurological disease, and cancer. However, based on information and data sources which monitor and analyze factors associated with this aspect of community quality, it was necessary to address them in the context of the following subject areas.

- Leading Causes of Death
- Injury and Violence-Related Mortality
- Health Risk Factors and Chronic Disease
- Life Expectancy (at Birth)
- Maternal and Child Health
- Access to Care and Preventative Services

The discussion that follows includes a description and analyses of: each of the above indicators; positive, neutral and negative public health impacts; comments received from individuals and representatives involved in the study process, along with clarifying responses; and recommendations for ongoing investigation, as well as possible strategies to mitigate adverse influences.

B. LEADING CAUSES OF DEATH

According to the Centers for Disease Control and Prevention (commonly known as CDC) in an August 2016 National Center for Health Statistics Data Brief, the mortality burden of cancer has surpassed that of heart disease in several states. (Rankings are based on the number of deaths and reflect mortality burden rather than risk of death.)

In 2000, there were only two states (Alaska and Minnesota) where cancer was the leading cause of death; in 2014, there were 22. Cancer is also now the leading cause of death for the non-Hispanic Asian or Pacific Islander populations, with the timing varying by group; and replaced heart disease as the leading cause of death for the Hispanic population in 2009.

Heart disease, on the other hand, remains the leading cause of death for the non-Hispanic white and non-Hispanic black populations, with cancer the second leading cause. In fact, among non-Hispanic black persons, they were more than twice as likely as non-Hispanic Asian or Pacific Islander persons to die of heart disease between 1999 and 2017. Risk factors contributing to high rates of heart disease include hypertension, obesity, diabetes and high total cholesterol. Non-Hispanic black adults, 20 years and older, were the most likely among these groups to suffer from all of these, except high total cholesterol.

Cancer

Incidents have decreased overall between 2012 and 2016, however, the rate per 100,000 population is higher in the Study Area than in King County or in other areas. The exception was the rate of cancer in Vashon Island in 2012 which was close to the Study Area rate. Study Area 2016 rates are close to those for Washington State and slightly higher than the US national rate.

Figure 12.1
Death Rate Per 100,000 Population for Cancer (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area		Cancer	
		2012	2016
Study Area Cities	City of Burien	170.4	159.2
	City of Des Moines	184.9	140.6
	City of Federal Way	180.6	168.6
	City of Normandy Park	184.9	140.6
	City of SeaTac	179.3	163.5
	City of Tukwila	179.3	163.5
Other Areas	Vashon Island	185.3	129.0
	Mercer Island/Point Cities	185.3	116.6
State and National	Washington State	170.4	162.5
	United States	166.5	152.5
King County		**159.2**	**150.5**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

Heart Disease

Incidents have decreased overall between 2012 and 2016, however, the rate per 100,000 population is higher in the Study Area than in King County or in other areas, and increased in Des Moines, Normandy Park, SeaTac, and Tukwila. Incidents in all Study Area Cities is above the average for King County and other areas. Study Area 2016 rates are close to those for Washington State and slightly higher than the US national rate.

Figure 12.2
Death Rate Per 100,000 Population for Heart Disease (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area		Heart Disease 2012	Heart Disease 2016
Study Area Cities	City of Burien	150.3	150.1
	City of Des Moines	138.9	156.8
	City of Federal Way	171.2	157.4
	City of Normandy Park	138.9	156.8
	City of SeaTac	140.5	146.8
	City of Tukwila	140.5	146.8
Other Areas	Vashon Island	121.9	100.8
	Mercer Island/Point Cities	83.6	79.9
State and National	Washington State	150.3	142.3
	United States	170.5	165.0
King County		**138.2**	**127.2**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

Alzheimer's Disease

Incidents have decreased slightly between 2012 and 2016 in King County. The Study Area remained relatively stable from 2012 to 2016, with only SeaTac and Tukwila reporting lower rates than King County. Study Area 2016 rates are lower than the rates for Washington State and the US.

Figure 12.3
Death Rate Per 100,000 Population for Alzheimer's Disease (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area		Alzheimer's Disease 2012	Alzheimer's Disease 2016
Study Area Cities	City of Burien	26.7	29.5
	City of Des Moines	45.0	57.3
	City of Federal Way	72.3	24.7
	City of Normandy Park	45.0	57.3
	City of SeaTac	27.6	26.9
	City of Tukwila	27.6	26.9
Other Areas	Vashon Island	30.8	34.5
	Mercer Island/Point Cities	33.3	29.8
State and National	Washington State	26.7	44.0
	United States	23.8	31.0
King County		**42.3**	**41.1**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

Chronic Lower Respiratory Disease

Incidents have decreased slightly overall between 2012 and 2016. The Study Area's rates remain generally higher than King County with the exception of Normandy Park (2012 only). Rates are lower for Vashon Island and Mercer Island/Point Cities. Study Area 2016 rates are slightly higher than those for Washington State and the US.

Figure 12.4
Death Rate Per 100,000 Population for Chronic Lower Respiratory Disease (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area		Chronic Lower Respiratory Disease 2012	2016
Study Area Cities	City of Burien	43.0	35.8
	City of Des Moines	31.5	30.9
	City of Federal Way	47.5	46.9
	City of Normandy Park	31.5	30.9
	City of SeaTac	44.4	43.0
	City of Tukwila	44.4	43.0
Other Areas	Vashon Island	21.2	21.2
	Mercer Island/Point Cities	20.3	13.4
State and National	Washington State	43.0	40.8
	United States	41.5	40.9
King County		**32.2**	**29.7**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

Stroke

Incidents have decreased overall between 2012 and 2016, with only the Cities of SeaTac and Tukwila showing increased rates during the same period. The Study Area's rates are close to those found in King County, except for Des Moines which was lower. Rates are also lower for Vashon Island and Mercer Island/Point Cities. Study Area 2016 rates are close to those for Washington State and the US.

Figure 12.5
Death Rate Per 100,000 Population for Stroke (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area		Stroke 2012	2016
Study Area Cities	City of Burien	38.4	32.9
	City of Des Moines	35.9	28.2
	City of Federal Way	43.4	37.6
	City of Normandy Park	35.9	28.2
	City of SeaTac	30.9	34.6
	City of Tukwila	30.9	34.6
Other Areas	Vashon Island	26.2	21.9
	Mercer Island/Point Cities	35.3	26.9
State and National	Washington State	38.4	35.5
	United States	36.9	37.6
King County		**36.6**	**31.4**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

Accidents and External Causes

Incidents have decreased slightly overall between 2012 and 2016, with 2016 Study Area rates only slightly above King County rates. Rates increased for Vashon Island, with a rate consistent with the Study Area. The Mercer Island/Point Cities rate, while increasing from 2012 to 2016, remained far lower than King County and the Study Area. Study Area 2016 rates are consistent with those for Washington State but are lower than those for the US.

Figure 12.6
Death Rate Per 100,000 Population for Accidents and External Causes (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area		Accidents and External Causes 2012	2016
Study Area Cities	City of Burien	45.1	32.2
	City of Des Moines	39.0	31.9
	City of Federal Way	28.2	32.3
	City of Normandy Park	39.0	31.9
	City of SeaTac	38.4	37.6
	City of Tukwila	38.4	37.6
Other Areas	Vashon Island	23.7	38.8
	Mercer Island/Point Cities	17.7	21.0
State and National	Washington State	45.1	38.4
	United States	39.1	49.4
King County		**31.7**	**30.7**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

As with national trends, the two leading causes of death in the Study Area Cities and King County have been and continue to be Cancer and Heart Disease, followed by Alzheimer Disease, Chronic Lower Respiratory Disease, Stroke and Accidents (not necessarily in this order).

Between the cities, all but Mercer Island/Point Cities exceeded the King County rate for cancer in 2012, and all but Vashon Island and Mercer Island/Point Cities (two communities located north of the Study Area) exceeded the County rate that same year for heart disease. In no other category did rates of illness so conclusively exceed those of the County.

Among the Study Area Cities, the highest incidence of cancer in 2012 was reported in Vashon Island, and in 2016 in SeaTac and Tukwila. Occurrences of heart disease in 2012 were the highest in Burien in 2012, and Federal Way in 2016.

While occurrences of cancer and heart disease in the Study Area Cities and King County declined between 2012 and 2016; rates within all but Des Moines, Normandy Park, Vashon Island and Mercer Island/Point Cities exceeded those of King County. Conversely, rates of heart disease in 2016 increased in Des Moines, Normandy Park, SeaTac, and Tukwila. 2016 also saw increases in Alzheimer's disease and accidents in select cities, and strokes in SeaTac and Tukwila.

Whereas figures published by the CDC demonstrate that some ethnic groups can be more prone to certain illnesses, for the purpose of this analysis, information regarding the ethnic profile of the Study Area Cities were cross-referenced with illness and mortality data.

Based on the ethnic profile of each of the Cities in 2017:

- Normandy Park appears to be the least ethnically diverse with fewer than 13% of their residents identifying as something other than Caucasian white. Among the Study Area Cities, Normandy Park is the only community with a less diverse ethnic profile than King County.
- The Cities of Tukwila and SeaTac appear to be the most diverse with nearly 70% identifying as something other than Caucasian white.
- Approximately 40% of King County residents identify as something other than Caucasian white.

With regard to ethnicity in the context of a public health discussion, what is most important is the number of individuals within specific ethnic groups that have a higher propensity to contract specific illnesses, not just ethnicity in general. As explained above, non-Hispanic blacks are significantly more prone to developing heart disease than other ethnic groups (Section 13 shows that Federal Way maintains the largest concentration of this group of individuals and is also the City with the highest concentration of this illness).

Also explained above, Asians are most likely to develop cancer. Tukwila has the largest concentration of individuals in this group in the Study Area and also has the highest concentration of cancer.

Airport-Related Health Impacts

A 2015 study by the New Jersey Institute of Technology (NJIT) reported identifying "significant and growing emissions of air pollution, including air toxics," from airports across the country." It explained that pollutants emitted by airports include: lead, nitrogen oxides, particulate matter, sulfur oxide and volatile organic compounds (VOCs), some of which are classified as air toxins by the EPA. The area most impacted was reportedly was nine miles around the respective airport, wherein pollutants were found to be 10 times higher than in areas outside this zone.

At the time this study was conducted, Seattle-Tacoma International Airport was found to be a "top polluter with carbon monoxide levels exceeding federal guidelines." A recommendation resulting from NJIT's work included advocating for regulators to reduce the sulfur content of aviation fuel for large commercial aircraft.

Another article that appeared in the Los Angeles Times reported on an air quality study related to "high levels of potentially harmful exhaust particles from jets using Los Angeles International Airport," disputed the assumption that a 9 mile area around an airport was the most impacted. That study detected a broad swath of contamination in an area up to 10 miles east of the runways. Claiming to be the most comprehensive of its type, the study this article reported on found that takeoffs and landings at LAX are a major source of ultrafine particles. It also likened emission levels from airplane exhaust around LAX to those of many of Los Angeles's freeways.

To put that in perspective, there are 930 miles of freeway in Los Angeles County, where LAX is located. Scientists have concluded that, "LAX should be considered one of the most important sources of [particle matter] pollution in Los Angeles whereas particles can become embedded in the lungs and enter the bloodstream, worsen existing lung conditions such as asthma and chronic obstructive pulmonary disease (COPD), and contribute to the development of heart disease."

These study findings were thought to raise health concerns particularly because of the nature of what they describe as "minute particles resulting from the condensation of hot exhaust vapor, similar to those from cars, diesel trucks and aircraft, and their potential to aggravate heart and lung conditions, including asthma and the development of blocked arteries." In addition, the study authors warned that while emissions of larger exhaust particles are regulated, ultrafine particles are not.

The 1997 Study drew no conclusion regarding the need for additional health care services resulting from expansion of Seattle-Tacoma International Airport's facilities and operations but did acknowledge concern among participants in the study process regarding potential healthcare related impacts. The 1997 Study concluded that, "Factors impacting the cities' needs for community services and facilities as a result of the Third Runway could come from several sources." Further, in terms of psychological factors, it stated that these would have their greatest impact on families and students. Effects on students are presented in the context of a larger discussion about Airport-related impacts on school facilities and school populations, later in this Section.

Despite drawing no conclusions regarding health related impacts resulting from proximity to the Airport, the 1997 Study did cite the following finding from a Rutgers University study prepared by professors Michael Greenberg and Dana Schneider:

> "Airports are associated with traffic jams, airplane crashes, and extraordinarily high levels of noise. When present, low-flying aircraft are an even more distressing source of noise than motor vehicles on highways. Jets, especially jumbo jets that cannot rise quickly, create an extremely high decibel level and a whining sound upon takeoff. Unlike a highway where the noise is relatively continuous and can often be masked by sound barriers and air conditioning, airport noise is discontinuous and is virtually impossible to mask. In addition to task interference and uncontrollable physiological changes observed in people living near highways, those residing near airports suffer from feelings of helplessness and lack of control."

A final study identified in the context of this effort, the findings of which were publicized in the International Journal of Environmental Research and Public Health in August of 2018, identified possible health consequences resulting from the aviation industry's use of automated flight systems. NextGen, one of these systems, was described as using GPS data from other flights, as well as atmospheric conditions, to optimize flight patterns. At that time, it had been implemented throughout the United States, including at Seattle-Tacoma International Airport, to "reduce pollution, flight time, costs and accidents due to human error." The study specifically investigated possible health impacts to the neighborhoods around LaGuardia Airport in New York resulting from flight patterns dictated by NextGen. The methodology employed was predicated on findings from other studies that found "high levels of exposure to aircraft noise had been linked to development of serious physical and mental health conditions such as cardiovascular disease (CVD) and anxiety." It also assumed that while additional adverse conditions can result from loud and sustained aircraft noise, among them a lack of sleep, productivity and educational outcomes, due to a lack of verifiable data, the authors would focus on CVD and anxiety. Conclusions from the study found that automated flight systems like NextGen do in fact reduce atmospheric pollution, increase productivity through reduced flight time, and increases in the timely delivery of products and services. However, it also found there to be an increase in disability and death, at least among individuals in the geographies where flights were most concentrated.

In order to understand the magnitude of impact related to NextGen on the Study Area Cities, assuming the findings revealed in the LaGuardia Airport Study are accurate, an analysis of flight patterns as measured by the Port's 24 noise monitors was conducted. That work revealed that approximately 88% of the recorded flights impacted the Study Area Cities. Of those flights, 90% were flown at a height below 3,000 feet and 83% above 3,000 feet.

C. INJURY AND VIOLENCE-RELATED MORTALITY

According to the National Center for Injury Prevention and Control of the CDC and U.S. Census Bureau, Washington State is in the 6th percentile for number of age-adjusted death rates per 100,000 population due to injury or suicide among all races and ethnic groups. As reflected in Figure 12.7, the number of motor vehicle accidents in all of the Study Area Cities and two additional cities located north of the Airport, were higher than King County. Between 2012 and 2016, homicides and deaths from firearms either declined or remained steady in all of the Cities except for Burien, as well as King County.

Falls, on the other hand, increased between these two years in all of the Cities except Burien. The single outlier in terms of an improved conditions among injury and violence-related causes of death were incidents of suicides. Between 2012 and 2016, the rate of suicides increased in King County, as well as every city in the area except for Tukwila.

Burien also experienced the highest rate of motor vehicle accidents in 2012, Vashon Island the highest rate of falls, SeaTac and Tukwila the highest occurrence of suicides and homicides, and Des Moines and Normandy Park the highest frequency of deaths by firearms. Rankings in 2016 remained constant for motor vehicle accidents and falls, but Vashon Island exceeded all of the other Cities in the number of suicides and number of deaths due to firearms, while Burien barely topped the others in terms of numbers of homicides.

Figure 12.7
Injury and Violence-Related Mortality Rate Per 100,000 Population for Select Cities In and Including King County (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area	Motor Vehicle Accidents		Falls		Suicide		Homicide		Firearms	
	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016
City of Burien	11.1	7.7	9.8	8.1	11.6	11.7	3.8	4.9	8.0	9.7
City of Des Moines	9.1	4.4	8.6	10.5	12.3	15.0	5.5	4.5	11.1	9.5
City of Federal Way	7.8	5.7	6.5	9.7	11.2	13.0	5.0	3.5	7.8	7.1
City of Normandy Park	9.1	4.4	8.6	10.5	12.3	15.0	5.5	4.5	11.1	9.5
City of SeaTac	8.3	7.6	6.6	9.2	12.5	10.4	6.2	3.6	10.7	3.0
City of Tukwila	8.3	7.6	6.6	9.2	12.5	10.4	6.2	3.6	10.7	3.0
Vashon Island	0.0	- - -	12.7	13.7	10.0	30.0	0.0	0.0	0.0	15.1
Mercer Island/Point Cities	4.3	2.6	7.7	7.7	6.9	8.5	0.0	0.0	4.8	4.4
King County	**6.2**	**5.2**	**9.3**	**9.6**	**10.8**	**12.1**	**3.2**	**2.6**	**6.7**	**6.7**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

Suicide

While suicide was not a specific indicator identified in the context of this Study, the following information was uncovered during this investigation.

Based on trends in rates and methods of suicide in the United States between 1985 and 2004, suicide was the 10th leading cause of death, fourth leading cause for males under 65 years, and highest among males aged 75 and older. In 2014, suicides outnumbered homicides almost three-to-one. According to the CDC's National Center for Health Statistics (NCHS), by 2017, recorded suicides reached 47,173. On average, adjusted for age, the annual US suicide rate increased 24% between 1999 and 2014, from 10.5 to 13.0 suicides per 100,000 people, the highest rate recorded in 28 years.

The World Health Organization expanded on these findings, reporting that the highest suicide rates in the U.S. are among Whites, American Indians and Alaska Natives. While the methods vary by gender, more than 75% occur either at or close to home. Further, about 75% of suicide incidents occur at home, with most (85%) individuals dying at the scene and never making it to the hospital (NVISS data). Suicide rates are highest in rural areas, in the west (excluding California), and to a lesser extent, in parts of the south and northern New England regions.

Although the frequency of suicides varies significantly between age cohorts, the most occur among individuals, male or female, age 45 to 54 years. With this understanding, and in order to understand if age is a factor in the Study Area Cities, their age distribution profile was cross-referenced with their suicide rates. What this analysis revealed was that Vashon Island and Normandy Park maintain the highest percentage of residents age 45 to 54 years, and also incurred the highest rate of suicide among the other Cities.

D. HEALTH RISK FACTORS AND CHRONIC DISEASE

Risk factors include everyday habits and behaviors that can pose significant risks to human health. Smoking tobacco, excessive alcohol consumption, a lack of exercise and poor diet, drug use, and unprotected sex are common examples. Such activities can increase the risk of numerous diseases including hypertension, heart disease, cancer, sexually transmitted diseases (STDs), and diabetes. These behaviors and habits not only impact the health of individuals but are also very costly.

As presented in Figure 12.8., in 2012, with the exception of a few anomalies, the percent of residents in the Study Area Cities and other cities north of Seattle-Tacoma International Airport, that either participate in or suffer from conditions adverse to their health exceeds those of the King County is consistently higher.

A comparison of city-level figures compared to the state figures are less conclusive. This pattern continued, with a similar number of anomalies in 2016, along with an overall increase in poor health habits between 2012 and 2016 within all of the geographies.

Figure 12.8
Health Risk Factors and Chronic Diseases (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area	Excessive Drinking		No Exercise		Obesity		Current Smoker		High Cholesterol		Hyper-tension		Heart Disease		Diabetes		Asthma	
(comparison years)	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016
City of Burien	18%	18%	21%	29%	28%	34%	17%	22%	35%	38%	27%	31%	5%	4%	7%	10%	11%	12%
City of Des Moines	22%	25%	22%	23%	25%	26%	13%	18%	47%	38%	35%	30%	6%	4%	8%	14%	7%	9%
City of Federal Way	16%	20%	21%	22%	32%	27%	21%	17%	34%	38%	28%	34%	5%	3%	6%	12%	10%	12%
City of Normandy Park	11%	25%	11%	23%	25%	26%	13%	18%	47&	38%	35%	30%	6%	4%	8%	14%	7%	9%
City of SeaTac	21%	21%	24%	29%	32%	28%	20%	24%	37%	41%	27%	18%	4%	3%	10%	8%	8%	7%
City of Tukwila	21%	21%	24%	29%	32%	28%	20%	24%	37%	41%	27%	18%	4%	3%	10%	8%	8%	7%
Vashon Island	18%	25%	12%	12%	17%	17%	11%	14%	49%	46%	22%	29%	4%	8%	4%	6%	6%	3%
Mercer Island/Point Cities	15%	15%	6%	9%	10%	12%	4%	6%	34%	32%	22%	26%	4%	2%	4%	5%	10%	7%
State of Washington	17%	18%	18%	20%	26%	27%	16%	16%	38%	38%	27%	30%	5%	4%	7%	9%	9%	10%
King County	**19%**	**21%**	**15%**	**16%**	**21%**	**22%**	**11%**	**14%**	**36%**	**35%**	**24%**	**26%**	**4%**	**3%**	**6%**	**7%**	**8%**	**9%**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.

E. LIFE EXPECTANCY

Overall life expectancy at birth compares the average number of years to be lived by a group of people born in the same year, if mortality at each age remains constant in the future. Life expectancy at birth is also a measure of overall quality of life in a country and summarizes the mortality of all ages.

As presented in Figure 12.9 below, Federal Way reported the lowest average life expectancy in 2012, despite having the second lowest median age among the Study Area Cities, and third lowest in 2016. Conversely, while Normandy Park has consistently maintained the highest median age, it has possessed a life expectancy figure comparable to the other Study Area Cities, rather than one that is higher. Compared to King County, the average life expectancy among all of the Cities was lower in 2012, except for Vashon Island and Mercer Island/Point Cities.

This trend continued in 2016, when life expectancy rates in all of the Study Area Cities remained lower than that of the County (81.8), as well as the State (80.2) and Nation (80.0). A review of how ages are distributed throughout the Study Area suggested that residents are aging in place, and that life expectancies are holding fairly constant, trends that should provide valuable baseline figures for future investigations.

Figure 12.9
Average Life Expectancy – Study Area Cities and King County (2012 and 2016)

xxx below County average xxx above County average **xxx** King County average

Area		Average Life Expectancy 2012	2016
Study Area Cities	City of Burien	79.9	80.1
	City of Des Moines	80.0	80.1
	City of Federal Way	78.8	79.2
	City of Normandy Park	80.0	80.0
	City of SeaTac	79.9	80.0
	City of Tukwila	79.9	80.0
Other Areas	Vashon Island	82.8	83.0
	Mercer Island/Point Cities	85.9	85.8
State and National	State of Washington	79.9	80.2
	United States	78.8	80.0
King County		**81.5**	**81.8**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham

F. MATERNAL AND CHILD HEALTH

Maternal and Child Health involves the delivery of care and provision of services for mothers and children including:

- Family planning and reproductive health services;
- Maternal, newborn, and child health services;
- Health communications;
- Health commodities and supplies; and,
- Health systems strengthening.

Figure 12.10 below reflects measures of maternal and child health in the Study Area Cities and other cities located north of the Airport for which information was available, as well as King County and the State of Washington. Across all of the indicators presented here, in 2012, the rate of individuals who were without early prenatal care in all of the Cities, except for Mercer Island/Point Cities, exceeded both the County and State figures.

City figures for smoking during pregnancy in the Cities also exceeded those for the County and State. Trends among babies born at a low or very low birth rate, or who died at birth, were either lower than or consistent with those of the County and State in every community except Burien, SeaTac and Tukwila. Incidents of teen births were also higher than the County and State figures in all of the Cities, except Federal Way, Vashon Island and Mercer Island/Point Cities. Among the Study Area Cities, Burien, SeaTac and Tukwila were ranked the highest in total factors contributing to adverse health conditions among women and children.

Figure 12.10
Incidents Per 100 Births – Study Area Cities, King County and State of Washington (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area	Late/No Prenatal Care		Smoking During Pregnancy		Low Birth Weight		Very Low Birth Weight		Teen Birth *		Infant Mortality **	
(comparison years)	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016
City of Burien	7.6	7.8	6.7	8.0	7.1	6.5	1.2	1.1	24.2	12.4	3.6	4.1
City of Des Moines	7.0	7.4	6.0	7.2	6.2	6.3	0.9	1.0	16.7	10.6	4.8	6.8
City of Federal Way	7.5	9.4	8.4	8.0	6.4	6.3	1.3	0.9	10.0	10.1	3.2	4.9
City of Normandy Park	7.0	7.1	9.0	7.2	6.2	6.3	0.9	1.0	16.7	10.6	4.8	6.8
City of SeaTac	9.1	9.4	4.9	5.7	7.5	6.9	1.2	1.2	26.2	15.1	4.9	5.4
City of Tukwila	9.1	9.4	4.9	5.7	7.5	6.9	1.2	1.2	26.2	15.1	4.9	5.4
Vashon Island	8.1	11.0	5.8	5.4	6.9	5.4	0.6	- - -	2.7	- - -	0.0	0.0
Mercer Island/Point Cities	2.7	2.2	0.6	6.5	4.6	6.5	0.5	0.8	0.0	- - -	5.1	- - -
State of Washington	5.9	6.1	9.9	6.3	6.4	6.3	1.0	1.0	14.8	10.5	4.9	4.6
King County	**5.2**	**5.5**	**4.2**	**6.5**	**6.7**	**6.5**	**1.0**	**1.0**	**9.6**	**6.3**	**4.1**	**4.2**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham.
* per 1,000 females age 15 to 17
** per 1,000 live births

In terms of how conditions may have changed between 2012 and 2016, increases and decreases were realized across all of the indicators in every city, as well as the County and State. By community, Federal Way realized the highest overall improvement with declines in smoking during pregnancy and birth weight, and Burien saw the single largest decline among all of the indicators, with a 50% drop in teen births. Regardless, the rank among the Study Area Cities across all measures, except infant mortality, either exceeded or were consistent with those of the County and State.

G. ACCESS TO CARE AND PREVENTATIVE SERVICES

The final measure of public health addresses the residents' access to care and preventative services, regardless of age or gender. Access to care and preventative services means having the timely use of personal health services to achieve the best health outcomes. Uninsured persons are less likely to receive medical care and are more likely to have poor health status.

As presented in Figures 12.11 and 12.12, in 2012, fewer residents in all of the Cities, age 18 to 64, have insurance than individuals in this same age cohort in all of King County and Washington State. Similarly, fewer residents in all but Vashon Island and Mercer Island | Point Cities, have seen a doctor, have a personal doctor, or received a flu shot. This trend reverses itself among factors including Pneumonia vaccines, mammograms, and pap smears whereas more residents in the Cities have accessed this care than those of either the County or State. However, between 2012 and 2016, access to medical care and services among residents of the Cities worsened across nearly every indicator, in nearly every city, with figures related to a lack of access to care and preventative services increasing, in some cases significantly.

Figure 12.11
Access to Care and Preventative Services – Study Area Cities, King County and State of Washington (2012-2016)

xxx above County rate xxx below County rate **xxx** King County rate

Area	Uninsured 16-64 years		Could Not See a Doctor		No Personal Doctor		No Flu Shot		No Pneumonia Vaccine *		No Mammogram **		No Pap Smear ***		No Dental Visit	
(comparison years)	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016	2012	2016
City of Burien	22%	23%	14%	22%	22%	29%	62%	63%	27%	29%	11%	25%	15%	24%	35%	41%
City of Des Moines	27%	23%	14%	18%	27%	29%	60%	69%	22%	29%	13%	26%	26%	29%	34%	49%
City of Federal Way	- - -	23%	13%	20%	22%	27%	58%	60%	33%	23%	7%	30%	29%	29%	22%	32%
City of Normandy Park	27%	23%	14%	18%	27%	29%	60%	69%	22%	29%	13%	26%	26%	29%	34%	49%
City of SeaTac	30%	30%	16%	24%	30%	34%	62%	64%	25%	22%	23%	28%	11%	30%	30%	55%
City of Tukwila	30%	30%	16%	24%	30%	34%	62%	64%	25%	22%	23%	28%	11%	30%	30%	55%
Vashon Island	- - -	9%	13%	17%	11%	16%	51%	56%	21%	38%	23%	35%	16%	26%	21%	30%
Mercer Island/Point Cities	- - -	4%	5%	4%	9%	16%	41%	46%	25%	23%	12%	22%	16%	21%	13%	12%
State of Washington	19%	18%	13%	15%	22%	25%	62%	62%	29%	27%	20%	29%	20%	32%	27%	33%
King County	**16%**	**15%**	**10%**	**14%**	**20%**	**26%**	**58%**	**60%**	**28%**	**28%**	**18%**	**28%**	**15%**	**22%**	**23%**	**29%**

Source: Washington State Department of Health, Center for Health Statistics and Ricker I Cunningham

* age 65+

** age 50 to 74

*** age 21 to 65

H. IMPACTS

Positive Impacts

Positive aspects public health influencing impacting Study Area include:

- The accident rate in all but Burien were lower than the same rate for the State and nation;
- Occurrences of cancer and heart disease in the Study Area Cities and King County declined between 2012 and 2016;
- Between 2012 and 2016, figures for all but Alzheimer Disease declined in the State of Washington; and,
- Nationally, figures for the leading causes of death – cancer, heart disease, and respiratory disease – all declined.

Neutral Impacts

Aspects of public health that are neither favorable or adverse which impacted the Study Area Cities, include:

- The rate of heart disease in all but Des Moines, SeaTac and Tukwila were higher than that of the State; and in Federal Way, they were was higher than the national rate.
- Despite studies of potential health impacts on residents of communities located with 10 miles of an airport, and while all of the Study Area Cities exhibited rates higher than King County for chronic illnesses, only three of the communities had figures higher than those for the State or nation.
- Between 2012 and 2016, homicides and deaths from firearms either declined or remained steady in all communities, except Burien and King County.

Negative Impacts

Negative aspects of public health impacting the Study Area Cities include:

- The two leading causes of death in the Study Area Cities and King County have been and continue to be cancer and heart disease;
- The frequency of falls between 2012 and 2016 increased in all of the Study Area Cities increased, except Burien;
- Between 2012 and 2016, the rate of suicides also increased in all of the Study Area Cities, except in Tukwila, and King County;
- The rate of individuals who were without early prenatal care in all the Cities, except for Mercer Island/Point Cities, exceeded both the County and State figures;
- Among the Cities, Burien, SeaTac and Tukwila were ranked the highest in total factors contributing to adverse health conditions among women and children;
- Access to medical care and services among residents of the Cities worsened across nearly every indicator, in nearly every City, with figures related to a lack of access to care and preventative services increasing, in some cases significantly;
- There was an overall increase in poor health habits between 2012 and 2016 within all of the geographies; and,
- Trends among babies born at a low or very low birth rate, or who died at birth, were either lower than or consistent with those of the County and State in every community except Burien, SeaTac and Tukwila.

Data Gaps

Information regarding the indicators for which there was either a lack of data, incomplete data, or data that was unavailable at the municipal level includes from the original list identified for this category include:

- Hearing and auditory dysfunction data for any geography lower than the federal level;
- Neurological disease data for any geography lower than the federal level;
- Health statistics were reported by King County by combining the Cities of SeaTac and Tukwila into one category;
- Health statistics were reported by King County by combining the Cities of Des Moines and Normandy Park into one category; and,
- Health statistics at a finer grain of detail (such as census tract or enumeration district) for the years 1997 through 2018.

There were no information gaps for the revised list of indicators reported.

I. WHAT WE HEARD FROM THE PUBLIC

During this study, the Consultant Team heard comments from the public during community meetings, stakeholder interviews, and monthly Technical Advisory Committee meetings. The following is a summary of this citizen input by topic area:

- **Airport Proximity Influences Health Statistics**

  Many community members believed the rates of certain illnesses within their communities were disproportionately higher than either other communities in the Study Area or elsewhere in the region. Residents of Tukwila and SeaTac zip codes were said to have shorter life spans, more heart issues, and diabetes. Some community members expressed more general concerns such as a belief that that incidents of lung and brain cancer were higher in communities located south of Seattle-Tacoma International Airport, along with a higher frequency of strokes, asthma, COPD and auto-immune disease. In terms of the rates of illnesses being higher in the Study Area Cities, the data presented and analyzed earlier in this Section generally confirms that there is a higher occurrence of certain, but not all illnesses.

- **Airport Proximity Exceeds Appropriate Health Standards**

  Others cited reports or organizations with information that confirmed their contention that illnesses in the immediate vicinity of Seattle-Tacoma International Airport exceeded appropriate standards. One was a Washington Department of Health Study that found cancer rates to be higher in all of the Study Area Cities located closest to the Airport, and cancers in children up by 50% . Another said that Seattle Public Health identified an increase in neuroplasticity. A third study was mentioned, prepared by the Department of Ecology in 2001, that reportedly concluded the number of respiratory, cardiovascular, brain and organ diseases were statistically more significant within one mile of Seattle-Tacoma International Airport. The above studies could not be reviewed in the context of this Study, and therefore the reported information could not be confirmed.

- **Noise-Induced Health Concerns**

  Several community members expressed concern regarding illnesses caused by aircraft-related noise impacts, including those resulting from frequent sleep disruption and corresponding stress. One person mentioned the excessive noise produced by late-night flights headed to China. This assumption could not be confirmed nor disputed since data regarding auditory-related impacts were not available at levels of geography that would be meaningful to the findings of this Study.

- **Port Programs and Other Efforts (Sustainability and Fly Quiet) Have Been Ineffective**

  Community members seemed aware of the Port's participation in the Federal Aviation Administration's Sustainability Program and the Airport's voluntary Late Noise Limitation Program. Observations, or assumptions, regarding the effectiveness of the Port's efforts to revise certain practices associated with the Sustainability Program were confined to Airport properties, and not for the benefit of the surrounding communities. In terms of nighttime curfews, some individuals thought the Port was reluctant to enforce stated goals for fear it could jeopardize their status as a major gateway to Asia. This assumption could not be confirmed nor disputed since available information related to this program was limited to what is presented on the Port's website.

- **Previous Noise Mitigation Packages are Ineffective**

  As noted previously in this document, many residents of the Study Area have noted the ineffectiveness and – in some cases – failure mitigation efforts by the Port of Seattle to insulate homes to decrease ambient noise. Complaints ranged from failed window systems to insulation that significantly reduces the home's air exchange, resulting in mold and stale air. Some residents reported that mold was also affecting their health. While homes are not currently eligible for "re-mitigation" (based on the terms of the previous Port agreement), Rep. Tina Orwall is currently sponsoring legislation to address these concerns in the Washington legislature.

- **The Port of Seattle is not Responsive to the Cities in the Study Area**
  In terms of the Port of Seattle's governance, a comment was made that meetings of the Authority are held in Seattle and SeaTac, but that Commissioners are elected at-large, with the current board occupied by individuals who live in the northern portion of the Metro Area, giving them "no reason to be responsive to South King County residents." In terms of the Commissioners' willingness to respond to South King County concerns, this information could not be confirmed nor disputed.

- **Impact of NextGen Has Enhanced Adverse Impacts**
  As explained previously, NextGen is an automated system that determines establishes flight routes in a manner intended to increase efficiencies and reduce costs. According to some community members, however, it effectively concentrates (or intensifies) aircraft-related noise over a narrower area, a geography one citizen described as a "superhighway." Based on the findings from the study of noise impacts on the health of residents in the vicinity of LaGuardia Airport, and assuming they are accurate, these comments from community members appear accurate.

Other comments regarding noise relate primarily to the practices of certain airlines and types of flights (cargo versus passenger). For instance, it was suggested that some airlines need to raise their glide slope to 3.0 degrees rather than ascending "low and slow." Another said the use of reverse thrust to slow aircrafts down was a problem, and that if it wasn't necessary, they assumed the "dome of noise issues would go away."

Finally, still other community members surmised that air-related noise was louder at night because of the lack of ambient background noise caused by highway traffic during the daytime hours. This assumption could not be confirmed nor disputed given the scope of this assignment.

J. RECOMMENDATIONS

To address the principal issues identified in this Section, the following recommendations are proposed.

- **Public Health Recommendation #1 – Establish an Independent Noise Monitoring Authority**
  Together with the Port of Seattle, the Study Area Cities should investigate the feasibility of establishing an independent noise monitoring authority. Collectively, members could decide if thresholds for noise established by the Federal Aviation Authority are adequate given local circumstances, as well as appropriate strategies for mitigating impacts.

- **Public Health Recommendation #2 – Expand the Study Area**
  In order to determine the comprehensive public health impacts of operations at Seattle-Tacoma International Airport, public health statistics should also be collected for areas north and northeast of the Airport. This would include West Seattle, Beacon Hill, and potentially the city of Renton. Given the presence of two other airports (Boeing Field/King County International Airport and Renton Municipal Airport), those facilities should also be taken into consideration.

- **Public Health Recommendation #3 – Develop More Detailed Public Health Statistics**
  The information reviewed collected data at the municipal level. In some cases, statistics of two neighboring communities was combined (SeaTac/Tukwila and Des Moines/Normandy Park). To get a more accurate depiction of the spatial distribution of various health metrics, this information should be gathered at the census tract or enumeration district level. (While reporting by street address would be ideal, it might be prohibited under HIPAA standards.) Such information could be overlaid with noise contours and flight tracks to see if there are correlations between aircraft activity and certain health outcomes.

- **Public Health Recommendation #4 – Approve/Reauthorize Bills to Address Mitigation**
  Request that the State Legislature reauthorize bills associated with the mitigation of residential properties, addressing multiple areas including past efforts that were either insufficient or that have not maintained their effectiveness; as well as properties in other communities that were not included in the initial round of funding. Investigate potential sources of funding to finance improvements (i.e., airport facility fee charged for the benefit of the Study Area Cities.) As of the writing of this report, a draft bill is pending to address homes that were mitigated under the previous Port of Seattle packages.

- **Public Health Recommendation #5 – Audit Local Building and Zoning Standards**
  Conduct an audit of the building and zoning codes for all Study Area Cities to identify any inconsistencies between local regulations and federal rules. Establish a unified system of rules in order to ensure equity among the communities.

- **Public Health Recommendation #6 – Identify New Construction Potentially Impacted by Airport Use**
  Identify relevant organizations that should be included as referral agencies for any new construction (residential or commercial) that may be impacted by air-related impacts (i.e., Puget Sound Clean Air Agency).

- **Public Health Recommendation #7 – Establish a Health Impact Assessment Process**
  The Study Area Cities should consider establishing a requirement that new construction projects (of a certain size and type) include preparation of a Health Impact Assessment (HIA). Health is emerging as a significant aspect of many real estate projects, as is how real estate developments affect the health of its users and occupants, along with the community at-large. An HIA is an evidence-based process that engages the community, gathers health-related information, and identifies strategies to improve community and individual health. This tool could serve both the developer and city, as well as inform future plans and policies.

- **Public Health Recommendation #8 – Require Alternative Fuel Use for Airport Users**
  Request the State Legislature establish an alternative fuels requirement on users of Port of Seattle facilities, that could be phased in as deemed feasible.

- **Public Health Recommendation #9 – Expand the Late Night Noise Limitation Program**
  Encourage the Port of Seattle to expand the Late Night Noise Limitation Program in ways that address community concerns, including:
  - Limiting runways and flight patterns that align with the Pacific Highway rather than established neighborhoods, during certain hours;
  - Accessing a graduated charge for landings and take-offs with lower fees charged during desirable hours and vice versa; and,
  - Relocate late-night cargo traffic to an alternative airfield.

- **Public Health Recommendation #10 – Replant Trees in the Study Area**
  Whereas construction of third runway reportedly necessitated the removal of several old growth trees, and whereas they were effective at absorbing some level of noise and toxins, consider establishing a replanting program in strategically advantageous locations (ensuring this uses tree and landscape species that repel and discourage bird nesting and feeding).

- **Public Health Recommendation #11 – Expand Port Efforts to Promote Public Health**
  Based on review of information associated with the Port of Seattle's efforts to further strategic initiatives associated with the Federal Aviation Administration's Airport Sustainability Program, it appears a limited emphasis has been placed on efforts to enhance the health and welfare of residents in the Study Area Cities, despite the fact that among its stated goals is to: "help achieve social progress by advancing a broad set of actions that ensure organizational goals are achieved in a way that is consistent with the needs and values of the local community." Existing programs including the Noise Compatibility Program and the Voluntary Airport Low Emissions (VALE) program should be adopted by the Port of Seattle. These and other solutions should be funded through the Airport Improvement Program grant funds.

K. THE FUTURE

Impacts on public health are influenced by numerous factors. And in the past two decades, there has been a national increase in the awareness and appreciation of healthy lifestyles. The incidents of some diseases has decreased, while there has been a rise in other issues, such as obesity.

As with other metrics addressed in this report, the future of public health may be impacted by the rise of certain technologies and consumer habits:

- **Consumer Demands for More Walkable Communities**
  Walkability is one of the top-selling amenities of new and old communities. Encouragement of walking between destinations not only improves health, it can reduce traffic, reduce air pollution, and reduce dependence on fossil fuels.

- **Consumer Demands for More Parks and Open Space**
  As with walkability, access to nearby parks and open space is a significant selling point, often raising property values or rents by as much as 25%. Access to parks and open space improves health, creates a more cohesive community, and has been found to make people happier. As the Study Area Cities promote more parks and open space, there should be a parallel improvement in certain health metrics.

- **Increased Use of Health-Related Wearable Technology**
  Step counters and activity trackers have been available for several years. The proliferation of smart watches and other wearable technology has raised health awareness and improved outcomes for some users. The increasing sophistication of these devices may also help supplant the need for in-person medical visits, thus saving money and lives. Similar advances in telemedicine and medical consultations video chat can benefit some users who currently do not (or cannot) seek medical attention.

- **Changes in Consumer Expectations**
  There has been an increased demand for locally-sourced produce and food ("locavore" culture), including community gardens, farm-to-table dining, and other healthy habits. This movement is expected to continue and increase over time. This should have beneficial consequences within the Study Area Cities.

- **Changes in the Provision of Healthcare Services**
  For many people, the cost of healthcare services is a major impediment to receiving proper medical attention. And for some, medical debt has been a significant factor in declaring personal bankruptcies. It is unknown at this time if there will be substantial changes in healthcare and insurance practices to increase coverage for people who are currently under-insured or uninsured.

L. SUMMARY

A widely-held narrative in the Study Area is that the health of the residents is being negatively impacted by activities at Seattle-Tacoma International Airport. The data available for the 2020 Study does not support a direct causation between Airport activity and poor health. Without additional detailed data, there appears to be a coincidental relationship at this point, rather than a co-relational one.

The health statistic reviewed for the Study Area Cities point to increased incidences of cancer and heart disease. There are also areas where Alzheimer's Disease and respiratory disease are at or above the average rate for King County. These may be in part due to a higher rate of poor health habits and risk factors in the Study Area (such as smoking, no exercise, smoking during pregnancy, etc.). Regardless, life expectancy in the Study Area Cities is almost equal to the average for the State of Washington and the US and is only slightly below the King County average.

There are numerous factors that may also be impacting human health outcomes, including but not limited to:

- Genetic pre-disposition/family history;
- Ethnic predisposition to certain illnesses;
- High-risk/high-stress occupations;
- Poor health habits;
- Ability to pay for medical services;
- Under-insured or not insured.

As discussed in Section 7 (Groundwater & Soil Quality), another potential source of health impacts is the now-closed Asarco Tacoma Smelter. According to Ecology's Site Summary Page, "For almost 100 years, the Asarco Company operated a copper smelter in Tacoma. Air pollution from the smelter settled on the surface soil over more than 1,000 square miles of the Puget Sound basin. Arsenic, lead, and other heavy metals are still in the soil as a result of this pollution."

The health data as reported is not at a detail conducive to a finer grain of analysis. Information is required at a more localized level so it can be mapped and comparted with activities associated with Seattle-Tacoma International Airport, including noise contours, air quality, and other external factors. Additionally, information from other potentially impacted areas – such as West Seattle, Beacon Hill, and Renton – should also be studied to determine the health profile of all communities in the vicinity of Seattle-Tacoma International Airport or similar facilities (including Boeing Field/King County International Airport).

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SECTION 13

SOCIO-ECONOMICS

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SECTION 13

SOCIO-ECONOMICS

A. INTRODUCTION

The scope of work for this study identified statistics related to the following conditions as appropriate measures of socio-economics in both the Study Area Cities and other jurisdictions located north of Seattle-Tacoma International Airport:

- Demographic profile;
- Income including poverty status;
- Housing profile;
- Education-related characteristics;
- Economic and land use development;
- Employment; and,
- Municipal tax revenues.

The discussion that follows includes a description and analyses of: each of the above indicators; positive, neutral and negative socio-economic impacts; comments received from individuals and representatives involved in the study process, along with clarifying responses; and recommendations for ongoing investigation, as well as possible strategies to mitigate adverse influences.

B. TRENDLINE ANALYSIS: DEMOGRAPHIC PROFILE

In order to establish a context and order of magnitude for several of the measures of quality of life, this discussion begins with a summary of key demographic characteristics.

The Study Area is comprised of six (6) cities, all located in King County. King County, with a population of approximately 2.2 million residents, is the largest of three (3) counties which comprise the Seattle Metropolitan Area (Metro Area) and is comprised of 42 cities and towns. The other two (2) counties, Snohomish and Pierce, with approximately 720,000 and 810,000 residents, respectively, comprise the remainder of the Metro Area.

Figure 13.1 presents population growth trends in the Study Area Cities over the past 21 years, as compared to King County. (Rows shaded in blue for 1997, 2009, and 2018 represent the three milestone years for the 2020 Study.)

As shown, population growth during the last several years of the analysis period (2009-2018) outpaced growth from 1997 to 2008 in every Study Area City but Tukwila. With the exception of Burien, none of the Study Area Cities grew as fast as King County overall during the past 21 years. In addition, Burien is the only Study Area City which grew at an average annual rate of greater than 1.0% since 2008. As noted in Section 2, Burien much faster in 2010 as a result of an annexation of the southern portion of the North Highline area, adding 14,292 new residents and 1,600 acres.

Figure 13.1
Population of Study Area Cities In and Including King County: 1997-2018

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
1997	29,139	27,692	79,237	6,517	24,123	16,416	**1,659,106**
1998	29,123	27,948	80,964	6,477	24,768	16,672	**1,686,266**
1999	31,346	28,906	81,999	6,434	25,259	16,905	**1,712,122**
2000	31,881	29,267	83,259	6,392	25,496	17,181	**1,737,046**
2001	31,957	29,558	83,965	6,376	25,537	17,321	**1,755,487**
2002	32,161	29,530	84,022	6,358	25,514	17,487	**1,777,514**
2003	31,995	29,193	83,723	6,260	25,444	17,477	**1,788,082**
2004	31,780	29,133	83,833	6,383	25,558	17,575	**1,800,783**
2005	31,839	29,074	86,263	6,336	25,714	17,560	**1,814,999**
2006	32,020	29,166	86,944	6,347	25,930	18,486	**1,845,209**
2007	32,567	29,291	87,823	6,338	26,329	18,655	**1,871,098**
2008	32,847	29,443	88,548	6,298	26,654	18,814	**1,891,125**
2009	33,314	29,613	89,001	6,314	26,643	18,939	**1,909,205**
2010	33,313	29,673	89,306	6,335	26,909	19,107	**1,931,249**
2011	47,660	29,680	89,370	6,345	27,110	19,407	**1,908,379**
2012	47,730	29,700	89,460	6,521	27,210	19,677	**1,940,977**
2013	48,030	29,730	89,720	6,562	27,310	19,765	**1,974,567**
2014	48,240	30,030	90,150	6,633	27,620	19,921	**2,008,997**
2015	48,810	30,100	90,760	6,694	27,650	19,300	**2,045,756**
2016	50,000	30,570	93,670	6,700	27,810	19,540	**2,079,550**
2017	50,680	30,860	96,350	6,698	28,850	19,660	**2,118,119**
2018	51,908	32,364	97,044	6,660	29,239	20,294	**2,233,163**

Source: US Census Bureau, American Community Survey, ESRI, and Ricker Cunningham.

ESRI's Updated Demographics include current-year estimates and 5-year projections of US demographic data. ESRI develops the annual demographic datasets using a variety of sources, beginning with the latest base, then adding a mixture of administrative records and private sources to capture changes.

Figure 13.2 presents the concentration of persons under the age of 18, as compared to King County. Population under 18 years of age is an indicator of family households.

Figure 13.2
Population Under 18 Year in Study Area Cities and King County: 2013-2017

xxx above County % xxx below County % **xxx** King County %

City	2013- 2017
City of Burien	23.6%
City of Des Moines	20.1%
City of Federal Way	23.6%
City of Normandy Park	17.0%
City of SeaTac	22.6%
City of Tukwila	23.1%
King County	**20.7%**

Source: American Community Survey and Ricker Cunningham

As shown, Burien (23.6%), Federal Way (23.6%), SeaTac (22.6% and Tukwila (23.1%) have higher populations under the age of 18 than King County (20.7%). Des Moines (20.7%) and Normandy Park (17.0%) both have lower populations under the age of 18 than King County.

Figure 13.3 presents the concentration of persons age 65 and over, as compared to King County and the State Washington. The age 65 and over population figures are further delineated by 5-year increments.

Figure 13.3
Population Age 65 and Over in Study Area Cities, King County and Washington State: 2013-2017

xxx above County %e xxx below County % **xxx** King County %

Indicator	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County	Washington State
% 65 to 69	4.0%	4.8%	4.2%	6.7%	4.6%	4.1%	**4.4%**	**5.1%**
% 70 to 74	3.6%	4.1%	3.3%	4.2%	2.3%	2.5%	**3.0%**	**3.6%**
% 75 to 79	2.7%	2.6%	2.3%	3.8%	1.0%	0.8%	**1.9%**	**2.3%**
% 80 to 84	1.8%	2.4%	1.5%	2.3%	1.0%	0.9%	**1.4%**	**1.6%**
% 85+	1.4%	2.9%	1.6%	5.7%	1.2%	1.5%	**1.8%**	**1.8%**
Total 65 and over	**13.5%**	**16.8%**	**12.9%**	**22.7%**	**10.1%**	**9.8%**	**12.5%**	**14.4%**
% Households with Population 65+	**26.5%**	**30.3%**	**24.8%**	**41.6%**	**21.0%**	**20.1%**	**22.2%**	--

Source: US Census Bureau; American Community Survey; ESRI; and Ricker Cunningham

Not surprisingly, among the Study Area Cities, Des Moines (16.8%) and Normandy Park (22.7%) have the highest concentrations of residents age 65 and over, and both have higher concentrations than either King County or the State of Washington. Burien (13.5%) and Federal Way (12.9%) have similar populations age 65 and over as compared to King County, but both cities are lower than the State figure. Des Moines (30.3%) and Normandy Park (41.6%) also have the highest share of households which include persons age 65 and over.

Figure 13.4 presents median age estimates for the Study Area Cities, as compared to King County and the State Washington.

Figure 13.4
Median Age – Study Area Cities and King County: 2013-2017

xxx above County median xxx below County median **xxx** King County median

City	2013-2017
City of Burien	38.4
City of Des Moines	40.5
City of Federal Way	36.4
City of Normandy Park	50.2
City of SeaTac	34.1
City of Tukwila	34.6
King County	**37.2**
Washington State	37.6

Source: American Community Survey and Ricker Cunningham

Persons of Hispanic Origin may be of any race. The Diversity Index measures the probability that two people from the same area will be from different race/ ethnic groups.

As shown, Normandy Park (50.2), Des Moines (40.5) Burien (38.4) all have median ages well above those for King County (37.2) and the State of Washington (37.6).

Figure 13.5 presents the ethnic profile for the Study Area Cities, as compared to King County.

Figure 13.5
Study Area Cities and King County Ethnicities: 2013-2017

xxx above County % xxx below County % **xxx** King County %

City	Hispanic	African-American	Asian	American Indian
City of Burien	24.3%	9.3%	14.2%	3.9%
City of Des Moines	18.2%	8.5%	16.5%	3.3%
City of Federal Way	18.1%	14.3%	17.3%	3.0%
City of Normandy Park	3.8%	1.1%	7.9%	0.1%
City of SeaTac	18.3%	26.3%	19.8%	3.1%
City of Tukwila	15.0%	22.7%	26.9%	4.9%
King County	**9.5%**	**8.1%**	**19.6%**	**2.2%**

Source: US Census Bureau, American Community Survey, ESRI, and Ricker Cunningham

As shown, all of the Study Area Cities, with the exception of Normandy Park, have higher Hispanic, African American and American Indian populations than King County. Burien (24.3%), SeaTac (26.3%) and Tukwila (4.9%) have the highest Hispanic, African American and American Indian populations, respectively. With respect to Asian populations, only SeaTac (19.8%) and Tukwila (26.9%) have higher populations than King County. In terms of overall ethnicity (non-white) populations, all of the Study Area Cities, with the exception of Normandy Park, have a higher degree of overall ethnicity. Tukwila and SeaTac have a significantly higher level of ethnicity than other Study Area Cities and King County.

Summary: Demographic Profile

In general, the Study Area has grown at a slightly slower pace than the average for King County since 2000. (The exception is Burien, which showed a large growth rate, due mostly to the 2010 annexation.) But the Study Area is not uniform when it comes to its demographic characteristics in comparison to King County:

- Burien's population shows higher averages for under 18 and 65-plus. It shows higher averages for residents that self-identify as Hispanic, African American, and American Indian;
- Des Moines' population skews slight older (higher averages for 65-plus). Like Burien, Des Moines shows higher averages for residents that self-identify as Hispanic, African American, and American Indian;
- Federal Way's population is close to the County average. Like Burien and Des Moines, Federal Way shows higher averages for residents that self-identify as Hispanic, African American, and American Indian;
- Normandy Park's population skews much older than the County average and has a much higher median age. It also shows a low percentage of minority residents;
- SeaTac's population generally skews younger (higher averages for under 18), and with a higher percentage of residents that self-identify as Hispanic, African American, Asian, and American Indian; and,
- Tukwila is similar to SeaTac, with a generally younger population (higher averages for under 18), and with a higher percentage of residents that self-identify as Hispanic, African American, Asian, and American Indian.

From the data reviewed, it is not possible to determine if proximity to Seattle-Tacoma International Airport has impacted the demographic composition of the Study Area. The Study Area is not monolithic and varies from an older and less diverse enclave community (Normandy Park) to younger and more diverse areas (SeaTac and Tukwila). The data was reported on a citywide level for each Study Area City, so there may be more diversity at the neighborhood and block levels that is not represented by the data.

C. TRENDLINE ANALYSIS: INCOME

Figure 13.6 presents median household income growth for the Study Area Cities, as compared to King County and the State of Washington.

Figure 13.6
Median Household Income for Study Area Cities, King County and Washington State: 2009-2019

xxx below County median | xxx above County median | **xxx** King County median

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County	Washington State
2009	$51,846	$59,319	$56,980	$80,511	$45,595	$44,262	**$67,246**	$56,384
2010	$51,995	$59,577	$56,509	$73,333	$48,341	$44,271	**$68,065**	$57,244
2011	$51,858	$60,762	$55,846	$80,333	$48,319	$43,887	**$70,567**	$58,890
2012	$50,595	$60,989	$57,583	$84,792	$49,414	$43,333	**$71,175**	$59,374
2013	$50,805	$59,799	$55,872	$84,679	$46,328	$43,331	**$71,811**	$59,478
2014	$52,140	$58,308	$54,186	$90,446	$45,573	$44,820	**$73,035**	$60,294
2015	$53,712	$58,057	$55,673	$89,736	$45,985	$45,923	**$75,302**	$61,062
2016	$54,546	$59,948	$58,855	$89,425	$48,487	$48,490	**$78,800**	$62,848
2017	$60,732	$60,814	$62,086	$95,313	$51,025	$51,318	**$83,571**	$66,174
2018	$62,792	$65,768	$65,507	$102,532	$54,009	$54,011	**$87,956**	$67,512
2019	$64,851	$70,722	$68,927	$109,751	$56,992	$56,703	**$92,340**	$68,876

Source: US Census Bureau, American Community Survey, ESRI, and Ricker Cunningham

Income represents the preceding year, expressed in current dollars. Household income includes wage and salary earnings, interest dividends, net rents, pensions, SSI and welfare payments, child support, and alimony.

As shown, all of the Study Area Cities exhibited median household income growth similar to, or higher than, the State as a whole, but only Normandy Park (3.15%) had a similar growth rate as King County. Among Study Area Cities, only Normandy Park ($109,751) had a higher current median household income than King County ($92,340). Tukwila ($56,703) and SeaTac ($56,992) have the lowest median household incomes among Study Area Cities.

Figure 13.7 highlights the share of households that are receiving income assistance within the Study Area Cities, as measured by public assistance, food stamps or supplemental nutrition assistance, and households with incomes below the poverty level.

Figure 13.7
Study Area Cities Households Receiving Income Assistance: 2013-2017

Indicator	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila
% of Households with Public Assistance	13.1%	10.0%	11.4%	2.5%	3.8%	18.3%
% of Households with Food Stamps/SNAP*	3.5%	3.2%	5.4%	0.0%	19.2%	4.5%
% of Households with Income Below Poverty Level	16.8%	14.5%	19.2%	2.2%	13.3%	25.8%

* Supplemental Nutrition Assistance Program

Source: US Census Bureau, American Community Survey, ESRI, and Ricker Cunningham

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Among the Study Area Cities, Tukwila (18.3%) had the highest share of households with public assistance, followed by Burien (13.1%) and Federal Way (11.4%). SeaTac (19.2%) had the highest share of households with Food Stamps or Supplemental Nutrition Assistance (SNAP), followed by Federal Way (5.4%) and Tukwila (4.5%). Lastly, Tukwila (25.8%) and Federal Way (19.2%) have the highest share of households with incomes below the poverty level. These indicators seem to somewhat reflect household incomes shown in Figure 13.6.

Summary: Income

In 2019, the average household income in King County was $92,340. Normandy Park was the wealthiest community relative to the Study Area ($109,751). Tukwila reported the lowest household income ($56,703) – almost half of the Normandy Park amount. The remainder of the Study Area was between 23% and 38% lower than the County average. Tukwila also had the highest percentage of households receiving public assistance, with Normandy Park showing the lowest.

From the data reviewed, it is not possible to determine if proximity to Seattle-Tacoma International Airport has impacted the demographic composition of the Study Area. The Study Area is not monolithic and varies from an more affluent and more residential community (Normandy Park) to younger and to areas with lower household incomes, but more no-residential land uses (Tukwila). Additional study would be necessary to determine the contributing factors as evidenced by the data available.

D. TRENDLINE ANALYSIS: EDUCATION-RELATED CHARACTERISTICS

The 1997 Study cited a report prepared for the Highline School District that studied noise impacts on classroom performance at Sunset Junior High School, located approximately six blocks from the end of one of Seattle-Tacoma International Airport's runways. The study was conducted in 1973, prior to construction of the Third Runway, but referenced in the 1997 Study to explain similar impacts that might result from this expansion of the Airport's facilities. While the noise study generally sought to understand the effect of Airport-related noise on the ability of teachers to teach and students to learn, it compared the ability of students in insulated classrooms with those in un-insulated classrooms to concentrate and stay on-task during a math test. Findings from the study showed that students in the sound proofed rooms performed, on average, 10% to 18% better than the students in the non-sound proofed rooms.

In order to gauge the quality and health of education in the Study Area Cities, the following indicators were analyzed:

- Early childhood enrollment (preschool and kindergarten)
- Educational attainment (bachelor's degree or higher)
- Student test scores
- Student demographics (race/ethnicity, language spoken at home, socio-economic status)
- Student health (overweight or obese, physical activity, screen time, and mental health)

Figure 13.8 presents the enrollment status of preschool- and kindergarten-age children for the Study Area Cities, as compared to King County. Children enrolled in early education are generally believed to be better prepared for academic achievement in later school years.

Figure 13.8
Population 3+ Years Enrollment Status in the Study Area Cities and King County: 2013-2017)

xxx below County % | xxx above County % | **xxx** King County %

Indicator	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
% Enrolled in Preschool	1.4%	1.2%	0.9%	1.8%	1.3%	1.1%	**1.7%**
% Enrolled in Kindergarten	1.7%	1.6%	1.4%	0.3%	1.1%	1.5%	**1.3%**

Source: US Census Bureau, American Community Survey, ESRI, and Ricker Cunningham

As shown, Burien (3.1%) is the only Study Area City whose share of preschool- and kindergarten-age children enrolled in school compares favorably to that of King County. Normandy Park (2.1%) has the lowest enrollment share but has a significantly lower school age population than other Study Area Cities.

Figure 13.9 presents educational attainment figures for the Study Area Cities, as compared to King County and the State of Washington.

Figure 13.9
Percent of Population Holding a Bachelor's Degree or Higher – Study Area Cities, King County and Washington State: 2009-2019

xxx below County % xxx above County % **xxx** King County %

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County	Washington State
2009	25.6%	23.0%	25.6%	46.8%	13.8%	17.6%	**44.8%**	30.8%
2010	25.3%	21.5%	25.3%	44.4%	15.3%	18.3%	**45.2%**	31.0%
2011	26.5%	21.4%	26.5%	46.9%	14.6%	18.8%	**45.7%**	31.4%
2012	24.0%	20.8%	24.0%	48.1%	16.4%	20.1%	**46.0%**	31.6%
2013	24.0%	22.8%	24.0%	52.1%	18.2%	21.2%	**46.6%**	31.9%
2014	23.1%	23.0%	23.1%	53.7%	18.8%	21.7%	**47.1%**	32.3%
2015	23.7%	23.5%	23.7%	53.6%	18.7%	21.4%	**47.9%**	32.9%
2016	24.9%	24.3%	24.9%	52.9%	19.9%	21.5%	**49.1%**	33.6%
2017	26.2%	25.1%	26.2%	54.6%	20.8%	21.9%	**50.3%**	34.5%
2018	27.3%	26.5%	27.0%	55.4%	21.7%	22.9%	**51.1%**	35.0%
2019	28.3%	27.9%	27.8%	56.2%	22.5%	23.9%	**51.8%**	35.5%

Source: US Census Bureau, American Community Survey, ESRI, and Ricker Cunningham.

With the exception of Normandy Park (56.2%), all of the Study Area Cities exhibited lower shares of the population with a bachelor's degree than both King County (51.8%) and the State (35.5%). While SeaTac (22.5%) and Tukwila (23.9%) have the lowest shares of the population with a bachelor's degree, they have exhibited the fastest growth in this population over the past 10 years.

There are 19 school districts in King County, 15 of which are either located within the Study Area Cities or north of the Seattle-Tacoma International Airport. Figure 13.10 presents school district performance within the Study Area Cities, as compared to Statewide figures. Performance in this context is measured by the percent of students meeting state standards in Arts and Math over the past 5 years.

Of the School Districts that are within or proximate to the Study Area Cities, Auburn, Federal Way, Highline, Kent, Renton and Tukwila have performed at lower levels than Statewide levels as a whole over the past five years. Districts which are located to the north of the Study Area Cities (Seattle, Shoreline, Northshore, and Bellevue) have performed at higher levels than Statewide levels as a whole, over that same time period. Vashon Island School District, which is located in the Puget Sound, west of the Study Area Cities, also performed at higher levels than the Statewide levels.

Figure 13.11 presents student demographic characteristics for the School Districts noted in Figure 13.10. Indicators evaluated include: race/ethnicity; language spoken at home; and socio-economic status.

Figure 13.10
Students Meeting State Standards – Study Area, Various School Districts and State Average: 2014-2019

xxx below State % xxx above State % **xxx** State %

School District	2014-2015		2015-2016		2016-2017		2017-2018		2018-2019	
	Arts	Math	Arts	Math	Arts	Math	Arts	Math	Arts	Math
Auburn	51.0%	48.7%	59.2%	48.2%	56.6%	49.5%	55.9%	49.1%	55.4%	45.7%
Bellevue	67.0%	65.3%	79.9%	65.8%	78.5%	64.2%	78.2%	73.6%	77.8%	71.7%
Federal Way	41.5%	33.7%	50.6%	34.5%	45.7%	33.8%	46.0%	34.5%	45.8%	33.4%
Highline	38.7%	36.9%	47.6%	37.4%	47.0%	36.8%	48.8%	38.6%	47.5%	34.6%
Issaquah	68.4%	65.9%	80.9%	67.5%	79.5%	67.4%	80.0%	75.6%	80.1%	76.0%
Lake Washington	72.8%	67.3%	83.2%	68.7%	82.0%	72.5%	83.0%	77.4%	83.2%	77.5%
Kent	46.9%	43.7%	58.8%	48.7%	57.7%	48.3%	57.5%	47.8%	56.2%	46.1%
Mercer Island	70.5%	69.1%	84.4%	74.8%	85.7%	72.2%	84.7%	80.9%	85.3%	81.3%
Renton	48.0%	44.6%	57.2%	45.3%	55.6%	45.7%	55.0%	47.3%	53.9%	46.0%
Seattle	55.6%	52.3%	67.0%	57.7%	67.0%	57.4%	69.0%	62.5%	69.8%	61.6%
Shoreline	68.6%	62.3%	77.6%	63.0%	76.9%	60.2%	76.2%	66.4%	74.8%	64.4%
Tahoma	65.0%	59.8%	74.3%	63.4%	73.7%	67.6%	75.4%	66.7%	74.6%	66.5%
Tukwila	39.9%	35.5%	46.9%	37.2%	44.1%	37.6%	41.5%	34.7%	39.0%	30.1%
Vashon Island	61.5%	53.6%	69.5%	57.9%	70.1%	56.0%	72.3%	59.6%	67.6%	55.7%
Washington State	**50.6%**	**44.3%**	**59.8%**	**47.2%**	**58.7%**	**47.4%**	**59.4%**	**49.5%**	**59.6%**	**48.9%**

Source: Washington Office of Superintendent of Public Instruction, and Ricker Cunningham

Figure 13.11
Student Demographics – Study Area School Districts, King County and Washington State: 2012

xxx above County % xxx below County % **xxx** King County%

School District	Race/Ethnicity					Language & Socio-Economic Status (SES)		
	White	Black	Hispanic	Asian	Other	Non-English Speaking at Home	Lower SES	Moderate-Higher SES
Auburn	39.4%	6.2%	17.2%	8.0%	29.2%	28.4%	48.1%	51.9%
Federal Way	30.4%	11.1%	23.0%	14.4%	21.1%	32.2%	32.2%	67.8%
Highline	24.4%	9.5%	26.3%	16.5%	23.3%	41.2%	54.3%	45.7%
Kent	36.9%	10.2%	13.0%	16.1%	23.8%	29.3%	37.9%	62.1%
Tukwila	9.5%	15.4%	20.4%	32.1%	22.6%	60.5%	62.0%	38.0%
Renton	24.6%	13.9%	15.3%	24.7%	21.5%	35.7%	41.1%	58.9%
Seattle	39.0%	13.3%	8.4%	20.4%	18.9%	28.4%	28.4%	71.6%
King County	**45.6%**	**7.4%**	**10.5%**	**17.1%**	**19.4%**	**25.1%**	**29.3%**	**70.7%**
Washington State	52.6%	4.0%	15.0%	7.7%	20.7%	19.3%	36.5%	63.5%

Source: Assessment, Public Health – Seattle & King County, and Ricker Cunningham

All of the School Districts that are within or proximate to the Study Area Cities, have a higher degree of ethnicity among students than either King County of the State of Washington. Tukwila, Highline and Renton school districts have the highest degree of ethnicity. These three cities also have the highest percentage of students living in non-English speaking households. Tukwila, Highline and Auburn school districts have the highest share of students who are considered be of a lower socio-economic status.

Figures 13.12 and 13.13 present student health indicators such as obesity, physical activity and screen time, for Study Area School Districts, as compared to King County and the State of Washington.

Figure 13.12
Student Obesity and Physical Activity – Study Area School Districts, King County and Washington State: 2012

xxx above County % | xxx below County % | **xxx** King County%

School District	Obesity (top 5% BMI)	Overweight or Obese (top 15% of BMI)	Physical Activity ≥ 60 minutes/day	Screen Time > 3 hours/day
Auburn	9%	29%	21%	58%
Federal Way	13%	28%	22%	58%
Highline	13%	29%	23%	57%
Kent	10%	24%	24%	56%
Tukwila	13%	26%	26%	52%
Renton	12%	26%	22%	50%
Seattle	7%	19%	23%	50%
King County	**8%**	**20%**	**23%**	**49%**
Washington State	10%	24%	26%	50%

Source: Assessment, Public Health – Seattle & King County, and Ricker Cunningham

Figure 13.13
Student Health by Socio-Economic Status – Study Area School Districts: 2012

School District	Lower Socio-Economic Status				Moderate-to-High Socio-Economic Status			
	Obesity (top 5% BMI)	Overweight or Obese (top 15% of BMI)	Physical Activity ≥ 60 minutes/day	Screen Time > 3 hours/day	Obesity (top 5% BMI)	Overweight or Obese (top 15% of BMI)	Physical Activity ≥ 60 minutes/day	Screen Time > 3 hours/day
Auburn	13%	29%	21%	58%	11%	25%	24%	46%
Federal Way	16%	33%	20%	59%	11%	24%	30%	56%
Highline	15%	31%	17%	57%	12%	29%	20%	53%
Kent	12%	28%	18%	59%	9%	21%	19%	53%
Tukwila	9%	24%	21%	56%	12%	35%	22%	63%
Renton	11%	25%	19%	59%	13%	28%	20%	58%
Seattle	11%	23%	15%	59%	5%	17%	22%	44%

Source: Assessment, Public Health – Seattle & King County, and Ricker Cunningham.

All of the School Districts that are within or proximate to the Study Area Cities, with the exception of Seattle and Kent, show higher shares of the student population that are considered obese or overweight than either King County or the State of Washington. Auburn (29%), Highline (29%) and Federal Way (28%) represent the school districts with the highest shares of obese or overweight students.

All of the School Districts that are within or proximate to the Study Area Cities, with the exception of Tukwila and Kent, show lower shares of the student population that perform an average of 60 minutes or more of physical activity on a daily basis, as compared to either King County or the State of Washington. Auburn (21%), Federal Way (22%) and Renton (22%) represent the school districts with the lowest shares of physically active students.

All of the School Districts that are within or proximate to the Study Area Cities, with the exception of Seattle, show higher shares of the student population that spend more than 3 hours a day of screen time, as compared to either King County or the State of Washington. Auburn (58%), Federal Way (58%) and Renton (58%) represent the school districts with the highest shares of students exhibiting excessive screen time.

When considering socio-economic status, all of the School Districts show more favorable indicators for students considered to be of a moderate/high socio-economic status.

Figure 13.14 presents student mental health indicators, as measured by the following: considered suicide in last 12 months; planned suicide in last 12 months; or felt hopeless for more than 2 weeks in the last 12 months. These indicators are presented for Study Area School Districts, as compared to King County and the State of Washington.

All of the School Districts that are within or proximate to the Study Area Cities show higher shares of the student population who have considered suicide in the last 12 months than either King County or the State of Washington. Auburn (21%) and Renton (20%) represent the school districts with the highest shares of students who have considered suicide.

Conversely, all of the School Districts that are within or proximate to the Study Area Cities show lower shares of the student population who have planned suicide in the last 12 months than either King County or the State of Washington. Auburn (17%) and Federal Way (17%) represent the school districts with the highest shares of students who have planned suicide.

Lastly, all of the School Districts that are within or proximate to the Study Area Cities show lower shares of the student population who have felt hopeless for more than 2 weeks in the past 12 months than either King County or the State of Washington. Federal Way (34%) and Highline (33%) represent the school districts with the highest shares of students who have felt hopeless for more than 2 weeks in the past 12 months.

Figure 13.14
Mental Health of Students Grade 6 Through 12 – Study Area School Districts, King County and Washington State: 2012

xxx above County % | xxx below County % | **xxx** King County%

School District	Considered Suicide in the Last 12 Months	Planned Suicide in the Last 12 Months	Felt Hopeless for more than 2 weeks in the Last 12 Months
Auburn	21%	17%	32%
Federal Way	18%	17%	34%
Highline	19%	16%	33%
Kent	18%	16%	29%
Tukwila	19%	15%	32%
Renton	20%	16%	31%
Seattle	14%	13%	25%
King County	**8%**	**20%**	**49%**
Washington State	10%	24%	50%

Source: Assessment, Policy Public Health – Seattle & King County, and Ricker Cunningham

Summary: Education

Results were not consistent across the Study Area. Generally, Normandy Park fared better than other Study Area Cities:

- Most Study Area Cities (except for Normandy Park) had fewer percentages of children in pre-school, but higher percentages (or close to County average) in kindergarten;
- Regarding education levels of the Study Area (those with an undergraduate/bachelor's degree), Normandy Park showed a percentage slightly above the King County average, while the percentages for the remaining Study Area Cities were close to half the County average.
- For student performance, results were generally mixed with respect to State standards. Students in the Federal Way, Tukwila, and the Highline School Districts generally underperformed in arts and mathematics from 2014 to 2019. Those same students also self-identified as minority students, many of which came from non-English speaking homes that were considered lower income.
- Student health in the Federal Way, Tukwila, and the Highline School Districts was generally poorer as well, with higher percentage of students listed as overweight or obese, spending longer periods of time each day with a digital device and fewer hours of physical activity. When looked at in more detail, these differences also tended to fall along income lines, with lower income students having poorer health habits.

- Student mental health, however, mixed, with all districts reporting higher than average percentages of students who "considered" suicide in the past 12 months and between a quarter and a third of all students feeling hopeless for more than 2 weeks over the past 12 months.

There is no way to determine from the data reviewed if proximity to Seattle-Tacoma International Airport has negatively impacted or contributed to concerns with education. There are numerous other externalities which may be contributing factors, including household income, a higher reliance on digital devices, a rise in bullying (both in person and online), and other elements.

E. TRENDLINE ANALYSIS: HOUSING PROFILE

Figure 13.15 presents household growth trends in the Study Area Cities over the past 21 years, as compared to King County. (Shaded rows for 1997, 2009, and 2018 represent the three milestone years for the 2020 Study.)

Household population includes persons not residing in group quarters. Average Household Size is the household population divided by total households. Persons in families include the householder and persons related to the householder by birth, marriage, or adoption. Per Capita Income represents the income received by all persons aged 15 years and over divided by the total population.

Households with children include any households with people under age 18, related or not. Multigenerational households are families with 3 or more parent child relationships. Unmarried partner households are usually classified as nonfamily households unless there is another member of the household related to the householder. Multigenerational and unmarried partner households are reported only to the tract level. ESRI estimated block group data, which is used to estimate polygons or non-standard geography.

As shown, household growth during the last several years of the analysis period (2009-2018) outpaced growth from 1997 to 2008 in every Study Area City but Federal Way. With the exception of Burien, none of the Study Area Cities grew as fast as King County overall during the past 21 years. In addition, Burien is the only Study Area City which grew at an average annual rate of greater than 1.0% since 2008.

Figure 13.16 presents household composition indicators for the Study Area Cities, as compared to King County and the State of Washington. Generally, a higher share of nonfamily and one- and two-person households is more indicative of a more transient community, characterized by a significant renter population.

As shown, none of the Study Area Cities show a higher share of nonfamily households than King County. Tukwila (39.2%), SeaTac (37.7%) and Des Moines (36.5%) are the only Study Area Cities that show a higher share of nonfamily households than the State as a whole. With the exception of Normandy Park (66.6%), which has a population that skews significantly older, none of the Study Area Cities have a higher share of one- and two-person households than either King County or the State of Washington.

Impacts considered to adversely impact student performance and outcomes, were attributed to a variety of socio-economic conditions, including: the educational attainment levels of parents in the Study Area; single versus two parent households; female labor force participation; child poverty; and low household income. As explained previously, while this 2019 Study agrees that these factors can have a correlative effect on student outcomes, the 1997 Study attributed the disproportionately high level of these characteristics to the significant number of rental properties in the subject cities at that time. For reasons explained in the introduction to this section, the authors of this Study believe it would be erroneous to continue to use housing tenure alone, as a predictor of student outcomes. Rather, this Study assumes household income, and to a certain extent concentrations of select ethnic groups, to be a more accurate predictor of this and other circumstances.

Figure 13.15
Households in the Study Area Cities and King County: 1997-2018

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
1997	12,350	11,017	30,458	2,608	9,698	7,089	**679,940**
1998	12,343	11,015	30,936	2,609	9,698	7,122	**690,768**
1999	13,285	11,300	31,145	2,609	9,699	7,144	**701,042**
2000	13,399	11,377	31,437	2,609	9,708	7,186	**710,918**
2001	13,377	11,469	31,658	2,606	9,652	7,161	**718,278**
2002	13,379	11,482	31,640	2,602	9,543	7,147	**727,049**
2003	13,238	11,398	31,439	2,565	9,470	7,062	**731,203**
2004	13,080	11,419	31,421	2,619	9,429	7,022	**735,653**
2005	13,021	11,327	32,278	2,603	9,431	6,938	**740,491**
2006	13,029	11,379	32,476	2,611	9,438	7,227	**752,639**
2007	13,173	11,470	32,751	2,611	9,477	7,214	**763,363**
2008	13,213	11,539	32,976	2,598	9,588	7,198	**772,474**
2009	13,327	11,617	33,106	2,608	9,476	7,169	**779,873**
2010	13,253	11,664	33,188	2,620	9,533	7,157	**789,232**
2011	14,148	11,470	34,328	2,756	9,912	7,310	**790,070**
2012	16,477	11,314	33,866	2,672	9,794	7,300	**796,555**
2013	17,488	11,437	33,760	2,638	10,060	7,279	**802,606**
2014	18,266	11,347	34,064	2,595	9,945	7,280	**808,729**
2015	18,273	11,490	34,117	2,633	9,831	7,308	**819,651**
2016	18,609	11,702	34,447	2,688	9,922	7,193	**831,995**
2017	18,606	11,704	34,755	2,807	9,857	7,123	**851,077**
2018	19,057	12,274	35,005	2,791	9,990	7,353	**897,303**

Source: US Census Bureau; American Community Survey; ESRI; and Ricker Cunningham

Figure 13.16
Household Composition – Study Area Cities, King County and Washington State: 2013-2017

xxx above County % xxx below County % **xxx** King County%

City	% of Family Households	% of Non-Family Households	% of 1 and 2 Person Households
City of Burien	65.1%	34.9%	58.3%
City of Des Moines	63.5%	36.5%	62.0%
City of Federal Way	68.2%	31.8%	58.7%
City of Normandy Park	68.1%	31.9%	66.6%
City of SeaTac	62.3%	37.7%	56.6%
City of Tukwila	60.8%	39.2%	53.7%
King County	**60.2%**	**39.8%**	**63.7%**
Washington State	64.7%	35.3%	62.5%

Source: US Census Bureau; American Community Survey; ESRI; and Ricker Cunningham

Figure 13.17 presents the average age of the housing inventory in each of the Study Area Cities, as compared to King County and the State of Washington.

Figure 13.17
Housing Inventory Age – Study Area Cities, King County and Washington State: 2019

xxx above County % xxx below County % **xxx** King County%

City	% of Units Built Before 1970	Median Year Built (all units)	Median Year Householder Moved In
City of Burien	62%	1964	2009
City of Des Moines	44%	1973	2009
City of Federal Way	22%	1982	2009
City of Normandy Park	54%	1967	2003
City of SeaTac	56%	1968	2011
City of Tukwila	48%	1971	2011
King County	**39%**	**1975**	**2010**
Washington State	49%	1970	2007

Source: US Census Bureau; American Community Survey; ESRI; and Ricker Cunningham

With the exception of Federal Way (22%), all of the Study Area Cities have higher shares of housing inventory built before 1970 than King County. When compared to the State as a whole, Burien (62%), SeaTac (56%) and Normandy Park (54%) have higher shares of housing inventory built before 1970.

Again, with the exception of Federal Way (1982), all of the Study Area Cities have older housing stocks than King County. When compared to the State as a whole, Burien (1964), Normandy Park (1967) and SeaTac (1968) have older housing stocks.

Lastly, with the exception of Normandy Park, the most established of the Study Area Cities, all have similar measures of the median year that the current householder moved in, when compared to both King County and the State.

Figure 13.18 presents housing tenure indicators for each of the Study Area Cities, as compared to King County and the State of Washington.

As shown, only Normandy Park (72.0%) and Des Moines (57.9%) have higher shares of owner-occupied households than King County (57.4%). Normandy Park is the only Study Area City with a higher share of owner-occupied households than the State as a whole.

Figure 13.18
Housing Occupancy– Study Area Cities, King County and Washington State: 2019

xxx above County % xxx below County % **xxx** King County%

City	% of Owner-Occupied Households	% of Renter-Occupied Households
City of Burien	53.5%	46.5%
City of Des Moines	57.9%	42.1%
City of Federal Way	57.1%	42.9%
City of Normandy Park	72.0%	28.0%
City of SeaTac	48.5%	51.5%
City of Tukwila	38.3%	61.7%
King County	**57.4%**	**42.6%**
Washington State	62.7%	37.3%

Source: US Census Bureau; American Community Survey; ESRI; and Ricker Cunningham

Figure 13.19 presents housing cost burden by type of household for each of the Study Area Cities, as compared to King County and the State of Washington. The indicator used is the percentage of households spending 30% or more of their income for housing.

Figure 13.19
Housing Cost Burden – Percentage of Households Spending 30% or More off Income on Housing – Study Area Cities, King County and Washington State: 2017

xxx above County % xxx below County % **xxx** King County%

City	% of Owner-Occupied Households	% of Renter-Occupied Households	% of All Occupied Households
City of Burien	30.3%	51.8%	40.3%
City of Des Moines	25.5%	47.9%	35.0%
City of Federal Way	28.1%	51.9%	38.3%
City of Normandy Park	22.2%	44.6%	28.4%
City of SeaTac	29.3%	57.8%	43.9%
City of Tukwila	26.0%	58.4%	46.0%
King County	**25.9%**	**44.3%**	**33.8%**
Washington State	25.1%	46.2%	32.9%

Source: US Census Bureau; American Community Survey; ESRI; and Ricker Cunningham

With the exceptions of Normandy Park (22.2%) and Des Moines (25.5%), all of the Study Area Cities have higher shares of owner-occupied households spending 30% or more of their income for housing, when compared to King County and the State as a whole. This trend is duplicated among renter-occupied households. Cities with the highest housing cost burden are Tukwila (46.0%), SeaTac (43.9%) and Burien (40.3%).

Figure 13.20 presents growth in residential building permits for the Study Area Cities over the past 10 years.

As shown, Federal Way (185), Burien (106) and Des Moines (75) have shown the highest growth in residential building permits over the past 10 years. Des Moines (120) and Tukwila (105) had the highest number of permits in 2018.

Figure 13.20
Housing Development Activity – Study Area Cities Residential Building Permits: 2009-2018

xxx below average xxx above average **xxx** average annual

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila
2009	17	14	36	5	49	5
2010	18	5	50	0	125	1
2011	54	5	57	3	0	6
2012	46	15	78	1	7	11
2015	418	147	773	7	19	32
2014	42	38	557	6	2	16
2013	51	23	111	11	22	18
2016	243	21	56	2	52	30
2017	128	366	62	15	9	14
2018	41	120	65	0	35	105
Average Annual (2009-2018)	**106**	**75**	**185**	**5**	**32**	**24**

Source: Puget Sound Regional Council and Ricker Cunningham

Figure 13.21 presents median home sale prices for the Study Area Cities over the last 10 years, as compared to the Seattle Metro Area as a whole.

Figure 13.21
Median Existing Home Sale Price – Study Area Cities and Seattle Metro Area: 2009-2018

xxx below Metro median | xxx above Metro median | **xxx** Metro median

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	Seattle Metro
2009	- - -	- - -	$227,200	- - -	- - -	- - -	$296,500
2010	- - -	- - -	$241,200	- - -	- - -	- - -	$288,900
2011	- - -	- - -	$162,000	- - -	$193,200	- - -	$245,600
2012	$225,400	- - -	$197,700	- - -	$165,700	- - -	$292,900
2013	$241,900	$211,400	$224,100	- - -	$212,300	$166,300	$308,300
2014	$264,100	$255,600	$240,900	$337,000	$216,300	$188,300	$320,800
2015	$316,700	$281,900	$278,200	$420,700	$259,500	$242,300	$346,200
2016	$346,800	$324,800	$304,200	$470,100	$300,100	$298,800	$375,900
2017	$417,700	$388,200	$341,200	$570,300	$361,200	$354,400	$423,900
2018	$407,300	$385,900	$360,100	$539,100	$371,000	$332,800	$439,600

Source: Zillow, Inc. and Ricker Cunningham

As shown, with the exception of Normandy Park, all of the Study Area Cities have lower median home sale prices than the Seattle Metro Area as a whole. In terms of annual sale price growth, all cities but Federal Way outpaced the overall Metro Area. Tukwila (14.9%), Des Moines (12.8%), and Normandy Park (12.5%) exhibited the highest annual growth rates among Study Area Cities. Interestingly, Federal Way maintains the newest inventory of residential units as measured by median age of total inventory yet commands the second lowest sale prices among the Study Area Cities.

Figures 13.22, 13.23 and 13.24 summarize multi-family market conditions for the Study Area Cities, as compared to King County. Indicators used to measure current and past market conditions include: rental rates per square foot; vacancy rates; and absorption, which is the amount of available space that is newly occupied as a percentage of total inventory.

Figure 13.22
Multi-Family Rental Rates Per Square Foot – Study Area Cities and King County: 2000-2019

xxx below County rate | xxx above County rate | **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	$0.93	$0.84	$0.88	$0.97	$0.84	$0.87	$1.08
2001	$0.97	$0.88	$0.90	$1.02	$0.88	$0.92	$1.10
2002	$0.95	$0.86	$0.91	$1.00	$0.85	$0.89	$1.08
2003	$0.94	$0.86	$0.87	$0.98	$0.84	$0.88	$1.06
2004	$0.96	$0.87	$0.86	$0.99	$0.84	$0.89	$1.06
2005	$0.99	$0.88	$0.87	$1.03	$0.87	$0.92	$1.09
2006	$1.04	$0.94	$0.92	$1.09	$0.93	$0.99	$1.17
2007	$1.11	$1.01	$0.99	$1.16	$1.00	$1.07	$1.28
2008	$1.15	$1.02	$1.02	$1.19	$1.12	$1.08	$1.32
2009	$1.09	$0.97	$0.96	$1.10	$1.04	$1.03	$1.21
2010	$1.13	$1.02	$0.98	$1.14	$1.07	$1.05	$1.24
2011	$1.15	$1.05	$0.99	$1.15	$1.08	$1.07	$1.29
2012	$1.19	$1.09	$1.03	$1.18	$1.12	$1.10	$1.37
2013	$1.25	$1.13	$1.07	$1.21	$1.17	$1.16	$1.47
2014	$1.30	$1.20	$1.14	$1.29	$1.23	$1.21	$1.56
2015	$1.43	$1.36	$1.25	$1.41	$1.36	$1.32	$1.72
2016	$1.57	$1.46	$1.33	$1.44	$1.45	$1.43	$1.83
2017	$1.67	$1.50	$1.40	$1.49	$1.48	$1.49	$1.90
2018	$1.73	$1.53	$1.47	$1.52	$1.55	$1.69	$1.97
2019	$1.75	$1.60	$1.54	$1.62	$1.59	$1.72	$2.06

Source: CoStar, Inc. and Ricker Cunningham

Figure 13.23
Multi-Family Vacancy Rate – Study Area Cities and King County: 2000-2019

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	4.6%	4.9%	3.9%	5.0%	3.6%	3.4%	**5.4%**
2001	7.0%	7.7%	6.1%	6.8%	5.9%	6.6%	**7.7%**
2002	7.8%	8.7%	7.6%	8.2%	7.2%	7.4%	**8.2%**
2003	7.6%	8.3%	7.7%	8.4%	6.6%	7.0%	**7.9%**
2004	7.3%	7.9%	7.5%	8.4%	6.2%	6.5%	**7.6%**
2005	6.5%	6.5%	6.8%	7.1%	5.2%	6.1%	**6.3%**
2006	4.8%	4.9%	5.2%	6.2%	3.3%	4.4%	**5.5%**
2007	4.6%	4.5%	5.1%	6.0%	3.5%	4.4%	**5.4%**
2008	5.8%	6.2%	7.5%	6.9%	5.0%	5.7%	**6.5%**
2009	6.8%	7.0%	7.7%	7.8%	6.2%	6.7%	**7.4%**
2010	6.1%	6.2%	6.2%	7.3%	7.7%	5.5%	**6.6%**
2011	6.1%	6.5%	6.4%	7.4%	6.2%	5.7%	**6.7%**
2012	5.1%	6.0%	5.1%	8.2%	5.1%	5.2%	**6.3%**
2013	4.5%	5.7%	4.7%	7.7%	4.2%	4.2%	**5.7%**
2014	4.2%	4.9%	4.1%	6.8%	3.5%	3.7%	**5.8%**
2015	4.1%	5.3%	4.7%	4.5%	3.6%	3.2%	**5.6%**
2016	4.1%	4.1%	4.5%	5.1%	4.5%	3.4%	**5.4%**
2017	4.5%	4.0%	4.4%	4.7%	3.9%	3.5%	**5.8%**
2018	5.0%	3.4%	4.3%	4.1%	3.8%	3.9%	**5.5%**
2019	5.2%	6.1%	4.2%	4.1%	4.1%	3.6%	**4.9%**

Source: CoStar, Inc. and Ricker Cunningham

Figure 13.24
Multi-Family Absorption Rate (Percentage of Inventory) – Study Area Cities and King County: 2000-2019

xxx below County rate xxx above County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	0.1%	0.0%	-0.4%	2.7%	-0.2%	0.1%	**2.0%**
2001	-2.0%	-2.9%	-2.1%	-2.7%	-2.4%	-3.2%	**-0.2%**
2002	-0.8%	-1.0%	-1.1%	-1.4%	-1.3%	-0.8%	**0.5%**
2003	0.3%	0.4%	2.3%	0.0%	0.5%	0.4%	**1.2%**
2004	0.4%	0.3%	0.3%	0.0%	3.1%	0.6%	**1.1%**
2005	3.3%	1.4%	0.7%	1.4%	1.0%	0.5%	**2.2%**
2006	1.7%	1.6%	1.5%	0.0%	2.0%	1.7%	**2.3%**
2007	0.4%	0.4%	0.2%	0.0%	1.5%	0.0%	**0.9%**
2008	-1.2%	-1.7%	-1.5%	-0.7%	-1.5%	-1.4%	**0.4%**
2009	-1.0%	-0.8%	0.2%	-0.7%	-2.3%	-1.0%	**0.7%**
2010	-5.2%	0.8%	1.5%	0.0%	7.1%	1.2%	**1.8%**
2011	-0.1%	-0.3%	-0.2%	0.0%	0.0%	-0.2%	**0.7%**
2012	1.1%	0.2%	1.3%	0.0%	1.2%	0.6%	**1.8%**
2013	0.6%	0.3%	0.3%	0.0%	0.9%	-1.4%	**2.2%**
2014	1.5%	0.8%	0.6%	0.7%	0.7%	0.5%	**3.1%**
2015	3.2%	-0.5%	3.1%	2.7%	-0.1%	0.6%	**3.3%**
2016	0.0%	1.1%	0.3%	-1.4%	-0.9%	-0.3%	**2.7%**
2017	5.1%	0.0%	2.0%	0.0%	0.5%	-0.1%	**2.4%**
2018	-0.5%	4.7%	0.2%	0.0%	0.1%	11.6%	**3.4%**
2019	-0.2%	4.7%	0.1%	0.0%	-0.3%	0.3%	**2.7%**

Source: CoStar, Inc. and Ricker Cunningham

As shown, average monthly rents in the Study Area Cities range from $1.54 to $1.75 per square foot, all of which are lower than King County's ($2.06). Burien ($1.75) and Tukwila ($1.72) are at the top of the market, with Federal Way ($1.54) and Des Moines ($1.60) at the lower end of the market. In terms of annual rental rate growth, only Tukwila (3.7%) rents grew at a rate higher than King County's (3.5%).

Also reflected, overall vacancy rates in the Study Area Cities range from 3.6% to 6.1%. Only two cities, Des Moines (6.1%) and Burien (5.2%) have higher vacancy rates than King County's (4.9%). Tukwila (3.6%), SeaTac (4.1%) and Normandy Park (4.1%) have the lowest vacancy rates. Normandy Park and King County are the only markets which have shown a decrease in vacancy rate over the past 19 years.

With respect to absorption of multi-family units, only Des Moines is currently outperforming King County. Over the past 2 decades, King County has outperformed all of the Study Area Cities, with Tukwila and SeaTac exhibiting the highest absorption rates among those cities.

Summary: Housing

The Study Area is uniformly composed of more family households (consistently over 60.8%) which is higher than the average for King County. It also tends to have an older housing stock than the County with the exception of Federal Way. Although Burien and Federal Way comprise 60% of the reported the residential building permits on average for the previous ten years, with Normandy Park reporting the fewest.

The Study Area City homes were generally more owner-occupied in Des Moines, Federal Way, and Normandy Park, and renter occupied in Burien, SeaTac, and Tukwila. The relative cost of housing in the Study Area (as a percentage of household income) track closely with King County for owners but is more expensive for renters.

Housing values are a relative bargain compared to the King County average, generally 8% to 25% lower than the County average. But given the Seattle metropolitan area's relative housing costs, these figures may be artificially influenced by the market. Normandy Park, on the other hand, was 122% more expensive than the County average.

Rental rates for Study Area multi-family units were generally below County averages, vacancy rates were lower, indicating more stable multi-family market.

It is not possible to determine from the data reviewed if proximity to Seattle-Tacoma International Airport has impacted the Study Area's housing market. Normandy Park seems to be the most stable and affluent of the Study Area Cities. Given the currently active and expensive housing market in the Seattle metropolitan area, it may also be a contributing factor to housing and rental rates. Additional study would be necessary to determine if Airport proximity is artificially depressing home values.

F. TRENDLINE ANALYSIS: ECONOMIC AND LAND USE DEVELOPMENT

According to the Urban Land Institute, in the past, it was assumed that the competitive advantage of airport cities as office locations was air connectivity and proximity to the airport terminal. But while air service was widely acknowledged as a locational advantage for more than 70% of the interviewed companies, most did not see direct proximity to an airport as a decisive location criterion.

Rather, air connectivity in general was desired, but companies consider a travel time up to 30 minutes to the airport to be more than adequate. In addition, hub airports were seen as slightly more advantageous than regional or smaller airports. Air connectivity, however, was just one important siting consideration. As important as connections by air were regional connection accessibility by all modes of transport.

After connectivity, non-aviation related companies stressed the importance of business agglomeration, either in terms of proximity to a specialized business cluster or to a more generalized commercial environment. Proximity to a specialized industry cluster delivers networking advantages and a more efficient supply chain, and amenities are more likely to fit their needs in areas with a concentration of like-minded businesses.

Among manufacturing businesses, financial incentives, including those often offered through economic zones are an advantage, both administratively and from a regulatory standpoint. Foreign companies in particular gravitate to zones where 100% foreign-ownership is permitted.

Finally, and for many a factor more important that convenient air access was access to an urban center. Companies want to be in areas with amenities such as dining, recreational centers, medical facilities, and retail for day-to-day needs (ATMs, supermarkets, convenience stores and dry cleaners). Companies participating in the research indicated they would not move to an airport city location that was far away from a city center or that did not offer certain amenities. In fact, they would rather locate in the central business district than in an isolated business park near the airport.

Summary: Economic and Land Use Development

Proximity to Seattle-Tacoma International Airport does not seem to be either an advantage or a hinderance for development in the Study Area. Other factors included regional access by a variety of modes, proximity to an urban center (large or small), proximity to other corporations, and financial incentives offered to attract (or retain) companies.

The Study Area Cities seem to understand the importance of developing a "center". For example:

- Burien has developed a walkable mixed-use district surrounding its City Hall/Library complex;
- Des Moines has preserved its "downtown" area close to Puget Sound;
- Federal Way has an active shopping district in the vicinity of South 320th Street and US Highway 99;
- Normandy Park developed a small mixed-use development (Normandy Park Towne Center, at First Avenue South and Southwest 200th Street);
- Tukwila has the region's largest shopping destination (Southcenter Mall); and,
- While the City of SeaTac is the "front door" to Seattle-Tacoma International Airport, it has not diversified its development along US Highway 99. The area is predominantly hotels, off-Airport parking lots, and a few fast-food restaurants.

It is not possible to determine from the data reviewed if proximity to Seattle-Tacoma International Airport has been advantageous or a challenge for the Study Area Cities. There is currently a significant expansion of Alaska Airlines corporate headquarters in Des Moines, while the City of Burien would like to attract a hotel that leverages their proximity to Seattle-Tacoma International Airport. Additional study would be necessary to determine if Airport proximity has had any impact on economic development and land use decisions.

G. TRENDLINE ANALYSIS: NON-RESIDENTIAL DEVELOPMENT

The 1997 Study asserted that, "Many of the adverse impacts of the Third Runway and related Airport facilities have to do with the direct, indirect or induced relative declines in property values that occur when Airport operations increase. One strategy for mitigating these property value impacts is to direct to the maximum extent, feasible airport economic functions into the five impacted cities.

For example, if Seattle-Tacoma International Airport's proposed new hotel were located in Burien or Des Moines instead of on Airport lands there would be a positive (mitigating) result. Equally, if the Airport were to construct a haul road for all air cargo movements which exited on the west side of the Airport, it is highly likely that new warehousing and distribution facilities would spring-up; and the increased value of resulting economic activity would mitigate the Third Runway's otherwise adverse impacts.

In order to understand the health of the real estate market within the Study Area Cities, particularly in terms of how they may, or may not be positioning themselves to be a supportive business environment for the Airport, several indicators were analyzed and are presented here. Figure 13.25 presents a 10-year history of total assessed value per capita for the Study Area Cities, as compared to King County.

Figure 13.25
Total Assessed Property Value Per Capita – Study Area Cities and King County: 2008-2018

xxx below County value xxx above County value **xxx** King County value

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2008	$117,062	$99,722	$101,757	$203,063	$172,825	$236,539	**$180,314**
2009	$129,174	$110,355	$111,029	$230,287	$184,256	$273,953	**$202,644**
2010	$110,036	$92,973	$96,556	$183,031	$168,322	$260,766	**$177,073**
2011	$97,080	$90,865	$92,518	$190,143	$156,636	$246,738	**$173,139**
2012	$88,527	$82,823	$86,329	$174,659	$166,283	$237,619	**$164,588**
2013	$83,392	$77,067	$79,615	$167,216	$144,453	$235,223	**$159,400**
2014	$85,195	$74,913	$81,930	$161,081	$146,170	$238,762	**$169,559**
2015	$94,985	$89,578	$92,284	$186,126	$152,430	$261,869	**$189,719**
2016	$103,200	$94,851	$95,071	$204,646	$177,467	$276,117	**$205,013**
2017	$111,746	$104,623	$98,498	$215,299	$188,271	$293,166	**$222,583**
2018	$123,020	$118,135	$106,151	$232,088	$210,860	$304,767	**$239,419**

Source: King County Assessor and Ricker Cunningham

Higher per capita assessed values in Tukwila and Federal Way are likely the result of higher concentrations of retail and industrial property, rather than value of residences. Both of these cities report the highest number of employees at 33,688 and 33,822, respectively. Normandy Park had the lowest per capita assessed value, yet highest median home sale price in 2018 at $539,100. When crime statistics among the cities are compared with per capita assessed values, it appears that Tukwila real estate is maintaining its value, despite this adverse condition. Most of the cities report a per capita assessed value that is lower than King County as a whole.

Retail Market

Figures 13.26, 13.27 and 13.28 summarize retail market conditions for the Study Area Cities, as compared to King County. Indicators used to measure current and past market conditions include: rental rates per square foot; vacancy rates; and absorption, which is the amount of available space that is newly occupied as a percentage of total inventory.

As shown, average monthly rents in the Study Area Cities range from $17.20 to $25.98 per square foot. Normandy Park ($25.98) and Tukwila ($23.95) are the only Study Area Cities which have rates higher than King County's ($20.63). Normandy Park ($25.98) and Tukwila ($23.95) are at the top of the market, with Burien ($17.20) and SeaTac ($18.04) at the lower end of the market. In terms of annual rental rate growth, Burien, Des Moines and Normandy Park rents grew at a rate higher than King County's

Figure 13.26
Retail Rental Rate Per Square Foot – Study Area Cities and King County: 2006-2019

xxx below County rate xxx above County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2006	$14.90	$16.20	$21.03	$20.00	$19.24	$35.79	**$21.39**
2007	$12.95	$21.07	$24.51	$29.35	$18.16	$31.53	**$22.11**
2008	$13.85	$19.64	$17.34	$27.53	$25.04	$31.47	**$21.38**
2009	$15.04	$16.02	$15.32	$24.20	$20.60	$21.77	**$18.66**
2010	$14.40	$17.66	$16.12	$21.80	$20.57	$19.71	**$17.61**
2011	$15.96	$19.53	$15.38	$19.06	$20.00	$19.15	**$17.70**
2012	$16.62	$16.92	$15.90	$19.08	$17.19	$19.10	**$17.45**
2013	$15.71	$16.61	$15.93	$20.18	$17.83	$18.66	**$17.30**
2014	$15.29	$18.57	$16.57	$24.69	$14.93	$19.56	**$17.60**
2015	$15.22	$15.96	$17.99	$24.43	$21.04	$20.07	**$17.55**
2016	$17.84	$20.42	$20.08	$22.18	$19.79	$23.07	**$18.60**
2017	$15.93	$18.64	$21.14	$20.17	$22.75	$21.00	**$19.22**
2018	$15.97	$15.21	$22.00	$24.03	$22.14	$23.80	**$20.11**
2019	$17.20	$19.57	$19.02	$25.98	$18.04	$23.95	**$20.63**

Source: CoStar Inc. and Ricker Cunningham

Figure 13.27
Retail Vacancy Rate – Study Area Cities and King County: 2006-2019

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2006	3.5%	7.0%	6.8%	3.1%	5.6%	4.2%	**4.6%**
2007	3.3%	3.4%	8.6%	33.9%	9.6%	5.5%	**4.3%**
2008	6.5%	3.5%	9.8%	36.4%	7.9%	5.5%	**5.0%**
2009	6.8%	6.3%	11.4%	39.6%	3.5%	6.7%	**6.6%**
2010	6.5%	7.8%	13.7%	36.6%	3.9%	5.5%	**6.8%**
2011	8.6%	8.7%	13.6%	33.7%	15.4%	4.3%	**6.6%**
2012	6.1%	3.9%	9.4%	26.2%	9.4%	4.3%	**5.7%**
2013	4.9%	4.6%	7.7%	20.3%	6.3%	5.7%	**5.8%**
2014	5.2%	3.2%	5.0%	6.3%	1.8%	4.0%	**4.6%**
2015	5.7%	3.0%	4.8%	3.6%	2.9%	3.3%	**4.0%**
2016	6.0%	4.4%	6.1%	4.5%	2.2%	2.8%	**3.5%**
2017	5.6%	1.5%	5.1%	0.0%	1.1%	1.3%	**3.4%**
2018	3.1%	3.8%	2.9%	8.4%	2.1%	2.5%	**3.1%**
2019	2.5%	1.1%	3.1%	5.3%	3.1%	2.5%	**2.9%**

Source: CoStar Inc. and Ricker Cunningham

In addition, overall vacancy rates in the Study Area Cities range from 1.1% to 5.3%. Three cities – Normandy Park (5.3%), SeaTac (3.1%) and Federal Way (3.1%) have higher vacancy rates than King County's (2.9%). Des Moines (1.1%), Tukwila (2.5%) and Burien (2.5%) have the lowest vacancy rates. Normandy Park is the only market which have shown an increase in vacancy rate over the past 19 years.

With respect to absorption of retail space, Des Moines, Federal Way and Normandy Park are currently outperforming King County. Over the past 2 decades, 4 cities (Normandy Park, SeaTac, Federal Way and Burien) have outperformed King County, with Normandy Park and SeaTac exhibiting the highest absorption rates among those cities.

Figure 13.28
Retail Absorption Percentage of Inventory – Study Area Cities and King County: 2006-2019

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2006	5.7%	6.7%	7.3%	1.6%	3.4%	2.2%	**4.0%**
2007	2.6%	3.3%	9.3%	17.3%	1.1%	5.7%	**5.2%**
2008	3.2%	0.8%	2.7%	10.3%	16.2%	8.7%	**5.0%**
2009	5.9%	2.9%	3.2%	11.2%	15.5%	1.7%	**4.3%**
2010	3.8%	1.1%	1.9%	4.1%	2.1%	5.0%	**3.2%**
2011	5.5%	4.3%	4.9%	6.9%	3.0%	3.0%	**3.8%**
2012	5.6%	12.8%	4.3%	8.8%	8.0%	3.9%	**3.7%**
2013	3.5%	0.5%	2.4%	5.9%	3.3%	1.2%	**2.9%**
2014	3.3%	1.4%	4.9%	30.0%	4.8%	3.4%	**3.3%**
2015	1.5%	4.3%	2.1%	4.2%	0.3%	1.1%	**3.2%**
2016	3.0%	1.4%	2.1%	1.9%	1.7%	1.7%	**3.1%**
2017	2.3%	4.4%	4.1%	6.2%	1.3%	2.7%	**3.0%**
2018	4.4%	0.2%	3.7%	0.0%	0.2%	0.5%	**2.7%**
2019	1.8%	2.6%	2.6%	4.5%	1.3%	1.6%	**1.8%**

Source: CoStar Inc. and Ricker Cunningham

Office Market

Figures 13.29, 13.30 and 13.31 summarize office market conditions for the Study Area Cities, as compared to King County. Indicators used to measure current and past market conditions include: rental rates per square foot; vacancy rates; and absorption, which is the amount of available space that is newly occupied as a percentage of total inventory.

As shown, average monthly rents in the Study Area Cities range from $20.00 to $25.94 per square foot. None of the Study Area Cities have rates higher than King County's ($34.53). SeaTac ($25.94) and Burien ($24.66) are at the top of the market, with Des Moines ($21.45) and Normandy Park ($20.00) at the lower end of the market. In terms of annual rental rate growth, only SeaTac rents grew at a rate higher than King County's.

Overall vacancy rates in the Study Area Cities range from 0% to 19.6%. Four cities – Federal Way (19.6%), Tukwila (11.4%), Burien (7.4%) and SeaTac (6.5%) have higher vacancy rates than King County's (2.9%). Normandy Park (0%) and Des Moines (5.1%) have the lowest vacancy rates. Normandy Park is the only market which have shown an increase in vacancy rate over the past 19 years.

With respect to absorption of office space, Des Moines is the only city currently outperforming King County. Over the past 2 decades, only Des Moines has outperformed King County.

Figure 13.29
Office Rental Rates Per Square Foot – Study Area Cities and King County: 2000-2019

xxx below County rate xxx above County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	$0.93	$0.84	$0.88	$0.97	$0.84	$0.87	**$1.08**
2001	$0.97	$0.88	$0.90	$1.02	$0.88	$0.92	**$1.10**
2002	$0.95	$0.86	$0.91	$1.00	$0.85	$0.89	**$1.08**
2003	$0.94	$0.86	$0.87	$0.98	$0.84	$0.88	**$1.06**
2004	$0.96	$0.87	$0.86	$0.99	$0.84	$0.89	**$1.06**
2005	$0.99	$0.88	$0.87	$1.03	$0.87	$0.92	**$1.09**
2006	$1.04	$0.94	$0.92	$1.09	$0.93	$0.99	**$1.17**
2007	$1.11	$1.01	$0.99	$1.16	$1.00	$1.07	**$1.28**
2008	$1.15	$1.02	$1.02	$1.19	$1.12	$1.08	**$1.32**
2009	$1.09	$0.97	$0.96	$1.10	$1.04	$1.03	**$1.21**
2010	$1.13	$1.02	$0.98	$1.14	$1.07	$1.05	**$1.24**
2011	$1.15	$1.05	$0.99	$1.15	$1.08	$1.07	**$1.29**
2012	$1.19	$1.09	$1.03	$1.18	$1.12	$1.10	**$1.37**
2013	$1.25	$1.13	$1.07	$1.21	$1.17	$1.16	**$1.47**
2014	$1.30	$1.20	$1.14	$1.29	$1.23	$1.21	**$1.56**
2015	$1.43	$1.36	$1.25	$1.41	$1.36	$1.32	**$1.72**
2016	$1.57	$1.46	$1.33	$1.44	$1.45	$1.43	**$1.83**
2017	$1.67	$1.50	$1.40	$1.49	$1.48	$1.49	**$1.90**
2018	$1.73	$1.53	$1.47	$1.52	$1.55	$1.69	**$1.97**
2019	$1.75	$1.60	$1.54	$1.62	$1.59	$1.72	**$2.06**

Source: CoStar Inc. and Ricker Cunningham

Figure 13.30
Office Vacancy Rates – Study Area Cities and King County: 2000-2019

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	4.6%	4.9%	3.9%	5.0%	3.6%	3.4%	**5.4%**
2001	7.0%	7.7%	6.1%	6.8%	5.9%	6.6%	**7.7%**
2002	7.8%	8.7%	7.6%	8.2%	7.2%	7.4%	**8.2%**
2003	7.6%	8.3%	7.7%	8.4%	6.6%	7.0%	**7.9%**
2004	7.3%	7.9%	7.5%	8.4%	6.2%	6.5%	**7.6%**
2005	6.5%	6.5%	6.8%	7.1%	5.2%	6.1%	**6.3%**
2006	4.8%	4.9%	5.2%	6.2%	3.3%	4.4%	**5.5%**
2007	4.6%	4.5%	5.1%	6.0%	3.5%	4.4%	**5.4%**
2008	5.8%	6.2%	7.5%	6.9%	5.0%	5.7%	**6.5%**
2009	6.8%	7.0%	7.7%	7.8%	6.2%	6.7%	**7.4%**
2010	6.1%	6.2%	6.2%	7.3%	7.7%	5.5%	**6.6%**
2011	6.1%	6.5%	6.4%	7.4%	6.2%	5.7%	**6.7%**
2012	5.1%	6.0%	5.1%	8.2%	5.1%	5.2%	**6.3%**
2013	4.5%	5.7%	4.7%	7.7%	4.2%	4.2%	**5.7%**
2014	4.2%	4.9%	4.1%	6.8%	3.5%	3.7%	**5.8%**
2015	4.1%	5.3%	4.7%	4.5%	3.6%	3.2%	**5.6%**
2016	4.1%	4.1%	4.5%	5.1%	4.5%	3.4%	**5.4%**
2017	4.5%	4.0%	4.4%	4.7%	3.9%	3.5%	**5.8%**
2018	5.0%	3.4%	4.3%	4.1%	3.8%	3.9%	**5.5%**
2019	5.2%	6.1%	4.2%	4.1%	4.1%	3.6%	**4.9%**

Source: CoStar Inc. and Ricker Cunningham

Figure 13.31
Office Absorption Percentage of Inventory – Study Area Cities and King County: 2000-2019

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	0.1%	0.0%	-0.4%	2.7%	-0.2%	0.1%	**2.0%**
2001	-2.0%	-2.9%	-2.1%	-2.7%	-2.4%	-3.2%	**-0.2%**
2002	-0.8%	-1.0%	-1.1%	-1.4%	-1.3%	-0.8%	**0.5%**
2003	0.3%	0.4%	2.3%	0.0%	0.5%	0.4%	**1.2%**
2004	0.4%	0.3%	0.3%	0.0%	3.1%	0.6%	**1.1%**
2005	3.3%	1.4%	0.7%	1.4%	1.0%	0.5%	**2.2%**
2006	1.7%	1.6%	1.5%	0.0%	2.0%	1.7%	**2.3%**
2007	0.4%	0.4%	0.2%	0.0%	1.5%	0.0%	**0.9%**
2008	-1.2%	-1.7%	-1.5%	-0.7%	-1.5%	-1.4%	**0.4%**
2009	-1.0%	-0.8%	0.2%	-0.7%	-2.3%	-1.0%	**0.7%**
2010	-5.2%	0.8%	1.5%	0.0%	7.1%	1.2%	**1.8%**
2011	-0.1%	-0.3%	-0.2%	0.0%	0.0%	-0.2%	**0.7%**
2012	1.1%	0.2%	1.3%	0.0%	1.2%	0.6%	**1.8%**
2013	0.6%	0.3%	0.3%	0.0%	0.9%	-1.4%	**2.2%**
2014	1.5%	0.8%	0.6%	0.7%	0.7%	0.5%	**3.1%**
2015	3.2%	-0.5%	3.1%	2.7%	-0.1%	0.6%	**3.3%**
2016	0.0%	1.1%	0.3%	-1.4%	-0.9%	-0.3%	**2.7%**
2017	5.1%	0.0%	2.0%	0.0%	0.5%	-0.1%	**2.4%**
2018	-0.5%	4.7%	0.2%	0.0%	0.1%	11.6%	**3.4%**
2019	-0.2%	4.7%	0.1%	0.0%	-0.3%	0.3%	**2.7%**

Source: CoStar Inc. and Ricker Cunningham

Industrial Market

Figures 13.32, 13.33 and 13.34 summarize industrial market conditions for the Study Area Cities, as compared to King County. Indicators used to measure current and past market conditions include: rental rates per square foot; vacancy rates; and absorption, which is the amount of available space that is newly occupied as a percentage of total inventory.

As shown, average monthly rents in the Study Area Cities range from $9.11 to $19.27 per square foot. Three of the Study Area Cities – Federal Way ($19.27), Des Moines ($11.40) and Tukwila ($10.48) have rates higher than King County's ($10.20). Federal Way ($19.27) and Des Moines ($11.40) are at the top of the market, with SeaTac ($9.11) and Burien ($10.20) at the lower end of the market. In terms of annual rental rate growth, only Federal Way rents grew at a rate higher than King County's.

Overall vacancy rates in the Study Area Cities range from 0% to 23.5%. Three cities – Des Moines (23.5%), Burien (20.6%) and Tukwila (5.4%) have higher vacancy rates than King County's (5.0%). SeaTac (1.8%) has the lowest vacancy rate. Federal Way and SeaTac are the only markets which have shown a decrease in vacancy rate over the past 19 years.

With respect to absorption of industrial space, Federal Way is the only city currently outperforming King County. Over the past 2 decades, only Federal Way has outperformed King County.

Figure 13.32
Industrial Rental Rate Per Square Foot – Study Area Cities and King County: 2000-2019

xxx below County rate xxx above County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	$11.00	- - -	$5.38	- - -	$7.72	$6.33	**$5.33**
2001	$11.00	- - -	$5.95	- - -	$6.72	$6.81	**$5.24**
2002	$11.40	- - -	$5.32	- - -	$7.19	$5.42	**$5.09**
2003	$11.40	- - -	$5.08	- - -	$6.93	$5.50	**$5.33**
2004	$11.40	- - -	$5.66	- - -	$8.04	$5.37	**$5.63**
2005	$11.40	- - -	$8.06	- - -	$8.14	$5.33	**$5.64**
2006	$12.00	- - -	$10.65	- - -	$8.59	$5.65	**$5.74**
2007	$9.00	- - -	$6.15	- - -	$8.77	$6.22	**$6.09**
2008	$10.33	- - -	$6.30	- - -	$9.52	$6.16	**$6.39**
2009	$10.71	- - -	$6.12	- - -	$7.18	$5.72	**$6.00**
2010	$7.80	- - -	$8.05	- - -	$5.12	$5.06	**$5.70**
2011	$6.00	- - -	$8.07	- - -	$6.09	$5.69	**$5.81**
2012	$6.72	- - -	$6.02	- - -	$5.25	$6.15	**$5.99**
2013	$6.00	$6.84	$5.78	- - -	$6.86	$5.87	**$6.12**
2014	$6.00	$6.00	$5.70	- - -	$7.68	$6.17	**$6.26**
2015	$6.00	$7.44	$4.82	- - -	$7.19	$6.31	**$6.44**
2016	$12.00	$6.96	$4.89	- - -	$9.23	$6.78	**$7.08**
2017	$12.00	- - -	$8.69	- - -	$7.47	$7.87	**$8.55**
2018	$12.00	- - -	$11.20	- - -	$8.34	$9.43	**$9.16**
2019	$10.20	$11.40	$19.27	- - -	$9.11	$10.48	**$10.20**

Source: CoStar Inc. and Ricker Cunningham

Figure 13.33
Industrial Vacancy Rates – Study Area Cities and King County: 2000-2019

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	3.3%	0.0%	8.9%	0.0%	5.4%	5.2%	**5.5%**
2001	3.3%	0.0%	14.5%	0.0%	5.3%	6.9%	**6.8%**
2002	28.2%	0.0%	10.1%	0.0%	5.9%	7.0%	**8.9%**
2003	28.2%	0.0%	9.9%	0.0%	5.3%	8.7%	**8.5%**
2004	13.9%	0.0%	6.9%	0.0%	6.9%	3.4%	**6.7%**
2005	7.5%	0.0%	5.1%	0.0%	7.4%	6.8%	**6.1%**
2006	4.3%	0.0%	2.7%	0.0%	6.8%	3.9%	**5.9%**
2007	10.4%	0.0%	2.1%	0.0%	4.0%	4.3%	**5.5%**
2008	18.3%	0.0%	2.3%	0.0%	13.0%	2.6%	**5.8%**
2009	11.9%	0.0%	2.3%	0.0%	13.7%	6.3%	**8.0%**
2010	8.6%	0.0%	3.7%	0.0%	7.8%	6.1%	**8.1%**
2011	10.5%	0.0%	11.0%	0.0%	7.5%	5.5%	**7.1%**
2012	5.0%	0.0%	10.2%	0.0%	7.2%	3.6%	**5.7%**
2013	7.6%	0.0%	10.2%	0.0%	5.9%	4.8%	**5.1%**
2014	5.0%	0.0%	11.6%	0.0%	4.4%	3.5%	**4.3%**
2015	4.5%	82.6%	6.0%	0.0%	5.2%	2.9%	**4.0%**
2016	4.5%	0.0%	3.6%	0.0%	3.2%	2.4%	**3.2%**
2017	0.3%	0.0%	4.0%	0.0%	1.7%	3.4%	**2.5%**
2018	58.5%	0.0%	7.6%	0.0%	2.5%	2.6%	**3.4%**
2019	20.6%	23.5%	5.0%	0.0%	1.8%	5.4%	**5.0%**

Source: CoStar Inc. and Ricker Cunningham

Figure 13.34
Industrial Absorption Percentage of Inventory – Study Area Cities and King County: 2000-2019

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
2000	0.0%	0.0%	1.7%	0.0%	6.6%	6.9%	**5.2%**
2001	0.0%	0.0%	14.1%	0.0%	6.2%	6.1%	**6.9%**
2002	0.0%	51.4%	7.7%	0.0%	3.9%	4.7%	**5.5%**
2003	0.0%	0.0%	4.3%	0.0%	5.7%	5.6%	**6.4%**
2004	0.0%	9.8%	9.5%	0.0%	5.3%	8.3%	**6.8%**
2005	0.0%	0.0%	3.6%	0.0%	6.2%	2.4%	**7.0%**
2006	0.0%	0.0%	4.8%	0.0%	8.4%	7.8%	**8.0%**
2007	0.0%	0.0%	4.8%	0.0%	6.1%	5.2%	**7.3%**
2008	0.0%	0.0%	2.1%	0.0%	2.5%	4.1%	**6.1%**
2009	0.0%	0.0%	1.8%	0.0%	7.2%	2.0%	**4.0%**
2010	0.0%	0.0%	3.5%	0.0%	10.2%	5.0%	**4.4%**
2011	0.0%	0.0%	6.1%	0.0%	3.2%	5.0%	**5.4%**
2012	0.0%	1.5%	3.6%	0.0%	3.4%	5.2%	**5.9%**
2013	0.0%	6.2%	4.2%	0.0%	4.4%	3.0%	**4.6%**
2014	0.0%	7.0%	5.4%	0.0%	4.4%	6.3%	**4.7%**
2015	0.0%	5.2%	11.5%	0.0%	5.8%	5.0%	**5.0%**
2016	0.0%	89.5%	8.1%	0.0%	6.3%	3.0%	**5.1%**
2017	0.0%	48.6%	9.1%	0.0%	4.1%	3.5%	**4.7%**
2018	0.0%	27.3%	5.1%	0.0%	3.5%	6.5%	**4.3%**
2019	0.0%	0.0%	6.8%	0.0%	2.5%	6.5%	**4.1%**

Source: CoStar Inc. and Ricker Cunningham

Hotel Market

Figure 13.35 summarize hotel market conditions for the Study Area Cities, as compared to King County. Indicators used to measure current and past market conditions include: occupancy rate; average room rate; and revenue per available room.

Figure 13.35
Hotel Occupancy Rates, Average Room Rates, and Revenue per Available Room (PAR) – Seattle Metro Subareas: 2017 and 2018

xxx below County rate xxx above County rate **xxx** King County rate

Submarket	Occupancy Rate		Average Room Rate		Revenue Per Available Room (PAR)	
	2017	2018	2017	2018	2017	2018
Arlington/Marysville	66.8%	65.2%	$130	$131	$87	$85
Bellevue CBD	72.3%	70.9%	$201	$202	$145	$143
East King County	72.2%	73.2%	$242	$238	$174	$174
Federal Way	71.8%	71.3%	$129	$134	$93	$96
Kent	76.5%	74.4%	$109	$113	$83	$84
SeaTac Midscale	78.7%	80.3%	$125	$127	$98	$102
SeaTac Upscale	83.5%	82.0%	$136	$139	$114	$114
Seattle CBD Midscale	85.6%	85.8%	$222	$227	$190	$195
Seattle CBD Upscale	83.3%	84.3%	$265	$270	$221	$228
South Lake Union	85.6%	83.4%	$206	$209	$176	$174
King County	**77.6%**	**77.1%**	**$176**	**$179**	**$137**	**$138**

Source: Kidder Mathews and Ricker Cunningham

The submarkets within or proximate to the Study Area Cities include the following (remaining submarkets are included for comparative purposes only):

- Bellevue CBD;
- East King County;
- Federal Way;
- Kent;
- SeaTac Midscale; and,
- SeaTac Upscale.

As shown, annual hotel occupancy rates in or near the Study Area Cities range from 70.9% to 82.0%. Only the SeaTac submarkets have higher occupancy rates than King County's (77.1%). SeaTac Upgrade (82.0%) and SeaTac Midgrade (80.3%) have the highest occupancy rates. The SeaTac submarkets and East King County are the only markets which have shown increases in occupancy rates over the past 2 years.

Average room rates in or near the Study Area Cities range from $113 to $238. Two submarkets - East King County ($238) and Bellevue CBD ($202) - have average room rates higher than King County's ($179). These submarkets are at the top of the market, with Kent ($113) and SeaTac Midscale ($127) at the lower end of the market. East King County is the only submarket which did not show a room rate increase over the past 2 years.

Hotel revenues per available room in or near the Study Area Cities range from $84 to $174. Two submarkets - East King County ($174) and Bellevue CBD ($143) - have hotel revenues per available room higher than King County's ($138). These submarkets are at the top of the market, with Kent ($84) and Federal Way ($96) at the lower end of the market. Bellevue CBD is the only submarket which showed a decrease in revenues per available room over the past 2 years.

Household Travel Expenditures

Figure 13.36 presents household travel expenditures among residents in the Study Area Cities. Indicators analyzed include: average expenditures per household; percentage of total expenditures; and a spending potential index (SPI – a household-based metric which represents the amount spent for a product or service relative to a national average of 100).

Figure 13.36
Household Travel Expenditures – Study Area Cities: 2019

City	Average per Household	Percentage of Total Expenditures	Spending Potential Index (SPI)
City of Burien	$2,349	3.1%	105
City of Des Moines	$2,427	3.0%	108
City of Federal Way	$2,322	3.0%	103
City of Normandy Park	$4,033	3.3%	180
City of SeaTac	$1,879	3.0%	84
City of Tukwila	$1,902	2.9%	85

Source: ESRI, Inc. and Ricker Cunningham

As shown, average household travel expenditures for the Study Area Cities range from $1,879 (SeaTac) to $4,033 (Normandy Park). SeaTac and Tukwila are at the lower end of the range, while Burien, Des Moines and Federal Way are in the middle. Similar relationships exist for the percent of total expenditures and spending potential index indicators.

Not surprisingly, these figures tie closely to average household incomes within each of the Study Area Cities. Whereas travel is considered a discretionary expense, it is not surprising, given the comparatively lower median household incomes in the Study Area Cities, that their spending indices are close to or less than the national index.

Summary: Non-Residential Development

The Study Area is not monolithic when it comes to non-residential development:

- **Property Values per Capita**
  These tend to be below County averages except for Tukwila (which has a significant amount of retail and commercial development) and Normandy Park (which has the wealthiest residential neighborhoods of the Study Area).
- **Retail**
  Rental rates trended close to and slightly lower than County average in Burien, Des Moines Federal Way, and SeaTac. Retail vacancy rates are close to or above average generally in Burien, Federal Way, Normandy Park, and SeaTac.
- **Office**
  Office rates are uniformly below County averages in the entire Study Area, although vacancy rates are fairly low in all areas except for Normandy Park. (This may be due to the relatively low number of office space in Normandy Park, which may be artificially skewing the percentage.)
- **Industrial**
  Industrial rates are close to or below County averages in the entire Study Area, while vacancy rates are above County averages in Burien, Federal Way and SeaTac. (Normandy Park is not ranked because there are no reported industrial land uses.I
- **Hotel**
  Room rates and revenues are generally lower than County averages.
- **Household Travel Expenditures**
  SeaTac and Tukwila reported lower than average Spending Potential Indices (SPI), with higher rates elsewhere in the Study Area – the highest being in Normandy Park.

It is not possible to determine from the data reviewed if proximity to Seattle-Tacoma International Airport has impacted non-residential development in the Study Area. Non-residential development has generally followed the pattern of land use development as included in the various comprehensive plans in the Study Area. Although some cities have expressed a desire for some land uses not currently present (a hotel in Burien, and more dining and retail choices in SeaTac). Additional study is required to determine if the non-residential growth patterns have been influenced by proximity to Seattle-Tacoma International Airport.

H. TRENDLINE ANALYSIS: EMPLOYMENT

Figures 13.37 and 13.38 present employment characteristics for each of the Study Area Cities, as compared to King County and the State of Washington. Employment by industry and daytime population are the indicators used to examine each city's job market.

As shown, most of the Study Area Cities have the highest concentration of employees in the educational and health services industries. SeaTac and Tukwila have the highest concentrations of employees in the trade, transportation and utilities industries, while the majority employed in leisure and hospitality reside in Tukwila and Federal Way, as opposed to other communities located closer to the Airport. Tese employment concentrations are also reflected in daytime population estimates, as SeaTac and Tukwila have the highest shares of workers versus residents.

Figure 13.37
Employment by Industry – Study Area Cities, King County and Washington State: 2018

Industry Category	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County	Washington State
Natural Resources, Mining and Construction	926	263	2,295	53	370	1,903	76,205	309,338
Manufacturing	452	83	781	39	192	3,328	102,110	284,094
Trade, Transportation and Utilities	2,682	710	7,058	164	7,267	12,396	268,945	621,690
Information	297	36	688	14	215	937	110,306	133,091
Financial Activities	852	364	3,537	51	950	2,354	69,852	147,948
Professional and Business Services	866	333	2,156	93	686	2,428	229,338	414,866
Educational and Health Services	4,596	2,720	8,493	250	834	2,063	176,367	465,737
Leisure and Hospitality	1,701	1,109	4,852	190	3,126	5,336	142,585	335,734
Other Services	1,443	992	2,768	107	752	1,597	45,152	99,103
Government	417	220	1,138	59	392	701	170,287	561,343
Unclassified	31	30	56	12	36	645	2,270	0
TOTAL	**14,263**	**6,860**	**33,822**	**1,032**	**14,820**	**33,688**	**1,393,417**	**3,372,944**

Source: ESRI, Inc.; Washington Employment Security Department; and Ricker Cunningham

Figure 13.38
Daytime Population – Study Area Cities and King County: 2018

xxx below County rate xxx above County rate **xxx** King County rate

Indicator	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
% Workers	41.1%	34.8%	46.3%	29.5%	56.4%	80.6%	**62.9%**
% Residents	58.9%	65.2%	53.7%	70.5%	43.6%	19.4%	**37.1%**

Source: ESRI, Inc. and Ricker Cunningham

Figure 13.39 presents unemployment rates for the Study Area Cities over the last 21 years, as compared to King County as a whole.

As shown, although all of the Study Area Cities have historically maintained higher current unemployment rates than King County's (3.5%), which has remained close to 4.0% since 2016. Over the past two decades, unemployment rates in the Study Area Cities have increased, while King County's has decreased. All of the Study Area Cities and King County experienced higher unemployment rates through the Great Recession (2008) and the subsequent recovery (2012).

As presented in the Community Comment portion of this Section, several individuals expressed opinions (favorable and negative) regarding the number of Study Area residents that were employed at the Airport. The majority seemed to assume actual totals had declined over the past two decades, while some thought the Port was not doing what it could to hire area-residents, first. What the data in Figure 13.40 reveals, however, is that the Airport employs approximately 30% of the area labor force, and 45% of total employment.

Figure 13.39
Unemployment Rate - Study Area Cities and King County: 1997-2018

xxx above County rate xxx below County rate **xxx** King County rate

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County
1997	4.0%	- - -	3.4%	- - -	- - -	--	**3.6%**
1998	3.6%	3.4%	3.1%	- - -	- - -	- - -	**3.3%**
1999	3.6%	3.4%	3.1%	- - -	3.1%	- - -	**3.3%**
2000	3.3%	5.1%	4.4%	- - -	5.5%	- - -	**3.7%**
2001	4.3%	6.6%	5.7%	- - -	7.1%	- - -	**4.8%**
2002	5.5%	8.4%	7.3%	- - -	9.0%	- - -	**6.1%**
2003	5.5%	8.3%	7.3%	- - -	9.0%	- - -	**6.1%**
2004	4.5%	6.8%	6.0%	- - -	7.3%	- - -	**5.0%**
2005	5.0%	5.2%	4.8%	- - -	5.5%	- - -	**4.4%**
2006	4.3%	4.4%	4.0%	- - -	4.5%	- - -	**3.7%**
2007	3.5%	3.8%	3.4%	- - -	3.9%	- - -	**3.2%**
2008	4.2%	4.7%	4.3%	- - -	4.6%	- - -	**3.9%**
2009	8.8%	9.6%	8.9%	- - -	9.8%	- - -	**8.0%**
2010	8.2%	10.6%	10.7%	- - -	11.6%	- - -	**9.0%**
2011	7.4%	9.3%	9.3%	- - -	10.0%	- - -	**7.9%**
2012	6.2%	7.8%	7.6%	- - -	8.3%	- - -	**6.3%**
2013	5.1%	6.1%	6.1%	- - -	6.4%	- - -	**5.1%**
2014	4.7%	5.6%	5.5%	- - -	5.7%	- - -	**4.7%**
2015	4.3%	5.1%	5.0%	- - -	5.4%	- - -	**4.3%**
2016	4.5%	4.7%	4.5%	- - -	5.1%	- - -	**3.9%**
2017	4.2%	4.3%	4.3%	- - -	4.5%	- - -	**3.6%**
2018	4.1%	4.1%	4.1%	- - -	4.3%	- - -	**3.5%**

Source: ESRI, Inc. and Ricker Cunningham

Information presented in Figure 13.41 reveals the mode of transportation used by employees in each of the Study Area Cities, as well as the distances traveled. A shown, the preferred method for travel to work is either by personal vehicle or a shared carpool within all of the communities, as well as King County and Washington State. Far fewer travel by public transportation, but among those that do, the most are residents of SeaTac. Among those individuals who work at home, the highest rates were reported in Federal Way and Normandy Park. These figures correlate fairly consistently with travel times to work. For example, those communities with a comparatively higher number of individuals who either bike, walk or work at home, also travel the shortest distances.

Figure 13.40
Airport Employment and Labor Force by City of Residence: 2017

City	Airport Employment	Percent of Total Employment	Labor Force	Share of Labor Force [1]
City of Burien	540	4.9%	26,040	2.1%
City of Des Moines	740	6.7%	16,670	4.4%
City of Federal Way	1,500	13.6%	49,640	3.0%
City of Normandy Park	100	0.9%	3,710	2.7%
City of SeaTac	1,050	9.5%	14,850	7.1%
City of Tukwila	1,030	9.3%	10,730	9.6%
Airport Employment	**11,070**	**44.9%**	**966,660**	**28.9%**

[1] Figures calculated in source material
Source: Seattle-Tacoma International Airport Economic Impacts Study, January 2018 and Ricker Cunningham

Figure 13.41
Workers 16+ Years by Travel to Work – Study Area Cities, King County and Washington State: 2013-2017

xxx below County rate xxx above County rate **xxx** King County rate

Indicator	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	King County	Washington State
Means of Transportation								
Drove Alone or Carpooled	81.2%	83.8%	84.2%	88.4%	78.4%	78.5%	**77.6%**	87.3%
Public Transportation	9.7%	8.5%	7.8%	2.9%	12.8%	12.3%	**14.0%**	6.7%
Bicycle	1.0%	0.5%	0.2%	0.8%	0.4%	0.5%	**1.0%**	0.3%
Walked	1.7%	0.8%	1.6%	1.3%	5.0%	4.4%	**5.4%**	0.5%
Worked at Home	4.5%	5.8%	4.8%	5.0%	2.8%	2.9%	**5.2%**	4.4%
Travel Time								
Less than 5 minutes	1.3%	1.1%	0.9%	2.2%	0.6%	1.7%	**1.2%**	2.0%
5 to 9 minutes	6.8%	4.5%	4.4%	8.8%	8.7%	10.4%	**6.1%**	9.9%
10 to 14 minutes	12.9%	11.0%	9.1%	6.4%	15.1%	13.2%	**9.9%**	12.9%
15 to 19 minutes	16.0%	17.4%	10.6%	17.3%	13.0%	16.8%	**13.4%**	15.2%
20 to 24 minutes	13.7%	15.3%	15.5%	17.5%	13.8%	14.0%	**15.1%**	14.4%
25 to 29 minutes	5.7%	4.9%	6.8%	5.6%	6.0%	5.7%	**7.3%**	6.5%

Source: American Community Survey and Ricker Cunningham

Summary: Employment

The Cities of SeaTac and Tukwila have the highest concentrations of employees in the trade, transportation and utilities industries, while the majority employed in leisure and hospitality reside in Tukwila and Federal Way. The City of SeaTac had the third highest number of hospitality workers, an unexpected result given the large number of hotels in SeaTac.

All of the Study Area Cities – except for Tukwila – have a higher than average percentage of daytime residents, indicating these cities "export" their residents to work in other area cities. But the unemployment rates for Burien, Des Moines, Federal Way, and SeaTac were higher than the County average (no unemployment figures were reported for Normandy Park or Tukwila). These numbers were highest between 2008 and 2011, the same period of the Great Recession. Not surprisingly, most people in the Study Area drove to work (around 80%) with most commutes taking between 5 and 30 minutes. That would rule out many jobs being located in Downtown Seattle or Bellevue that are filled by Study Area residents.

I. TRENDLINE ANALYSIS: MUNICIPAL TAX REVENUES

Figures 13.42 and 13.43 summarize taxable sales figures used to calculate municipal sales and use tax revenues.

Considering annual growth in taxable sales used for municipal sales tax purposes, Des Moines, SeaTac and Burien outpaced King County's annual growth over the past 13 years. Tukwila, despite the presence of Southcenter Mall, along with Federal Way, experienced the lowest annual growth in taxable sales. As for taxable sales used for municipal use tax purposes, all of the Study Area Cities, with the exception of Normandy Park, had higher growth rates than King County, which actually experienced a slight decline in sales.

Figure 13.42
Total Taxable Sales for Sales Tax – Study Area Cities and Balance of King County: 2005-2018

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac	Tukwila	Rest of King County
2005	$466,317,848	$196,847,032	$1,290,164,509	$41,835,540	$938,960,134	$1,917,878,233	$1,429,443,619
2006	$509,825,194	$214,786,724	$1,401,412,482	$33,911,414	$996,297,232	$2,045,733,563	$1,482,847,537
2007	$577,001,629	$242,860,668	$1,474,686,404	$47,295,313	$964,539,050	$2,189,941,072	$1,619,744,902
2008	$557,065,786	$209,624,058	$1,354,503,450	$52,292,542	$932,175,133	$1,999,860,023	$1,639,361,663
2009	$470,116,653	$189,510,992	$1,208,587,158	$55,668,050	$866,894,747	$1,637,751,905	$1,468,084,325
2010	$460,924,502	$216,100,241	$1,195,494,759	$34,527,622	$878,958,880	$1,634,524,060	$1,439,610,340
2011	$501,989,452	$185,172,249	$1,216,636,090	$34,095,994	$901,469,281	$1,711,714,074	$1,531,923,952
2012	$535,798,328	$176,434,358	$1,220,710,322	$38,816,152	$888,906,520	$1,685,474,338	$1,558,852,485
2013	$594,006,494	$199,509,462	$1,299,073,826	$51,212,171	$951,192,942	$1,764,572,994	$1,663,957,663
2014	$665,312,052	$227,729,378	$1,397,097,268	$49,260,539	$1,100,075,514	$1,856,552,535	$1,744,836,624
2015	$690,158,279	$279,429,639	$1,527,015,663	$54,358,277	$1,186,178,372	$2,073,592,985	$1,785,421,582
2016	$816,803,110	$328,801,622	$1,616,664,109	$60,315,125	$1,294,303,276	$2,037,232,519	$2,010,968,660
2017	$867,752,925	$388,224,637	$1,632,540,331	$62,967,270	$1,528,180,600	$2,051,982,936	$2,114,953,121
2018	$875,025,340	$422,766,036	$1,671,698,212	$71,626,821	$1,818,240,385	$2,255,439,002	$2,472,417,146

Source: Washington Department of Revenue and Ricker Cunningham

Figure 13.43
Total Taxable Sales for Use Tax – Study Area Cities and Balance of King County: 2005-2018

Year	Burien	Des Moines	Federal Way	Normandy Park	SeaTac [1]	Tukwila	Rest of King County
2005	$8,819,672	$2,667,206	$34,983,697	$1,279,448	$145,475,359	$50,891,997	$77,220,588
2006	$8,990,786	$3,434,989	$35,851,925	$1,180,107	$161,801,239	$56,759,995	$73,107,072
2007	$9,204,914	$2,760,698	$37,350,863	$745,845	$186,453,671	$82,475,866	$92,377,747
2008	$12,072,895	$2,807,432	$30,441,152	$842,434	$240,829,712	$86,162,027	$79,441,868
2009	$6,372,073	$2,604,310	$22,571,150	$986,921	$143,124,192	$57,172,631	$48,268,246
2010	$6,603,638	$2,781,337	$26,987,461	$1,085,039	$155,787,182	$63,457,189	$46,734,204
2011	$8,344,780	$3,314,380	$27,302,847	$711,775	$223,216,867	$68,140,679	$55,258,767
2012	$7,672,114	$2,803,489	$29,798,847	$412,747	$204,944,215	$83,824,266	$82,680,090
2013	$7,279,407	$3,043,058	$31,607,334	$312,980	$224,959,228	$81,863,841	$81,552,759
2014	$11,987,415	$2,495,048	$33,777,127	$446,441	$235,868,953	$72,879,280	$89,986,985
2015	$11,817,872	$2,988,248	$39,276,919	$292,145	$184,000,037	$101,122,865	$67,976,973
2016	$10,367,530	$4,102,495	$41,896,313	$410,354	$181,759,788	$90,967,686	$69,351,053
2017	$11,378,198	$5,586,092	$31,476,577	$544,584	$191,868,179	$62,803,506	$52,148,744
2018	$11,507,928	$3,125,513	$36,438,900	$956,742	$237,977,874	$74,853,326	$70,029,432

[1] Total taxable sales for the City of SeaTac are likely understated given revenue-sharing agreements in-place, yet inaccessible as of the date of this report.

Source: Washington Department of Revenue and Ricker Cunningham

Summary: Municipal Tax Revenues

From 2005 to 2018, the Cities of Burien, Des Moines, and SeaTac outpaced King County's annual growth for taxable sales. The Cities of Federal Way and Tukwila (the latter, despite the presence of Southcenter Mall) experienced the lowest annual growth in taxable sales. But taxable sales (for municipal use tax purposes) in all Study Area Cities except for Normandy Park had higher growth rates than King County. Normandy Park's performance is due to the fact that it has a much smaller sales tax base than the other Study Area Cities.

The Study Area has enjoyed a higher growth rate in sales tax revenues tan the County's growth rate. But it is unknown how much of this growth is attributable to activity at Seattle-Tacoma International Airport and how much is due to natural growth patterns within the Study Area. Additional research would be required to determine the direct municipal revenue benefits due to Airport proximity.

J. IMPACTS

Positive Impacts

Positive aspects impacting the Study Area Cities include:

- Seattle-Tacoma International Airport is a source of employment for a fairly significant number of residents in the Study Area Cities (30% of the area labor force, and 45% of total employment). Based on an analysis of the modes used by area residents to travel to work, it appears that the vast majority use a personal vehicle or carpool alternative. This could suggest that proximity does not necessarily provide a transportation advantage; however, it still provides a quality-of-life advantage.
- Revenue from hotel rooms and supporting businesses in the vicinity of the Airport, along with established agreements between the Port and host communities, have a significant, yet disproportionate economic impact.
- Proximity to air service provides a locational advantage for companies located within a 30 minute drive of the Airport; particularly those also served by the commercial elements of an urban center.

The Airport provides a regional advantage addressing the travel needs of business and leisure travelers and visitors. They also enable the efficient movement of people and goods across distances, strengthening ties between communities, regions, and countries and encouraging economic growth. In addition, they play an integral role in shipping time-critical and high-value cargo.

Neutral Impacts

Aspects of that are neither favorable or adverse, impacting the Study Area Cities, include:

- Burien and SeaTac maintain the oldest housing inventory among the Study Area Cities and King County, as reflected in the percent of units built before 1970 and median age of the housing inventory.
- With the exception of Normandy Park, all of the Study Area Cities have lower median home sale prices than the Seattle Metro Area as a whole. Even Federal Way, despite maintaining the newest inventory of residential ownership units, only commands the second lowest prices in the Study Area.
- Overall multi-family vacancy rates in the Study Area Cities range from 3.6% to 6.1%, with only two cities, Des Moines and Burien, reporting higher rates than King County. Further, Normandy Park and King County are the only markets which have shown a decrease in their vacancy rate over the past 19 years. Despite vacancy rates which would otherwise indicate a condition of pent-up demand or at a minimum, room to increase rental rates; average monthly multi-family rents in the Study Area Cities are all lower than King County's rate, and only Tukwila's rate grew at a rate higher than King County's.
- As evidenced by market indicators for employment uses, those communities located farthest from the Airport are considered more valuable, commanding higher rental rates and absorbing space at a higher rate. This is consistent with the findings of an Urban Land Institute Survey of industry professionals who explained direct proximity to an airport facility is less desirable than a site closer to an urban center with airport access within a 30 minute drive.
- All of the Study Area Cities have commercial vacancy rates well below equilibrium, a consistent trend being experienced in many cities since the Great Recession; however, in terms of rental rates, they are relatively modest, particularly given their proximity to the Airport, a location that in many markets would be able to command disproportionately higher rates.

Negative Impacts

Negative aspects impacting the Study Area Cities include:

- All of the school districts which educate residents of the Study Area Cities have a reported "lower socio-economic profile" than that of King County. Additionally, all have performed at comparatively lower levels in math and the arts than Statewide levels as a whole. Conversely, districts located to the north of the Study Area Cities (Seattle, Shoreline, Northshore, and Bellevue) have performed at higher levels than Statewide levels as a whole, over that same time period.
- All of the Study Area Cities, with the exception of Normandy Park, have lower median household incomes below the average for King County, and in most instances lower than the State average, as well.
- With the exceptions of Normandy Park and Des Moines, all of the Study Area Cities have higher shares of owner-occupied households than King County and the State as a whole, spending 30% or more of their income for housing.
- Over the past two decades, unemployment rates in the Study Area Cities have increased, while King County's have decreased. In addition, the Study Area Cities have historically maintained higher current unemployment rates than King County's of 3.5%.

Data Gaps

Information regarding the indicators for which there was either a lack of data, incomplete data, or data that was unavailable at the municipal level includes:

- Small business growth data at either a municipal or county level
- Wage information at a municipal level (compounding difficulties related to wage information was the lack of information regarding actual job types held by residents in the Study Area Cities at the Airport or its affiliates).

K. WHAT WE HEARD FROM THE PUBLIC

During this study, the Consultant Team heard comments from the public during community meetings, stakeholder interviews, and monthly Technical Advisory Committee meetings. The following is a summary of this citizen input by topic area.

- **Relationship with Port Varies by Community**

  In terms of Port communications with the Study Area Cities, one community member said they were good at responding to noise complaints, but not as effective outside government channels. A SeaTac respondent described the Port as pro-growth, pro-economic development and pro-community concerns, and another thought the Port's business plan was to improve the economy of the region, including the surrounding communities. People on the other side of this issue thought the Airport was not effective at coordinating with the local communities, particularly regarding future plans (i.e., taking down trees, pursuing certain international carriers, etc.). Regardless, a "no surprises clauses" requires Airports to regularly communicate with the host city where they are located. Whereas these were individual and subjective comments, they were neither confirmed nor refuted.

  An additional community member reported the Port "plans to take out a park to accommodate employee parking." While this contention could neither be confirmed or denied, Section 4 (f) of the US Department of Transportation Act of 1966 requires that projects that receiving funding or approval by any US DOT agency must avoid impacts to Section 4(f) properties.

These properties are reported to include public parks and recreation lands, wildlife and waterfowl refuges, and historic sites. When a project cannot avoid Section 4(f) properties, they are required to provide documentation and seek approval by the federal lead USDOT agency.

- **Concerns that Airport Revenues are not Shared with South King County**

  With regard to Airport revenues, several comments were received regarding how revenues generated at the Airport were distributed. For instance, someone said "12% of sales and parking tax revenue, as well as hotel room sales collected inside SeaTac went to the County and State rather than staying within the city;" while others thought they were the only community to directly benefit from these resources. Other comments suggested that "a significant share of sales tax revenues generated by the Airport goes to the cities of Seattle and Bellevue, while South King County gets far less." And finally, another said SeaTac was unable to generate a reasonable level of taxable sales since "42% of its land mass was owned by the Port for Airport operations;" while still others expressed a belief that "the positives outweighed the negatives, and would continue to do so as long as the ILA remained in place (reportedly $30 million over 10 years, renegotiated after 10 years)." These statements were not confirmed nor disputed in the context of this Study but should be part of a supplemental investigation.

  In terms of factors of other economic impacts, some residents of Federal Way didn't believe these extended to their community, but that perhaps they benefit from business promotion and recruitment by the Port. For example, they acknowledged that organizations like World Vision (a non-profit) located there because of access to the Airport.

  Overall, the most favorable comments regarding their partnerships with the Port came from residents of Federal Way, SeaTac, and Normandy Park. A review of community plans for these and the other Study Area Cities supported this trend whereby these largely spoke favorably about the advantages of having the Airport "in their backyard," so to speak, while discussions in the others were largely about how to mitigate adverse circumstances. For example, Burien recently passed a resolution regarding airport growth, noise, and health impacts. Regarding growth, one person commented that while Sound Transit intended to extend their services to I-5 and 320th by 2024, they were confident that the growth this might bring would be widely supported by local residents. Whereas these were individual and subjective comments, they were neither confirmed nor refuted.

- **Most Vulnerable Groups are Being the Most Adversely Affected**

  Community members who shared opinions during the Study process expressed concern regarding the income levels of residents, disproportionately high poverty levels, rates of illness and life expectancy, and less access to healthcare (the latter two which were addressed in the previous section). Others commented on the increasing number of immigrant families, but primarily in the context of how the Port limits their communications with these groups by not presenting information in more than one language. Finally, a learned resident referenced the potential eligibility of broad sections of the community for environmental justice. (Environmental justice seeks to ensure the fair treatment of all people from different races, ethnicities, and income from the laws, regulations, and policies that affect their environment.)

  Based on research regarding this topic, while the State of Washington has considered establishing a statutory definition of environmental justice, those efforts have failed, as recently as 2019. Regardless, based on criteria established by other states, and review of demographic characteristics presented here, it appears several of the Study Area Cities could in-fact potentially qualify. Regardless of a lack of legislation, the Port and member communities could still elect to employ similar practices in a pursuit of equitability.

- **Positive and Negative Impacts Vary Among the Study Area Cities**

  Based on comments received, there seems to be a fairly unified consensus that among the Study Area Cities, the benefits and liabilities associated with proximity to the Airport are experienced differently. Opinions seemed to differ, however, with regard to their origin and the Port's role in either mitigating or amplifying them. For instance, some Tukwila residents thought they were at a competitive disadvantage for new investment because of what they described as a higher percentage of multi-family residential units (60% multi-family, 40% single family), and that the Port had done little to assist through economic development promotion. Conversely, others thought that Port grants had led to "spin-off economic development opportunities." Whereas these were individual and subjective comments, they were neither confirmed nor refuted.

- **Housing Most Adversely Impacted Real Estate Near Airport**

  Given the focus on mitigating adverse impacts on housing and neighborhoods following construction of the Third Runway, it wasn't surprising to receive numerous comments regarding housing-related issues and concerns. For instance, several individuals spoke about the devaluation of their homes due to increased air traffic, and regardless of whether or not they received a Port package. Residents of Normandy Park thought their home values had "remained fairly steady, even during the Great Recession;" while residents of Des Moines described their city as "one of the last affordable communities in the area with some increase in value, but not at the same rate as Seattle and Bellevue."

  Overall, the most comments received expressed the belief that air operation-related noise had suppressed values, despite high levels of demand throughout the Seattle Metro Area. Specifically, South King County home values were thought to be lower than Seattle's, as well as those on the east side of Bellevue, and that they hadn't increased proportionately with most northern and eastern neighborhoods. Based on a review of new home construction and resale information, along with data regarding the age of existing inventories, it appears accurate to conclude that despite a more established register of homes, both South King County and Pierce County | Tacoma were still destinations for area residents, if for no other reason than price alone.

  Another dimension of housing in the Study Area Cities commented on by Study participants related to past mitigation efforts, including: the process for qualifying, limitations on eligible contractors, and market perception regarding their sustained value. Among those received, the majority believed that houses in receipt of a Port package were less desirable and viewed in the same vain as homes impacted by flight paths. A different, yet related comment said that flight paths gave preference to higher income neighborhoods, especially those to the north of the Airport. Again, whereas these were individual and subjective comments, they were neither confirmed nor refuted; however, since this issue speaks directly to potential ongoing impacts that could not be addressed with a one-time Port package, they should be investigated in the context of a supplemental study.

- **School Performance Has Suffered Due to Adverse Impacts**

  Community comments regarding the status of school districts in the Study Area and the Port's possible impact on them ranged from believing the Airport | Port had "spent a lot of money improving schools, for example Highline Community College" to, "the rate of absences in the Highline School District is high, and in-part due to noise and emissions which also cause sleep and hearing issues." Fairly consistently, members expressed a belief that the Highline School District was "one of the poorest in the State," reportedly due to the influence air operation-related noise has had on learning, along with a lack of financing. This assumption could not be confirmed nor disputed given the scope of this assignment, but potentially warrants further investigation.

- **Airport Employment Levels for Area Residents Are Not What They Used to Be**
  As referenced earlier in this Section, many community members have spoken favorably about the Airport's role in providing jobs for area residents; however, several think actual number have declined over time (over 14% of Federal Way's population once worked at the Airport, and now closer to 7% do), and that the Port "hasn't tried hard enough to choose area residents first, when positions have become available." With regard to where employees of the Area live today, they thought they primarily resided in Des Moines, Federal Way, and Burien; with very few living in SeaTac. In addition, others thought proximity to work provided a "huge benefit" for employees. Based on the findings presented in this Section, Seattle-Tacoma International Airport continues to employ a fairly significant number of area residents (30% of the area labor force, and 45% of total employment); and residents in the vicinity of the Airport strongly preferred using a personal vehicle to get to work, thereby suggesting that while proximity might pose a quality of life advantage, it was not a necessity with regard to their reliance on either public transportation or other mode of transportation. Collectively, this information seems to refute comments received regarding this topic.

L. RECOMMENDATIONS

To address the principal issues identified in this Section, the following recommendations are proposed.

- **Socio-Economic Recommendation #1 – All Parties Should Commit to a Shared Objective**
  This is essentially evolving the Airport and the Study Area Cities together. An Airport City (as defined herein) is the "inside the fence" airport area of a large airport, including the airport (terminals, apron, and runways) and on-airport businesses such as air cargo, logistics, offices, retail, and hotels. The airport city is at the core of the "aerotropolis," a new urban form evolving around many major airports. Source: Wikipedia. Conversely, an Aerotropolis is the "airport city" and outlying corridors and clusters of aviation-linked businesses and associated residential development that feed off each other and their accessibility to the airport. The Aerotropolis is analogous in shape to the traditional metropolis made up of a central city and its rings of commuter-linked suburbs.

  These definitions are significant in that historically, airports have largely focused on the airport city, those areas and uses within them that comprise the principal functions of their operations. Beginning a few decades ago, and now in full swing in more than 40 major metropolitan areas around the world, are development of aerotroplis facilities, which are actually more micro-cities than airports. Given their extent, which can encompass as much as 20 or more miles around the airport itself, these are almost exclusively evolving in what is often described as greenfield locations, or in other words, areas on the edge of cities where the land is largely undeveloped. For infill airports such as SeaTac, where certain uses were already established, and new uses have continued to fill in around them, this type of evolution can be much more difficult, but not necessarily impossible. While airports and the cities that host them have often had conflicting goals, many airport operators have realized the benefits of partnering with their host community, jointly planning for compatibility, mitigating adversity, and growing as an extension of each other. As such, they are becoming joint economic engines that benefit from the success of the other.

  Seattle-Tacoma International Airport, like many other infill airports, needs to see the communities around it as their partner, and best opportunity to evolve into an "aerotropolis." In order to do this, several things must happen, a few of which include: common understanding of desired outcomes, equal commitment to a healthy whole (airport and all impacted communities), regulatory alignment, consistent marketing and shared oversight.

A recent article in The Guardian Magazine about potential impacts resulting from construction of a third runway at Heathrow Airport in London mirrored much of what has been written about the addition of the third runway at Seattle-Tacoma International Airport. Unlike the Seattle-Tacoma International Airport, experience, however, was the decision to work together (community members and airport operators) to define criteria for growth by which all actions would be measured. Ultimately, four tests were identified: commitment to delivering of increased capacity; compliance with UK climate change obligations; graduated targets for minimizing local noise and air quality impacts; and continually working towards what was best for the UK economy, as a whole.

While there are multiple models for how this could occur, a few specific elements might include: modification of the Port of Seattle Board to include equal geographic representation; revised protocols for new development and redevelopment projects that engages various referral agencies including those involved in mitigating adverse air, water and noise impacts; joint planning initiatives with representation from all relevant governmental and quasi-governmental entities: enhanced communication and transparency between public, private, non-profit, neighborhood and other organizations represented in the Study Area Cities (multi-lingual); and shared messaging and promotion across all business sectors. (The Council of Governments used to have designated aviation planning specialist, but when the position was last vacated, it was never refilled. This type of professional could potentially provide oversight to all joint planning efforts between the Port and Study Area Cities.) One such example is the Metro Denver Network Model.

- **Socio-Economic Recommendation #2 – Consider a "Study Area-Wide" Impact Overlay District**

  This concept was mentioned in Section 11 in the context of public safety. While this type of organizational framework could provide the structure from which to advance the recommendations presented above in the context of an "aerotroplis," is not essential. The idea behind an Airport Overlay District evolved from discussions with community members regarding perceived inequities between and among the Study Area Cities, particularly as they relate to positive and negative impacts resulting from Airport operations. The intention is to establish a mechanism whereby revenues and expenses could be shared equitably (if not equally), and comparative inequities could be neutralized. For example, if one community is deemed more appropriate for a certain airport-supporting business or land use, facilitate its development in that location, but allow all of the communities to share in its economic contribution.

  As explained earlier, the actual boundaries of the district could be determined after a second level study (assuming there is one), in order to ensure that communities most, or even partially impacted, are included. Also, reparation levels could be graduated by distance and | or impact level, depending on the ability to isolate monetary advantages and disadvantages in the different geographies. This could replace any existing agreements (or ILAs) depending on the desires of the interested parties.

  An overlay district could also maintain design and development standards and regulations in order to ensure consistency across municipal lines. Several community members mentioned inconsistencies not only between the Federal Aviation Administration's rules and requirements and the Port's, but between the rules and regulations of these entities and those of the local jurisdictions. For example, if a new building or building retrofit is proposed near a public airport, it must comply with Federal Aviation Administration rules outlined in Part 77 of their Regulatory manual that addresses methods for addressing safety concerns such as height restrictions and building setbacks. While insulation from noise and other environmental factors are also addressed, some communities have elected to rely on local policies and standards, leading to inconsistencies and comparative disparities. (The Vision 100-Century of Aviation Reauthorization Act (Public Law 108-176) required the Federal Aviation Administration to "make noise exposure and land use information from noise exposure maps [prepared under 14 CFR Part 150] available to the public via the Internet on its website in an appropriate format.")

- **Socio-Economic Recommendation #3 – Conduct Additional Analyses**
  This has been mentioned in previous Sections of this report but consider amending work completed for this effort with similar analyses of other jurisdictions potentially equally impacted by airport operation. These analyses should also be supplemented with review of various reports that were ongoing while this one was being prepared (i.e., Draft NEPA/SEPA due Fall 2019); and additional research into areas omitted from the scope of this assignment. Additional areas of investigation might include: cost-benefit analysis of percent of SeaTac City landmass owned and operated by the Port; update to airport trip origins research relied on in the 1997 Study; surveys of local commercial and residential brokers regarding the perceived impact of airport operations on real estate in the Study Area Cities; and market feasibility studies for land uses and real estate product types that are either absent or under-serving local markets (i.e., hotel development in Burien, greater variety of commercial operators and restaurants, and others); and the housing inventory in order to understand the actual impact port packages have, absent age, condition, and location.

M. THE FUTURE

A myriad of factors may influence a community over time. These can range from changes in infrastructure and traffic congestion, to innovations in employment of workplace options, to potentially disruptive technologies in personal transportation. The one commonality linking these is that no one can say for sure when (or if) they will become reality and to what extent they will influence community development.

An aspect of the socio-economic development of communities that has remained constant is the desire to maintain a certain "quality of life" – a metric that is often subjective and may vary from one community to another. An area that many communities tend to desire is to have a "center", a place that identifies the core of the community. Burien, Des Moines, Federal Way, Normandy Park and Tukwila have all developed these centers (of varying sizes and land use composition). The City of SeaTac has not yet identified a location for its center, although US Highway 99/Pacific Highway seems to be serving as a *de facto* center.

There have been recent changes in consumer preferences for housing. A return to pre-WW II patterns of walkable neighborhoods and mixed-use buildings has been increasing nationwide for most than a decade. Evidence of this pattern can also be seen in Downtown Burien's growth in an around its City Hall/Library complex.

Should King County and the Seattle MSA continue to grow, two patterns are expected to emerge. One is the continuing expansion of the metropolitan area to the north, south, and east. The other is the desire to "backfill" the core of the region and increase density where it can be accommodated which provides more walkable mixed-use neighborhoods.

Should the region continue to grow, it may also become poly-nodal, with numerous additional employment centers and destinations beyond Downtown Seattle. This can be seen in the growth of the downtown core of Bellevue. With its key location between Seattle and Tacoma, the Study Area has the potential to become a financially attractive alternative to areas that may be economically unattainable, especially when serviced by the expansion of the Sound Transit Link light rail line and provision of other services (such as bus rapid transit). The Study Area has the potential to "reverse commute", creating employment destinations south and southeast of Downtown Seattle.

Over time, it is hoped that the Study Area Cities will continue to grow consistent with their unique characters, including Des Moines coastal downtown, Burien's Southwest 152nd Street corridor, Normandy Parks heavily-treed residential neighborhoods, etc.

N. SUMMARY

There are a variety of socio-economic impacts evidenced in the Study Area, but most cannot be directly attributed to the proximity of Seattle-Tacoma International Airport. These include:

- **Demographic Profile**
  The Study Area has grown at a slightly slower pace than the average for King County since 2000. It is demographically diverse area, except for Normandy Park which has the lowest percentage of minority population.

- **Income**
  The Study Area's average household income was general lower than King County with the exception of Normandy Park which was higher than the County average.

- **Education**
  Results were not consistent across the Study Area. For those an undergraduate/bachelor's degree, Normandy Park showed a percentage slightly above the King County average, while the percentages for the remaining Study Area Cities were close to half the County average. Student performance in public schools was generally mixed with respect to State standards. Student health in the Federal Way, Tukwila, and the Highline School Districts was generally poorer as well, with higher percentage of students listed as overweight or obese. All districts reported a higher than average percentage of students who "considered" suicide in the past 12 months and between a quarter and a third of all students feeling hopeless for more than 2 weeks over the past 12 months.

- **Housing**
  The Study Area is uniformly composed of more family households than non-family households. It also tends to have an older housing stock which is owner-occupied more often than renter-occupied. Homes tended to be more affordable, but rental units were reporting higher than average rent rates, making it more expensive for renters than owners. Overall, housing values were 8% to 25% lower than the County average, but again, Normandy Park was the exception, with a more expensive housing stock.

- **Economic and Land Use Development**
  Proximity to Seattle-Tacoma International Airport has not seemed to give the Study Area any unique competitive advantage regionally. Most of the Study Area Cities have developed (or continued to develop) centers unique to their communities, including Burien, Des Moines, and Normandy Park.

- **Non-Residential Development**
  The Study Area is not monolithic when it comes to non-residential development. Property values per capita are lower across the Study Area except for Tukwila and Normandy Park. Retail rental rates were higher in than the County average in Burien, Des Moines Federal Way, and SeaTac, although office and industrial rental rates were generally average to below average (there are not large portions of the Study Area developed as industrial). Hotel rooms rates were lower than the County average, despite having a concentration of hotel rooms in SeaTac and Tukwila. And only SeaTac and Tukwila had lower than average Spending Potential Indices (lower than 100).

- **Employment**
  The Cities of Federal Way, SeaTac and Tukwila have the highest concentrations of employees in the trade, transportation, utilities, and hospitality industries, while the majority employed in leisure and hospitality reside in Tukwila and Federal Way. Despite proximity to Seattle-Tacoma International Airport, the share of the labor force working at the Airport was relatively low – between 2.1% (Burien) and 9.6% (Tukwila). All of the Study Area Cities – except for Tukwila – have a higher than average percentage of daytime residents, indicating they "export" their residents to work in other area cities.

But the unemployment rates for Burien, Des Moines, Federal Way, and SeaTac were higher than the County average (no unemployment figures were reported for Normandy Park or Tukwila).

- **Municipal Tax Revenues**
  The Cities of Burien, Des Moines, and SeaTac outpaced King County's annual growth for taxable sales. The Cities of Federal Way and Tukwila experienced the lowest annual growth in taxable sales. But taxable sales (for municipal use tax purposes) in all Study Area Cities except for Normandy Park had higher growth rates than King County.

Given the readily available data and noted data gaps, it was not possible to draw a conclusion between existing socio-economic metrics and Study Area's proximity to Seattle-Tacoma International Airport. Additional research is required to determine the magnitude of this impact (if any) upon the Study Area.

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SECTION 14

SUMMARY OF FINDINGS

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SECTION 14

SUMMARY OF FINDINGS

A. APPROACH

This Study spent 7 months (from June 2019 through the end of December 2019) objectively and independently evaluating and assessing readily-available existing data to determine the extent of impacts – positive, negative, and neutral – that were associated with the operation of Seattle-Tacoma International Airport. Data was reviewed for the period 1997 to 2019, with three milestone years of interest:

- **1997**
  This year was selected since there was data available from the 1997 Study which examined similar issues for a nearly-identical area (the City of SeaTac was not part of the 1997 at that time);

- **2009**
  This was the first full year of operation of Runway 16R/34L (the Third Runway), a controversial expansion of the Airport's capacity, which was ultimately approved and constructed. 2009 was also impacted by a significant recession that affected the entire nation. If there were a decrease in operations and/or economic activity due to a decrease in commercial flights (business and pleasure), this year would most likely reflect that; and,

- **2019**
  This was considered as the "present year" for most evaluations (a few were in 2018 due to the way that data was originally collected).

As stated on page 1 of this Study, it acknowledges that Seattle-Tacoma International Airport is a significant regional and statewide asset, and the Study takes no sides – it does not argue for or against the Airport, nor does it advocate for any city, neighborhood, organization, or resident. Rather, it asked the following two questions central to this Study:

- Do the cities that comprise the Study Area – Burien, Des Moines, Federal Way, Normandy Park, SeaTac, and Tukwila – enjoy any benefits by being close to Seattle-Tacoma International Airport?
- Do the cities that comprise the Study Area shoulder a disproportionate burden because of their location close to Seattle-Tacoma International Airport?

From 1997 to 2019, the Seattle region experienced significant growth, roughly doubling in population. The Consultant Team attempted to determine what impacts were the result of natural organic regional growth (induced impacts), and which were directly related to Seattle-Tacoma International Airport operations (direct impacts). In some cases, it was not possible to differentiate between impacts that were the result of Airport operation and those related to regional growth.

B. THE STUDY AREA CITIES

It is important to appreciate the unique characteristics and qualities of each of each of the cities that comprise the Study Area. While referred to collectively as the "Study Area Cities", each is unique in their own way and may experience impacts to a greater or lesser extent:

- **Burien**
  Burien is located west and northwest of the Airport and is predominantly a residential community, but also has a strong commercial corridor (First Avenue South), a revitalized mixed-use downtown area, and Puget Sound views. It shares most of its eastern border with Seattle-Tacoma International Airport and has previously raised issues with Airport operations, including the 1997 Study and wining a 2019 lawsuit the challenged the 250-degree turns with overflights above the City.

- **Des Moines**
  Des Moines is located predominantly south of the Airport and is also a mostly-residential community with a strong commercial corridor (US Highway 99). Unique to the Study Area Cities, Des Moines has a downtown district adjacent to Puget Sound. Most of the northern border of Des Moines abuts Seattle-Tacoma International Airport.

- **Federal Way**
  Federal Way is located south of the Airport and is the largest of the Study Area Cities (40.8% of the Study Area population and 36.7% of its land area). Federal Way has a larger mix of land uses, with a concentration of retail and commercial uses along US Highway 99 and at the intersection with South 312th Street. While it has no direct border Seattle-Tacoma International Airport, residents reported concerns with south flow overflights.

- **Normandy Park**
  Normandy Park is located west of the Airport is the smallest of the Study Area Cities (approximately 2.8% of the Study Area population and 4.1% of its land area). It is mainly a single-family residential community with a small retail center at First Avenue South and Southwest 200th Street. Normandy Park shares no common border with Seattle-Tacoma International Airport but has voiced concerns with overflights.

- **SeaTac**
  The City of SeaTac has perhaps the most unique relationship with Seattle-Tacoma International Airport. While sharing a very similar name, it also surrounds the Airport and has strong commercial ties to Airport activity – specifically hotels, off-Airport parking lots, retail and dining – with direct roadway and pedestrian access to the Airport via US Highway 99. It also provides direct access from IH-5 via South 188th Street.

- **Tukwila**
  Tukwila is located east and north of Seattle-Tacoma International Airport and shares no common border with the Airport. Tukwila spans both sides of IH-5 and is home to a major retail center (Westfield Southcenter Mall and surrounding retail), numerous hotels, office and warehouse/distribution centers, in addition to established residential neighborhoods. Tukwila is also the closest Study Area City to two other nearby airports – King County International Airport/Boeing Field, and Renton Municipal Airport.

Two of the Study Area Cities – Tukwila and SeaTac – are served Sound Transit Link Light Rail, which is proposed to extend south into Des Moines and Federal Way (and further into Tacoma and Pierce County). While Burien and Normandy Park are not currently served by any light rail transit system, a future Bus Rapid Transit (BRT) line is proposed to connect to Lynnwood (proposed to start in 2024).

The Study Area Cities span many economic and demographic groups, affluent to low-income, a wide variety of ethnicities and ages, and many other unique qualities. One area of commonality is that they all have Airport Committees comprised of local citizens, that advise the City Councils on local issues and concerns surrounding Seattle-Tacoma International Airport.

The impacts and recommendations included in this Study do not uniformly represent the Study Area as monolithic. There are subtle nuances and distinctions unique to each City that must be appreciated and further considered prior to initiating or adopting any recommendation in this Study.

While not technically a "city", the unique characteristics of Seattle-Tacoma International Airport are also important considerations in this Study. This Study recognizes the Airport's important role as a member of the local, regional, and statewide economy. It is a significant employer – not only those who work for the Port of Seattle, but those who work for the airlines, concessionaires, and all the vendors and service professionals that support the Airport. Seattle-Tacoma International Airport is also an integral part of the region's business and tourism industries.

This Study also acknowledges that the Airport, the Port of Seattle, and the Federal Aviation Administration have been the focus of numerous concerned citizens over many years. The Airport is surrounded by urbanized development, with little room for further expansion. This is not an unusual relationship and the Study reviewed three similar airports (Boston, Miami and Phoenix) for examples. There are many more US (and international) airports with similar urban relationships and any follow-up studies should conduct a wider inventory of these facilities.

C. PUBLIC INPUT

The Consultant Team sought public input through a variety of methods – a Technical Advisory Committee; a series on in-depth interviews with Study Area stakeholders (1-on-1 and in small groups); and public presentations in Tukwila and Burien.

Public input helped the Consultant Team in identifying what the Study Area felt were the most pressing concerns. When members of the public provided additional data and documentation, it was independently verified before being integrated into the 2020 Study by the Consultant Team. Information and data which could not be validated was used to help reinforce anecdotal evidence of community concerns.

Noise was the most-often mentioned issue with operations at Seattle-Tacoma International Airport. A close second were impacts on **Air Quality** resulting from aircraft operations (impacting health, landscaping, etc.). Other concerns raised by the public included

- Failure of mitigation packages as part of the third runway mitigation process
- Traffic congestion, specifically on Airport Expressway, along International Boulevard/US Highway 99 at Arrivals Drive/South 182nd Street, on State Route 518 westbound (west of the I-5/I-405 interchange), and State Route 518 eastbound (west of the Des Moines Memorial Drive interchange).
- Concerns that South King County is a "dumping ground", noting the development of the Federal Detention Center (2425 South 200th Street) and the Federal Aviation Administration Flight Standards District Office (2200 South 216th Street) – neither of which contribute property tax revenues to the local communities; and,
- A general mistrust by members of the public of the Federal Aviation Administration, the Port of Seattle, and Seattle-Tacoma International Airport. This level of skepticism appears to most acute in areas generally north and south of the Airport – Burien, Des Moines, Federal Way, Normandy Park, and the City of SeaTac.
- Violent crime, property crime, and motor vehicle theft in the Study Area Cities is disproportionate;
- Property crime activity in the study area cities is disproportionate;
- Motor vehicle theft and related activity in the study area cities is disproportionate;

- Homelessness is a regional problem and is pervasive near the Airport;
- Airport proximity influences health statistics;
- Airport proximity exceeds appropriate health standards;
- There are noise-induced health concerns;
- Port programs and other efforts (sustainability and fly quiet) have been ineffective;
- Previous noise mitigation packages are ineffective;
- The relationship with the Port is generally poor, but also varies by community;
- Airport revenues are not shared with South King County communities;
- The most vulnerable groups are being the most adversely affected;
- Positive and negative impacts vary among the Study Area Cities;
- The housing that is most adversely impacted is near the Airport;
- School performance has suffered due to Airport impacts;
- The Port of Seattle is not responsive to the Cities in the Study Area;
- The impact of NextGen procedures has enhanced adverse impacts; and,
- Airport employment levels for area residents are not what they used to be.

It is important to appreciate the fact that the Study Area Cities do not speak with a single voice and experience different degrees of impacts. For example, Burien, Des Moines, Federal Way, Normandy Park and portions of SeaTac immediately north of the Airport tended to identify concerns with noise and aircraft overflights more frequently. So even when the 2020 Study refers to "the Study Area Cities", these communities are not always monolithic – each have issues unique to themselves, their proximity to the Airport, and other externalities.

D. IMPACT: NOISE & VIBRATION

Noise was the most-often mentioned issue with operations at Seattle-Tacoma International Airport. Since noise is a common criticism by airport communities elsewhere in the US and internationally, this finding was not unexpected. The Consultant Team noted the following positive, neutral, and negative impacts associated with noise and vibration (refer to Section 5 for more information on impacts):

Positive Impacts from Noise & Vibration

There are no known positive impacts of receiving noise. Crowds cheer during air shows such as when the Blue Angels roar overhead, at the Seafair hydroplane races, or sporting events such as NASCAR or Formula 1 races, or the Super Bowl. However, those are unique and isolated events. While there is ongoing technological research and testing to develop quieter aircraft, this does not address current and historic concerns.

Neutral Impacts from Noise & Vibration

There are no known neutral impacts from noise and vibration.

Negative Impacts from Noise & Vibration

The increase in air carrier operations at Seattle-Tacoma International Airport from 1997 to 2019 has increased the number of noise events and the likelihood of adverse effects. While an average residential structure can provide some sound attenuation, there is no technology to mitigate noise impacts in outdoor areas (yards, parks). Aircraft noise events can result in a variety of negative effects, including:

- Annoyance;
- Sleep Disturbance;
- Cardiovascular Effects;
- Children's Learning and Cognitive Impairment;
- Speech Interference;
- Depressed Property Values; and,
- Impacts on Wildlife and Domestic Pets.

The incidence of noise related complaints generally aligns with flight tracks, late night operations, and occasional on-airfield maintenance run-ups and reverse thrusting. Despite being in what Federal standards consider to be "acceptable", many of these complaints are located within the 65 DNL noise contour. The DNL method of averaging noise over a 24-hour period is not an accurate representation of how area residents, workers, and visitors experience noise, which is as an individual single event.

E. IMPACT: AIR QUALITY

Concerns about air quality were a close second to noise complaints. This appears to be a common criticism by from airport communities in the US and internationally. In many ways, noise and air quality are related – where noise pressure is experienced is often impacted by air pollution. The Consultant Team noted the following positive, neutral, and negative impacts associated with air quality (refer to Section 6 for more information on impacts).

Positive Impacts on Air Quality

There are some areas associated with air quality that may be considered as positives:

- On the whole, King County's air quality is in attainment;
- Some air monitors show improvement in Air Quality (but many monitors are inactive);
- Toxic emissions are showing a downward trend;
- The Airport has taken initiatives to reduce emissions and also intends to fuel all flights at the Airport with sustainable aviation fuels by 2028.

The above are positives in the sense they are helping to reduce emissions and existing areas of concern. But there are no known positive impacts in the Study Area as a result of ongoing air pollution. And the above positive impacts by themselves do not accurately represent air quality impacts in the Study Area..

Neutral Impacts on Air Quality

There are no known neutral impacts from air quality issues and pollution.

Negative Impacts on Air Quality

Despite some positive gain as described above, air quality concerns remain:

- Ultrafine Particulate (UFP) pollution, which requires further study to understand the potential impacts on human health.
- Increased aircraft operations negatively affect air quality, so when specific event-level pollution is reduced, dramatic increases in annual operations contribute to local and regional air pollution;
- Black carbon emissions from aircraft also contribute to atmospheric warming; and,
- There are numerous data gaps that require further study including:
  - How and if UFPs will be regulated in the US, including any follow-up studies nationally and abroad;
  - Ability to compare data from EDMA to AEDT models;
  - Differences between 2016 and 2017 emissions data;
  - Dated EIS data relating to air quality and emissions;
  - Toxic concentration information not based on data from local monitoring stations.

F. IMPACT: MOBILITY

There have been numerous investments in the local and regional mobility network to address mobility and congestion. Some new improvements – Consolidated Rental Car Facility and the Sound Transit Link Light Rail service – divert traffic that would have been headed to the terminal or area parking lots. Improvements and changes to the roadway network, transit service, pedestrian access and parking all require some degree of follow-up study to determine the extent to which mobility has improved, or if one mode improves at the expense of another. The Consultant Team noted the following positive, neutral, and negative impacts associated with mobility (refer to Section 7 for more information on impacts).

Positive Impacts on Mobility

There are several areas in which mobility has improved, but further study is necessary to document specific performance costs and benefits associated with each:

- Improvements to Airport circulation (such as Airport Expressway, Air Cargo Road, and the Consolidated Rental Car Facility) have helped to manage traffic in and around the main terminal.
- Continuous Center Turn Lanes on major local roadways improve congestion as left-turning vehicles do not block traffic in through lanes
- Dedicated Lanes and direct on-ramps for transit and carpool vehicles help encourage HOV use
- Link Light Rail Service has brought a new non-roadway travel mode to the Airport
- Express bus and RapidRide service increases transit options to the Airport
- Transit service has been funded to allow service expansions in the future, including rail and BRT
- Capacity has been increased at the Main Parking Garage, providing passenger convenience (and additional Port revenue)
- Employee parking lots relocates employee traffic away from the terminal, but also requires operation of a shuttle bus

- Private transport services from outlying communities help to reduce traffic congestion and the need for long-term parking.
- Park & Ride lots promote transit usage (but some report that these lots are also being used by Airport employees instead of the dedicated employee parking lots north and south of the Airport).
- Local parking requirements in the Study Area Cities generally exceed ITE standards for off-street parking and also manage on-street street issues through regulation and permits
- Pedestrians can access transit stations and walk to the terminal from the City of SeaTac, as well as access transit stations throughout the Study Area.

Increased reliance on transit and shared ride services also has a benefit of reducing traffic congestion and mobile-source air pollution.

Neutral Impacts on Mobility

The following mobility improvements require further study and analysis to fully understand their positive and/or negative impacts:

- On-demand rideshare and shuttle Services (e.g., Lyft and Uber) reduce the need for Airport parking but may also contribute to traffic congestion accessing the terminal.
- Private Airport parking lots divert traffic from the Main Parking Garage, but also rely on shuttle buses to take customers to and from the terminal
- The new Cell Phone Lot provides a temporary waiting area for those picking up arriving passengers, but also adds northbound traffic onto US Highway 99

Negative Impacts on Mobility

The following have not improved the overall mobility in the Study Area:

- Most changes to the roadway infrastructure since 2000 have been to accommodate bus services and multimodal elements such as sidewalks and bicycle lanes. While investing in transit and multimodal infrastructure makes them more viable options, there has been little increase in the capacity of the area's roadway and highway network. This capacity appears to not have kept pace with the growth of the region during this same time period
- Average vehicle delays have increased and roadway Level of Service (LOS) ratings have worsened since 1997. In some of the most significant locations, there has been an average increase of 85% in vehicle delay and LOS has worsened by 1 to 2 levels

G. IMPACT: SURFACE WATER QUALITY

In general, the actions of the Port of Seattle in the Airport and surrounding area have improved water quality and the receiving waters' habitat conditions from what they were before. The Consultant Team noted the following positive, neutral, and negative impacts associated with mobility (refer to Section 8 for additional information on surface water quality).

Positive Impacts on Surface Water Quality

The following Airport improvements were noted that had positive impacts on surface water quality:

- Constructed 112 acres of wetland near the Airport;
- Enhanced about 2 miles of stream habitat including the relocation of 1,000 feet Miller Creek's stream channel;
- Excavated 60-acre feet of floodplain storage capacity;
- Installed 200 pieces of large woody debris, removed two culverts that blocked fish passage, and focused on stabilizing four eroded portions of Miller Creek's stream channel;
- Supplements streamflow to Miller and Des Moines creeks every summer to ensure adequate water levels for fish;
- Created and enhanced 65 acres of off-site wetland and wetland buffer adjacent to the Green River in Auburn to mitigate the loss of wetland habitat for waterfowl near the Airport;
- Upgraded the IWS and SDS stormwater management systems to more efficiently capture and treat stormwater runoff from the Airport; and,
- Kept stormwater discharges from the Airport well below permit limits with low variability in comparison to other airports and industrial stormwater.

Neutral Impacts on Surface Water Quality

There are no known neutral impacts on surface water quality.

Negative Impacts on Surface Water Quality

The required mitigation in response to Master Plan improvements, plus the near-constant monitoring of stormwater runoff water quality required by the NPDES permitting program and adjustments to stormwater management in response to water quality results leave little in the way of negative impacts to surface water quality and habitat in the immediate area.

However, Seattle-Tacoma International Airport is still a contributor of pollutants, and occasionally exceeds those criteria, despite its best management practices and treatments. As fish habitat continues to improve in the receiving streams, such violations, even short-term ones, could affect salmon present. With instances of pre-spawning mortality already recorded in Miller, Walker, and Des Moines Creeks, and throughout the Puget Sound region it is important to understand the impacts any pollution can have on salmon populations.

H. IMPACT: GROUNDWATER & SOIL QUALITY

Many of the sites of potential concern relating to impacts on Study Area groundwater and soils occur on Airport property. And there are some off-Airport sites of concern due to non-aviation sources (such as industrial or dry cleaner operations). The Port of Seattle is monitoring and addressing on-Airport areas of interest. However, long-term monitoring is required to assure the integrity of the ground water and soil systems throughout the Study Area.

Positive Impacts on Groundwater & Soil Quality

Incidents of on-Airport contaminated and NPDES exceedances have been documented by the Port of Seattle, the Department of Ecology, and other agencies. The Port of Seattle has taken steps to address areas of concern, but on-going work and monitoring is required. Aside from knowing the extent of potential polluting sources, there are no known positive impacts on groundwater and soil quality as a result of pollution in the Study Area.

Neutral Impacts on Groundwater & Soil Quality

There are no known neutral impacts on groundwater and soil quality.

Negative Impacts on Groundwater & Soil Quality

The following Airport improvements were noted that had negative impacts on the quality of groundwater and soils:

- Known on-Airport contaminated sites include Budget Auto Facility, Concourse B/Gate B, Continental Airlines Hydrant System, Delta Airlines Auto Gas Tank Cluster, Delta Airlines Fuel Farm, Northwest Airlines Hangar Tanks, Northwest Airlines Fuel Farm, Northwest Airlines Hydrant Systems, South Satellite Baggage Tunnel, Pan Am Airlines Avgas (Aviation Gas) Tanks, Pan Am Airlines Fuel Farm, Consolidated Rental Car Facility, and United Air Lines (UAL) Fuel Farm/Continental Airlines Fuel Farm;
- Based on compounds detected in normal urban stormwater runoff, the Airport's NPDES permit monitoring requirements, and/or on long-term surface water quality exceedances detected in Miller and Des Moines Creeks, the copper, zinc, ethylene glycol and propylene glycol are considered chemical of concern;
- There are several sites within Airport property that have chemicals of concern, including total petroleum hydrocarbons (TPH), fuel-elated aromatic hydrocarbons (BTEX), chlorinated solvents and naphthalene;
- Several underground storage tanks which are not on Airport property were noted to be leaking according to the Department of Ecology's database;
- There may be long-term impacts that were also associated with the operation of the former Asarco Tacoma Smelter (opened in 1917, closed in 1985); and,
- Citizens raised concerns regarding the impact on soils, gardens, and landscaping from "black soot" that they believe are the result of air pollution associated with aircraft.

I. IMPACT: LIGHT

Light impacts were not expected to be a significant concern, since there were no issues raised by members of the surrounding communities. The Consultant Team noted the following positive, neutral, and negative impacts associated with light in and around the Airport (refer to Section 10 for additional information).

Positive Impacts from Light

Seattle-Tacoma International Airport is replacing the older-generation of lighting (metal halide) with energy efficient LED fixtures. LED is much more controllable than older-style lights, which often create glare and skyglow. LED lights use less energy, have a higher degree of controllability, and can reduce or eliminate glare and night-sky disruption in surrounding neighborhoods. Newer LED fixtures could also include controls to lower or turn off these sources when gates are not in use (since they do not require a warm-up period to reach the required level of brightness.

Neutral Impacts from Light

There are no known neutral impacts from the lighting in and around Seattle-Tacoma International Airport. This was also not an issue that mentioned by Study Area citizens as a significant concern, both in the past and currently.

Negative Impacts from Light

Glare and increased skyglow are concerns with standard metal halide lighting, but Seattle-Tacoma International Airport is taking steps to replace these aging fixtures. Replacement with new LED fixtures also saves energy.

J. IMPACT: PUBLIC SAFETY

Citizens were concerned about public safety in their neighborhoods and communities throughout the Study Area. The Consultant Team noted the following positive, neutral, and negative impacts associated with public safety impacts in the Study Area (refer to Section 11 for additional information).

Positive Impacts on Public Safety

The following positive aspects of public safety were noted in the Study Area Cities:

- Incidents of motor vehicle thefts have generally declined in the Study Area over the past two decades; and,
- Among the three major criminal categories investigated in the 2020 Study (violent, property and motor vehicle theft), 2018 figures were lower than 1997 figures in the Study Area Cities except Normandy Park, and Tukwila relative.

Neutral Impacts on Public Safety

Aspects of public safety that are neither favorable or adverse, impacting the Study Area Cities, include:

- Despite reports of, on average, one vehicle per day being stolen from the garage at the rental car facility, motor vehicle thefts in Tukwila have historically exceeded those in SeaTac.
- The number of motor vehicle thefts in all of the Study Area Cities, except Normandy Park, were lower than those for King County in 2009 and again in 2018, with the exception of SeaTac and Tukwila.
- Property crime rates in Tukwila that have historically exceeded those in all of the other Study Area Cities, are considered more attributable to the presence of the Southcenter Mall than the Airport.

Negative Impacts on Public Safety

Negative aspects of public safety impacting the Study Area Cities include:

- Violence rates among the Study Area Cities have increased in all but Tukwila and SeaTac since 2016;
- Figures for violent crime in the Study Area Cities in 1997 were higher than the number for King County (213) in 1997 and 2009, with the exception of Normandy Park, as well as in 2018 with the exception of Burien and Normandy Park; and,
- Figures for property crime in the Study Area Cities were higher than the number for King County and the State of Washington in 1997. In 2009, they were lower in the Cities, but higher than state figures in all but Des Moines and Normandy Park. In 2018, the City figures were again lower than County figures, but higher than State figures in Federal Way, SeaTac and Tukwila.

K. IMPACT: PUBLIC HEALTH

Many citizens raised concerns about the potential health impacts of living and working close to Seattle-Tacoma International Airport. The Consultant Team noted the following positive, neutral, and negative impacts associated with public health impacts in the Study Area (refer to Section 12 for additional information).

Positive Impacts on Public Health

Positive aspects public health influencing impacting Study Area include:

- The accident rate in all but Burien were lower than the same rate for the State and nation;
- Occurrences of cancer and heart disease in the Study Area Cities and King County declined between 2012 and 2016;
- Between 2012 and 2016, figures for all but Alzheimer Disease declined in the State of Washington; and,
- Nationally, figures for the leading causes of death – cancer, heart disease, and respiratory disease – all declined.

Neutral Impacts on Public Health

Aspects of public health that are neither favorable or adverse which impacted the Study Area Cities, include:

- The rate of heart disease in all but Des Moines, SeaTac and Tukwila were higher than that of the State; and in Federal Way, they were was higher than the national rate.
- Despite studies of potential health impacts on residents of communities located with 10 miles of an airport, and while all of the Study Area Cities exhibited rates higher than King County for chronic illnesses, only three of the communities had figures higher than those for the State or nation.
- Between 2012 and 2016, homicides and deaths from firearms either declined or remained steady in all communities, except Burien and King County.

Negative Impacts on Public Health

Negative aspects of public health impacting the Study Area Cities include:

- The two leading causes of death in the Study Area Cities and King County have been and continue to be cancer and heart disease;
- The frequency of falls between 2012 and 2016 increased in all of the Study Area Cities increased, except Burien;
- Between 2012 and 2016, the rate of suicides also increased in all of the Study Area Cities, except in Tukwila, and King County;
- The rate of individuals who were without early prenatal care in all the Cities, except for Mercer Island/Point Cities, exceeded both the County and State figures;
- Among the Cities, Burien, SeaTac and Tukwila were ranked the highest in total factors contributing to adverse health conditions among women and children;
- Access to medical care and services among residents of the Cities worsened across nearly every indicator, in nearly every City, with figures related to a lack of access to care and preventative services increasing, in some cases significantly;
- There was an overall increase in poor health habits between 2012 and 2016 within all of the geographies; and,

- Trends among babies born at a low or very low birth rate, or who died at birth, were either lower than or consistent with those of the County and State in every community except Burien, SeaTac and Tukwila.

L. IMPACT: SOCIO-ECONOMIC METRICS

During the Study, citizens and stakeholders said that they believed South King County had a reputation as a "dumping grounds", which depressed property values and negatively impacted various quality-of-life metrics. The Consultant Team noted the following positive, neutral, and negative impacts associated with public safety impacts in the Study Area (refer to Section 13 for additional information).

Positive Impacts on Socio-Economic Metrics

Positive aspects impacting the Study Area Cities include:

- Seattle-Tacoma International Airport is a source of employment for a fairly significant number of residents in the Study Area Cities (30% of the area labor force, and 45% of total employment)
- Revenue from hotel rooms and supporting businesses in the vicinity of the Airport, along with established agreements between the Port and host communities, have a significant, yet disproportionate economic impact.
- Proximity to air service provides a locational advantage for companies located within a 30 minute drive of the Airport; particularly those also served by the commercial elements of an urban center.

Neutral Impacts on Socio-Economic Metrics

Aspects that are neither favorable or adverse, impacting the Study Area Cities, include:

- Burien and SeaTac maintain the oldest housing inventory among the Study Area Cities and King County, as reflected in the percent of units built before 1970 and median age of the housing inventory.
- With the exception of Normandy Park, all of the Study Area Cities have lower median home sale prices than the Seattle Metro Area as a whole. Even Federal Way, despite maintaining the newest inventory of residential ownership units, only commands the second lowest prices in the Study Area.
- Overall multi-family vacancy rates in the Study Area Cities range from 3.6% to 6.1%, with only two cities, Des Moines and Burien, reporting higher rates than King County.
- Communities located farthest from the Airport are considered more valuable, commanding higher rental rates and absorbing space at a higher rate.
- All of the Study Area Cities have commercial vacancy rates well below equilibrium, a consistent trend being experienced in many cities since the Great Recession.

Negative Impacts on Socio-Economic Metrics

Negative aspects impacting the Study Area Cities include:

- All of the school districts which educate residents of the Study Area Cities have a reported "lower socio-economic profile" than that of King County. Additionally, all have performed at comparatively lower levels in math and the arts than Statewide levels as a whole.
- All of the Study Area Cities, with the exception of Normandy Park, have lower median household incomes below the average for King County, and in most instances lower than the State average, as well.

- With the exceptions of Normandy Park and Des Moines, all of the Study Area Cities have higher shares of owner-occupied households than King County and the State as a whole, spending 30% or more of their income for housing.
- Over the past two decades, unemployment rates in the Study Area Cities have increased, while King County's have decreased. In addition, the Study Area Cities have historically maintained higher current unemployment rates than King County's of 3.5%.

M. RECOMMENDATIONS

A total of 70 recommendations are presented for further consideration as part of the 2020 Study.

Noise & Vibration Recommendations

The following 10 recommendations are offered to address noise and vibration issues (refer to Section 5 of this Study for further information):

N.1 ..... Develop a Set of Alternative Nosie Metrics

The Federal Aviation Administration is encouraged to complete its study of alternative noise metrics for assessing the impact of noise on residential areas. If the metric is not changed, the Port of Seattle should advocate for an alternate metric.

N.2 ..... Increase Arrival Glideslope

Work with the Federal Aviation Administration to increase the arrival glide slope to a minimum of 3-degrees for all arrival aircraft.

N.3 ..... Conduct an Environmental Review for Flight Track Changes

Any desired changes in flight tracks should have adequate environmental review and provide opportunities for public involvement.

N.4 ..... Institute Noise Abatement Procedures

The Port of Seattle should consider noise reduction measure for take-off and landing procedures during low traffic and late-night hours. A limit on late-night flights (between midnight and 7:00 AM) should be considered, including both cargo and passenger flights.

N.5 ..... Expand Noise Monitor Locations

The Port of Seattle should consider installing additional permanent and mobile noise monitoring stations to monitor noise in the areas receiving the highest number of complaints. This information would be valuable understand the extent of noise impacts and to inform current and future mitigation programs.

N.6 ..... Address Existing Mitigation Packages

There have been numerous reports of faulty installations of sound insulation features on homes within the 65 DNL contour, mostly mitigated during the third runway project. It is recommended that the Port of Seattle accommodate faulty and failed installations and ensure that future installations are inspected to comply with appropriate building codes.

N.7 ..... Direct Representation on the Port Commission

The Port of Seattle is governed by a 5-member Commission, with each Commissioner elected at-large and serving a 4-year term. It is recommended that the Port of Seattle designate one Commission position to be directly representative of the Study Area Cities. This "District Commissioner" would represent the constituents of the Study Area Cities and would be a resident of the City of Burien, Des Moines, Federal Way, Normandy Park, SeaTac, or Tukwila.

N.8 ..... Conduct Additional Vibrational Monitoring

Residences where the louder SEL events occur (exceeding 75 dB) and should include monitoring of the windows, walls and floors for vibration. This monitoring should occur over a longer timeframe (the previous study only evaluated the effects over a 24-hour period).

N.9 ..... Determine SEL Impacts

Residents living in the vicinity of Seattle-Tacoma International Airport should participate in a panel to rate the annoyance of individual aircraft SEL events in their homes and conduct a statistical analysis to establish the best combination of measures to predict annoyance (using such metrics as the Hubbard Exterior Sound Pressure Level Threshold Criteria).

N.10 ..... Determine the Effectiveness of Sound Insulation Practices

The practices and efficiency of the sound insulation techniques authorized by Port of Seattle to limiting LFN in homes and businesses under its Part 150 program should be evaluated for effectiveness. Homes and businesses where current noise mitigation are insufficient or which have failed should be replaced with appropriate measures.

Air Quality Recommendations

The following 5 recommendations are offered to address air quality issues the issues (refer to Section 6 of this Study for further information):

AQ.1 ..... Improve the Current Monitoring Network

Improve the current air quality monitoring network by increasing the number and location of monitors in and around the Airport, including measurements of ozone and particulate-based.

AQ.2 ..... Establish Monitoring Guidelines for New Locations

Establish guidelines for air quality monitor locations that consider economics, security, logistics, and atmospheric and pollution considerations.

AQ.3 ..... Deploy Purple Air Monitors

To supplement the above air quality monitor network, deploy a collection of smaller, less expensive monitors (such as those from Purple Air) throughout the Study Area (100 to 200 monitors, for example) in areas of concern to get a general sample of air quality trends. A quality assurance program should be part of this effort to ensure the monitors are deployed, placed, and maintained correctly. This, in turn, may assist in indicating which areas should receive future FRM/FEM monitor in the future.

AQ.4 ..... Research the Connection of Ultrafine Particles and Health Impacts

Further study and research should be conducted to establish a definitive link between UFPs and health impacts.

AQ.5 ..... Aviation Emissions Rise and Impact Decline

While there has been region compliance with air quality standards, EPA data has shown a general increase over the past decade that correlates to a rise in Airport operations, especially with a large increase from 2014 to 2017. Additional study and an improved monitoring network are warranted to determine the extent of regional are pollution impacts that are directly related to Airport activity.

Mobility Recommendations

The following 25 recommendations are offered to address mobility issues, including access via roads, transit, pedestrian, as well as area parking. Many of these recommendations include additional studies and inventories to augment existing data gaps (which is not complete – refer to Section 7 of this Study for further information):

M.1 ..... Generate Rental Car Forecasts

The Port of Seattle should work generate annual service demand for rental cars to ensure the Consolidated Rental Car Facility can accommodate future customer volumes and vehicle storage.

M.2 ..... Conduct an Annual Parking Demand Study

The Port of Seattle should conduct an annual study parking demand and occupancy for the Main Parking Garage and employee parking lots to better assess parking demand and plan for supply over time in the Seattle-Tacoma International Airport parking system.

M.3 ..... Conduct an Annual Cell Phone Lot Demand Study

The Port of Seattle should conduct an annual survey of the Cell Phone Lot usage in terms of occupancy and typical vehicle parking duration. The survey should examine whether the Cell Phone Lot reduces congestion at the arrivals and departures areas in front of the terminal.

M.4 ..... Inventory Private Parking Lot Data

The Port of Seattle should create a consolidated list of private parking facilities along with inventory and occupancy data to maintain a record of off-site parking accommodations and how changing supply may increase demand at the main garage. The Port should also identify private lots that may be redeveloped as other non-parking uses in the near and long-term in anticipation of a parking demand shift.

M.5 ..... Conduct an Airport Mobility Modes Survey

The Port of Seattle should analyze the historical and current passenger mode trends to assess how passengers and employees travel to and from the Airport. The Port of Seattle should institute annual passenger surveys to forecast and respond to mobility demands.

M.6 ..... Conduct a Drop-Off/Pick-Up Zone Study

The Port of Seattle should create a data source for drop-off and pick-up zones for airport shuttles to assess congestion and vehicle and pedestrian flow in and around the Airport property.

M.7 ..... Forecast Employee/Vendor/Tenant Demand

The Port of Seattle should work with its staff, vendors, and tenants to generate annual employee forecasts to ensure there are parking and mobility options to accommodate changing employment.

M.8 ..... Develop an Airport Parking Master Plan

The Port of Seattle should create a parking master plan based on anticipated passenger volumes and employment forecasts, in collaboration with Airport vendors and employees, surrounding cities, King County Metro, and Sound Transit.

M.9 ..... Develop a Transportation Improvement Program Database

The Port of Seattle should work with WsDOT, Sound Transit, King County Metro and local planning and/or local economic and development departments to create a database of all historical and current capital improvements in the Seattle-Tacoma International Airport area to better understand how the physical network changes overtime

M.10 .... Conduct a Rental Car Origin-Destination Study

The Port of Seattle should conduct a vehicle origin-destination study at the Consolidated Rental Car facility to better understand vehicle patterns and movements along the transportation network around the facility as well as understand where vehicles are traveling from to reach the facility. This study should conduct an origin-destination analysis for SOVs, transit, shuttles, and airporters.

M.11 .... Develop a Targeted Annual Traffic Monitoring System

The Port of Seattle should work with WsDOT and local traffic engineering departments to create an Airport-specific traffic monitoring system and program. Critical intersections and roadway segments should be identified and monitored on an annual basis to create a consistent and reliable database that monitors congestion over time. The traffic analysis should target specific time frames to include both off-peak and peak seasons, and AM and PM peak time periods. Future traffic monitoring efforts should include level of service, vehicle delay, vehicle/capacity ratios, and AADT analyses.

M.12 .... Conduct an Annual Transit Demand Analysis

The Port of Seattle, King County Metro, and Sound Transit should participate in an annual transit analysis on ridership, use, perception, and demand in and around the Airport. This study should document transit demand in the Study Area and ways to improve transit ridership to the Airport.

M.13 .... Improve Airport Passenger and Employee Transit Utilization

The Port of Seattle should partner with King County Metro and Sound Transit to identify annual transit utilization of Airport passengers and employees.

M.14 .... Analyze Park & Ride Utilization

The Port of Seattle, King County Metro, or Sound Transit should conduct a detailed analysis of the Park & Ride facilities in the study area to determine how many individuals use the facilities to access the Airport

M.15 .... Conduct a Park & Ride License Plate Analysis

A License Plate Analysis should be conducted at Park & Ride lots to determine where vehicles originate and to better understand Park & Ride demand patterns.

M.16 .... Conduct an Off-Street Parking License Plate Analysis

In conjunction with the above, a License Plate Analysis should be conducted at key off-street parking facilities and neighborhoods to understand where vehicles originate from in the Study Area and the use of certain on-and off-street facilities.

M.17 .... Conduct a Transit Origin/Destination Study

Similar to the above, an Origin/Destination Study should be conducted for key transit centers and hubs in the region to determine which users access the Seattle-Tacoma International Airport via transit modes. An Origin/Destination study analyzes travel patterns and average daily traffic in a specific study area along key roadways and points to assess where vehicles are traveling.

M.18 .... Conduct Annual Pedestrian Counts

The Port of Seattle, King County Metro, and Sound Transit should participate in an annual pedestrian access analysis to determine the number of individuals that utilize the sidewalk along the front of the terminal and the Link Light Rail Airport/SeaTac station pedestrian bridge to access the Airport.

M.19 .... Identify and Eliminate Pedestrian Mobility Barriers

The Port of Seattle, King County Metro, Sound Transit, and the City of SeaTac should participate in a study to identify potential mobility barriers for pedestrians traveling between the terminal and US Highway 99 (e.g., lack of wayfinding/signage, crosswalk locations, crosswalk signal timing, etc.).

M.20 .... Conduct an On-Going On-Street Parking Study

The Cities of Burien, Tukwila, and SeaTac should maintain on-going parking studies with specific emphasis on-street segments adjacent to transit centers, light rail stations, and the Seattle-Tacoma International Airport. The study should monitor supply, utilization, duration, and areas with excessively high use from non-residents.

M.21 .... Establish Existing/Baseline Conditions

The initial parking studies should document existing conditions of specified off-and on-street parking facilities in the area, in communities including Burien, SeaTac, and Tukwila. Utilization counts should be conducted in these facilities during peak morning, afternoon, and evening peak periods during a typical weekday and weekend.

M.22 .... Establish and Maintain a Parking Supply Database

Develop a database of existing parking facilities, inventory, and utilization/demand to provide insight on parking demand in the area and give local communities an inventory that can be expanded and monitored over time.

M.23 .... Adopt or Expand Parking Permit Programs

Burien and Tukwila should adopt/expand their parking permit programs to discourage long-term Airport passenger and employee parking on residential streets. Permit programs should focus on areas close to light rail and RapidRide stations (within a 10-minute walk, or roughly one-half mile).

M.24 .... Parking Limitation Education at the Airport

The Port of Seattle should create an informational program to educate Airport employees and passengers regarding local parking restrictions – especially Burien, SeaTac and Tukwila – to discourage on-street parking on surrounding streets for Airport purposes. The Port of Seattle should also post off-airport parking restrictions on the Airport webpages, signage in and around the terminal, and through employee information sharing.

M.25 .... Develop Employee Parking Restrictions

The Port of Seattle should adopt a formal policy that prohibits Airport employees from utilizing on-street off-Airport parking during working hours. The Port of Seattle should educate employees of the policy and adopt enforcement and associated disciplinary measures for violators.

Surface Water Recommendations

The following 3 recommendations are offered to address surface water quality issues, involving methods to expand the knowledge of how surface water may be impacted in the Study Area (refer to Section 8 of this Study for further information):

WQ.1.... Correct Potential Errors and Data Gaps

Correct potential errors in the data to determine if sampling methodology from NPDES permit periods is completely comparable over the 22 years examined. If necessary, a more complete analysis of the NPDES water quality results for all outfalls and all parameters may be required.

WQ.2.... Improve Receiving Stream Data

Establish more permanent monitoring stations downstream and collect a suite of water quality parameters that are collected at outfalls on a schedule that makes results more consistent and comparable.

WQ.3.... Further Study Air Pollution Impacts on Surface Water

Conduct independent analyses of citizen-reported pollution samples on surface water locations. Also, develop a better understanding of the toxicity of traffic- and aircraft-related UFPs through further study and analysis.

Groundwater & Soil Recommendations

The following 3 recommendations are offered to address impacts to groundwater and soils, involving methods to expand the knowledge of how surface water may be impacted in the Study Area (refer to Section 9 of this Study for further information):

GW.1 .... Conduct Independent Testing of "Black Soot"

Incidents of "black soot" in the Study Area should be reported and tested by an independent third-party laboratory to determine its chemical composition and potential source(s).

GW.2 .... Conduct Ongoing Monitoring and Sampling

The Port of Seattle should conduct ongoing groundwater monitoring, sampling, and analysis in several remaining AOMA Unit C1 groundwater monitoring wells for key indicator parameters, to be performed on a three-year cycle. Results should be reviewed with groundwater data from the Study Area municipal water wells.

GW.3 .... Coordinate with Study Area Comprehensive Plans

Natural systems such as groundwater and soils do not begin or end at City or Airport borders. The Port of Seattle cooperatively work with surrounding communities to ensure the ongoing health and preservation of groundwater and soil areas. As Study Area Cities update their individual specific comprehensive plans, they should coordinate with the Port of Seattle to ensure all parties are adopting plans and policies that do not harm that local and regional environment.

Light Recommendations

The following 2 recommendations are offered to address impacts to lighting in and around the Study Area (refer to Section 10 of this Study for further information):

L.1 ..... Update Airport High Mast Lighting

To reduce glare potential, Seattle-Tacoma International Airport should replace the high mast flood lighting with LED sources similar to those used around the terminal aprons, at locations in the Cargo Area and adjacent to North Loop Road. This may be phased in over a period of time – no longer than 5 years is suggested.

L.2 ..... Adoption of Study Area Lighting Standards

Seattle-Tacoma International Airport and the Study Area Cities should consider implementing coordinated Lighting Guidelines for development of community friendly infrastructure. The lighting installations for off-site parking, transit, and the Consolidated Rental Car Facility are currently not aligned with industry standards for similar developments within neighborhoods or residential communities. To better support the communities that are directly adjacent to such infrastructure, the Study Area Cities (notably the City of SeaTac) should consider the adoption of Community Lighting Standards which would establish guidelines for future developments and renovations of existing facilities.

Public Safety Recommendations

The following 4 recommendations are offered to address public safety issues in the Study Area (refer to Section 11 of this Study for further information):

PS.1 ..... Expand the Study Area

Assuming the State determines it valuable to continue this 2019 Study, consider both expanding the Study Area to include investigations in communities located north of Seattle-Tacoma International Airport (across all of the indicators identified herein); and allocating appropriate resources to conduct more detailed analyses of criminal incidents on a neighborhood and area-specific basis (at least in the City of SeaTac and other communities located within a specified distance of the Airport.

PS.2 ..... Consider an Airport Impact Overlay District

This concept will be picked up again in a later Section, but as it relates to Public Safety, consider establishing an Airport Impact Overlay District that both shares in revenues and expenses associated with Airport-related operations. The boundaries could be determined after a future second level study in order to ensure that communities most, or even partially impacted, are included. Reparation levels could be graduated by distance and/or impact level, however, this concept will depend significantly on the ability to isolate monetary advantages and disadvantages to the Study Area Cities from Airport-related activities, as well as the Port's willingness to recognize the value of agreements with all of the communities, as opposed to single agreements with only a few.

PS.3 ..... Pursue Multiple Approaches to Assist Victims of Sex Trafficking

Possible roadways to identify victims and get them help include educating doctors and other medical professionals about what to look for, as well as employees in the airline and hospitality industries. Individuals in both of these arenas should be receive the Trafficking Education Network that can make them better equipped to respond to human trafficking. Finally, the Coalition Against Trafficking in Women (CATW) influences the shaping of US policy against trafficking.

PS.4 ..... Consider CPTED Principles in Portions of the Study Area

Crime Prevention Through Environmental Design (CPTED) is a design principle intended to deter criminal activity through a variety of design strategies. These include designs that encourage more pedestrian activity, street-level retail with upper-level apartments that overlook the street ("eyes on the street"), and other principles that create a diverse mixed-use environment where residents have a sense of ownership in the success of the "neighborhood". Areas that could benefit from CPTED principles include US Highway 99 in the Cities of SeaTac, Des Moines, and Federal Way, and First Avenue South in Burien. CPTED principles also help to diversify a community's land uses and economic base.

Public Health Recommendations

The following 11 recommendations are offered to address public health issues in the Study Area (refer to Section 12 of this Study for further information):

PH.1 ..... Establish an Independent Noise Monitoring Authority

Together with the Port of Seattle, the Study Area Cities should investigate the feasibility of establishing an independent noise monitoring authority. Collectively, members could decide if thresholds for noise established by the Federal Aviation Authority are adequate given local circumstances, as well as appropriate strategies for mitigating impacts.

PH.2 ..... Expand the Study Area

In order to determine the comprehensive public health impacts of operations at Seattle-Tacoma International Airport, public health statistics should also be collected for areas north and northeast of the Airport. This would include West Seattle, Beacon Hill, and potentially the city of Renton. Given the presence of two other airports (Boeing Field/King County International Airport and Renton Municipal Airport), those facilities should also be taken into consideration.

PH.3 ..... Develop More Detailed Public Health Statistics

The information reviewed collected data at the municipal level. In some cases, statistics of two neighboring communities was combined (SeaTac/Tukwila and Des Moines/Normandy Park). To get a more accurate depiction of the spatial distribution of various health metrics, this information should be gathered at the census tract or enumeration district level. (While reporting by street address would be ideal, it might be prohibited under HIPAA standards.) Such information could be overlaid with noise contours and flight tracks to see if there are correlations between aircraft activity and certain health outcomes.

PH.4 ..... Approve/Reauthorize Bills to Address Mitigation

Request that the State Legislature reauthorize bills associated with the mitigation of residential properties, addressing multiple areas including past efforts that were either insufficient or that have not maintained their effectiveness; as well as properties in other communities that were not included in the initial round of funding. Investigate potential sources of funding to finance improvements (i.e., airport facility fee charged for the benefit of the Study Area Cities.) As of the writing of this report, a draft bill is pending to address homes that were mitigated under the previous Port of Seattle packages.

PH.5 ..... Audit Local Building and Zoning Standards

Conduct an audit of the building and zoning codes for all Study Area Cities to identify any inconsistencies between local regulations and federal rules. Establish a unified system of rules in order to ensure equity among the communities.

PH.6 ..... Identify New Construction Potentially Impacted by Airport Use

Identify relevant organizations that should be included as referral agencies for any new construction (residential or commercial) that may be impacted by air-related impacts (i.e., Puget Sound Clean Air Agency).

PH.7 ..... Establish a Health Impact Assessment Process

The Study Area Cities should consider establishing a requirement that new construction projects (of a certain size and type) include preparation of a Health Impact Assessment (HIA). Health is emerging as a significant aspect of many real estate projects, as is how real estate developments affect the health of its users and occupants, along with the community at-large. An HIA is an evidence-based process that engages the community, gathers health-related information, and identifies strategies to improve community and individual health. This tool could serve both the developer and city, as well as inform future plans and policies.

PH.8 ..... Require Alternative Fuel Use for Airport Users

Request the State Legislature establish an alternative fuels requirement on users of Port of Seattle facilities, that could be phased in as deemed feasible.

PH.9 ..... Expand the Late Night Noise Limitation Program

Encourage the Port of Seattle to expand the Late Night Noise Limitation Program in ways that address community concerns, including:

- Limiting runways and flight patterns that align with the Pacific Highway rather than established neighborhoods, during certain hours;
- Accessing a graduated charge for landings and take-offs with lower fees charged during desirable hours and vice versa; and,
- Relocate late-night cargo traffic to an alternative airfield.

PH.10 ... Replant Trees in the Study Area

Whereas construction of third runway reportedly necessitated the removal of several old growth trees, and whereas they were effective at absorbing some level of noise and toxins, consider establishing a replanting program in strategically advantageous locations (ensuring this uses tree and landscape species that repel and discourage bird nesting and feeding).

PH.11 ... Expand Port Efforts to Promote Public Health

Based on review of information associated with the Port of Seattle's efforts to further strategic initiatives associated with the Federal Aviation Administration's Airport Sustainability Program, it appears a limited emphasis has been placed on efforts to enhance the health and welfare of residents in the Study Area Cities, despite the fact that among its stated goals is to: "help achieve social progress by advancing a broad set of actions that ensure organizational goals are achieved in a way that is consistent with the needs and values of the local community." Existing programs including the Noise Compatibility Program and the Voluntary Airport Low Emissions (VALE) program should be adopted by the Port of Seattle. These and other solutions should be funded through the Airport Improvement Program grant funds.

Socio-Economic Recommendations

The following 3 recommendations are offered to address public health issues in the Study Area (refer to Section 13 of this Study for further information):

SE.1 ..... All Parties Should Commit to a Shared Objective

This is essentially evolving the Airport and the Study Area Cities together. Seattle-Tacoma International Airport, like many other infill airports, needs to see the communities around it as their partner, and best opportunity to evolve into an "aerotropolis." In order to do this, there needs to be: common understanding of desired outcomes, equal commitment to a healthy whole (airport and all impacted communities), regulatory alignment, consistent marketing and shared oversight.

SE.2 ..... Consider a "Study Area-Wide" Impact Overlay District

This concept was mentioned in Section 11 in the context of public safety. The idea behind an Airport Overlay District evolved from discussions with community members regarding perceived inequities between and among the Study Area Cities, particularly as they relate to positive and negative impacts resulting from Airport operations. The intention is to establish a mechanism whereby revenues and expenses could be shared equitably (if not equally), and comparative inequities could be neutralized. For example, if one community is deemed more appropriate for a certain airport-supporting business or land use, facilitate its development in that location, but allow all of the communities to share in its economic contribution. An overlay district could also maintain design and development standards and regulations in order to ensure consistency across municipal lines.

SE.3 ..... Conduct Additional Analyses

This has been mentioned in previous Sections of this report but consider amending work completed for this effort with similar analyses of other jurisdictions potentially equally impacted by airport operation. These analyses should also be supplemented with review of various reports that were ongoing while this one was being prepared; and additional research into areas omitted from the scope of this assignment. Additional areas of investigation might include: cost-benefit analysis of Port-owned parcels in the City of SeaTac; update to airport trip origins; surveys of local brokers regarding the perceived impact of airport operations on real estate; market feasibility studies for land uses and real estate product types absent or under-represented; and a housing inventory to understand the impact of Port mitigation packages.

General Recommendations

The following 7 recommendations are offered to general address issues and concerns not covered by individual Sections of this Study:

G.1 ..... Establish a single source data clearinghouse

The 2020 Study collected and reviewed a wide variety of data from numerous agencies and sources. Many data gaps were noted because of the way data was collected over a 22-year period, missing information, inconsistencies in the way data was reported, etc. Given that much of this data was available online, it is recommended that a single source be established to collect and compile the information for the areas covered in this Study. This could be a series of live links to existing databases maintained by other agencies, a single local or regional agency that collects and updates these databases, or some other method. A regional agency like the Puget Sound Regional Council is one option, but other options should be explored to determine an appropriate "data clearinghouse".

G.2 ..... Expand the Study Area

The Study Area covered a 61.36 square mile area in South King County. The Consultant Team was not involved in the determination of the Study Area but suggests that it should be expanded so the Airport falls in the center of the Study Area. That means areas to the north of Seattle-Tacoma International Airport which were not part of the 2020 Study Area would be similarly research and assessed. Based on community comments from residents outside of the Study Area, it is suspected that there are undocumented impacts outside of the Study Area which would be a more accurate representation of community impacts.

G.3 ..... Expand Participation by the Port of Seattle

Initially, representatives of the Port of Seattle were to be members of the Technical Advisory Committee (TAC) to help the Consultant Team during this Study. The Port of Seattle declined to participate on the TAC, although Port staff did provide the Consultant Team with information and data when requested during the Study. The Consultant Team believes the Study would have benefitted from the ongoing and active TAC participation by the Port of Seattle. Should follow-up studies be conducted with a similar advisory committee, Port of Seattle staff should be invited to be a more active participant.

G.4 ..... Improve the Airport/Community relationship

At stakeholder interviews and the Public Workshops, a great deal of community distrust was displayed regarding Seattle-Tacoma International Airport, the Port of Seattle, and the Federal Aviation Administration. This included comments which go as far back as the second runway (1970), the mitigation packages associated with the third runway, noise concerns associated with NextGen procedures, and other similar concerns. It would be beneficial for both the Airport and the Study Area Cities to find areas of common ground and work together to not only improve this relationship, but to minimize the impacts noted by this Study.

G.5 ..... Develop a Plan for Airport-adjacent perimeter areas

The Port of Seattle should work collaboratively with Burien, Des Moines, and SeaTac to develop a plan for undeveloped and under-developed areas surrounding Seattle-Tacoma International Airport as revenue-generating uses that are compatible with each City's comprehensive plan. Uses such as the Federal Detention Center and the Federal Aviation Administration campus bring employment, but as federal entities generate no revenue for the local community. This Plan would include Airport property and extend into neighboring areas where new compatible development could be accommodated (such as mixed-use transit-oriented development around the Angle Lake Link light rail station, and new hospitality/conferencing development in Burien, Des Moines and SeaTac). A market study would be necessary to determine which land uses would be warranted and developed parcels should remain as revenue-generating portions of each host City.

G.6 ..... Follow NPIAS Attribute #5 regarding surrounding communities

On page 1 of the NPIAS (National Plan of Integrated Airport Systems) – a report submitted to Congress every two years by the Secretary of Transportation – list eight attributes that airports should follow. Attribute #5 is particularly appropriate, stipulating that "Airports should be compatible with surrounding communities, maintaining a balance between the needs of aviation, the environment, and the requirements of residents". The Port of Seattle should work collaboratively with all of the cities within the Study Area to assure that the operation and growth of Seattle-Tacoma International Airport is compatible with its surrounding communities.

G.7 ..... Conduct an expanded Phase 2 Study

The 2020 Study was tasked with evaluating data for the period 1997 through 2019 in a wide variety of subjects. The schedule for the entire project was set at 12 months, with all research, assessment, and documentation compressed into a 7-month time-frame and limited only to readily-available data (no new sampling, monitoring, or modelling), with a consultant budget of $496,000. While there were some parallels with a similar study prepared for CTED (completed in 1997), that effort had a larger budget ($775,000) – approximately $1.3 million in 2020 dollars Therefore, it is recommended that a Phase 2 Study be authorized with a budget that allows for more sampling, monitoring, and modelling.

N. THE FUTURE

The Greek philosopher Heraclitus is credited with the quote "the only constant in life is change". That still holds true today. Everything in the Study Area has continued to evolve and change from 1997 to 2020:

- Since 1997, population has continued to grow in each Study Area City, in King County, in Seattle, and throughout the region;
- Operations have increased at Seattle-Tacoma International Airport;
- Technological improvements have lowered emission aircraft emissions and noise;
- Technological improvements have made vehicles more fuel efficient and less polluting; and,
- Technological changes have altered the way we do business (email, video conferencing, co-working spaces), and the way we travel (light rail, Uber, Lyft, etc.), to name a few.

No study or report can accurately predict the future. However, there are some potentials on the horizon that may influence travel at Seattle-Tacoma International Airport. Should these occur, it is recommended that the Study Area be considered to ensure there are no adverse impacts as a result of these new potentials:

- A potential new airport to augment/supplement operations at Seattle-Tacoma International Airport;
- Changes in aviation technology including STOL/VTOL aircraft, advanced engines and aircraft design;
- Electric cars which reduce air pollution and reliance on fossil fuels;
- Autonomous vehicles which might improve traffic congestion;
- Flying cars and taxis are currently being developed by several companies and are scheduled to be tested in 2020 through 2023;
- 5G cellular technology which holds the promise of high-speed digital service that could change the nature of offices and commuting;
- Increasing reliance on Low-Impact Design (LID) and sustainable green building practices;

- Ongoing regional growth has the potential to strain all infrastructure – water, sanitary sewer, storm drainage, roadways – resulting in increased potentials for pollution and congestion; and,
- The Hyperloop concept, which may offer an alternative to short and medium-haul air travel.

No future is assured. Any one of the above could be unsustainable, not feasible, too expensive, not accepted by the public, or could fail for any number of unknown reasons. Similarly, there may be other technological advancements as-yet unknown that could have a significant impact on daily life.

O. CLIMATE CHANGE

While the issue of climate change was not part of the project scope, the issue arose as a question from several community members during this project. The Consultant Team was asked "what are you doing to address climate change" and some community members expressed frustration that this was not part of the project.

To clarify, the Consultant Team was not asked to investigate any impacts that Seattle-Tacoma International Airport might have on climate change. The project resources (time and budget) were also insufficient to address such a broad and complex issue.

The 2020 Study agrees with the bulk of climate research – that the climate has been increasingly affected by human activity. This is supported by research by scientists and academicians across the world. In 2016, 196 countries signed the Paris Accords to address climate change and its underlying causes. (The US withdrew from the agreement in June 2017.)

The 2020 Study did not research the issue of aviation-induced climate change, but it was addressed at the 2019 Paris Air Show. An article in Fortune magazine (June 2019) contained the following quote:

> "Aviation currently accounts for around 2.5% of global carbon emissions and the industry has pledged to halve its 2005-level footprint by 2050 through an offsetting program. Therefore, engineering firms were keen to showcase a range of eco-friendly inventions such as hybrid engines, urban mobility vehicles, and autonomous flight systems at the annual event, the largest for the aerospace industry. . . .It's not just environmental considerations driving the research: UBS estimates sales of hybrid engines will be worth $178 billion by 2040, while the electric vertical take-off and landing (eVTOL) market will be a $285 billion business by 2030."

The above quote did not specify which components of "aviation" account for 2.5% of global carbon emissions nor the source of this figure. It could be limited to aircraft emissions while operational, or it could involve the entire product life-cycle – from manufacture to decommissioning. The 2.5% figure likely does not address other airport-related activities, including ground transportation by travelers and employees.

The above quote makes an economic case for changes in aircraft technology (likely as a cost-savings for airlines and owners), which will have a secondary benefit of addressing environmental concerns. These remain speculative projections at this point, but it is hoped that advances in hybrid and electromotive propulsion will have the added benefit of significantly reducing noise and air pollution.

Beyond aircraft technology, there are promising trends in market acceptance of automobiles and light trucks with hybrid and fully-electric engines. This can help to reduce tailpipe emissions but may also shift some energy-generation burdens to the power grid (for electric vehicle recharging). Simpler and perhaps more effective measures are those that promote developments that encourage walkability, biking, and transit use – something that is happening across the region and the US.

The Port of Seattle is taking steps to address environmental concerns – from replacing old high-mast lighting with high-efficiency LEDs and usage of more hybrid and electric vehicles, to development of the Sustainable Airport Master Plan. But the 2020 Study will not address – and was not asked to address – any potential climate change impacts associated with operations at Seattle-Tacoma International Airport. This is an issue that is worthy of a separate investigation and study.

P. CONCLUSION

To reiterate the statement made on page 1 of this document, the 2020 Study is not intended to oppose or impede the operations, growth, or success of Seattle-Tacoma International Airport. The 2020 Study acknowledges the regional and statewide significance of Seattle-Tacoma International Airport, and has attempted to objectively and independently evaluate and assess a variety of impacts – positive, negative, and neutral – associated with its operation and to establish a baseline which may be used to evaluate future operations.

The Consultant Team has attempted to gauge the impacts of have the Airport as a "neighbor", but all answers are entirely clear. Additional studies, including expansion of the Study Area, are necessary to get a more comprehensive and complete picture of any impacts associated with Seattle-Tacoma International Airport.

As noted in this document, the principal issues associated with Airport activity were **Noise** and **Air Quality**:

- The 2020 Study can conclude that there is a direct correlation between aviation activity and noise complaints in the Study Area. Noise impacts may also have an associative relationship to other concerns, including stress, health impacts, learning disruption, home values, and others. But those associative impacts require additional modelling, sampling, and study in order to make a direct correlation.
- Similarly, there are associative impacts with emissions from aircraft usage. Due to the inadequate air quality monitoring network, the extent of these impacts cannot be identified. There are similar anecdotal concerns about impacts on health, property values, and economic development, but more data is necessary to show a direct causation. Ongoing research on human health issues associated with UFPs (ultra-fine particulate matter) will also be helpful in this effort.

Other issues investigated – **Mobility**, **Surface Water Quality**, **Groundwater and Soil Quality**, **Public Safety**, **Public Health**, and **Socio-Economic Impacts** – require additional study to determine what impacts (if any) are associated with Seattle-Tacoma International Airport. Only impacts associated with **Light** were found not to be a significant issue in the Study Area.

Q. EPILOGUE

Change has been the one constant in South King County and the region. The Study Area Cities and Seattle-Tacoma International Airport have grown up together for more than 75 years. There are portions of the Study Area Cities that are much more urbanized in 2020 than they were years earlier. And while the Airport has continued to grow, the pace of its growth has accelerated since 2000, far eclipsing the pace of growth locally and regionally.

The 1997 Study could not predict the rise of such innovations as smartphones, social media, or app-driven car services. Twenty-three years later, much has changed that is now part of everyday life. Even something as basic as light rail was only a proposal in 1997 – but in 2020, it is an important link in accessing Seattle-Tacoma International Airport.

So, in the next 23 years – by 2043 – there could be new changes that are presently beyond imagination, including new modes of travel, new means of aircraft propulsion, and new technologies that change how we live, work, play and travel.

As enticing as the future is, there are pressing concerns that face the Study Area Cities in 2020. While an important component in the region's economy, Seattle-Tacoma International Airport should also strive to minimize impacts from its operation so that the residents of Burien, Des Moines, Federal Way, Normandy Park, SeaTac, and Tukwila do not bear an undue burden, primarily due to noise and air quality impacts.

Often attributed to President John F. Kennedy, a well-known aphorism states, "a rising tide lifts all boats". It is recommended that this be a guiding principle in the development and operation of Seattle-Tacoma International Airport. What benefits the Airport should have an associated benefit to the surrounding Study Area Cities. And by extension, operations at the Airport should not negatively impact its neighbors.

APPENDICES

Appendix A – References

Appendix B – Stakeholder Interviews

Appendix C – Project Contacts

Appendix D – Glossary

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APPENDIX A

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APPENDIX B

STAKEHOLDER INTERVIEWS

A. Summary of Interview Process

A total of 48 people were named by the Study Area cities for stakeholder interviews, which were conducted in June and July 2019. There were 36 sessions conducted – stakeholders were interviewed either 1-on-1 or in small groups. Each stakeholder was asked the same two questions:

1. What are the benefits/positive impacts of living/working near Seattle-Tacoma International Airport?
2. What are the challenges of living/working near Seattle-Tacoma International Airport?

Stakeholder responses are presented below without attribution to names or relationship to the Study Area.

B. Individual Stakeholder Session Summaries

The following summaries represent input from the stakeholders that were interviewed. The quotes, opinion, statements, and other information are those of the individual stakeholders. None of the following summary represents any opinion or observations by the consultants.

Session #1 **Stakeholders #1, #2 and #3 (Tukwila, 03 June 2019, 9:30 AM)**

General:

- City is further east of flight path – also in flight path of Boeing Field.
- Noise, traffic concerns (passengers almost double in last 10 years).
- Second runway opened in 1973, Third runway in 2008.
- Highline Forum – cooperative group of airport cities.
- Soundside Alliance – also created for economic development.
- Need a cooperative relationship with Seattle-Tacoma International Airport, but more to be done.
- Wants a well-functioning airport and well-functioning cities.
- Needs to be another regional airport, not just Seattle-Tacoma International Airport.
- South King County seen as a place to put undesirable facilities.
- Seattle-Tacoma International Airport should be asking "how can we improve air quality in the region"?
- Income growth has not happened – "we are poorer".
- Area is a big draw for "New Americans".
- Higher property values would encourage more MF and townhomes.

Economic Development:

- Impacting property values hurts city revenues/budgets.
- Average home value is 50% to 67% of other parts of Seattle.
- 5000 hotel rooms in SeaTac and Tukwila.
- Third Runway mitigation removed homes in Des Moines and decreased school funding.
- Southcenter Mall is largest mall in Pacific Northwest (2.1 million SF, plus 2 million SF of surrounding retail) – 16 million visitors per year.
- Seattle-Tacoma International Airport brings in visitors to Southcenter Mall.
- Biggest economic development is working at Seattle-Tacoma International Airport (9% work at airport, based on a study done by the Port of Seattle).
- Seattle-Tacoma International Airport brought more parking, but not many corporate headquarters.
- Biggest benefit is jobs associated with Seattle-Tacoma International Airport.
- Port of Seattle's mission is economic development.
- Mall benefits from Seattle-Tacoma International Airport but would be strong by itself – built in 1967, expanded in 2008.
- Seattle-Tacoma International Airport accommodates the regional demand, does not create it.
- Alaska Airlines headquarters is the largest corporate headquarters near Seattle-Tacoma International Airport.
- Bellevue's benefit from Seattle-Tacoma International Airport is proportionally better than Tukwila b Ecuador they do not have the same burdens.
- Being close to Seattle-Tacoma International Airport as a consultant gives great access.

Transportation:

- Cell phone data showed traffic increases on SH 99/Tukwila International Boulevard.
- Tukwila services I-5/405 corridors – more traffic and fires require more services.
- Main entry goes right through I-5 and 405.
- Much of the traffic is cut-through.
- Most residents are concerned about traffic.
- Light rail station in Tukwila was one of the first outside of the downtown core.
- Cargo and freight truck traffic also impact roads in Tukwila.
- Light rail will extend to Bellevue and Redmond.
- 518 & International Blvd station - other Tukwila stations (Gateway and Boeing Access Road) were removed in planning. Longest stretch of no stations.
- Light rail does not connect to Southcenter, so route ended up in Othello corridor.
- Light rail was supposed to connect economic centers (like Southcenter) but it purposely did not.

Public Safety:

- Smaller hotels along Highway 99 had more criminal element. Removed many of the properties to curtail crime (Federal program in 2013) – have removed 7 hotels.
- Crimes included prostitution, human trafficking, money laundering, etc.

Public Health:

- Air particulates also a concern (due to winds – especially on residences)
- ZIP code of Tukwila and SeaTac have health issues – shorter life spans, heart issues, diabetes, etc. May also be due to low income area.

Session #2 **Stakeholders #4 and #5 (Tukwila, 03 June 2019, 2:30 PM)**

Pros:

- Easy to get to Seattle-Tacoma International Airport for residents.
- 19,000 jobs at Seattle-Tacoma International Airport, other jobs dependent on Airport.
- 9th business airport in the US.
- Tukwila has the second largest concentration of hotels in the State - over 5,000 rooms.
- Economic development and future investment because of Seattle-Tacoma International Airport – good RevPAR (revenue per available room) for hotels.
- Encourages both development and redevelopment.
- Hospitality & tourism are job drivers.
- Washington is a trade-defendant state – global trade & logistics.
- Site locators like having an international airport in Seattle.

Cons:

- Hear a lot of concerns about environmental impacts, such as Ultra-Fine Particles.
- Hard to measure specific impacts associated with Ultra-Fine Particles.
- Traffic is a problem – highway system is constrained by water.
- Gateway Project – expansion of 500 and 518 and 167 to I-5.
- Traffic congestion, especially after remodel of airport drive.
- Seattle-Tacoma International Airport's physical size is a restriction to growth – too expensive to expand (Bonney Watson Cemetery in SeaTac is also a constraint).
- Seattle region is one of the largest human trafficking cities – domestic and foreign. Not necessarily just related to Seattle-Tacoma International Airport.
- South King County is a relatively depressed income area.
- Transient population contributes to higher crimes.
- Sometimes tourists are an easy target.
- Luggage crime at Seattle-Tacoma International Airport (criminals steal bags right off the carousel).

General:

- Tukwila is also in the flight path of Boeing Field but no noise complaints about them.
- More Tukwila noise complaints related to truck and rail lines.
- Light rail was opposed by community in Tukwila.

Session #3 **Stakeholders #6 and #7 (Burien, 04 June 2019, 10:30 AM)**

Airport Committee:

- Burien Res. 405 formed Airport Committee in 2017. Meets monthly to address concerns about Seattle-Tacoma International Airport. Looks at positive and negative aspects. Advises City Council.
- Passed resolutions regarding Seattle-Tacoma International Airport growth, noise and health impacts.
- No coordination on regional airport facilities (20+ airports in the region).
- Asked the Federal Aviation Administration and the Puget Sound Regional Council to consider a new airport – study enacted to look at airspace capacity.
- SB 5370 to look at additional capacity.
- Noise is still a problem – Part 150 is "woefully out of date".
- No accountability for not following Part 150.
- Need a formal documentation of noise impacts.
- NextGen aircraft putting a more significant impact on neighborhoods.

Third Runway:

- Close neighborhoods experiencing more noise - as far as Vashon Island.
- Not being used as was characterized (only for inclement weather).
- City is in the process of putting a white paper together that shows the Port of Seattle is in violation of their own Part 150 and using federal funds inappropriately.

Air Pollution:

- Concerns about air quality, especially Ultra-Fine Particles.
- Asking for permanent monitors to understand impacts of air pollution and Ultra-Fine Particles.

Sustainable Airport Master Plan (SAMP):

- NEPA/SEPA process – cities supplied draft comments.
- Seattle-Tacoma International Airport posted 75 pages of comments.
- Seattle-Tacoma International Airport is too small for its capacity – how does it compare with other US airports.
- No nighttime curfew for flights (major gateway for flights to Asia).

Community & Economic Development:

- Many Burien residents are pilots, flight attendants, and other workers
- Doesn't believe that Burien benefits from sales taxes – no hotel.
- City has a parcel that it is trying to develop as a hotel.
- Advertising "foodie paradise" in Burien.
- Annexed North Highline area in 2010 – now 52,000 total populationl.
- Largest employer is Highline School District also healthcare and retail workers – all of which cannot afford homes elsewhere.
- Burien home prices have not increased as much as other areas further away from Seattle-Tacoma International Airport.

Transportation:

- Light rail – long-range plan (to be studied in 2034).

Education:

- Schools have degraded because of influx of "New Americans" and multiple languages – coming to South King County because of affordability of housing.

Crime:

- Homelessness is a regional problem. Actual census has decreased but perception is that it is increasing.
- Addiction, needles in the parks, mental health issues are a public challenge.
- Property crime has decreased (for the most part), but violent crime/murder rate has increased – strictly gang-related.
- Opioid crisis is profound and subtle.

Session #4 **Stakeholders #8 and #9 (Burien, 04 June 2019, 11:30 AM)**

Pros:

- Convenient.
- Good for business travelers.
- Some Seattle-Tacoma International Airport workers (pilots, flight attendants, workers) live in Burien.
- Suburban areas seem to be catching up with the rest of the region.

Cons:s

- Noise – no consistency but is louder and more frequent.
- Noise seems higher in summer flights.
- Air emissions have impacted air quality.
- Q400 (small turbo proportion regional flights) turn sooner and now impact Gregory Heights (neighborhood due west of Seattle-Tacoma International Airport).
- Late night flights are egregious and have increased in the past 2 years.
- AirNoise.io to track flights and automatically lodge complaints.
- Crime seems to be increasing – can't tie it to Seattle-Tacoma International Airport. Maplewild Avenue has seen an uptick in crime.
- Ultra-Fine Particles can impact health issues.
- JFK, SFO, Phoenix, D-CALIF, BWI, and Burbank are all dealing with Ultra-Fine Particles and health issues.

Airport:

- NextGen – Replaces radar with GPS, increases runway capacity and allows more frequency.
- Third Runway not being used as originally said.
- If there were other alternatives to short-haul flights, problems might be fewer.
- Need more emphasis on rail and other modes.
- What if cargo operations were relocated to another airport?
- Could the Port of Seattle have a business model that expands beyond air travel.

Session #5 **Stakeholder #10 (Burien, 04 June 2019, 12:30 PM)**

Airport:

- Sustainable Airport Master Plan (SAMP) hired a DC consultant to respond to NEPA/SEPA process (Burien, Des Moines, Federal Way and Normandy Park).
- So much growth at Seattle-Tacoma International Airport (including new terminal expansions) that SAMP is actually separate from that – currently in comment phase.
- The Port of Seattle has documented all comments online and how they will be addressed.
- Draft NEPA/SEPA due Fall 2019.

Pros:

- Seattle-Tacoma International Airport is a significant employer (pilots, flight attendants, staff, etc.).
- Market for a hotel (none in Burien).
- New City Hall built in 2009, condos followed ($2.50 to $3.00/ft), all units are full.
- Northeast Redevelopment Area (NERA) – northeastern part of the city. Develop as more than just airport parking. Now has warehousing, cold storage, etc.

Cons:

- South flow landings are impacting neighborhoods in Burien.
- Runway was initially to be used only for inclement weather but is really being used as a main runway.
- Lots of concerns with Ultra-Fine Particle pollution – impacts health, communities.
- Volume of flights is significantly more than before – more larger jets and more frequent.
- City currently suing on 250-degree turn for turbo prop flights - take a north flow left turn at 500 feet altitude.
- How do missed approaches impact SeaTac in comparison to other cities? Is Seattle-Tacoma International Airport establishing a de facto new flight path. Also impacts Des Moines on a south flow.
- Noise – Burien sits to the west of Seattle-Tacoma International Airport and experiences increased noise as aircraft stop during crossing taxiways – need 50% thrust to get a plane started to roll. A continuous taxiway policy would reduce the noise.
- Angle of approach – south flow 2.87 (34R) rather than 3 degrees could mitigate impacts.
- Runway utilization times also impact neighborhoods.
- World Health Org Study – Decibel levels above 45 (nighttime above 40) impacts people, being pursued by other airports (like Boston).
- Nighttime operations are midnight to 5 AM – long-haul Asian late night flights (and cargo) is an issue
- Seattle-Tacoma International Airport has a voluntary "Fly Quiet" program – public relations are the only benefit (no negatives for non-compliance).
- Chinese-owned massage businesses that are front for prostitution and drug trafficking.

Session #6 **Stakeholder #11 (Burien, 04 June 2019, 1:30 PM)**

Pros:

- Hard to see the positives.
- It should be positive for airport-related businesses, conference center/hotel.
- Hard to attract a hotel in the past (tried 4 times in the past).
- Want a more robust economy and a small walkable town but can't attribute difficulty to Seattle-Tacoma International Airport.
- Warehouses on Des Moines Memorial Drive, but higher paying jobs have people living elsewhere.
- Need to manage noise and reduce air pollution to entice new businesses and residents.
- Mixed-use opportunity between 152nd and 153rd.
- Crime doesn't seem to be any worse than anywhere else – not attributable to Seattle-Tacoma International Airport.
- Des Moines Memorial Drive – the Port of Seattle offering landscaping and other enhancements, New Commission members are more community and environmentally aware.

Cons:

- Was a robust community from the 1950's until incorporation in 1993. Interchanges on I-5, 509 and 518 had signs to Burien. Economy decreased (# of school children went down by half).
- Maybe the County and State need to step in, since Seattle-Tacoma International Airport benefits their region and State. State funding beyond Federal Aviation Administration to help Burien businesses?
- Economic vitality should be the goal, bringing in more businesses so that residents are not impacted.
- People are afraid to move to Burien because of air quality and noise.
- Third runway had new flight paths without public approval.
- Port is not maintaining some of its outlying properties (like Highline Botanic Garden, surrounded by residential) – reports of homeless, drugs, and violent crimes.

Other:

- Plan in the 1980s for a regional airport in Moses Lake, and one south (in Thurston County)
- Tranec – rail line to connect to Vancouver and central portion of Eastern Washington. Train would have connected directly to new airport (follow I-90 ROW).
- Port of Seattle is partnering with Port of Tacoma (used to be rivals).
- Council is more innovative than before.

Session #7 **Stakeholder #12 (Burien, 04 June 2019, 2:30 PM)**

Pros:

- Proximity to airport.
- Economic development hard without a hotel, but currently negotiating with a developer.
- The Port of Seattle is making more overtures to the public.

Cons:

- Operations have increased dramatically since the opening of the Third Runway (2008), is being used consistently.
- Seattle-Tacoma International Airport is preparing its master plan (SAMP) without considering impacts beyond their property line.
- Noise impacts Burien residents.
- Particulates also impacting Burien residents.
- Those that received mitigation previously are no longer entitled to new mitigation.
- Impact "creep" over time.

Airport Litigation:

- Awaiting decision from 9th Circuit Court of Appeals.
- Port in 2016 due to new flight tracks by Q400 Bombardier flights. Flights are low-altitude and 250-degree turns impact Shoreline neighborhood). Claims route did not go through NEPA process.
- Met with Federal Aviation Administration regional office (Renton) to discuss the Q400 process.
- Federal Aviation Administration started a Preliminary Environmental Analysis (not a standard process), took comments, and issued a Categorical Exclusion (CatEx) to allow the new route in June 2018. Used previous 250-degree as a basis for the exclusion.
- The Federal Aviation Administration decision did not consider residential areas an environmentally sensitive area.
- Requesting an appropriate environmental assessment be conducted.

Session #8 **Stakeholder #13 (Burien, 04 June 2019, 3:30 PM)**

Part 150 Study:

- For the period 2013-2018.
- Focused only on Third Runway, ignored other two.
- All projections were understated, too low – operations and frequency were low.
- Noise was under-projected - compatibility boundary was very small.
- Said "aircraft are quieter now, so we don't have to do much mitigation".
- Volume at Seattle-Tacoma International Airport increased 33%, now the 8th busiest airport (from 14th busiest).
- The Port of Seattle said no new noise modeling would be done until 2021, when SAMP is completed.
- Have not accounted for 12 years' worth of noise – not consideration of vibration impacts.
- SAMP projects will cost around $3 billion – predicting an increase of 80,000 passengers per year.
- The Port of Seattle hired CRS for architectural mitigation.
- Avigation easements are required by state law.
- Homeowners that received previous mitigation are ineligible for further mitigation.

- Poor mitigation practices resulted in poor reputation of dealing with Seattle-Tacoma International Airport.
- Sense of distrust remains with the Port of Seattle even before the Third Runway.

Cons:

- Seattle-Tacoma International Airport access and egress is hard, especially around the holidays.
- Transit not convenient for everyone.
- Port of Seattle commissioners are elected at-large, not by districts.

Crime:

- Washington is a blue state. Progressive attitudes about no policing, on-site injection, created a permanent addicted class that is enabled by the government.
- Crime not directly attributed to Seattle-Tacoma International Airport – Burien crime is more attributed to Seattle.

Environmental Justice:

- Up to 25% Hispanic population, most are low income.
- All communications from the Port of Seattle are in English, but many can't speak English or don't have access to online sources.
- The Port of Seattle is not acknowledging the population diversity.

Session #9 **Stakeholder #14 (Burien, 04 June 2019, 4:30 PM)**

Pros:

- Easily accessible.
- Seattle-Tacoma International Airport facilities are not local.

Cons:

- Noise.
- Pollution.
- Q400 turn to the west was one of the reasons for forming the Quiet Skies Coalition.
- The turn procedure violates Federal Aviation Administration paragraph 7110, paragraph 5-8-5.
- Shortcuts are a disservice to public safety.
- Started to do the 250-degree turns on July 2016.
- Will there be future shortcuts as Seattle-Tacoma International Airport expands?
- Missed approaches are up 30%.
- Separation should be 1000 feet vertical and 3 miles horizontal.
- Reverse thrust (to slow the aircraft down) is also a problem – may not be necessary. If they stopped doing this, dome of the noise issues would go away.
- Third runway is not being used in the fashion it was promised.
- No noise restrictions (hours or operations).

Session #10 **Stakeholder #15 (Burien, 04 June 2019, 5:30 PM)**

NextGen:

- Port of Seattle "lied to the community" about the Third Community in terms of use and length.
- Can land two planes simultaneously using the Third Runway and original inboard runway.
- Also impacts other airports, including Phoenix.
- No noise limitations (flight times) according to the Federal Aviation Administration.
- When the Third Runway was built, it removed trees on the west side and filled in a 200-foot ravine - nothing to abate noise.

Cons:

- "The cities that abut the airport have the most problems".
- City of Seattle and the Port of Seattle run Seattle-Tacoma International Airport – don't want a regional approach.
- Puget Sound Regional Council was told by the Federal Aviation Administration 20 years ago to find a site for a new airport.
- Highline area (Burien, Des Moines, Normandy Park, White Center) is largely low income and more immigrants.
- Most new businesses are restaurants, none associated with Seattle-Tacoma International Airport.
- Housing values have not increased proportional with the region.
- Second runway (1973) removed 1600 homes – school district went from 40,000 to 18,000.
- Homeless and gang-related crimes, drugs, prostitution are regional problems.
- Park next to Burien Community Center has had homeless problems (148th Street).
- 50% of people flying into Seattle-Tacoma International Airport have business north of the area (Bellevue, Mercer Island, etc.).
- Port of Seattle charges property tax to all of King County.
- Do not use hush houses for maintenance run-ups.
- "Push for a civil rights action suit for the burden of the airport impacts".
- "Tired of mitigation".

Session #11 **Stakeholders #16, #17 and #18 (Normandy Park, 06 June 2019, 10:30 AM)**

Pros:

- Looking to redone for hotel development.
- One of the greenest cities in King County (most dense tree canopy) - good location for eco-tourism.
- Looking to leverage for more dining, and other businesses.
- Potential for higher density development along First Avenue.
- Large lots – residential areas of 2 to 5 acres.

- Affluent community but high property taxes – looking for more commercial development, such as co-working offices.
- First Avenue is the main commercial corridor – development must be cohesive, village-like

Cons:

- Noise has been an increasing problem. Increased dramatically since 2011, especially at night (after 7 to 8 PM).
- 50+ late night flights (midnight to 5 AM), most of which are 747 cargo jets, interrupts sleep cycle.
- Can smell jet fuel, residue on cars, decks, etc. – dependent on prevailing winds.
- Port of Seattle cut down 2,000 trees for clearance standards – conifers previously helped absorb noise and air pollution.
- Sea-Tac is growing faster (went from 14th to 8th largest) – growth due to regional growth, Delta hub, more regional flights, more cruise flights.
- Noise problem also associated with start/stop taxiing for aircraft crossing runways.
- Biggest problem in air pollution and Ultra-Fine Particles.
- Patterns of disease around Seattle-Tacoma International Airport are evident – correlation to Ultra-Fine Particles?
- Seattle Public Health study showed increased health problems the closer you live to an airport (especially neuroplasticity) – reduces childhood lung capacity.
- Seattle-Tacoma International Airport seriously impacts property values (not, however, in Normandy Park).

Other:

- Second airport now being studied – but there is a high-level of mistrust with the Port of Seattle.
- Paine Field only handling a few passenger flights – cargo could be relocated to increase capacity.
- Airport at Moses Lake and high-speed rail to Seattle?
- Need more high-speed rail options.
- 80% of flights are domestic.
- South King County always gets what other cities don't want (prisons, etc.).
- "I want a runway use agreement with some teeth" (times, aircraft type, etc.).

Session #12 **Stakeholder #19 (Normandy Park, 06 June 2019, 4:30 PM)**

Pros:

- No benefits as a resident.
- Benefits in grants from the Port of Seattle, such as a website for an economic development committee.
- Would like to capitalize on Seattle-Tacoma International Airport proximity – boutique hotels, eateries. No current attractions for airport visitors.
- Possible hotel sites along either First Avenue or with views of Puget Sound. Prefer boutique or local businesses.

- Some Airport workers have meals or shop in Normandy Park.
- Some residents work for Port of Seattle or airlines.
- Good regional connectivity, working with the Port of Seattle – has a good community outreach.
- Home values have always held – even during the recession.
- Seattle-Tacoma International Airport is relatively good in responding to noise complaints from Normandy Park.

Cons:

- Hear noise, especially between 9 PM and 11 PM.
- Understands that more planes result in more sound.
- Fly-overs are more aggravating – have had 737's over his house, maybe 1000-1500 feet altitude.
- Q400 overflights are more frequent, but not as loud.
- No economic hit except for the lawsuit cost for the Third Runway.
- Port of Seattle doesn't do a good job of communicating outside of government channels.

General:

- 6600 to 6700 pop, 2.5 square miles land (6 square miles with water).
- Rely mostly on property taxes – one of the highest incomes/household in King County.
- Also an educated population – originally homes for executives from companies like Boeing.
- Small collection of multifamily along First Avenue and along 200th.
- "One of my goals was to heal the relationship with the Port of Seattle."
- There have been previous good reasons to "fight" with the Port of Seattle, but it should be a learning experience.
- The Port of Seattle's business plan is to improve the economy of the region, including the surrounding communities.
- Quality of life can suffer due to a variety of factors - traffic, litter, transient population.
- The Port of Seattle could work more closely with area cities on future plans.
- Av may be a technological shift that may change daily life.

Session #13 **Stakeholder #20 (SeaTac, 07 June 2019, 8:30 AM)**

Pros:

- Biggest economic engine for City of SeaTac – hotels, restaurants, rental car sales taxes, etc.
- Whole state benefits from Seattle-Tacoma International Airport – City of SeaTac is the gateway.
- Might be able to growth north, south or west.
- Is pro-growth and pro-economic development, and pro-community concerns.
- Need to improve the visual quality of the City as the gateway for the state.
- Good access to both Seattle-Tacoma International Airport and I-5 (and planned new bypass from I-5 to Hwy 509).

- Light rail will eventually extend to Tacoma.

Cons:

- Locating another airport will impact other host community (noise and traffic).
- Traffic issues ever since main entry was re-routed - would like more bypasses for traffic to exit from 176th or 180th - traffic circulation needs attention.
- Suffers from noise and air pollution (City is on the east, north and south sides of Seattle-Tacoma International Airport).
- Night-time take-offs disrupt his sleep.
- Window glazing (double-glazed) is ineffective.
- Impacts also a result of ground operations (taxiing, etc.).
- Reauthorization bill may also allow re-mitigation of homes previously mitigated.
- Should also re-mitigate apartment buildings.
- Cities should strengthen building codes for better sound insulation – set up special fund for homeowners to account for additional costs – could be funded through an airport facility fee.
- Higher mortality rate, though cannot directly attributed to Seattle-Tacoma International Airport.
- Should have restful and peaceful nights.
- Also concerns about reverse thrust.
- Vibration is also a problem but not aware of any studies looking at vibration.
- Light rail encourages more transients into the City of SeaTac – property crimes, drug trafficking, some harassment.
- Need more police presence as a deterrent – maybe a new station at 200th & International Boulevard.
- Property values not consistent with Seattle and other areas – airport communities are less desirable.
- Noise interrupts conversation and learning in schools.
- No Starbucks or McDonalds within the City of SeaTac, no fitness centers.

Session #14 **Stakeholder #21 (SeaTac, 07 June 2019, 9:30 AM)**

Pros:

- Less expensive than other parts of the region.
- Good regional access by freeways.
- Good close accessibility to Seattle-Tacoma International Airport.
- Many people live close to Seattle-Tacoma International Airport because that's where their jobs are.
- Seattle-Tacoma International Airport has to grow to keep up with regional growth, but difficult to find enough land.

Cons:

- Aircraft operations seem to be non-stop, also creates wind.
- Need better signage from I-5.
- Noise seems louder at night because of lack of ambient background noise.
- Burien had a bad reputation, but it is not necessarily deserved.
- City of SeaTac needs more destinations, restaurants.
- Crime – County has not helped by not detaining juveniles.
- Air pollution.
- Transient population.
- Lots of socio-economic challenges – more lower income.
- Property values have increased, but not as fast as other areas.

General:

- Technology constantly changes, may impact community in ways we can't predict.

Session #15 **Stakeholder #22 (SeaTac, 07 June 2019, 10:30 AM)**

Pros:

- Seattle-Tacoma International Airport is positive economic engine for the region.
- City of SeaTac benefits from hotel and parking taxes.
- Real growth will be on development of other uses surrounding Seattle-Tacoma International Airport.
- Could develop training facilities, conference centers, etc.
- Seattle-Tacoma International Airport and Burien should be embracing each other and make the relationship work.
- Region needs a full-service international airport.
- Cargo is a big part of Seattle-Tacoma International Airport's operations – new warehouses in Des Moines.
- Port of Seattle has become more responsive to community needs.
- Airport noise has decreased, aircraft are quieter.
- People moved in with an airport already and complain about noise.
- Need more diverse development – more offices coming along International Boulevard.
- Opportunity to build more amenitized facilities across from Seattle-Tacoma International Airport, especially for airport workers.

Cons:

- Challenges on road system – need to improve road access.
- Uber pick-ups/drop-offs were mishandled by Seattle-Tacoma International Airport – were mixed with regular traffic (now separated).
- Port of Seattle is sometimes slow to react.
- Surface Water Management (SWM) – City wanted to raise fees for parking. Jet fuel residue on streets affects runoff.

- Crime is a problem in self-parking lots, gang problems.

General:

- Light rail was projected to be around 5% of airport traffic, is really closer to 1%.
- Seattle-Tacoma International Airport growth between 6% and 13%, but Uber has captured a lot of that growth.
- Don't anticipate any changes in airport demand for the next 5 years.
- 44 million enplanements today, expanding to 60 million.
- What's improved connectivity between Seattle-Tacoma International Airport and community to improve experience for passengers and City?

Session #16 **Stakeholder #23 (SeaTac, 07 June 2019, 11:30 AM)**

Pros:

- Seattle-Tacoma International Airport is a demand generator – 45 million traveler and double in next 15 years.
- Travelers and workforce may outnumber City residents.
- Opportunity to capture a larger market.
- $15/hour movement started in City of SeaTac, but most airport employees don't live here.
- Nowhere else in Seattle within a 15-minute drive with this affordable of housing.

Cons:

- Travelers not spending a lot of money in SeaTac directly.
- Airport parking lots are profitable but put other use values out of whack. Can't justify rents to pencil the high land values.
- Tremendous amount of crime in SeaTac - car theft, vandalism, etc. King County has zero juvenile detention, resulting in crimes without consequences. Lots of violent crime (shootings and stabbings). 30,000 cars parked in and around Seattle-Tacoma International Airport are easy targets.
- More transient population (travelers, etc.) create opportunities for crime.
- Noise impacts residential quality of life – associated with more growth at Seattle-Tacoma International Airport.
- People in SeaTac are complaining of health impacts.
- Traffic is bad on International Boulevard.
- City is doing nothing to attract new development.

General:

- Not sure if Inter-Local Agreement (ILA) sufficiently mitigates impacts.
- Need to increase density to improve tax base and to improve access to airport.
- Need to connect Seattle-Tacoma International Airport to the City – maybe via bridges to an entertainment or shopping district.

Session #17 **Stakeholder #24 (SeaTac, 07 June 2019, 12:30 PM)**

Pros:

- Accessibility to Seattle-Tacoma International Airport is an advantage.
- Lots of "decent" jobs at Seattle-Tacoma International Airport (not necessarily high paying, but employment is available).
- Collect sales tax and parking tax from Seattle-Tacoma International Airport and local hotels – get about 12% of the total taxes collected in the City (most go to the County and State).
- Positives outweigh negatives as long as the ILA continues ($30 million over 10 years) – renegotiate after 10 years.
- "No Surprises Clauses" requires the Port of Seattle to regularly communicate with the City.
- Relationship has improved over the years – new leadership and Commissioners.
- Seattle-Tacoma International Airport is an economic engine for the region and the State.
- If the Airport Business District were more accessible, SeaTac residents might use it more.
- Property values have increased, but not as high (or fast) as Seattle.
- Seattle-Tacoma International Airport is a preferred destination for Pacific Rim destinations and arrivals.

Cons:

- Challenges with larger daytime population bring traffic, crime, litter, etc.
- Traffic inside City of SeaTac is bad – getting out of town towards I-5 in the evening is also congested.
- Frequency of overflights is more of an issue than individual noise.
- More airplanes on the ground taxiing and reverse thrust.
- Trees being removed by Port on Port land for "air corridor safety".
- Air pollution more due to cars than planes.
- More people are affected by noise and sleep disruption, rather than health issues.

General:

- Have 17 flight attendants and 3 pilots live on her same street.
- 29,000 pop in City of SeaTac – most work elsewhere.
- 42% of city area is taken up by Seattle-Tacoma International Airport property.
- Area near Kent/Auburn will change and potentially become denser.

Session #18 **Stakeholder #25 (SeaTac, 07 June 2019, 2:30 PM)**

Pros:

- City budget surplus is a direct result of the ILA.
- ILA funds 7 police positions.
- ILA got Seattle-Tacoma International Airport to admit it had an impact on the City - thinks the City is entitled to more money than in the Inter-Local Agreement (ILA).
- Around $3 million/year with the understanding that traffic and crime may come along with it.

Cons:

- Port officials have the least interest of impacts on surrounding population.
- The Federal Aviation Administration had no interest in concerns of area citizens.
- Drivers of taxis and cabs live in the City, creating more traffic.
- Passengers were parking illegally on residential streets – have enacted a permit basis as a test.
- Luggage theft is a problem - could find abandoned open luggage on your lawn.
- Some flights are 60 feet above homes (neighborhoods north and south of Seattle-Tacoma International Airport). Port of Seattle should be able to buy these homes.
- Concerned that Seattle-Tacoma International Airport will exceed its operational limits (due to size, number of operations, number of runways).
- Cargo flights are the loudest (Prime Air, FedEx, UPS).
- People feel like they have lost their rights.
- World Health Organization study shows noise causes more stress.
- Businesses are not being responsible to community and environment.
- How can the City develop more tourism and resources?

General:

- Airport Committee established in 2016 to address how Seattle-Tacoma International Airport impacts the City. Committee got involved in development of the ILA.
- Seattle-Tacoma International Airport is regulated by a "quagmire" of laws – Federal Aviation Administration, state, etc.
- Before 2016, City was run by the "33rd Democrats" by 30 years. SeaTac was one of the richest cities at that time (taxes, etc.). Enacting a utility tax to address a deficit made the voters mad. Have a $50 million surplus now.
- Was known as "Boeing-ville", highly pro-union.
- Large cultural mix (85 languages) in SeaTac but it is not working.
- City should rezone areas north and south of Seattle-Tacoma International Airport to change the character from residential to commercial.

Session #19 **Stakeholder #26 (Federal Way, 24 June 2019, 9:00 AM)**

Pros:

- Economic engine is a great thing but has unintended consequences.

Cons:

- South King County home values are lower than Seattle and east side (Bellevue).
- Not as affluent/high-income.
- More immigrants, minorities moving in but do not have a voice.
- Noise in Marine Hills from overflights - hearing that it is getting worse. Plane as flying lower and flying longer/later hours.
- New light rail extension should have affordable housing as part of a TOD.

- Regional gentrification is pushing new residents from downtown to South King County areas.
- Area perceived as the unsafe "dumping grounds".
- Three tax credit properties developed in 2014-16 have impacted schools - created an "us vs them" atmosphere. Not necessarily because of Seattle-Tacoma International Airport.
- Area schools considering under-performing, mainly due to under financing.
- Metro (transit) needs to run more frequently for workers who work non-standard hours.
- Also a need for 24-hour child care (for late shift workers) – Seattle-Tacoma International Airport not doing enough outreach for minority worker issues.

Session #20 **Stakeholder #27 (Federal Way, 24 June 2019, 9:30 AM**

Pros:

- Choose to live because husband "travelled constantly".
- Economic benefits extend to Federal Way but don't know how much – should be quantified specifically for Federal Way.
- Maybe a new remote parking garage when the light rail is extended.
- Lots of residents work at Seattle-Tacoma International Airport.

Cons:

- Experiencing more overflights – since around 2014, as early as 5 AM and as late as 1 AM. Pretty constant between 7 PM and 11 PM – bigger jets (not regionals).
- Neighborhood off 288th (low income, non-English speaking) - directly in the path of "big Delta jets". Renters are "afraid to report".
- "Get used to airport noise" but it becomes obvious when you go to non-airport communities.
- Some schools are negatively affected by noise. Port of Seattle should reach out further than before.
- Thinks Seattle-Tacoma International Airport has lots of environmental issues, but no one may know for sure.
- Sleep disruption is a problem (China-bound cargo flights).
- Cargo-only airport at Moses Lake?

Session #21 **Stakeholder #28 (Federal Way, 24 June 2019, 11:00 AM)**

Pros:

- One of the key points in recruiting/attracting businesses to Federal Way.
- Access to two ports (Seattle and Tacoma).
- Good relationship with the Port.

Cons:

- Seattle-Tacoma International Airport area is small (2500-acres) – capacity will eventually be an issue.

- What is "the maximum fill line"? Need another regional airport.
- Marine Hills topography amplifies the noise – flight path moved further west as a result of NextGen procedure.
- Need a new sound monitor at Nautilus Elementary School.
- Most people using Seattle-Tacoma International Airport live north of I-90 – those impacted lived in South King County.
- Sleep interruptions and constant noise are not good for individuals.
- Emissions from jet fuel is a concern.
- Quality of life is impacted when you can't have a conversation outside your home.
- Changes glide-slope (to higher than 3.0) might help – but plans are flying over Federal Way when they are too high (3000+ feet).
- Seattle-Tacoma International Airport has been more responsive but there are no concrete steps taken. Outreach doesn't result in change.

Session #22 **Stakeholder #29 (Federal Way, 24 June 2019, Noon)**

Pros:

- Proximity to Seattle-Tacoma International Airport for work is a "huge benefit". But have not maximized benefits associated with this proximity.
- Sound Transit will extend to I-5 & 320th by 2024 (although there is a strong anti-growth segment of the population).
- 316th and PBR Way – Performing Arta & Event Center.
- Sees no correlation between Seattle-Tacoma International Airport and crime.

Cons:

- Noise is more noticeable now than last 3-4 years. Need a new sound monitor at Nautilus Elementary.
- NextGen procedure has "created a superhighway" over Federal Way.
- Seattle-Tacoma International Airport "lied" about only using third runway for landings during inclement weather.
- Disproportionate percentage of affordable (low income) housing in Federal Way.
- Some overflights between midnight and 2 AM (Air China) but doesn't interrupt his sleep.
- Mitigation was never offered to Federal Way homes.

Session #23 **Stakeholders #30, #31 and #32 (Federal Way, 24 June 2019, 1:00 PM)**

Pros:

- Very convenient to Seattle-Tacoma International Airport, easy access.
- Have had many residents who were pilots and airport workers
- At one time, over 14% of City population worked at Seattle-Tacoma International Airport – now closer to 7%.
- World Vision (non-profit) here because of Seattle-Tacoma International Airport.

- Weyerhaeuser property is being marketed, but no takers yet.
- Aquatics Center and Centennial Park are local attractions, but not because of Seattle-Tacoma International Airport.

Cons:

- Haven't seen proportionate increase in home values as seen in north and east area.
- Have fewer high-income residents, more low income that require more services and drive demand for school.
- Noise is the #1 issue.
- Washington Dept of Health 2015 study – "Cancer rates are up closer to Seattle-Tacoma International Airport", "more lung cancer", "51% more cancers in children".
- Concerned about future Seattle-Tacoma International Airport expansions upon value and beauty of Puget Sound area.
- "Smells kerosene" outside.
- Overflights and noise have been increasing for the last 15 years.
- Port of Seattle is not responsive to complaints.
- Port of Seattle meetings are in Seattle or SeaTac, and Commissioners live north – no reason to be responsive to South King County residents.
- Port of Seattle is the SEPA agency – "fox in the hen house".
- Call noise complaint hotline and no one ever responds.
- Port of Seattle should be a "win/win" for all cities, but trust is not good since the perception is they lied about the Third Runway.
- NextGen is a problem that the Federal Aviation Administration will not address.

Session #24 **Stakeholder #33 (Federal Way, 24 June 2019, 2:00 PM)**

Pros:

- State of Washington is top 5 for international trade – Canada, China, Taiwan, Japan, and South Korea.
- 1 out of 3 jobs in region associated with international trade.
- Believes there is a positive impact to Federal Way.
- Many city residents work at Seattle-Tacoma International Airport.
- Seattle-Tacoma International Airport has spent a lot of money improving schools, Highline Community College.
- South King County and Pierce County/Tacoma have become new destinations as housing becomes more expensive in Seattle.
- Need to utilize Paine Field more than they are.
- Doesn't think Seattle-Tacoma International Airport has a trust issue.
- Doesn't experience any criminal activity as result of Seattle-Tacoma International Airport.
- "Puget Sound regional climate at is moderate and rainwater can clear the air."
- Pros outweigh the cons.

Cons:

- Noise is a primary concern.
- 20-30 years ago, the flight path was over the Sound, not over Federal Way.
- Seattle-Tacoma International Airport capacity is being incrementally expanded, but still cannot keep up with demand.
- Late night cardio flights (midnight to 2 AM) create a lot of noise.
- Public sector is always late in solving problems.

Session #25 **Stakeholders #34 and #35 (Federal Way, 24 June 2019, 4:00 PM)**

Pros:

- None stated.

Cons:

- 2018 Quiet Skies Study, presented to the Port of Seattle, was a pro-bono effort by citizens in Federal Way.
- Port Commissioner committed that the report would be presented to the Commission.
- "Bureaucrats are protecting their interests by not admitting they are lying."
- # of flights have increased dramatically from the 2013 (2014) Part 150 Study.
- Overflights have increased over 40% since 2012 (increase in operations).
- "Seattle-Tacoma International Airport doesn't want to be influenced by residents."
- The Federal Aviation Administration is saying glide slope is 3.0 but is closer is 2.75.
- $10 million over 5 years for South County mitigation.

Session #26 **Stakeholders #36, #37 and #38 (Federal Way, 24 June 2019, 5:00 PM)**

Pros:

- Close to Seattle-Tacoma International Airport for business and pleasure travel.

Cons:

- Traffic has increased and Seattle-Tacoma International Airport is too small.
- Noise limits ability to enjoy the outside of my home - should fly out over the Sound.
- Minimum wage jobs at Seattle-Tacoma International Airport.
- Air quality is impacting nearby elementary and middle schools.
- Seeing fewer birds around homes and gardens.
- 90,000 noise complaints in 2018.
- Seattle-Tacoma International Airport and the Federal Aviation Administration are not people-oriented.
- "People are sick and dying north of Marine Hills."

Session #27 **Stakeholder #39 (Des Moines, 27 June 2019, 8:30 AM)**

Pros:

- Helped Alaska Airlines grow.
- "Tremendous economic benefits are a given."
- Gateway to trade in the Pacific Rim.
- Convenient and accessible.
- 31,000 residents and 721 jobs at the Port (2018 Port of Seattle Economic Benefit Study).
- Encourages Seattle-Tacoma International Airport's growth but the challenges have to be addressed.
- Have to address both pros and cons of Seattle-Tacoma International Airport and that's what the 1997 Study did.

Cons:

- Disparity between work at Seattle-Tacoma International Airport and proximity.
- Study Area cities shoulder a disproportionate share in supporting Seattle-Tacoma International Airport.
- Impacts are also closely related to how close the cities are and where they are.
- Des Moines and Federal Way get the most impacts.
- Woodmont neighborhood (Des Moines) is also getting a similar impact to Marine Hills, attributable to Third Runway increased usage.
- 2014-2015 – middle runway was shut down for repairs and shifted flights to Third Runway.
- Port consultant reported that operations went from 5,000/month to eventually 10,000 to 12,000/month.
- Thinks that mass tort litigation will impact the aviation industry, especially regarding noise and Ultra-Fine Particle impacts.
- World Health Organization report needs to be taken more seriously by the Federal Aviation Administration.
- Need a night curfew (10-6 would be ideal), but Seattle-Tacoma International Airport would "take a hit" in slower growth but would improve health and improve public relations.
- Need to fix "Third Runway issue" – not rely on Third Runway for daily operation.
- Phoenix case – Federal Aviation Administration did not take into account communities that were historically "quiet".
- Need to make policy – there is enough science to support concerns.

Session #28 **Stakeholder #40 (Des Moines, 27 June 2019, 10:30 AM)**

Pros:

- "No question that Seattle-Tacoma International Airport provides huge economic engine for the region", but cities close to it suffer disproportionate impacts, like a bulls-eye.
- Job creation – 4,000 jobs and 2.5 million sf attributable to Seattle-Tacoma International Airport (part of the mitigation package), plus another 2.1 million sf that's since been developed.

- Washington state has few business incentives – RCW 53 governs ports, which have a primary mission of economic development.
- Port could contribute to Des Moines Marina improvement.
- City has a conflicted relationship – makes money but has negative impacts.
- All of South King County experiences gang activity but cannot say it is connected at all to Seattle-Tacoma International Airport.

Cons:

- Lost a potential corporate development because of aircraft noise.
- NextGen impacts neighborhoods that are on the runway heading. NextGen shrinks DNL contour but concentrates it in one area. Operations and frequency should be taken into account.
- Global cities demand the need for international air transport.

Session #29 **Stakeholder #41 (Des Moines, 27 June 2019, 11:30 AM)**

Pros:

- Moved to Des Moines for proximity to business connections (non-profits for wildlife conservation and education) in Tacoma.
- Access to Seattle-Tacoma International Airport for personal travel.

Cons:

- Noise.io app is used to report noise - but can't tell if Port is actually using it.
- Occasionally see parallel landings (following Shoreline and Pacific Highway).
- International cargo flights are heavier, fly lower, and are noisier. And China-bound flights at around 2 AM.
- Concerned about use of fossil fuels and carbon footprint - do not address issues at Seattle-Tacoma International Airport.
- Environmental justice and equity are not address. Seattle-Tacoma International Airport should serve all businesses equally (some businesses are affected by aircraft noise) - not an "economic engine" but an "economic server".
- South King County matters but problems are not being addressed.
- Port culture is resistant to a regional/state system.
- NextGen concentrates noise rather than reducing it.
- Traffic congestion around Seattle-Tacoma International Airport is also a problem, both car traffic and airplane traffic.
- Airline/jet fuel is not taxed.
- Port of Seattle cannot grasp the relationship with its surrounding communities being integral to their mission.

Session #30 **Stakeholder #42 (Des Moines, 27 June 2019, 1:30 PM)**

Pros:

- Quick drive, good accessibility.

- Provides lots of jobs – supposedly Seattle-Tacoma International Airport is to reserve a certain number of jobs for local residents.
- Seattle-Tacoma International Airport likes to publicize how they are caring for the environment, but only contained within the airport.

Cons:

- Bought home in 2014 (Woodmont neighborhood) but only heard planes over Pacific Highway (every few minutes). After 2014, third runway became the principal runway continuously and moved flights over Woodmont neighborhood.
- Concerned about air quality.
- Nighttime flights (1:30-3:00 AM) are low, heavy and slow – disrupt sleep.
- WHO report - 45 dB is harmful to human health and flights are routinely over 70 dB.
- Noise monitor at Salt Water Park.
- Ultra-Fine Particle team is also looking at Capitol Hill neighborhood for similar issues with air quality and noise.
- Lung cancer, brain cancer, etc., being reported in higher numbers in communities south of Seattle-Tacoma International Airport.
- All airport communities nationwide have crime problems.
- Most criminal activity in Des Moines happens along Pacific Highway (drugs, loitering, potential car thefts).
- Home devaluation due to increased air traffic. Some move as far away as Tacoma to avoid Seattle prices.
- Port should create a remote overnight parking facility at light rail stations.
- Use of Third Runway – Port should find a way to use other runways to keep plans over Pacific Highway, rather than over residential areas. Cargo traffic at night would be a good start.
- Pollution into Puget Sound must be bad but haven't heard anything from environmentalists. Also cut down thousands of old growth trees (100 feet tall) on the south side of Seattle-Tacoma International Airport.
- Would like to see Congress mandate alternative fuels for jets.
- Port is trying to increase frequency of flights, despite small footprint. Don't see how they can increase, and this could be a safety issue.

Session #31 **Stakeholder #43 (Des Moines, 27 June 2019, 2:30 PM)**

Pros:

- Hard to see any benefits.

Cons:

- Culture of Port of Seattle has to change – staff has characterized residents like KKK members. Port is not accountable and do not keep their promises/agreements.
- "Anything that delays the expansion is a major threat" (from Lance Little, Aviation Director) and did not remove the reference to the communities.
- Port of Seattle is the largest agency in the State.

- $10 million community grant fund is non-specific and too general - they don't want to hear from the area cities regarding how the funds should be spent.
- Cannot expand beyond SH 509, beyond International Boulevard, to the north, or the south.
- Seattle-Tacoma International Airport infrastructure is vulnerable to attack (such as the SH 509 sniper).
- Sustainability aspects of Seattle-Tacoma International Airport only relate to airport, not to surrounding communities.
- Part 150 study for Third Runway did not presume runway would be used full-time. Need to do a new Part 150 study for full-time usage.
- Port says they never promised Third Runway would only be used for landings in inclement weather.
- Sleep disruption increases stress - flights every 60 seconds or so.
- Sales tax revenues goes more to city of Seattle Andre Bellevue, while South King County is farther down the list.
- Need more air quality monitors - none in any of the Study Area cities.
- Seattle-Tacoma International Airport does not coordinate with local communities regarding future plans (such as removing trees, pursuing international carriers, etc.).
- NextGen concentrates noise while saving fuel – should raise glide slope to 3.0 instead of "low and slow". Should also come in over Pacific Highway weather than residential neighborhoods.
- "Wake recat" doesn't trigger open houses regarding NextGen.
- Believes there is over-flow crime on the north side of the city, mainly due to low-income residents/transients. More prevalent on Pacific Highway.
- One of the poorest school districts (Highline District) in the State - noise impacts learning.
- Want to take down a park in SeaTac for employee parking.
- 40% fewer trees in South King County than areas north of Seattle.

Session #32 **Stakeholder #44 (Des Moines, 27 June 2019, 3:30 PM)**

Pros:

- Accessible and convenient.
- Most Air BnB renters are family visitors (summer) or traveling nurses.
- More multi-generational homes in Des Moines.

Cons:

- Traffic has gotten worse, getting to/from SH 509 to Federal Way.
- Des Moines is the last affordable city in the area, home values have increased but not at the same rate as Seattle or Bellevue. Noise has kept values low.
- Mitigation has failed in many homes.
- Vibration has damaged homes, windows, foundations.
- Residue is caused by airplane pollution.
- High degrees of cancer and stoke nearby.

- Plans to move away and downsize.
- Sees landing lights from aircraft landing from the south.
- Fruit trees are not doing as well.
- High instance of asthma/COPD, lots of use of inhalers.

Session #33 **Stakeholder #45 (Des Moines, 27 June 2019, 4:30 PM)**

Pros:

- Ease of access, convenient.
- Economic (jobs associated with the Seattle-Tacoma International Airport) – lots of employees with Alaska Airlines live in Des Moines, Federal Way, Burien with high-paying jobs.
- Likes seeing airplanes (as a former Boeing employee).
- Good downtown, easier to get around than other areas.
- More affordable housing options.

Cons:

- Live pretty much dead center under the Third Runway - can't use outside deck because of overflights.
- Landings are low & slow where take-offs are higher altitude and more thunder.
- White noise (fans) helps at night but not always.
- Neighbors say it has gotten worse over the past couple of years.
- Occasionally reports noise to Seattle-Tacoma International Airport but it does not resolve the problem.
- Occasional night flight (747-400) 1:00 to 3:00 AM cause sleep disruption.
- Different flight paths are the most logical way to address noise.
- Balance is in favor of airlines, not in favor of the surrounding communities.
- Can smell burnt jet fuel every so often.
- Lack of communication from the Port of Seattle or the Federal Aviation Administration in working with the public to address issues.
- Want the Port of Seattle and airlines succeed but should also take the community into account.
- The Port of Seattle is a governmental entity but operates like a for-profit corporation.

Session #34 **Stakeholder #46 (Des Moines, 27 June 2019, 5:30 PM)**

Pros:

- Accessible and conveniently located.
- Likes light rail connection.
- Uber and Lyft are restricted to using cars 45 MPG for trips originating from Seattle-Tacoma International Airport.

Cons:

- Noise is a problem but living near an airport, noise should be obvious. Issue is not frequency of flights, but the variety of aircraft noise types.
- Having trouble with landscaping issues (grass, trees, etc.) – same problem with many of his neighbors.
- More crime along the Highway 99 corridor.
- Sees more prostitutes along SH 99, homeless at bus stops and transit stations, and aggressive panhandling – not a direct result of Seattle-Tacoma International Airport, but growth of tourism.
- Traffic congestion is an ongoing problem - regional access is constrained.
- May move in the future (for other reasons), will the noise and traffic devalue their home.
- Take-offs are more aggressive (higher degree and steeper turns).
- No communication with the general public as to why things happen.

Session #35 **Stakeholder #47 (Burien, 28 June 2019, 10:30 AM)**

Pros:

- 400 jobs by Burien residents (less than 1% of the population - 51,000 pop).
- Convenient for community access, but no other benefits.

Cons:

- Competes with Seattle-Tacoma International Airport for businesses (such as residents).
- Seattle-Tacoma International Airport's goal is to capture travelers inside the terminal.
- 40% of Delta passengers are connecting to other flights (many headed to Asia).
- Security is a deterrent to passengers going elsewhere while on a layover.
- Seattle-Tacoma International Airport has a lot of money and can advertise and outreach for themselves, but the cities around them don't share in that.
- No hotel in Burien because there is no interest on the part of the City's Economic Development team.
- No costs calculated for congestion, health issues, noise.
- Third Runway took a lot of taxable land and Highline School District has lost as a result (369 DU's and 119 business lost between Burien, Des Moines and SeaTac for area for Third Runway).
- Burien is a bedroom community to Seattle.
- Highest noise contours in the State according to USDOT – highest noise is concentrated around airports.
- Relationship with the Port of Seattle is adversarial – Commissioners listen to staff who drive the agenda.
- NRDC 1996 report says airports produce more pollution than steel mills.
- Rise in emissions and CO2 by acre (stated in the EIS) - the planes are to blame.
- Jet fuel use is increasing at SeaTac (3 million gallons/day).

- NextGen – not consistent through the area (not used at Boeing Field and Renton). Sold as saving fuel and fuel burn, decreasing emissions, but increased efficiency and concentrated use in tighter corridors.
- Department of Ecology 2001 Study- Respiratory, cardiovascular, brain, and organ diseases as a result of air pollution - statistically significant increased rates of diseases within 1 mile of Seattle-Tacoma International Airport.
- Port has few checks and balances. Main concern is economic development on a regional basis.
- Burien used to be a middle-income bedroom community - now is more renters than owners, Asian and Hispanic population has increased. Higher levels of poverty in South King County.
- Long-time owners moved away and turn their properties into rental properties – direct result of Seattle-Tacoma International Airport's growth and expansion.
- Seattle-Tacoma International Airport should move the Delta hub elsewhere – use the other airports in the State (123 airports in the State of Washington) to spread out the traffic.
- Runoff from Seattle-Tacoma International Airport burdens the surrounding cities.
- Burien is currently suing the Federal Aviation Administration over runway usage - to be heard in Fall 2019.
- World Health Organization has done studies looking at costs associated with noise and air quality.
- 51% higher hospitalization rate in Burien than the County average.
- "I'm the expert - you have to take my word for it".
- "Seattle-Tacoma International Airport promised there would never be an expansion after the second runway and lied".
- "Government's job is to protect the health and welfare of the population".

Session #36 **Stakeholder #48 (Federal Way, 03 July 2019, 3:30 PM)**

Pros:

- Good to have an airport, but don't know of any residents that moved to Federal Way to specifically be close to Seattle-Tacoma International Airport.

Cons:

- "Complete asymmetry of justice" – NextGen compacts noise into a narrower pathway.
- Nobody bought into this narrow corridor – both departures and arrivals with all runways.
- Some Federal Way residents work at Seattle-Tacoma International Airport, but not many – jobs are lower-pay non-professional.
- Hard to see any economic development benefit in Federal Way.
- Port and Airlines need to create some resident-by-resident benefit to account for the impacts.
- Cites WHO/Europe study and New Yorker article regarding noise as a health impact.
- Seattle-Tacoma International Airport has located noise monitors to minimize noise impacts.

- South King County is the dumping ground for less privileged folks.
- Seattle-Tacoma International Airport is not an engine of growth, but its growth is a consequence of regional growth – not a driving factor. Seattle-Tacoma International Airport does not do a strategic business plan. Seattle-Tacoma International Airport expansion does not create growth.s
- Disputes that Seattle-Tacoma International Airport is good for the region.
- Rate of home value rise is much slower than areas north and east of Seattle-Tacoma International Airport.
- Told by Federal Way police that they prefer to charge crimes in Pierce County (because of a tougher prosecutor).

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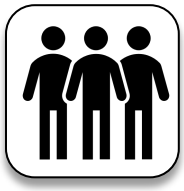
APPENDIX C

PROJECT CONTACTS



Techincal Advisory Committee

Representing the City of Burien, Washington:

Rose Clark.....Resident
Brian Wilson.....City Manager

Representing the City of Des Moines, Washington:

Steve Edmiston.....Resident
Michael Matthias.....City Manager

Representing the City of Federal Way, Washington:

Dave Berger.....Resident
Bill Vadino.....Policy Advisor to the Mayor

Representing the City of Normandy Park, Washington:

Mark Hoppen.....City Manager
Kathleen Waters.....Resident

Representing the City of SeaTac, Washington:

Roger Kadeg.....Resident
Steve Pilcher.....Community & Economic Development Director

Representing the City of Tukwila, Washington:

Brandon Miles.....City Economic Development Liaison
Jim Haggerton.....Resident

At-Large Members:

Rep. Tina Orwall.....33rd Legislative District
Rep. Mike Pellicciotti.....30th Legislative District

Study Area Cities

City of Burien, Washington:

Walter Bala.....Resident
Pat Cagney.....Resident
Larry Cripe.....Resident
Jeff Harbaugh.....Resident
Vicky Hartley.....Resident
Karen Lynch.....Resident
Lorraine Mahler.....Resident
Lisa Marshall.....City Attorney
Jimmy Matta.....Resident and Mayor

City of Burien, Washington (continued)

Beth McCasland	Resident
Jim McMullen	Resident
Kitty Milne	Resident
Sharyn Parker	Resident
Andrea Puacy	Resident
Bill Rioerdan	Resident
Bob Sanders	Resident
Scott Stevson	Resident
Nancy Tosta	Resident and City Council member
Meg Van Wyk	Resident
Debi Wagner	Resident
Rose Winterhalder	Resident

City of Des Moines, Washington:

Bill Adams	Resident
Ann Anna	Resident
Rob Back	Resident
Bob Bisordi	Resident
Sandy Bisordi	Resident
Sheila Brush	Resident
Traci Buxton	Resident
Susan Cezar	Resident
David Clark	Resident
Ryan Crompton	Resident
Melody Edmiston	Resident
Dr. Wendy Ghiora	Resident
Doreen Harper	Resident
J.C. Harris	Resident
Blanche Hill	Resident
Lyn Johnson	Resident
Rick Johnson	Resident
Dave Kaplan	Resident
Anne Kroeker	Resident
Alli Larkin	Resident
David Lucky	Resident
John Madden	Resident
Matt Mahoney	Resident
Carol Mohler	Resident
Saundra Mouck	Resident and business owner
Jeremy Nutting	Resident
Mary Paynter	Resident
Nancy Robertson	Resident
Kathy Scott	Resident
Claire Smith	Resident
Susan White	Resident

City of Federal Way, Washington:

Lydia Assefa-Dawson	Resident and Council member
David Berger	Resident
Jeanne Burbidge	Resident

City of Federal Way, Washington (continued)

Jim Ferrell	Resident and Mayor
Mary Gates	Resident
Chris Hall	Resident
Dana Hollaway	Resident
Susan Honda	Resident and Deputy Mayor
Mark Koppang	Resident and Council member
Michael Kun	Resident
Bernadine Lund	Resident
Kurt Moss	Resident
Mike Park	Resident
Sue Peterson	Resident
Cristina Pishchenko	Resident
John Resing	Resident
Gigi Sather	Resident
Louise Wessel	Resident
Dave Yelle	Resident
Sergey Zherlakov	Resident

City of Normandy Park, Washington:

Ine Boysen	Resident
Jaime Boysen	Resident
Jonathan Chicquette	Mayor
Sherri Cho	Resident
Brett Fish	Resident
Jeff Herberg	Resident
Blanche Hill	Resident
Sue-Ann Hohimer	Resident
Stuart Jenner	Resident
John Shanker	Resident
Kathleen Sherry	Resident
Kathleen Sikes	Resident
Michelle Sipes-Marvin	City Council member
Earnest Thompson	Planning Commission and StART committee
Anne-Rose Ucht	Resident
Ira Wayne	Resident
Amy Yahnke	Resident
Mark Yokers	Resident

City of SeaTac, Washington:

Robert Akhtar	Resident and StART committee member
Craig Baker	Resident and City Airport Advisory Committee
Leslie Baker	Resident
Jag Basra	Resident
Tejvir Basra	Resident, Plan Commission, and StART committee
Kelli Burton	Resident
Carolyn Cloutier	Resident
Ray Dverhoff	Resident
Glenn Erickson	Resident
Pam Fernidad	Resident
Takele Gobori	Resident

City of SeaTac, Washington (continued)

Cathy Boysen Heiberg	Resident
Peter Kwon	Resident
Vicki Lockwood	Resident
Marianne Markkanen	Resident
Roger McCracken	Local business owner
Rita Palomino Morrow	Resident
John Oden	Resident
Kent Palossari	Resident
Page Sales	Resident
Erin Sitterley	Resident and Mayor
Cathea Stanley	Resident
Janice Taylor	Resident
Penny Thomas	Resident
Robyn Todd	Resident
Stan Tombs	Resident
Joel Wachtel	City Council member and Airport Committee chair
Judy Williams	Resident
Lynda Wong	Resident

City of Tukwila, Washington:

David Cline	Tukwila City Administrator
Trina Cook	Resident, StART committee, and police crime analyst
Alan Ekberg	Mayor
Andrea Reay	President, Seattle Southside Chamber of Commerce

Other Contacts

Outside the Study Area:

Ben Bakkenta	Seattle
Lyndall Bervar	(did not identify location)
Marge Bravo	Seattle
Madison Brown	Seattle
M. Chevin	Seattle/Beacon Hill
Sam Cho	Kirkland
Deirdre Cole	Seattle
Jeff Cox	Tacoma
Andy Gregory	Shoreline
Robert Hodgman	Olympia
Michele Ishimitsu	Seattle
Kris Johnson	Seattle
Nina Martinez	Seattle
Stacy Oaks	Seattle
Wendi Pickerel	Seattle-central
Mike Piper	Seattle
Jean Ray	Kent
Mark Reichin	Bellevue
David Rocheleau	Kent
Linda Rocheleau	Kent

Outside the Study Area (continued)

Linda Roney.....Unincorporated King County
Joe Scorio.....Tacoma
Laura Wheeler.....Seattle

Port of Seattle:

Clare Gallagher.....Director, Capital Project Delivery
Eric Ffitch.....Government Relations Manager

Client

Washington Department of Commerce:

Gary Idelburg.....Senior Planner, Growth Management Services
Dave Anderson.....Managing Director
Mark Barkley.....Assistant Director
Mark McCaskill *.....Director, Growth Management Services
Ike Nwankwo *.....Western Washington Manager
Matthew Ojennus.....Senior Planner

(* former Washington Department of Commerce employees)

Consultant Team

Stantec:

Project Director

Joseph A. Pobiner, FAICP, CNU-A.....Director of Planning & Urban Design/Senior Associate

Project Team

Amelia Casey.....Transportation Planner/Urban Places Group
David Christie.....Urban Planner
Eric Clark, PE.....Project Engineer
Ralph DeNisco.....Senior Principal/Urban Places Group
Seth Ely.....Senior Lighting Designer
Denise Fong, IALD, CLD, LEED AP, MIES.....Principal, Lighting Discipline
Ryan Givens, AICP.....Senior Planner
Dan Heiser, PE.....Manager, Engineering
Gary Maynard.....Senior Associate/Environmental Services
Anushree Nallapaneni, MUD, CAPM.....Urban Designer/Transportation
Tim Nightengale.....Environmental Scientist
Katrina Nygaard **.....Planner
Elias Rashmawi.....Vice President, Urban & Brownfield Development
Carol Shestag, LG.....Senior Geologist

(** former Stantec employee)

Ricker Cunningham:

Anne Ricker.....Principal/President
Bill Cunningham.....Principal/Vice President

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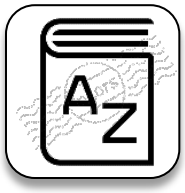
APPENDIX D

GLOSSARY



A

AADT
Average Annual Daily Traffic

AAQS
Ambient Air Quality Standards

Access to Care and Preventative Services
Having the timely use of personal health services to achieve the best health outcome.

ACC
Airport Communities Coalition

AEDT
Aviation Environmental Design Tool

Aerotropolis
Airport city and outlying corridors and clusters of aviation-linked businesses and associated residential development that feed off each other and their accessibility to the airport. The Aerotropolis is analogous in shape to the traditional metropolis made up of a central city and its rings of commuter-linked suburbs, sometimes stretching up to 20 miles (30 kilometers) outward from the airport.

Airport Cities
An airport city is the "inside the fence" airport area of a large airport, including the airport (terminals, apron, and runways) and on-airport businesses such as air cargo, logistics, offices, retail, and hotels. The airport city is at the core of the aerotropolis, a new urban form evolving around many major airports.

Airport Trip Origins
Location where the leg of one's journey begins when their destination is the airport.

AIRTRACT
Washington State Air Transportation Commission

AKART
All Known, Available and Reasonable methods of prevention, control and Treatment

AMSL
Above Mean Sea Level

AOA
Air Operations Area

AOMA
Aircraft Operations and Maintenance Area

ANAP
Aviation Noise Abatement Policy

ASIL
Acceptable Source Impact Level

ASNA
Aviation Safety and Noise Abatement Act

ASV
Annual Service Volume

ATADS
Air Traffic Activity Data System

ATC
Air Traffic Control

ATL
Hartsfield-Jackson Atlanta International Airport

B

BAAQMD
Bay Area Air Quality Management District

BGS
Below Ground Surface

BMP
Best Management Practice

BOD
Biochemical Oxygen Demand

BTEX
Benzene, Toluene, Ethylbenzene, and Total Xylenes

BUG
Backlight, Uplight and Glare Rating

C

CAA
Clean Air Act

CAL3QHC
An air quality computer model

Cancer

Uncontrolled growth of abnormal cells in the body. Old cells do not die and instead grow out of control, forming new, abnormal cells. These extra cells may form a mass of tissue, called a tumor.

Cardiovascular Disease

Disease that affects the heart or blood vessels. The risk of certain cardiovascular diseases may be increased by smoking, high blood pressure, high cholesterol, unhealthy diet, lack of exercise, and obesity. The most common cardiovascular disease is coronary artery disease (narrow or blocked coronary arteries), which can lead to chest pain, heart attacks, or stroke. Other cardiovascular diseases include congestive heart failure, heart rhythm problems, congenital heart disease (heart disease at birth), and endocarditis (inflamed inner layer of the heart). Also called heart disease.

CDC

The Centers for Disease Control and Prevention

CDP

Comprehensive Development Plan

CFR

Code of Federal Regulations

cfs

Cubic feet per second

Chronic Diseases

Conditions that last one year or more and require ongoing medical attention or which limit activities of daily living or both.

CIP

Capital Improvement Program. New construction and rehabilitation improvement projects employing people in jobs such as construction, architecture, engineering, and consulting.

City Center

Central part or main business and commercial area of a city. It is also the commercial, cultural and oftentimes the historical, political, and geographic heart of a city. Also referred to as an urban center and downtown.

Cm

Centimeter

CMS

Congestion Management System

CNEL

Community Noise Equivalent Level

CO

Carbon monoxide

COIs

Chemicals of Concern

Commercial Service Visitor

Non-local passenger (visitors) arriving via commercial airlines. The direct output of this group is assumed equal to their spending on hotel, food and beverage, transportation (but not including airfare or rental car, which were captured in the on-airport impacts), retail and entertainment expenses during their trip.

CPS
Cycles per second (same as "Hertz")

CPTED
Crime Prevention Through Environmental Design

CSM
Conceptual Site Model

CTED
Department of Community, Trade, and Economic Development

CTPP
Census Transportation Planning Package

Cu
Copper

CUL
Cleanup Level

CWA
Clean Water Act

D

DASA
Division of Alcohol & Substance Abuse

Daytime Population
Workday population comprising two primary groups: workers and residents. Daytime workers cover persons who not only live and work in the same area but also those who work in the area but live elsewhere (i.e., commuters). Those employed but not at work are classified as a daytime resident. Daytime residents also include the population under 16 years of age and working-age persons who are unemployed or not in the labor force (i.e., retirees; homemakers; college students; and miscellaneous non-institutional and institutional group quarters populations in nursing homes, juvenile detention centers, homeless shelters, etc.).

dB
Decibel – a unit for measuring the relative intensities of sound. The decibel scale is logarithmic, so a sound with an intensity that is twice that of a reference sound corresponds to an increase of little more than 3 decibels.

dBA
A-weighted decibels, which is an expression of the relative loudness of sounds in air as perceived by the human ear. A-weighted decibel values of sounds at low frequencies are reduced, compared with unweighted decibels, in which no correction is made for audio frequency.

DEIS
Draft Environmental Impact Statement

DEQ
Arizona Department of Environmental Quality

Direct Impact
Measure of the total amount of additional expenditure within a defined geographical area, which can be directly attributed to staging an event. In the context of a airport, for example, this would include an economic activity such as the purchase of aviation goods and services on the airport, on-airport construction, and spending by airline passengers passing through the region.

DHS
Department of Homeland Security

DMRs
Discharge Monitoring Reports

DMSPs
Defense Meteorological Satellite Program satellites

DNL
Day/Night Noise Level

DOC
Washington Department of Commerce

DOE
Washington Department of Ecology

DOT
United States Department of Transportation

DPM
Diesel particulate matter

DSHS
Washington Department of Social and Health Services

DU
Dwelling Unit

E

Economic Output
Total value of all goods and services produced in an economy. It is a regular tool used in macroeconomic analysis to determine whether an economy is growing or contracting by comparing output during two different points in time. In the context of an airport, economic activity generated by commercial airports and associated activity such as the annual average capital improvement project expenditures plus annual revenues generated by a company, or, in the case of organizations that do not generate revenues (e.g., air traffic control), their annual operating expenses.

EDMS
Emissions and Dispersion Modeling System

EIM
Environmental Information Management

EIS
Environmental Impact Statement

EMIS
Environmental Management Information System

Employment
Paid work agreement between an employer and an employee. The term applies to a person who is hired for a salary or fee to perform work for an employer. In the context of an airport, it is the number of employees that have jobs that can be tied to commercial operations. These are expressed in full-time equivalents, where two part-time jobs are assumed to equal one full-time job.

ESA
Economic Services Administration

ESRI
A firm that supplies GIS (geographic information system) software, which integrates, stores, edits, analyzes, shares and displays geographic information for decision-making.

ESSB
Engrossed Substitute Senate Bill

F

FAA
Federal Aviation Administration

FAR
Federal Aviation Regulations

FEIS
Final Environmental Impact Statement

FEM
Federal equivalent method for air quality sampling and monitoring

FEMA
Federal Emergency Management Agency

FFEC
Fuel Facility Environmental Committee

FHWA
Federal Highway Administration

FICON
Field Condition notice

FIRM
Flood Insurance Rate Maps

Free Economic Zones
Special economic zone in a country or municipality that is subject to unique economic regulations and charges that differ from other regions of the same country, often providing an economic benefit to the user.

FRM
Federal reference method for air quality sampling and monitoring

G

GA
General aviation

GHGs
Greenhouse gases

GIS
Geographic Information System

GMA
Growth Management Act

GPS
Global Positioning Satellite system

GSE
Ground Support Equipment

H

HAPs
Hazardous Air Pollutants

HC
Hydrocarbon

Hearing and Auditory Dysfunction (also known as Central Auditory Processing Disorder – CAPD)
A hearing problem whereby one cannot process what they hear in the same way as others do.

HFN
High frequency noise

HIPAA
The Health Insurance Portability and Accountability Act of 1996 (Public Law 104-191)

HOV
High Occupancy Vehicle

Human Trafficking

Sex trafficking where a commercial sex act is mandated by force, fraud or coercion, or where the person is forced to perform the act is not at least 18 years old; or, the harboring, recruitment, transportation, provision or obtaining an individual for labor or services through using fraud, force, or coercion for the purpose to subject the individual to involuntary solitude, debt bondage, slavery or peonage.

Hz

Hertz (or cycles per second)

I

I/O

Indoor/Outdoor

IATA

International Air Transport Association

ICAO

International Civil Aviation Organization

ICP-MS

Inductively Coupled Plasma Mass Spectrometry test

IH

Interstate Highway

IHD

Ischemic Heart Disease

ILA

Inter-Local Agreement

ILS

Instrument Landing System

INM

Integrated Noise Model

Illegal Drug Trafficking

Global illicit trade involving the cultivation, manufacture, distribution and sale of substances which are subject to drug prohibition laws.

IoT

Internet of Things

ISA

Integrated Science Assessment

ISO

International Organization for Standardization

ITE

Institute of Transportation Engineers

IWS
Industrial Wastewater System

IWTP
Industrial Wastewater Treatment Plant

L

LAX
Los Angeles International Airport

LCDI
Land Cover Change Index

LDN
Average Day/Night Sound Level (same as DNL)

LED
Light Emitting Diode

LEED
Leadership in Energy and Environmental Design

LEQ
Average Daily Sound Level

Leq
Average sound pressure level

LFN
Low frequency noise

LID
Low Impact Design

Lmax
Maximum sound level

LOS
Level of Service

LTOs
Low Temperature Oxides

LUST
Leaking Underground Storage Tank

M

µg/m3
Micrograms per Cubic Meter

Massport
Massachusetts Port Authority

Maternal and Child Health
Delivery of care and provision of services for mothers and children including:

- Family planning and reproductive health services;
- Maternal, newborn, and child health services;
- Health communications;
- Health commodities and supplies; and,
- Health systems strengthening.

MBTA
Massachusetts Bay Transportation Authority

MCY
Million cubic yards

MDAD
Miami-Dade Aviation Department

$MgCO_2e$
Megagrams of Carbon Dioxide equivalent

MIT
Massachusetts Institute of Technology

MLS
Microwave Landing System

MOBILESA
Mobile source emission program from US EPA

Morbidity and Mortality Services
One's level of health and well-being; and one's risk of death. Morbidity does not necessarily mean that ill-health is immediately life-threatening. Co-morbidity refers to multiple disorders occurring in the same person.

MOU
Memorandum of Understanding

MOVES
EPA transportation emission model

MOV-UP
Mobile Observations of Ultrafine Particles study by the university of Washington

MPU
Master Plan Update

MRLC
Multi-Resolution Land Characteristics

MSA
Metropolitan Statistical Area

MTCA
Model Toxic Control Act

Multiplier Impact
Increase in final income arising from any new injection of spending. This "re-spending" of money can occur multiple times and takes two forms - indirect and induced. Indirect impacts occur when businesses spend their revenue on business expenses, while induced impacts occur when employees spend their earnings on goods and services.

N

NAAQS
National Ambient Air Quality Standards

NAO
Noise Abatement Office

NASA
National Aeronautics and Space Administration

NEI
National Emissions Inventories

NEPA
National Environmental Policy Act

NEPL
North Employee Parking Lot

Neurological Disease
Diseases of the central and peripheral nervous system, including the brain, spinal cord, cranial nerves, peripheral nerves, nerve roots, autonomic nervous system. Neuromuscular junction, and muscles.

NextGen
Next Generation Air Transportation System

NFA
No Further Action

NJDOH
New Jersey Department of Health

NLCD
National Land Cover Database

NO_2
Nitrogen Dioxide

NOAA
National Oceanic and Atmospheric Administration

NOISEMAP
Aircraft noise model developed by the US Air Force

Non-Residential Land Uses
All land uses, commercial, industrial, institutional, and others except for those used for habitation by one or more individuals, such as single family residential units and multi-family structures.

NORAH
Noise-Related Annoyance, Cognition and Health study

North Flow
Departure aircraft to the north, arriving aircraft from the south

NOX
Generic term for various nitrogen oxides produced during combustion

NPDES
National Pollutant Discharge Elimination System

NPIAS
National Plan of Integrated Airport Systems

nW/cm2 sr
An expression of light emission

O

O_3
Ozone

O-D
Origin-destination survey

On-Airport Activity
Airport tenants that are businesses with employees, such as airlines, rental car agencies, FBOs, flight schools, concessionaires, and governmental agencies. Governmental agencies include public airport sponsors, air traffic controllers, other FAA units, as well as various other state and federal agencies. Direct impacts for employment, payroll and output were obtained from existing studies, or estimated as described later.

Overall Life Expectancy at Birth
The average number of years to be lived by a group of people born in the same years, if mortality at each age remains constant in the future. Life expectancy at birth is also a measure of overall quality of life in a country and summarizes the mortality of all ages.

P

PARIS
Permitting and Reporting Information System

Part 150
Airport program to address noise concerns

Payroll
Overall term used for several types of operations related to paying employees and paying payroll-related taxes due to federal and state agencies.

PC Air
Pre-conditioned air

PFC
Passenger Facility Charge

pH
A figure expressing the acidity or alkalinity of a solution on a logarithmic scale

PILOT
Payment In Lieu Of Taxes

PM_{10}
Particulate matter (10 microns or less)

$PM_{2.5}$
Particulate matter (2.5 microns or less). See also UFPs.

PNA
Polynuclear aromatic

POS
Port of Seattle

ppb
Parts per billion

ppm
Parts per million

Property Crimes (residential and commercial, burglary and vandalism)
Many common crimes relating to theft or destruction of someone else's property, including residential and commercial, burglary and vandalism. Crimes can range from lower level offenses such as shoplifting or vandalism to high-level felonies including armed robbery and arson. Most property crimes include a spectrum of degrees depending on factors including the amount stolen and use of force or arms in theft related cases, and actual or potential bodily injury in property destruction crimes such as arson.

PSAPCA
Puget Sound Air Pollution Control Authority

PSCAA
Puget Sound Clean Air Agency

PSRC
Puget Sound Regional Council

Public Health
Science of protecting and improving the health of people and their communities. Work in this area is achieved by: promoting healthy lifestyles; researching disease and injury prevention; and detecting, preventing and responding to infectious diseases. Overall, public health is concerned with protecting the health of entire populations, as small as a local neighborhood, or as big as an entire country or region of the world.

R

Respiratory Disease
Disease that affects the lungs and other parts of the respiratory system. Respiratory diseases include asthma, COPD (chronic obstructive pulmonary disease), pulmonary fibrosis, pneumonia, and lung cancer. Also called lung disorder and pulmonary disease.

Risk Factors
Everyday habits and behaviors that can pose significant risks to human health. Smoking tobacco, excessive alcohol consumption, a lack of exercise and poor diet, drug use, and unprotected sex are common examples. Such activities can increase the risk of numerous diseases including hypertension, heart disease, cancer, sexually transmitted diseases (STDs) and diabetes. These behaviors and habits not only impact the health of individual but are also very costly.

RP
Reasonable Party

RTA
Regional Transit Authority

RUSLE
Revised Universal Soil Loss Equation

S

SAF
Sustainable aviation fuel

SAMP
Sustainable Airport Master Plan

SASA
South Aviation Support Area

SBS
Sick Building Syndrome

SCC
Source Classification Code

SDS
Storm Drain System

SEL
Sound Exposure Level (sometimes also referred to as "Single-Event Level")

SEPA
Washington State Environmental Protection Agency

SEPL
South Employee Parking Lot

sf
Square foot (or square feet)

SI
Serviceability Index

SIP
Statewide Implementation Program

SIREN
Social Interventions Research & Evaluation Network

sm
Square miles

SO_2
Sulfur Dioxide

South Flow
Departure aircraft to the south, arriving aircraft the north

SOV
Single Occupancy Vehicle

SOX
Generic term for various sulfur oxides produced during combustion

SPCC
Spill Prevention, Control and Countermeasure Plan

SR
State Route

STAMINA
Roadway noise computer model

StART
Sea-Tac Stakeholder Advisory Round Table

Suicide
Act of a person causing direct violence at themselves with the intent to end their lives, and they die because of their actions.

SWTP
King County's South Wastewater Treatment Plant

T

TA
Threshold Analysis (also referred to as "Time Above")

TAC
Technical Advisory Committee

TAZ
Traffic Analysis Zone

TCP
Toxic Cleanup Program

TIA
Traffic Impact Analysis

TRACON
Terminal Radar Control Area

TRB
Transportation Research Board

TSA
Transportation Security Administration

TSM
Transportation System Management

TSS
Total Suspended Solids

U

UAL
United Air Lines

UFP
Ultra-Fine Particulate Matter

UNODC
United Nations Office on Drugs and Crime

URAA
Uniform Relocation Assistance Act

US DOT
United States Department of Transportation

US EPA
United States Environmental Protection Agency

USACE
United States Army Corps of Engineers

USC
United States Code

USGS
United States Geological Survey

UST
Underground Storage Tank

UW
University of Washington

V

VALE

Voluntary Airport Low Emissions program

V/C
Volume/Capacity Ratio

VIIRS DNB
Day/Night Band of the Visible Infrared Imaging Radiometer Suite instrument

Violent Crime
All types of personal crime (rape, sexual assault, robbery, assault and murder) where a victim is harmed by or threatened with violence. Public safety refers to the welfare and protection of the general public, usually expressed as a governmental responsibility. It is as much a person's sense of safety, as it is a community's relationship with police and the justice systems. To this end, it includes how people treat one another; as well as which policies, social conditions, and systems may make some neighborhoods safer than others. At its core, public safety is a measure of community vitality, economy and health outcomes.

VOCs
Volatile Organic Compounds

vpd
Vehicles per day

W

WAC
Washington Administrative Code

WATERWORKS
Hydraulic analysis computer program

WHO
World Health Organization

WISHA
Washington Industrial and Safety Health Act

WPPSS
Washington Public Power Supply System

WsDOT
Washington Department of Transportation

Z

Z
Zinc