REGIONAL AVIATION BASELINE STUDY

Working Paper 1
Airport and Aviation Activity

July 2019

Prepared for

Puget Sound Regional Council

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Contents

Chapter 1: Introduction and Summary

Chapter 2: Data Collection and Inventory

Chapter 3: Economic and Socioeconomic Context

Chapter 4: Commercial Aviation Trends and Forecast

Chapter 5: General Aviation Trends and Forecast

Chapter 6: Air Cargo Trends and Forecast

Chapter 7: Multimodal Connections and Access

Chapter 8: Goals, Objectives, and Metrics

Appendix A: Study Metrics

Appendix B: Drive Times

REGIONAL AVIATION BASELINE STUDY:
WORKING PAPER 1

Chapter 1
Introduction and Summary

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Contents

1. Introduction and Summary 1-1
1.1 INTRODUCTION 1-1
1.1.1 Study Background and Purpose 1-1
1.1.2 Study Process 1-2
1.1.3 Study Area 1-2
1.1.4 Agency Jurisdiction 1-4
1.1.5 Hierarchy of Airports 1-4
1.2 WORKING PAPER SUMMARY 1-6
1.2.1 Overview of Regional Aviation System 1-6
1.2.2 Trends and Forecasts by Aviation Sector 1-9
1.2.3 Key Multimodal Connections and Access 1-11
1.2.4 Objectives and Metrics 1-12

Tables

Table 1-1. Airports in the Study Area 1-5
Table 1-2. Regional Aviation Baseline Study Goal Areas and Objectives 1-12

Figures

Figure 1-1. Regional Aviation Baseline Study Area and Relevant Airports 1-3

Acronyms

FAA .... Federal Aviation Administration
KCIA .... King County International Airport
NPIAS .... National Plan of Integrated Airport System
PSRC .... Puget Sound Regional Council
Sea-Tac .... Seattle-Tacoma International Airport
SPB .... Seaplane Base

1. Introduction and Summary

1.1 INTRODUCTION

1.1.1 Study Background and Purpose

The central Puget Sound region plays a pivotal role in aviation in the Northwest. It serves as the hub for the 5th largest airline by enplanements (Alaska Airlines), serves as the west coast gateway for the nation's 2nd largest airline by enplanements, contains the 8th busiest airport in the nation (Seattle-Tacoma International Airport [Sea-Tac]), and hosts major manufacturing and operations activities of the largest aerospace company in the world—the Boeing Company. The aviation system is a critical part of an ecosystem that supports high paying jobs, housing, and economic development.

The purpose of the Regional Aviation Baseline Study is to provide a clear picture of the different roles and purposes of each aviation activity at each of the region's airports, describe how these activities interact, and identify future needs in the central Puget Sound region (King, Pierce, Snohomish, and Kitsap Counties) to set the stage for future planning. This study is expected to provide a common baseline for policymakers about the region's aviation needs and options to consider for meeting those needs in the future. This study is the first phase of potentially more focused studies on specific areas of emphasis. This study is not intended to provide solutions but is intended to inform follow-up actions.

The Regional Aviation Baseline Study was initiated to address the PSRC's concern to accommodate existing and future aviation demand activity in the central Puget Sound region. Recent rapid growth is likely to affect the quality and level of aviation service. State and regional leaders need solid and reliable information about the current usage and projected regional growth to adequately plan and provide for future aviation needs. The desired outcomes of the Regional Aviation Baseline Study follow:

- Identify the roles of each airport and the aviation activities within the region.
- Provide a regional perspective on how aviation activities at airports in the study area interact with each other, the community, and the broader economy.
- Obtain input from stakeholders about their needs and build a common understanding about aviation and airspace constraints.
- Identify future aviation needs within central Puget Sound region and set the stage for future planning.

The study will provide a regional understanding of the aviation system. In addition to data gathered about the system and from aviation stakeholders, the study will leverage data from current airport master planning efforts and other regional/statewide aviation studies.

1.1.2 Study Process

The study is being conducted between October 2018 and October 2020. Key phases for the study follow:

- **Airport and Aviation Activity Analysis Phase –** During this phase, the study team is examining existing conditions, regional demand forecasts, goals, objectives, and metrics for the system, and analyzing socio-economic conditions, market trends, airspace flow, and multimodal connections. The key deliverables are this working paper and a separate analysis of the airspace flow.
- **Future Aviation Issues Analysis Phase –** During this phase, the study team will analyze the feasibility of airports in the region to accommodate demand as well as the regional economic effects of the aviation industry. The key deliverable will be Working Paper 2.
- **Scenarios Definition and Evaluation Phase –** During this phase, the study team will define and evaluate scenarios for accommodating future aviation demand. The key deliverable will be Working Paper 3.
- **Final Report and Project Completion –** During this phase, the study team will publish key findings in a report.

To support study transparency and ensure timely stakeholder input during each phase, the study team will consult stakeholders so that their perspectives can be considered in the development of findings and recommendations. Between these periods of more active communications, the Puget Sound Regional Council (PSRC) will pursue opportunities to report on study findings and to reinforce key messages about the purpose and need for the study.

1.1.3 Study Area

The central Puget Sound region covers four counties: Snohomish, King, Pierce, and Kitsap. As shown in Figure 1-1, the aviation system in the study area consists of 27 public-use airports and Joint Base Lewis-McChord (an installation with two airfields). The following three airports are considered regionally significant, and play a critical role in the commercial passenger, air cargo, and commercial jet aircraft production markets:

- Sea-Tac
- King County International Airport (KCIA)
- Paine Field/Snohomish County Airport (Paine Field)

The region's public-use airports are vital to their communities and support the region's economy and air transportation network.

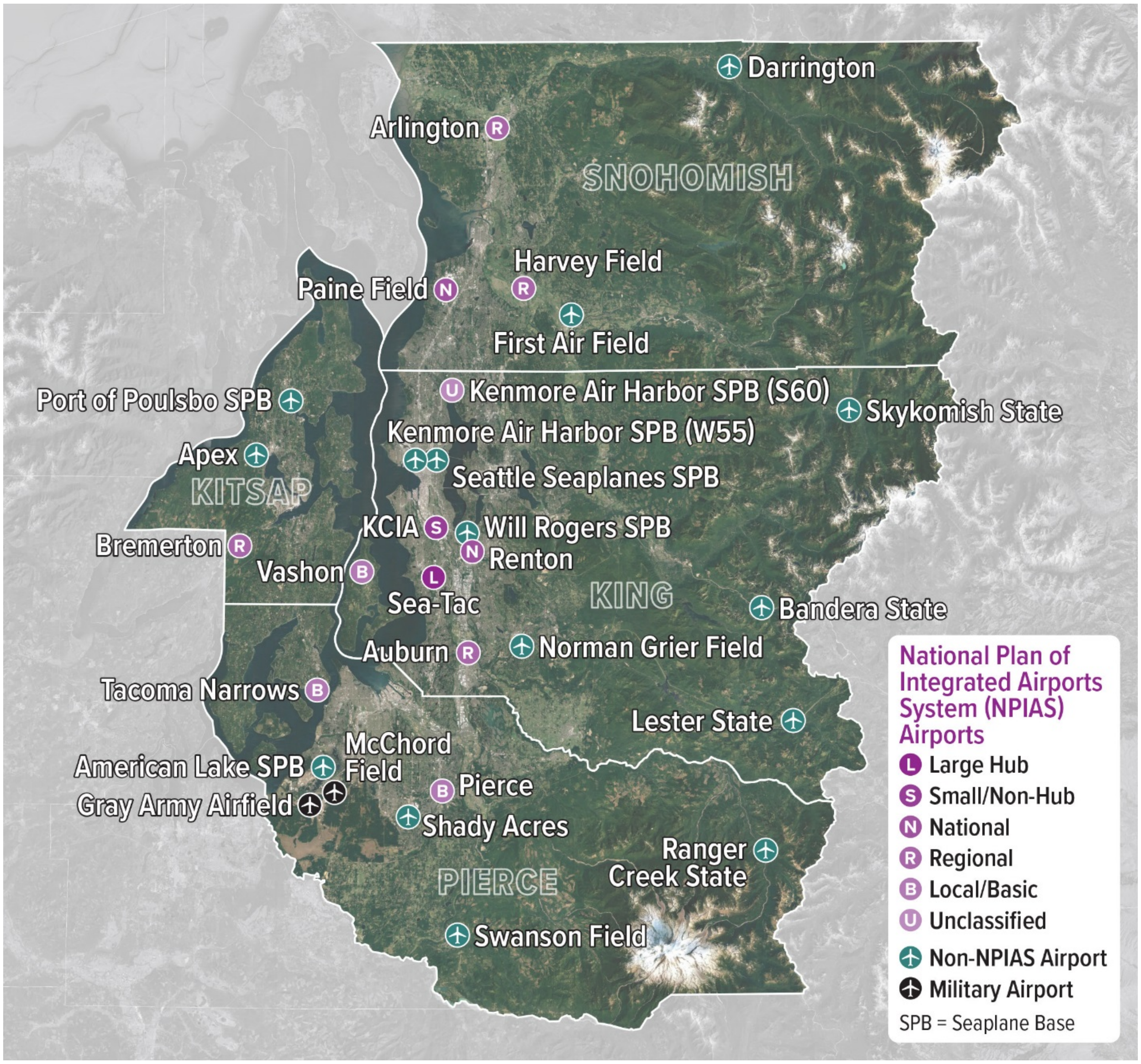
Because of their importance for the Washington state airport system and their influence on the region, the following four airports outside the central Puget Sound region are being considered in the study:

- Bellingham International
- Spokane International

- Grant County International
- Olympia Regional

These airports are not analyzed in a similar manner to the regional airports but are included because their influence affects the region/airspace.

Figure 1-1. Regional Aviation Baseline Study Area and Relevant Airports



Source: 2019-2023 National Plan of Integrated Airport System

1.1.4 Agency Jurisdiction

The Federal Aviation Administration (FAA) works closely with state aviation agencies and local planning organizations to identify public-use airports that are important to the system for inclusion in the National Plan of Integrated Airport System (NPIAS). The NPIAS identifies nearly 3,330 existing and proposed airports that are included in the national airport system, the roles they currently serve, and the amounts and types of airport development eligible for federal funding under the Airport Improvement Program over the next 5 years. The FAA is required to provide Congress with a 5-year estimate of Airport Improvement Program-eligible development every two years. The Secretary of Transportation transmitted the 2019–2023 NPIAS to Congress on September 26, 2018. The NPIAS contains all commercial service airports, all reliever airports, and selected public-owned general aviation airports.

Airports are grouped by statute into two major categories: primary and nonprimary. Primary airports are defined in the FAA's authorizing statute as public airports receiving scheduled air carrier service with 10,000 or more enplaned passengers per year. Primary airports are further grouped into four hub categories defined in statute: large hub, medium hub, small hub, and nonhub.

Nonprimary airports primarily support general aviation aircraft. The nonprimary category includes nonprimary commercial service airports (public airports receiving scheduled passenger service and between 2,500 and 9,999 enplaned passengers per year), general aviation airports, and reliever airports. These airports are further grouped into five FAA defined roles: national, regional, local, basic, and unclassified.

1.1.5 Hierarchy of Airports

Table 1-1 lists the airports in the study area. Twelve airports in the central Puget Sound region are federally obligated and are included in the NPIAS. This includes two primary airports, four reliever airports, and six general aviation airports. In addition, 15 non-NPIAS airports comprise general aviation airports and seaplane bases. Finally, the study area includes one military base that comprises two airfields.

In sum, the study area includes the following:

- One large hub airport (Sea-Tac)
- One nonhub airport (KCIA)
- Ten NPIAS-general aviation airports
- Fifteen non-NPIAS airports
- One military installation with two airports

Table 1-1. Airports in the Study Area

S. NO.	AIRPORT NAME (NAME USED IN WORKING PAPER)	FAA I.D.	CITY	COUNTY	DESIGNATION	CATEGORY
1	Seattle-Tacoma International (Sea-Tac)	SEA	Seattle	King	NPIAS	Commercial service - primary
2	King County International/ Boeing Field (KCIA)	BFI	Seattle	King	NPIAS	Commercial service - primary
3	Paine Field/Snohomish County International (Paine Field)	PAE	Everett	Snohomish	NPIAS	New Commercial service 2019
4	Renton Municipal	RNT	Renton	King	NPIAS	Reliever
5	Auburn Municipal	S50	Auburn	King	NPIAS	Reliever
6	Harvey Field	S43	Snohomish	Snohomish	NPIAS	Reliever
7	Kenmore Air Harbor Sea Plane Base (SPB)	S60	Kenmore	King	NPIAS	General Aviation
8	Vashon Municipal	2S1	Vashon	King	NPIAS	General Aviation
9	Bremerton National	PWT	Bremerton	Kitsap	NPIAS	General Aviation
10	Pierce County	PLU	Puyallup	Pierce	NPIAS	General Aviation
11	Tacoma Narrows	TIW	Tacoma	Pierce	NPIAS	General Aviation
12	Arlington Municipal	AWO	Arlington	Snohomish	NPIAS	General Aviation
13	Bandera State	4W0	Bandera	King	Non-NPIAS	General Aviation
14	Lester State	15S	Lester	King	Non-NPIAS	General Aviation
15	Skykomish State	S88	Skykomish	King	Non-NPIAS	General Aviation
16	Norman Grier Field	S36	Kent	King	Non-NPIAS	General Aviation
17	Kenmore Air Harbor SPB	W55	Seattle	King	Non-NPIAS	General Aviation
18	Seattle Seaplanes SPB	0W0	Seattle	King	Non-NPIAS	General Aviation
19	Will Rogers—Wiley Post Memorial SPB	W36	Renton	King	Non-NPIAS	General Aviation
20	Apex Airpark	8W5	Silverdale	Kitsap	Non-NPIAS	General Aviation
21	Port of Poulsbo SPB	83Q	Poulsbo	Kitsap	Non-NPIAS	General Aviation
22	Ranger Creek State	21W	Greenwater	Pierce	Non-NPIAS	General Aviation
23	Swanson Field	2W3	Eatonville	Pierce	Non-NPIAS	General Aviation
24	Shady Acres Airport	3B8	Spanaway	Pierce	Non-NPIAS	General Aviation
25	American Lake SPB	W37	Tacoma	Pierce	Non-NPIAS	General Aviation
26	Darrington Municipal	1S2	Darrington	Snohomish	Non-NPIAS	General Aviation
27	First Air Field	W16	Monroe	Snohomish	Non-NPIAS	General Aviation
28	McChord Field	TCM	Tacoma	Pierce	Non-NPIAS	Military
29	Gray Army Airfield	GRF				
AIRPORTS TO BE CONSIDERED DUE TO THEIR INFLUENCE ON THE CENTRAL PUGET SOUND						
	Bellingham International	BLI	Bellingham	Whatcom	NPIAS	Commercial Service
	Olympia Regional	OLM	Olympia	Thurston	NPIAS	General Aviation
	Grant County International	MWH	Moses Lake	Grant	NPIAS	General Aviation
	Spokane International	GEG	Spokane	Spokane	NPIAS	Commercial Service

Among the civilian facilities are the following:

- Commercial service and air cargo airports (KCIA and Sea-Tac with Paine Field initiating passenger service in March 2019)
- Three industrial airports involved with large aircraft manufacturing (KCIA, Paine Field and Renton Municipal)
- Six seaplane bases
- Multiple general aviation facilities

1.2 WORKING PAPER SUMMARY

This working paper is organized into eight chapters. Topics include an introduction; inventory of airports; socioeconomic context, trends, and forecasts for each aviation sector (Commercial Services, Air Cargo, and General Aviation); multimodal access; and preliminary metrics. The following sections summarize the existing conditions.

1.2.1 Overview of Regional Aviation System

Within the central Puget Sound region, aviation activity is concentrated in King and Snohomish Counties.

King County is home to 13 public-use airports and several major Boeing facilities, including the final assembly lines for the 737 and P-8 aircraft at its Renton plant, final delivery preparations, and test flights at KCIA. Snohomish County is home to five public-use airports and the Boeing facility in Everett. It is the final assembly site for the 747, 767, the new 777X (including the composite wings), composite-based 787 Dreamliner, and the Air Force's KC-46 aerial refueling aircraft, built on a 767 platform. The county also hosts suppliers and related companies. Pierce County is home to six public-use airports and two military airbases, and has a smaller aerospace sector than King and Snohomish Counties, but is an important center for suppliers and related industries. Kitsap County has three public-use airports and aerospace-related companies.

The three commercial service airports are discussed along with their contributions to the region. Sea-Tac connects the central Puget Sound region to the world, by serving approximately 50 million passengers annually. Thirty-four airlines serve 91 nonstop domestic and 28 international destinations. Sea-Tac is in King County, with the entire airport covering an area of 2,500 acres or 3.9 square miles—which is much smaller than other U.S. airports with similar annual passenger numbers—and is severely constrained by urban development and existing topography. Sea-Tac is one of the region's leading economic engines. From airport workers who live in neighboring communities to cherry farmers in central Washington, and from shops in tourist destinations like Pike Place Market to corporate giants like Microsoft and Boeing, Sea-Tac touches nearly every aspect of the economy in the central Puget Sound region. Sea-Tac's economic impact totaled $22.5 billion in business revenues in 2017. [1]

[1] https://www.portseattle.org/page/airport-basics

KCIA is one of the nation's busiest primary nonhub airports and is in King County. The airport averages 200,000 takeoffs and landings each year. The airport serves small commercial passenger airlines, cargo carriers, private aircraft owners, helicopters, corporate jets, and military, and other aircraft. It is also home to Boeing Company final production aircraft services and flight testing operations as well as The Museum of Flight. This airport is severely land constrained with ongoing urban encroachment. The airport is confined by the Duwamish River and Boeing Complex to the west and major railway and interstate to the east. Due to its strategic location just four miles south of downtown Seattle and close to other business centers, it frequently hosts celebrities, dignitaries, and sports teams, and supports $3.5 billion in local business.[2]

Paine Field is a unique airport located in Snohomish County, particularly with the recent change in status with commercial and Part 139 certification.[3] The airport has 24 daily flights by Alaska and United Airlines and is home to over 650 aircraft, including small, single-engine recreational aircraft, corporate jets, vintage Warbirds, and new Boeing Dreamliners. Located about 30 miles north of downtown Seattle, the airport has become a major tourist destination with the opening of the Future of Flight Aviation Center & Boeing Tour, the Flying Heritage & Combat Armor Museum, and the Historic Flight Foundation. Other attractions include the Legend Flyers-Me-262 Project and the Museum of Flight Restoration Center. The airport's economic impact is estimated at $20 billion annually. [4]

Airports in the central Puget Sound region serve different sectors and roles, such as business, recreation, flight instruction, medical, search and rescue, and law enforcement. The four counties that make up the central Puget Sound region are unique in their demographics, economics, and geographic terrain, thus, requiring the airports to serve a diverse need within the region.

1.2.1.1 KING COUNTY

The population of the county is 2,188,649 based on the 2017 census and the county seat is Seattle, which is the largest city in the state. The county has a total area of 2,307 square miles, of which 2,116 square miles is land and 191 square miles is water. Sea-Tac and KCIA serve the population and businesses of this county. Additionally, this county has two general aviation reliever airports: Renton Municipal and Auburn Municipal.

Renton Municipal is home to Boeing 737 production and is co-located with Will Rogers-Wiley Post Memorial SPB supporting economic vitality and tourism to the area. Auburn Municipal is a general aviation reliever airport and is the 3rd busiest in Washington state for average daily operations. This airport has limited room to expand and future re-development will depend on re-routing major arterial roads. Kenmore Air Harbor SPB S60 on Lake Washington is a privately owned SPB classified as a commercial service airport. Vashon Municipal has a single turf runway that provides year-round access/exit to Vashon island and is particularly important when ferry service is disrupted.

2 https://www.kingcounty.gov/services/airport.aspx
3 Part 139 certification includes requirements for airports serving scheduled air carrier operations in aircraft designed for more than 9 passenger seats but less than 31 passenger seats.
4 https://www.painefield.com/27/About-Our-Airport

Additionally, three state-owned airports—Bandera State, Lester State, and Skykomish Airports—are within the county. These airports are located at relatively higher altitude—above 1,600 feet (except Skykomish, which is located at 1,002 feet)—and are open seasonally between June 1 and October 1. The airports support emergency management functions, emergency medical operations, firefighting, law enforcement and recreational activities. Norman Grier Field is family owned and provides flight school and training for the nearby Green River community. In addition to Kenmore Air Harbor SPB S60 on Lake Washington, the county also has three additional SPBs to connect various island communities to the region. Kenmore Air Harbor SPB W55, Seattle Seaplanes SPB on South Lake Union, and Will Rogers-Wiley Post Memorial on Lake Washington are in King County. Kenmore Air Harbor SPB W55 is at Lake Union in Seattle and connects Washington state and Vancouver Island. Seattle Seaplanes SPB is privately owned and offers scenic flights and pilot training.

1.2.1.2 SNOHOMISH COUNTY

The population of the county is 801,633 (based on 2017 census data). Everett is the county seat and largest city. The county has a total area of 2,196 square miles, of which 2,087 square miles is land and 109 square miles is water. Paine Field is in this county. Additionally, Snohomish County hosts one privately owned, public-use general aviation reliever airport—Harvey Field—which is family owned and located 8 miles from Paine Field. Arlington Municipal is a general aviation airport strategically located at the economic center of Arlington and could be expanded into a reliever airport. The City of Arlington recognizes this importance and opportunity and continues to support the airport through city planning, financing, and development. Snohomish County also houses Darrington Municipal, which is co-owned, and First Air Field, which is privately owned.

1.2.1.3 PIERCE COUNTY

The population of the county is 876,764 based on 2017 census data. Tacoma is the county seat and largest city. The county has a total area of 1,806 square miles, of which 1,670 square miles is land and 137 square miles is water. Pierce County is notable for being home to Mount Rainier (the tallest mountain in Washington state) and a volcano in the Cascade Range. General aviation airports Pierce County and Tacoma Narrows are located within the county. Pierce County Airport is the 6th busiest airport in the state, is 25 miles northwest of Mount Rainier, and serves as the base for search/rescue operations and emergency response. Tacoma Narrows has a control tower, thus, making it an ideal training facility for student pilots and military operations and provides for corporate aviation serving the Greater Tacoma region.

Ranger Creek State is a state-managed airport that is seasonally open between June 1 and October 1. This airport is at 2,650 feet in the White River Valley not far from Mount Rainier, and supports emergency management, forest fire fighting, emergency medical operations, and recreation. Swanson Field is a public airport located 25 miles from Mount Rainier. Shady Acres Airport is privately owned and American Lake SPB serves as a seasonal aircraft charter and provides emergency medical aircraft operations. Pierce County also serves as the home for two military base airports: McChord Field and Gray Army Airfield that are located on Joint Base Lewis-McChord.

1.2.1.4 KITSAP COUNTY

The population of the county is 266,414 based on 2017 census data. The county seat is Port Orchard and the largest city is Bremerton. The county has a total area of 566 square miles, of which 395 square miles is land and 171 square miles is water. Bremerton National is a general aviation airport owned by the Port of Bremerton that supports regional business activities through its connected business park as well as military activities. In cases of emergency or natural disaster, Bremerton National provides a corridor of transportation. Apex Airpark is privately owned and has recently opened to the public. This airpark is uniquely located 2 miles south of the prohibited airspace over the Bangor naval submarine base and intercontinental ballistic missile base. Port of Poulsbo SPB is a popular destination for seasonal recreational flights. The Port of Bremerton is making plans to explore and expand sea plane operations to build a commercial seaplane terminal.

1.2.2 Trends and Forecasts by Aviation Sector

1.2.2.1 COMMERCIAL

Overall, the growth of both the local population and economy is providing a catalyst for the increase in the central Puget Sound region's aviation demand. From 2010 to 2017, population in the four PSRC counties grew at a faster rate than Washington state and the United States. Additionally, the proximity to Canada and its third-most populous metropolitan area—Vancouver, British Columbia—has further served as a catalyst for additional demand for transporting people and goods in this region. Comparatively cheaper air fare options, lower airline taxes in the United States, differences in airline competition at airports, lower costs for domestic flights, and the presence of discount airlines in the United States make it appealing to the residents in bordering Canadian cities to utilize Sea-Tac and other airports within reasonable proximity to the Canadian border. Finally, Delta Air Lines' development of Sea-Tac as the West Coast Hub and its primary gateway to Asia, in addition to the increased competition between Delta and Alaska Airlines has further driven growth of aviation demand in the region. Commercial enplanements in the central Puget Sound region are forecasted to grow between 2.4 percent and 2.8 percent annually between 2017 and 2050 while aircraft operations are forecasted to increase between 2.1 percent and 2.4 percent annually for the same period.

1.2.2.2 GENERAL AVIATION

General aviation airports in the central Puget Sound region serve different sectors of the aviation community based on the location and local demand. The unique geographic terrain of the region is a mix of coastal land, Puget Sound low lands, and the Olympic and Cascade mountain ranges, and is home to Mount Rainier, and a volcano in the Cascade mountain range. It is characterized by a complex array of saltwater bays, islands, and peninsulas carved out by prehistoric glaciers. Thus, the geographic terrain presents unique opportunities for recreational flight and tourism, in addition to business, flight instruction, medical, emergency management, law enforcement, local transportation (air ferry), and search/rescue operations. Depending on the needs of the user, several different airports meet the needs of the varying interests within the region as outlined in the discussion of the four counties previously.

In the central Puget Sound region, the overall pilot population is remaining steady while the private pilot population is experiencing a slow decline, which is similar to trends at the state and national levels. This trend will likely affect the user-base at many of the noncommercial service airports in the central Puget Sound region. Aircraft maintenance technician numbers in the region are also declining, affecting the services and necessary time for repairs to general aviation aircraft. Finally, a decrease in nationwide personal flight hours stems from the decline in pilots and mechanics available to service and fly general aviation aircraft—an important trend that could affect the future of central Puget Sound region airports.

The technological trends that are affecting general aviation are important qualitative areas of the industry that are also highly unpredictable, with new regulations and improvements affecting how they are implemented. FAA has mandated that all aircraft be outfitted with ADS-B Out, which provides air traffic controllers with information that is critical to ensuring aircraft separation via satellite rather than ground-based radar. This could result in a portion of the general aviation fleet being denied use of certain airspace starting January 2020, although, that denial should last only until the avionics industry can catch up with ADS-B installation requests.

In the central Puget Sound region, the replacement of avgas and the advent of electric-powered aircraft could lead to an increase in the types of aircraft and number of pilots, with cheaper and more user- and environmentally friendly options becoming available.

1.2.2.3 AIR CARGO

Air cargo services enable global marketing of goods and services, providing a competitive transportation medium, especially for time-sensitive products and trade with distant markets. Economic growth, international trade, and air transport are inextricably linked. Specifically, air cargo service:

- Provides fast and reliable delivery of high-value products especially relevant to central Puget Sound region industries, such as the pharmaceutical, technology, aircraft assembly and aerospace equipment sectors.
- Supports the express carrier industry, which provides guaranteed, rapid, door-to-door delivery services and increasingly offers logistics support for companies.
- Facilitates the development of e-commerce, enabling companies to transport online shopping orders quickly and reliably between regions and countries, and allowing products to be stored in large warehouses, which reduces retail and distribution costs.
- Allows improved stock management and production techniques, reducing companies' storage costs, losses due to stock outages, and disruption caused by failure of machinery on production lines.
- Improves companies' handling of returns and complaints, allowing a quick turnaround of repairs or delivery of replacement parts.

Air cargo in the central Puget Sound region is generated primarily by activity at Sea-Tac and KCIA, which, combined, account for over 85 percent of the total Washington state market. Sea-Tac handles two-thirds of the cargo tonnage and has the greatest variety of cargo offerings in the central Puget Sound with a mix of domestic and international belly cargo, domestic and international freighter cargo, as well as integrator/express cargo generated by FedEx, DHL, and Amazon Air.

Air cargo at KCIA is generated almost exclusively by the integrator all-cargo carrier, UPS. Paine Field generated approximately 19,300 metric tons of air cargo in 2017. Almost all the air cargo at Paine Field is entirely related to the Boeing aircraft assembly process and for all intents and purposes should be considered general aviation rather than commercial air cargo activity.

According to the recently completed Washington State Air Cargo Goods Movement Study, fresh cherries and seafood together represented over one-quarter of the region's air cargo exports, by metric tons, in 2016. Sea-Tac is a significant gateway to East Asia for footwear parts, electronic integrated circuits, and machines and apparatus for manufacturing semiconductors. Most of the growth in air cargo within the region is driven by the increase in international wide-body aircraft air service at Sea-Tac and the growth of e-commerce. Air cargo at Sea-Tac increased by 16 percent from 2016 to 2017, although preliminary data from 2018 indicates a moderation of this growth to less than 2 percent year-over-year due to a significant drop in the cherry export season.

The robust regional economy will serve as a catalyst for both domestic and international air cargo demand in the long term. The air cargo forecast anticipates average annual growth of 2.75 percent for the 33-year period between 2017 and 2050.

1.2.3 Key Multimodal Connections and Access

The central Puget Sound region has invested in a strong multimodal connection to the interstate highway system, state highways, and public transportation that are necessary to connect airports to the four-county region and beyond. Interstate and state route access and transit connect the three commercial service airports—Sea-Tac, KCIA, and Paine Field. Overall, 24 out of the 26 active, nonmilitary system airports are within 2 miles of an interstate, U.S., or state route, indicating that most airports are easily accessible by automobile for local trips. Only 12 of these airports are within 5 miles of an interstate, however, which provides an important connection to the rest of the state for recreational, business, and freight operations. The relatively limited number of airports within close proximity to an interstate places additional emphasis on this group for current and future charter, commercial, and cargo operations.

Rental car companies are present at four airports: Sea-Tac, Paine Field, KCIA, and Tacoma Narrows. Shuttle service is also available at Sea-Tac to and from nearby hotels. A special ground service option is offered from Kenmore Air Harbor SPB W55 at Lake Union to Sea-Tac to connect passengers flying to and from remote areas.

Automobile parking has been identified as a challenge. Many of the parking spots at Paine Field are now dedicated to commercial service, which began in March 2019. Renton Municipal, co-located with Will Rogers-Wiley Post Memorial SPB, also noted a strain on parking, especially for tenants located near the Boeing production facilities where there is limited area to expand. Harvey Field (in Snohomish) indicated that an overflow gravel lot was often used when the 105-space parking lot was full. Considerations for additional parking could be made in future master plans while also considering the context of the future regional transportation system.

Congestion is a serious problem throughout the metropolitan area that particularly affects Sea-Tac and KCIA. According to the 2018 PSRC Regional Transportation Plan, the region is expected to see 16.6 million more vehicles miles per day by 2040—an increase of 21 percent from the base year. Hours of delay are also projected to increase dramatically, with 233,000 hours added daily to the region by 2040. Traffic growth will put pressure on roads, which underscores the need for additional transit and other alternative modes. Chapter 7 of this working paper discusses anticipated improvements and new service trends that should be considered in future planning.

1.2.4 Objectives and Metrics

The study team conducted a review of relevant plans and policies at the start of the study and identified certain goal areas from the Washington Aviation System Plan, completed by Washington State Department of Transportation Aviation in 2017, as relevant for use in this study. The team developed objectives associated with each goal area. Table 1-2 shows the study goal areas and objectives.

Table 1-2. Regional Aviation Baseline Study Goal Areas and Objectives

STUDY GOAL AREAS	STUDY OBJECTIVES
Economic Development and Vitality	▪ Identify aviation needs of growing population. ▪ Support meeting aviation needs to support economic growth now and in future. ▪ Support needs of aerospace industry for manufacturing and cargo that must be on, or in the immediate vicinity of, the airport. ▪ Quantify the economic impacts of each airport using Federal Aviation Administration guidance.
Education, Outreach, and Community Engagement	▪ Understand community perceptions about regional aviation needs. ▪ Provide information that is credible and provides a consistent base for stakeholders and decision makers regarding the aviation system and constraints. ▪ Obtain feedback from the general public regarding aviation needs and scenarios to address them.
Infrastructure Improvement, Preservation, and Capacity	▪ Develop a set of benchmarks that identify what each airport needs to fulfill its role. ▪ Determine the aviation demand and capacity at each airport based on airport master plans and other existing plans. ▪ Assess the existing and future regional aviation airspace configurations and constraints, taking into consideration Federal Aviation Administration NextGen airspace improvements.
Modal Mobility, Capacity, and Accessibility	▪ Provide adequate ground access to/from airports. ▪ Support road capacity and access improvement alternatives. ▪ Support and improve multimodal connections, including multiple transportation options for users. ▪ Support adequate vehicle parking at airports.
Stewardship	▪ Protect the continued operation of airports from encroachment by limiting incompatible uses and development on adjacent lands.

The study team established preliminary metrics for evaluating the study objectives (as described in Chapter 8) and has begun evaluating the regional aviation system against these metrics. Next steps include establishment of benchmarks. Further evaluation of current and future system performance against the benchmarks and identification of gaps and needs will take place as part of Working Paper 2.

Regional Aviation Baseline Study: Working Paper 1

Chapter 2
Data Collection and Inventory

July 10, 2019

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Contents

2. Data Collection and Inventory 2-1
2.1 OVERVIEW OF AIRPORTS IN STUDY AREA 2-2
2.1.1 Seattle-Tacoma International Airport 2-2
2.1.2 King County International Airport 2-6
2.1.3 Snohomish County Airport/Paine Field 2-10
2.1.4 Renton Municipal Airport 2-14
2.1.5 Auburn Municipal Airport 2-18
2.1.6 Harvey Field 2-22
2.1.7 Vashon Municipal Airport 2-26
2.1.8 Bremerton National Airport 2-30
2.1.9 Pierce County Airport 2-34
2.1.10 Tacoma Narrows Airport 2-38
2.1.11 Arlington Municipal Airport 2-42
2.1.12 Bandera State Airport 2-46
2.1.13 Lester State Airport 2-49
2.1.14 Skykomish State Airport 2-51
2.1.15 Norman Grier Field 2-54
2.1.16 Kenmore Air Harbor Seaplane Base (S60) 2-57
2.1.17 Kenmore Air Harbor Seaplane Base (W55) 2-60
2.1.18 Will Rogers-Wiley Post Memorial Seaplane Base 2-63
2.1.19 Apex Airpark 2-65
2.1.20 Port of Poulsbo Seaplane Base 2-67
2.1.21 Ranger Creek State Airport 2-69
2.1.22 Swanson Field 2-71
2.1.23 American Lake Seaplane Base 2-73
2.1.24 Darrington Municipal Airport 2-75
2.1.25 Seattle Seaplanes SBP 2-77
2.1.26 Shady Acres Airport 2-79
2.1.27 First Air Field 2-81
2.1.28 McChord Field 2-83
2.1.29 Gray Army Airfield 2-85

Tables

Table 2-1. Seattle-Tacoma International Airport Statistics 2-4
Table 2-2. King County International Airport Statistics 2-8
Table 2-3. Paine Field Statistics 2-12
Table 2-4. Renton Municipal Airport Statistics 2-16
Table 2-5. Auburn Municipal Airport Statistics 2-20
Table 2-6. Harvey Field Statistics 2-24
Table 2-7. Vashon Municipal Airport Statistics 2-28
Table 2-8. Bremerton National Airport Statistics 2-32
Table 2-9. Pierce County Airport Statistics 2-36
Table 2-10. Tacoma Narrows Airport Statistics 2-40
Table 2-11. Arlington Municipal Airport Statistics 2-44
Table 2-12. Bandera State Airport Statistics 2-48
Table 2-13. Lester State Airport Statistics 2-50
Table 2-14. Skykomish State Airport Statistics 2-53
Table 2-15. Norman Grier Field Statistics 2-56
Table 2-16. Kenmore Air Harbor Seaplane Base (S60) Statistics 2-58
Table 2-17. Kenmore Air Harbor Seaplane Base Statistics 2-61
Table 2-18. Will Rogers-Wiley Post Memorial Seaplane Base Statistics 2-64
Table 2-19. Apex Airpark Statistics 2-66
Table 2-20. Port of Poulsbo Seaplane Base Statistics 2-68
Table 2-21. Ranger Creek State Airport Statistics 2-70
Table 2-22. Swanson Field Airport Statistics 2-72
Table 2-23. American Lake Seaplane Base Statistics 2-74
Table 2-24. Darrington Municipal Airport Statistics 2-76
Table 2-25. Seattle Seaplanes Seaplane Base Statistics 2-78
Table 2-26. Shady Acres Airport Statistics 2-80
Table 2-27. First Air Field Airport Statistics 2-82
Table 2-28. McChord Field Airport Statistics 2-84
Table 2-29. Gray Army Airfield Airport Statistics 2-87

Figures

Figure 2-1. Seattle-Tacoma International Airport 2-3
Figure 2-2. Seattle-Tacoma International Airport Runway Protection Zones 2-3
Figure 2-3. Seattle-Tacoma International Airport Surrounding Land Use 2-5
Figure 2-4. King County International Airport 2-7
Figure 2-5. King County International Airport Runway Protection Zones 2-7
Figure 2-6. King County International Airport Surrounding Land Use 2-9
Figure 2-7. Paine Field 2-11
Figure 2-8. Paine Field Runway Protection Zones 2-11
Figure 2-9. Paine Field Surrounding Land Use 2-13
Figure 2-10. Renton Municipal Airport 2-15
Figure 2-11. Renton Municipal Airport Runway Protection Zones 2-15
Figure 2-12. Renton Municipal Airport Surrounding Land Use 2-17
Figure 2-13. Auburn Municipal Airport 2-19
Figure 2-14. Auburn Municipal Runway Protection Zones 2-19
Figure 2-15. Auburn Municipal Airport Surrounding Land Use 2-21
Figure 2-16. Harvey Field 2-23
Figure 2-17. Harvey Field Runway Protection Zones 2-23
Figure 2-18. Harvey Field Surrounding Land Use 2-25
Figure 2-19. Vashon Municipal Airport 2-27
Figure 2-20. Vashon Municipal Runway Protection Zones 2-27
Figure 2-21. Vashon Municipal Surrounding Land Use 2-29
Figure 2-22. Bremerton National Airport 2-31
Figure 2-23. Bremerton National Runway Protection Zones 2-31
Figure 2-24. Bremerton National Surrounding Land Use 2-33
Figure 2-25. Pierce County Airport 2-35
Figure 2-26. Pierce County Airport Runway Protection Zones 2-35
Figure 2-27. Pierce County Airport Surrounding Land Use 2-37
Figure 2-28. Tacoma Narrows Airport 2-39
Figure 2-29. Tacoma Narrow Airport Runway Protection Zones 2-39
Figure 2-30. Tacoma Narrows Airport Surrounding Land Use 2-41
Figure 2-31. Arlington Municipal Airport 2-43
Figure 2-32. Arlington Municipal Airport Runway Protection Zones 2-43
Figure 2-33. Arlington Municipal Airport Surrounding Land Use 2-45
Figure 2-34. Bandera State Airport 2-47
Figure 2-35. Bandera State Airport Runway Protection Zones 2-47
Figure 2-34. Lester State Airport 2-49
Figure 2-36. Skykomish State Airport 2-52
Figure 2-37. Skykomish State Airport Runway Protection Zones 2-52
Figure 2-38. Norman Grier Field 2-55
Figure 2-39. Norman Grier Field Runway Protection Zones 2-55
Figure 2-40. Kenmore Air Harbor Seaplane Base (S60) 2-57
Figure 2-41. Kenmore Air Harbor Seaplane Base (S60) Surrounding Land Use 2-59
Figure 2-42. Kenmore Air Harbor Seaplane Base (W55) 2-60
Figure 2-43. Kenmore Air Harbor SPB (W55) Surrounding Land Use 2-62
Figure 2-44. Will Rogers-Wiley Post Memorial Seaplane Base 2-63
Figure 2-45. Apex Airpark 2-65
Figure 2-46. Apex Airpark Runway Protection Zones 2-66
Figure 2-47. Port of Poulsbo Seaplane Base 2-67

Figure 2-48. Ranger Creek State Airport 2-69
Figure 2-49:. Ranger Creek State Airport Runway Protection Zones 2-70
Figure 2-50. Swanson Field 2-71
Figure 2-51. Swanson Field Runway Protection Zones 2-72
Figure 2-52. American Lake Seaplane Base 2-73
Figure 2-53. Darrington Municipal Airport 2-75
Figure 2-54. Darrington Municipal Airport Runway Protection Zones 2-76
Figure 2-55. Seattle Seaplanes Seaplane Base 2-77
Figure 2-56. Shady Acres Airport 2-79
Figure 2-57. Shady Acres Airport Runway Protection Zones 2-79
Figure 2-58. First Air Field 2-81
Figure 2-59. First Air Field Runway Protection Zones 2-82
Figure 2-60. McChord Field 2-83
Figure 2-61. McChord Field Runway Clear Zones and Accident Potential Zones 2-84
Figure 2-62. Gray Army Airfield 2-85
Figure 2-63. Gray Army Airfield Runway Clear Zone and Accident Potential Zone (APZ) 2-86

Acronyms

ADG .... Airplane Design Group
Avgas .... Aviation Gasoline
FAA .... Federal Aviation Administration
FBO .... Fixed-Base Operator
KCIA .... King County International Airport
NPIAS .... National Plan of Integrated Airport Systems
RPZ .... Runway Protection Zone
Sea-Tac .... Seattle-Tacoma International Airport
SPB .... Seaplane Base
TNC .... Transportation Network Companies
WSDOT .... Washington State Department of Transportation

2. Data Collection and Inventory

The existing conditions inventory provides a clear picture of the roles and purposes of each airport; outlines the existing infrastructure, services, constraints, and challenges to inform the region's stakeholders of their existing asset; accurately reflects the aviation activities; and serves as a tool for decision making. The inventory identifies the key relationships and dependencies between airports within the region.

A key tool for data collection was a written survey provided to airport management via email and U.S. mail. Participants were also informed that the survey could be conducted over the phone if this was their preference. Surveys were distributed on February 13, 2019, and responses were received through March 2019. The survey included requests for information in the following categories:

- Airport key business sectors
- Role of the airport
- Unique value to the community
- Airport constraint and opportunities
- Aviation market trends
- Capital plan
- Hangar demand capacity
- Apron demand capacity
- Terminal demand capacity
- Seaplane aircraft storage demand & capacity
- System level airport needs

Airport managers, Washington State Department of Transportation (WSDOT) Aviation Division staff, and study consultants participated in providing data for the survey. Follow-up phone calls to airport managers were made by study consultants to maximize the survey responses, and many surveys were completed by phone or additional email correspondence with airport management or administrative staff. In addition, information was verified and supplemented through the following secondary sources:

- Federal Aviation Administration (FAA) Form 5010, Airport Master Record
- FAA Air Traffic Activity System and Traffic Flow Management System Counts
- FAA Aeronautical Data
- National Plan of Integrated Airport Systems (NPIAS)
- WSDOT Airport Information System database
- WSDOT Aviation Division 2016 Statewide Airports Profile Report
- Airport master plans (as available)
- Airport layout plans (as available)

A total of 26 surveys of the 29 study facilities were completed and submitted—a 90 percent response rate. The next section summarizes the inventory data.

2.1 OVERVIEW OF AIRPORTS IN STUDY AREA

2.1.1 Seattle-Tacoma International Airport

Seattle-Tacoma International Airport (Sea-Tac) is a large-hub primary commercial service airport per the NPIAS[1] and the primary commercial passenger airport for the Western Washington area. Sea-Tac has a unique three-parallel-runway system, with its airport landside infrastructure located to the east of the terminal facilities. The airport is in the national top ten for passenger traffic and ranks 16th for air cargo tonnage. Although Sea-Tac is an Airplane Design Group (ADG) D-V airport, the FAA-approved Modification of Standards allowing regular operations of the Boeing 747-8, which is an ADG-VI aircraft type.

Sea-Tac is the only large-hub international airport in the region and Washington state. As such, it has a large domestic and international route structure, and is Alaska Airlines' primary hub and a Delta Air Lines' West Coast gateway and hub. Thirty-one airlines provide service to 91 domestic and 28 international destinations.

The airport's service area includes the headquarters of multiple large companies (Amazon, Microsoft, Nordstrom, Costco, REI). These companies contribute to a robust economy and need to be well connected to other cities in the United States and throughout the world, generating continued opportunities for Sea-Tac and the air carriers serving the airport.

Sea-Tac is constrained by its land size, topography, and use. The airport has one of the smaller footprints in the large-hub category, and further expansion of the airport would be extremely costly and challenging given its surroundings. As a result, the airport's ability to provide air services needed to meet the regional aviation demand for passengers and cargo for the long-term horizon is becoming increasingly difficult.

In 1996, the State of Washington passed legislation that required all towns, cities, and counties to discourage encroachment of incompatible development adjacent to public-use airports through policies and development regulations. Sea-Tac is located within an urban growth boundary, but does not have avigation easements, and no city or county policies or ordinances were discovered that would protect the airport from incompatible development occurring around the airport. King County has zoned the area around Sea-Tac as "Aviation and Transportation-Related" (Figure 2-3).

[1] The National Plan of Integrated Airport Systems (NPIAS) is a bi-annual report to the U.S. Congress and an inventory of the airport facilities in the United States maintained by the Federal Aviation Administration for federal funding purposes, and particularly, Airport Improvement Program grant allocation.

Figure 2-1. Seattle-Tacoma International Airport

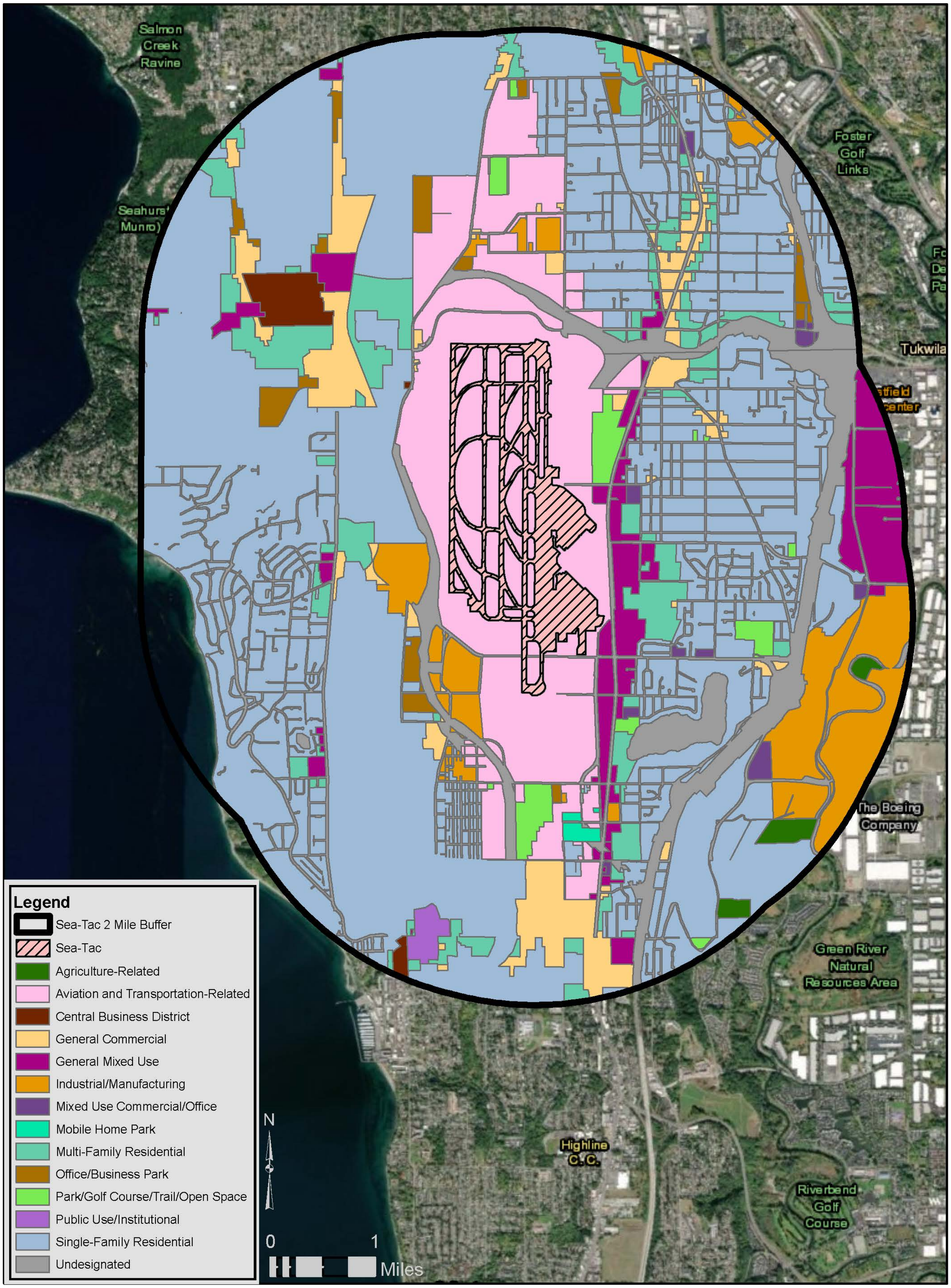
Figure 2-2. Seattle-Tacoma International Airport Runway Protection Zones

Table 2-1. Seattle-Tacoma International Airport Statistics

Airport Statistics	2017 Aircraft Operations	416,124
	2017 Based Aircraft	2
	2017 Total Passengers	46,934,619
Airside	Runway(s)	▪ 16L-34R; 11,901 feet; Concrete ▪ 16C-34C; 9,426 feet; Concrete ▪ 16R-34L; 8,500 feet; Concrete
	Taxiway(s)	▪ Twy T: full-length parallel between Rwys 16R-34L and 16C-34C ▪ Twy B: partial-length parallel to Rwy 16L-34R
	Apron	72.3 Acres
Terminal	▪ Airlines ▪ Fixed-Base Operator	▪ 3.15 million SF ▪ Yes/size unknown
Landside	Vehicle Parking ▪ Public On-Airport ▪ Public Off-Airport ▪ Employee	 ▪ 14,712 spaces ▪ 14,345 spaces ▪ 5,978 spaces
	Ground Transportation	Yes (Rend-A-Car, Taxi, TNC, Shuttles, Public Buses and Light Rail, Courtesy Car)
	Business Park	Yes
Hangars	Airline Maintenance	4
	Cargo	5
	Transiplex	4
	Corporate	1 (to be demolished)
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	Yes; Seasonal
	Emergency Operations	Yes; Weekly
	Fuel Type	Jet A, Avgas
	Aircraft De-/Anti-Icing Services	Yes
	Maintenance	Yes (Airline Aircraft Maintenance)
Land Use Compatibility[2]	Runway Protection Zone	▪ Rwy 16R RPZ: not compliant-public roadways ▪ Rwy 16C RPZ: not compliant-public roadways ▪ Rwy 16L RPZ: not compliant-public roadways ▪ Rwy 34L RPZ: not compliant-public roadways, distribution center ▪ Rwy 34C RPZ: not compliant-public roadways ▪ Rwy 34R RPZ: not compliant- public roadways
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential ▪ South – Residential ▪ East – Residential ▪ West – Residential

[2] An RPZ that is not compliant has incompatible land uses, which include public roadways, buildings, parking lots, and railroad tracks

Figure 2-3. Seattle-Tacoma International Airport Surrounding Land Use



2.1.2 King County International Airport

King County International Airport (KCIA) is a primary non-hub commercial service airport per the NPIAS located approximately 5 miles southwest of downtown Seattle and 6 miles north of Sea-Tac. The airport is home to the Boeing Company's manufacturing and delivery center and has significant air cargo activity.

The airport has a broad spectrum of users, including aircraft manufacturing, air cargo, corporate aviation, flight training, and recreational aviation. Significant airport services at KCIA include five flight training facilities with daily activities, along with daily military operations. It is also a busy general aviation airport that has a large economic impact on the region. Additionally, Kenmore Air Express offers scheduled commercial flights from KCIA to the San Juan Islands.

KCIA is land constrained with significant ongoing urban encroachment. The airport is confined by the Duwamish River and Boeing facilities to the west, and a dense corridor with major railways and Interstate 5 to the east. It is in an urban growth boundary and has avigation easements. King County limits the height of structures and trees to those established by the airport height maps for Sea-Tac and KCIA. The county also has a special district overlay ¼ mile around the airport that is used to limit encroachment of non-commercial airports on residential areas and requires the title of property in the overlay area to state that it is located near an airport; therefore, air traffic is in the area. King County has zoned the area around KCIA as "Industrial/Manufacturing" (Figure 2-6) with the long-term and continuously growing presence of Boeing and its contractors.

Figure 2-4. King County International Airport

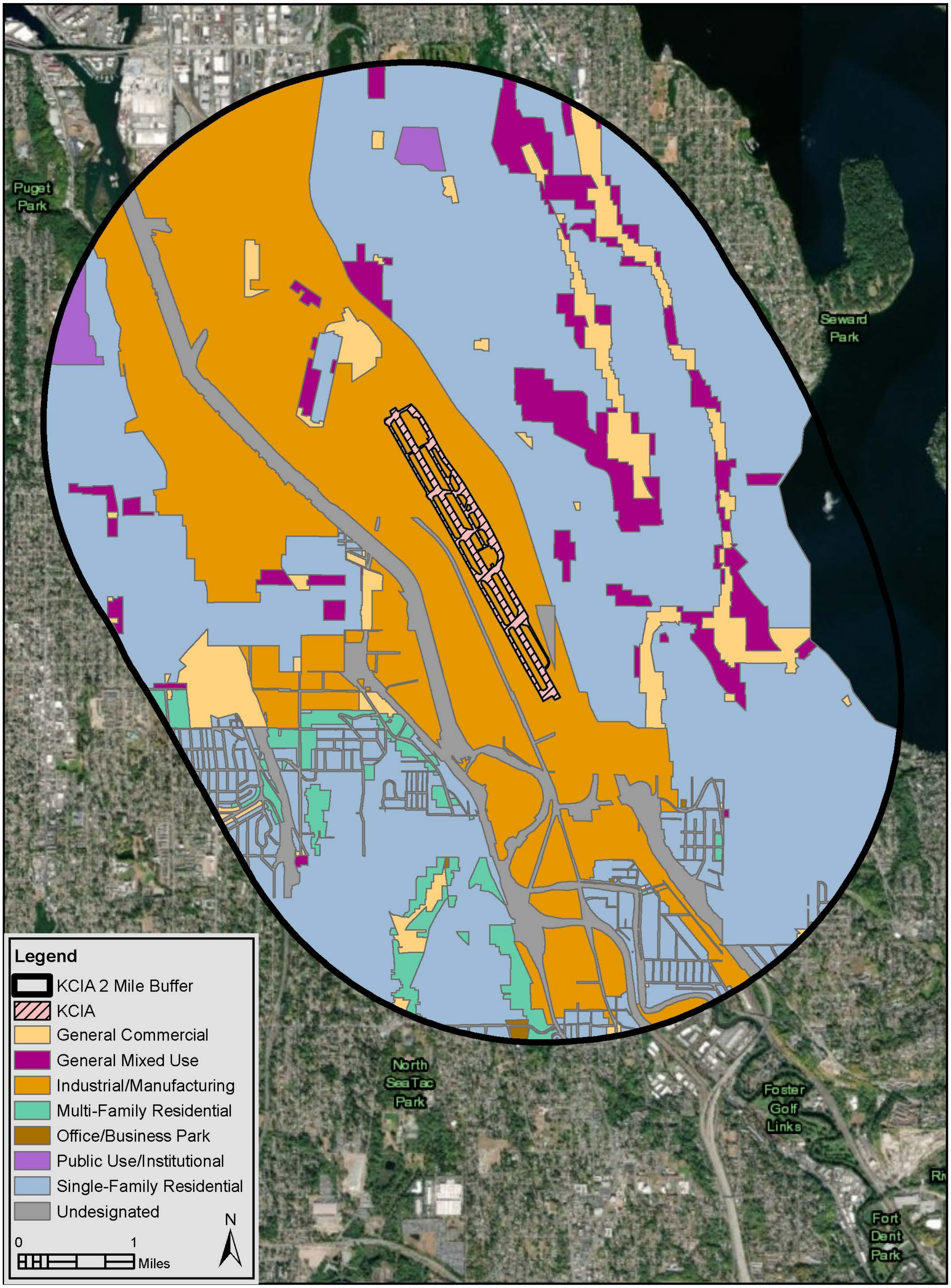
Figure 2-5. King County International Airport Runway Protection Zones

Table 2-2. King County International Airport Statistics

Airport Statistics	2017 Aircraft Operations	184,182
	2017 Based Aircraft	384
	2017 Total Passengers	17,294
Airside	Runway(s)	▪ 14R-32L; 10,007 feet; Asphalt ▪ 14L-32R; 3,709 feet; Asphalt
	Taxiway(s)	▪ Taxiway A full parallel to Runway 14L-32R, partial parallel to Runway 14R-32L ▪ Taxiway B full parallel to Runway 14R-32L ▪ Multiple Entrance and Exit Taxiways
	Apron	▪ Passenger Terminal Apron: 1.6 acres ▪ Air Cargo Apron: 16.3 acres ▪ Boeing Aircraft Apron: 49.5 acres ▪ General Aviation Apron: 18.9 acres
Terminal	Fixed-base Operator (FBO)	▪ Terminal Building: 23,200 sq. ft. ▪ Signature Flight Support ▪ Kenmore Aero Services ▪ Clay Lacy Aviation
Landside	Vehicle Parking	207
	Ground Transportation	Rental Car, Courtesy/Crew Car, Taxi, Shuttle
	Business Park	Unknown
Hangars	Conventional	11 hangars
	T-Hangar	74 hangars
	Condo	Unknown
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Daily
	Emergency Operations	Yes; Daily
	Fuel Type	100LL/Jet A/MOGAS
	Aircraft De-/Anti-Icing Services	11 de-icing positions (public and tenant owned)
	Maintenance	Yes
Land Use Compatibility[3]	Runway Protection Zone	▪ RWY 14L-32R RPZ compliant ▪ RWY 14R-32L RPZ not compliant-incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential ▪ South – Residential ▪ East – Residential ▪ West – Residential

[3] An RPZ that is not compliant has incompatible land uses, which include public roadways, buildings, parking lots, and railroad tracks

Figure 2-6. King County International Airport Surrounding Land Use



2.1.3 Snohomish County Airport/Paine Field

Snohomish County Airport/Paine Field (Paine Field) is listed as a national general aviation reliever airport per NPIAS, but it was recently approved for commercial service by the FAA in early March 2019, and new two-gate privately owned and operated passenger service terminal was recently constructed to support commercial service by Alaska Airlines and United Airlines. San Juan Airlines provides passenger service to the surrounding San Juan Islands and operates from the FBO Castle and Cook Aviation. The largest tenant at Paine Field is the Boeing manufacturing facility. Paine Field is home to the production of Boeing 747, 767, 777, and 787 transport category aircraft and the KC-46 tanker.

Paine Field is also home to Aviation Technical Services, the largest maintenance, repair, and overhaul facility west of the Mississippi River. Other tenants include two community colleges, three flying museums, and the Boeing Tour (the largest tourist attraction in Snohomish County). Significant airport services at Paine Field include four flight training facilities with daily activities, weekly military operations, and daily emergency management operations. Contributing more than 46,000 jobs covering over 220 aerospace and high-tech companies, Paine Field's economic impact is estimated at $30 billion per year.

Paine Field is surrounded by significant development and is located within an urban growth boundary. The airport does have avigation easements—the county ordinances have an airport compatibility area that discourage incompatible land uses around the airport—and zoning regulates height hazards. The airport compatibility area is an area within a specified distance, based on runway length, that extends from the runway end. Snohomish County has zoned the area around Paine Field as "Light Industrial" (Figure 2-9).

Figure 2-7. Paine Field

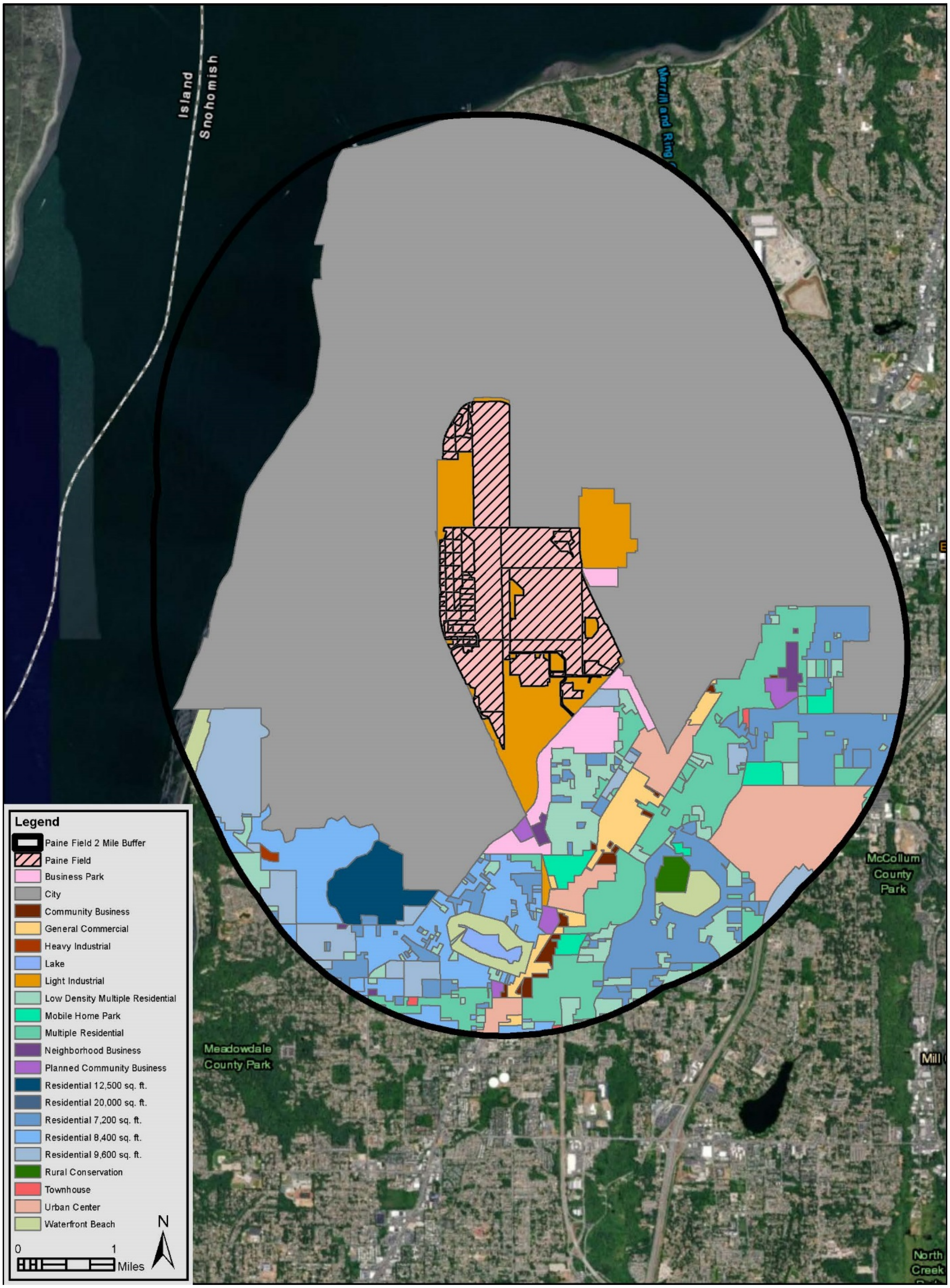
Figure 2-8. Paine Field Runway Protection Zones

Table 2-3. Paine Field Statistics

Airport Statistics	2017 Aircraft Operations	108,350
	2017 Based Aircraft	484
	2017 Total Passengers	623
Airside	Runway(s)	▪ 16R/34L; 9,010 feet; Asphalt/Concrete ▪ 16L/34R; 3,004 feet; Asphalt ▪ 11/29; 4,504 feet; Asphalt* *(11/29 currently closed and used for storing aircraft by the Boeing assembly plants)
	Taxiway(s)	Full Parallel
	Apron	33.2 Acres
Terminal	Fixed-Base Operator (FBO)	4 as of 2010 *awaiting airport manager response
Landside	Vehicle Parking	1,170 spots
	Ground Transportation	Yes – Courtesy/Crew Car, Taxi
	Business Park	Yes – Museum and hotel
Hangar	Corporate	*awaiting airport manager response
	T-Hangar	357
	Condo	212
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Weekly
	Emergency Operations	Yes; Daily
	Fuel Type	100 LL/ Jet A
	Aircraft De-/Anti-Icing Services	Chemical and Radiant/Hangar De-Icing; No Chemical Pad
	Maintenance	Yes – Airframe Turbine and Piston, PP Turbine and Piston, Avionics shop
Land Use Compatibility[4]	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Highway and Boeing facility ▪ South – Commercial businesses ▪ East – Commercial businesses and forest ▪ West – Forest and highway

[4] An RPZ that is not compliant has incompatible land uses, which include public roadways, buildings, parking lots, and railroad tracks

Figure 2-9. Paine Field Surrounding Land Use



2.1.4 Renton Municipal Airport

Renton Municipal Airport is, per the NPIAS, a regional general aviation reliever airport and is also home of the Boeing 737 family final assembly line. The airport is co-located with Will Rogers-Wiley Post Memorial Seaplane Base, making it one of a few airports in the country that has a public seaplane base (SPB) adjacent to a public airport. These factors contribute to the unique mix of operations at the airport. Over the past 20 years, general aviation has dominated Renton Municipal's total operations: air carrier operations as a percentage of total operations have always been less than 1 percent; air taxi operations have consistently ranged between 1 and 2 percent of total operations; and military operations have ranged widely. Based on the approved forecast, the FAA approved the Boeing 737-800 for the existing and future critical aircraft (Runway Design Group of D-III). Significant airport services at Renton Municipal include five flight training facilities with daily activities, seasonal military operations, and monthly emergency management operations.

Renton Municipal is surrounded by a lake, river, and major public roadways. It is located within an urban growth boundary and does not have any avigation easements. city of Renton policies and zoning discourage incompatible land use development around the airports, along with zoning to regulate height hazards and prohibit penetrations of the Part 77 surfaces. Also, the King County's special district overlay (¼ mile around the airport) limits encroachment of non-commercial airports on residential areas. The overlay requires the property title in the overlay area to state that it is located near an airport and therefore there is air traffic in the area. King County has zoned the area around Renton Municipal as "Industrial/Manufacturing" (Figure 2-12).

Figure 2-10. Renton Municipal Airport

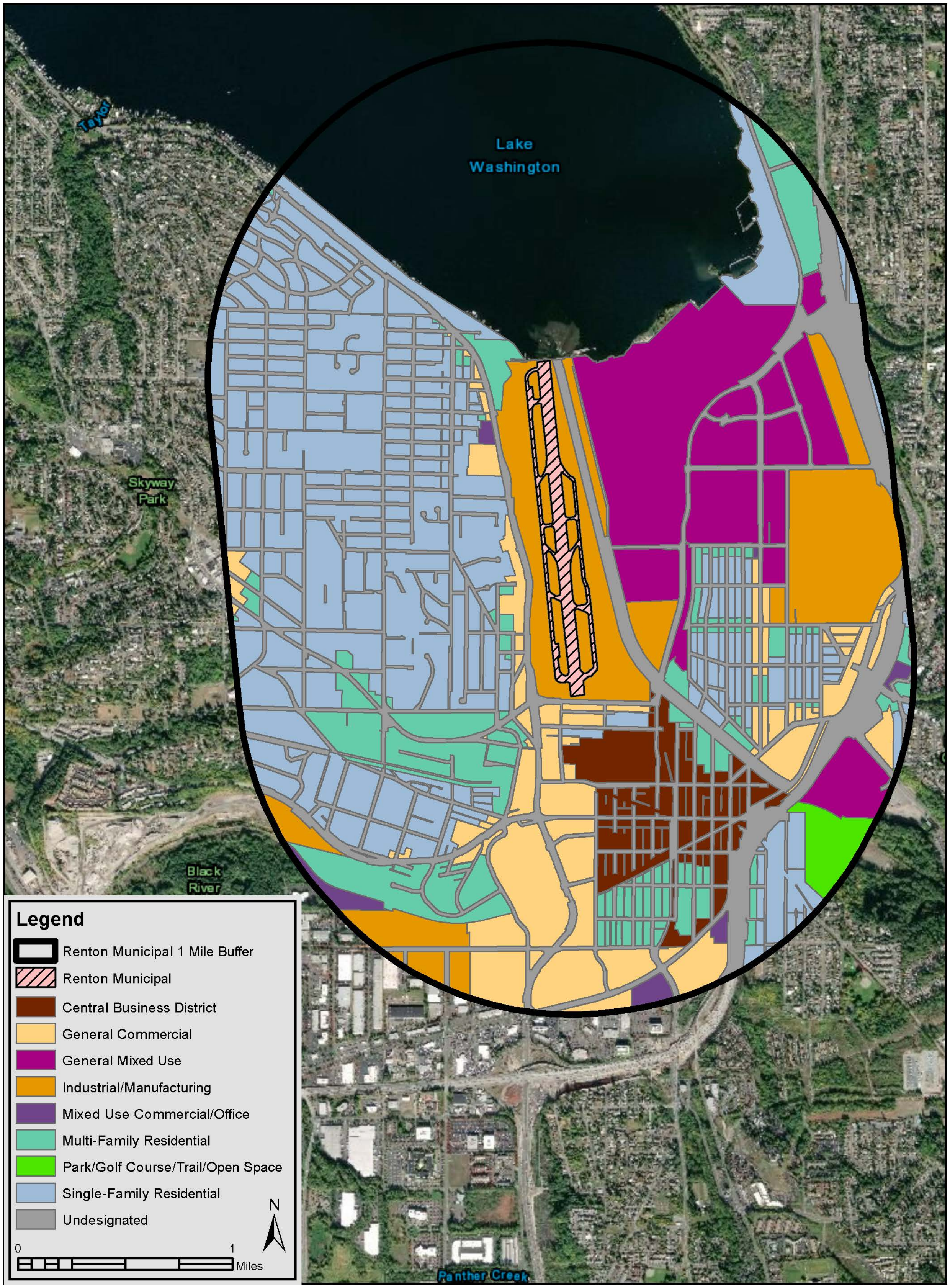
Figure 2-11. Renton Municipal Airport Runway Protection Zones

Table 2-4. Renton Municipal Airport Statistics

Airport Statistics	2017 Aircraft Operations	135,287
	2017 Based Aircraft	246
Airside	Runway(s)	16/34; 5,382 feet; Asphalt/Concrete
	Taxiway(s)	Full Parallel
	Apron	1.56 acres
Terminal	Fixed-Base Operator (FBO)	2 as of 2010 *awaiting airport manager response
Landside	Vehicle Parking	0 (parking lots privately owned)
	Ground Transportation	Courtesy/Crew Car, Taxi, and TNC
	Business Park	No – Restaurant and two hotels nearby, not on-airport property
Hangar	Corporate	*awaiting airport manager response
	T-Hangar	64
	Condo	19
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Seasonal
	Emergency Operations	Yes; Monthly
	Fuel Type	100 LL/ Jet A
	Aircraft De-/Anti-Icing Services	Yes
	Maintenance	Yes – Airframe turbine and piston, PP turbine and piston, and Avionics shop
Land Use Compatibility[5]	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Water (Lake Washington) and Mercer Island ▪ South – Renton city center ▪ East – Highway ▪ West –Will Rogers – Wiley Post Memorial Seaplane Base

[5] An RPZ that is not compliant has incompatible land uses, which include public roadways, buildings, parking lots, and railroad tracks

Figure 2-12. Renton Municipal Airport Surrounding Land Use



2.1.5 Auburn Municipal Airport

Auburn Municipal Airport is, per the NPIAS, a regional general aviation reliever airport located in Auburn, approximately 19 miles south of downtown Seattle. It is the third-busiest airport in Washington state for average daily operations, which is ideal for all forms of recreational aircraft per the airport manager. General aviation has dominated the total aircraft operations over the years, with the remaining operations conducted by air taxi and military, corresponding to less than 1 percent. Based on the FAA-approved forecast, the existing critical aircraft are the Beech Baron 58 and the Cessna 402, which are 6- to 10-passenger piston aircraft. The future critical aircraft will be the Cessna 441 and the Super King Air 200, which are 6- to 10-passenger turboprop aircraft (Runway Design Group B-I to B-II). Significant airport services at Auburn Municipal include four flight training facilities with daily activities, monthly military operations, and weekly emergency management operations.

The airport has limited room to expand, and future development would depend on rerouting major arterial roads. Auburn Municipal is located within an urban growth boundary. It has avigation easements, and the city zoning regulates height hazards and regulations to prohibit penetrations of the Part 77 surfaces. King County has zoned the area around Auburn Municipal as “Aviation and Transportation-Related” with adjacent “General Commercial” and “Industrial/Manufacturing” zoning (Figure 2-15).

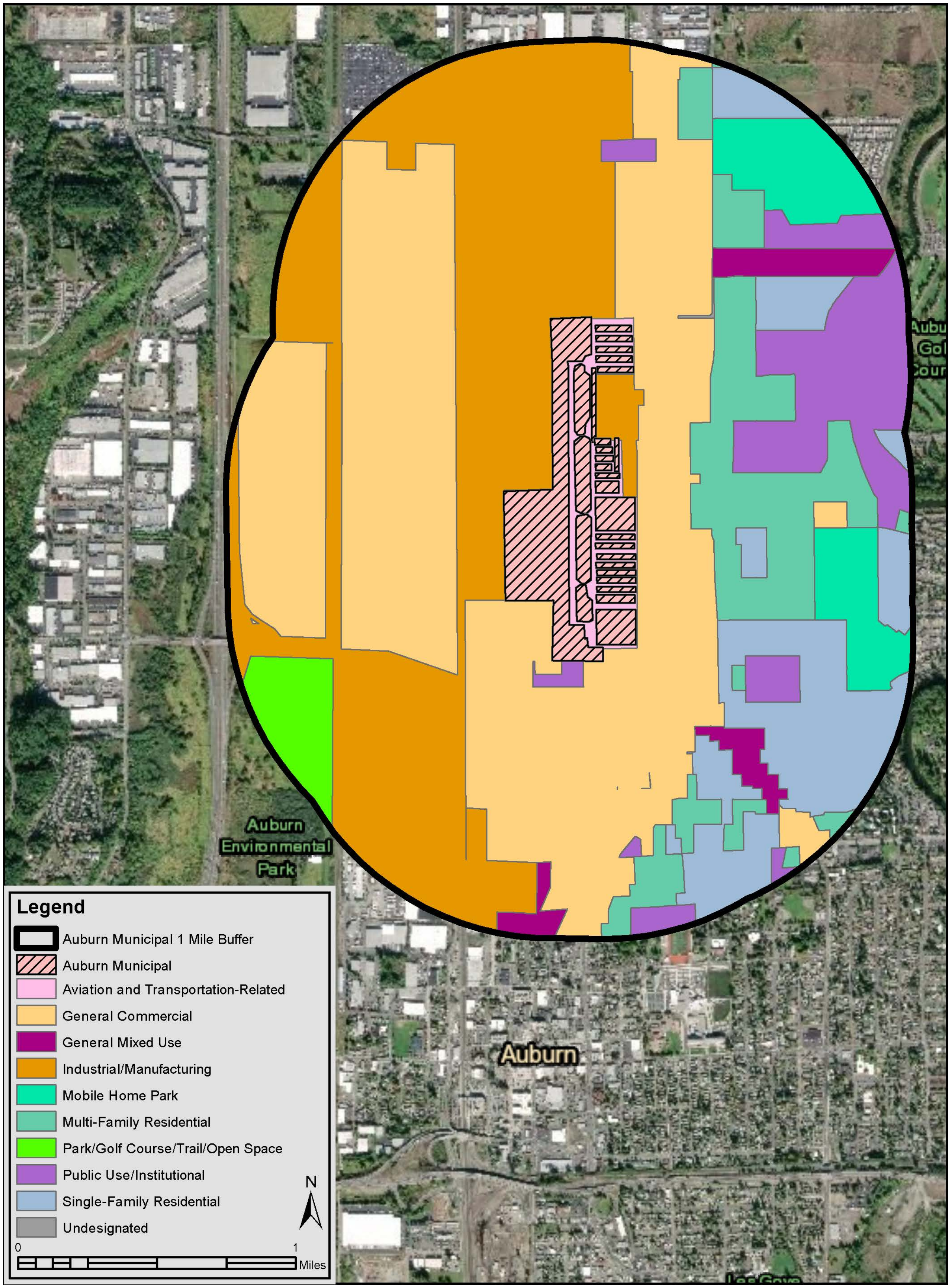
Figure 2-13. Auburn Municipal Airport

Figure 2-14. Auburn Municipal Runway Protection Zones

Table 2-5. Auburn Municipal Airport Statistics

Airport Statistics	2017 Aircraft Operations	164,539
	2017 Based Aircraft	315
Airside	Runway(s)	16-34; 3,400 feet; Asphalt
	Taxiway(s)	Partial Parallel
	Apron	47,800 square yards
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	35 spaces (FBO)/33 spaces (Building "506")/ 7 spaces (Airport Office)
	Ground Transportation	Yes—Taxi; TNC
	Business Park	Yes
Hangar	Corporate	
	T-Hangar	135
	Condo	81
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Weekly
	Fuel Type	100LL and Jet A
	Aircraft De-/Anti-Icing Services	None
	Maintenance	Yes – Airframe Turbine and Piston, PP Turbine, Avionics Shop
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	None of the RPZs are compliant.

Figure 2-15. Auburn Municipal Airport Surrounding Land Use



2.1.6 Harvey Field

Harvey Field is a private, family-owned airport designated as a regional general aviation reliever airport per the NPIAS. It is located 8 miles east of Paine Field, and provides convenient reliever assistance as Paine Field begins commercial service. Traditional services offered by Harvey Field include aviation fixed-based operation involving aviation gasoline (avgas) and aircraft maintenance, and flight training in small airplanes and helicopters. Harvey Field is also an active skydiving drop zone with an additional parachute student drop zone. Home to nearly two dozen businesses and featuring a hot-air balloon charter business, the estimated economic impact from aviation and airport activities is approximately $14.9 million. Harvey Field is in the process of planning a runway that meets FAA safety and design standards to accommodate ARC B-II aircraft. While Harvey Field is lined by railroad tracks to the north and public roadways to the south and east, there is still potential space for expansion. The airport is within an urban growth boundary and has avigation easements. City zoning policies discourage incompatible land use development around the airport, county ordinances have an airport compatibility area that discourages incompatible land uses around the airport, and zoning regulates height hazards. The airport compatibility area is within a specified distance, based on runway length, that extends from the runway end. Snohomish County has zoned the area around Harvey Field as “Industrial Park” with adjacent “Rural-5 Acre” zoning (Figure 2-18).

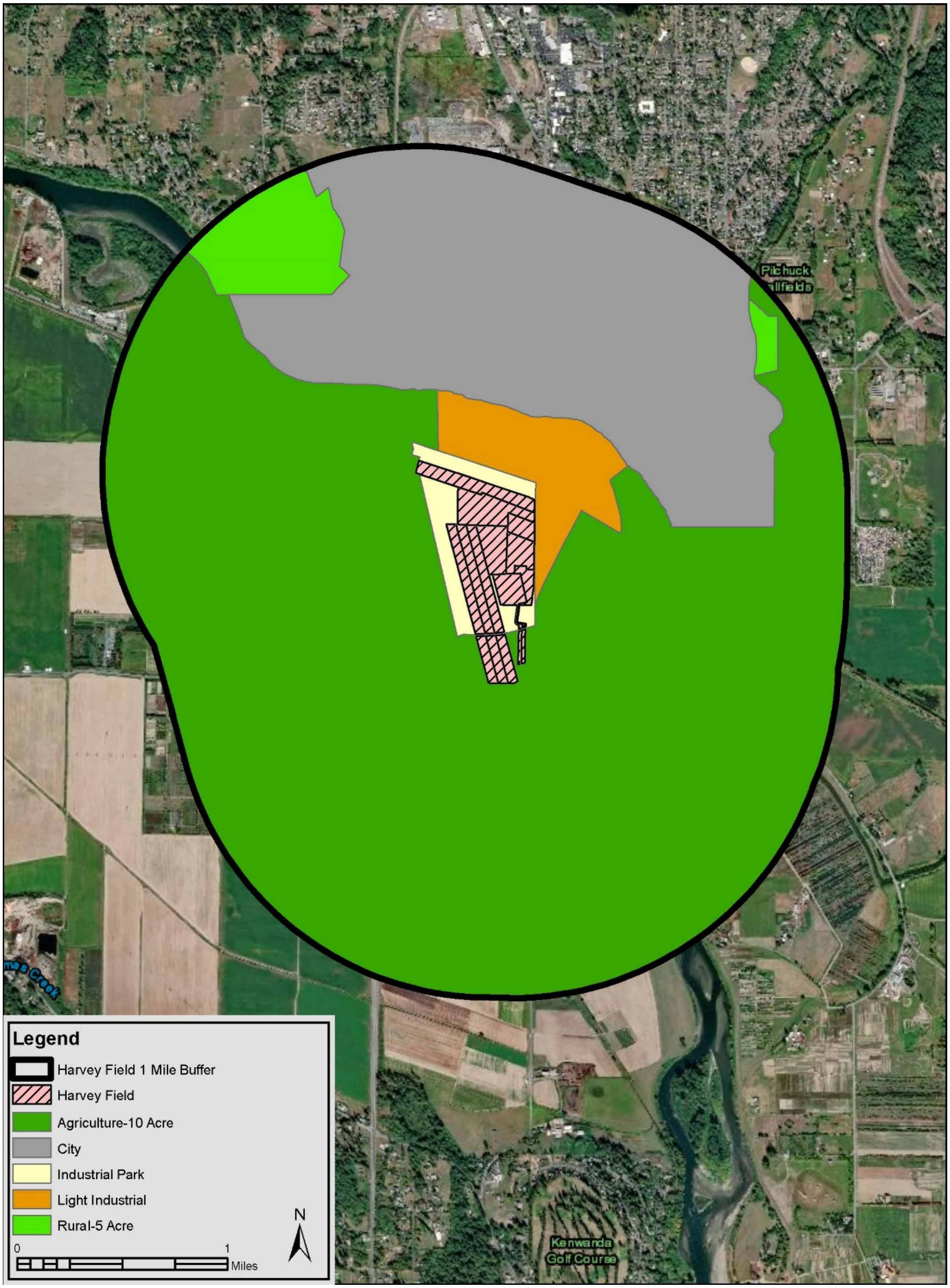
Figure 2-16. Harvey Field

Figure 2-17. Harvey Field Runway Protection Zones

Table 2-6. Harvey Field Statistics

Airport Statistics	2017 Aircraft Operations	100,220
	2017 Based Aircraft	206
Airside	Runway(s)	▪ 15L/33R; 2,672 feet; Asphalt ▪ 15R/33L; 2,430 feet; Turf* *(15R/33L Closed Nov 1 – May 31)
	Taxiway(s)	Full Parallel
	Apron	1.3 acres
Terminal	Fixed-Base Operator (FBO)	1 as of 2010 *awaiting airport manager response
Landside	Vehicle Parking	Yes – 105 spots
	Ground Transportation	Yes – Courtesy/Crew Car, Taxi
	Business Park	Yes – Café, Restaurants, Hotel, Hot-Air Balloon Rides, and Sky diving
Hangar	Corporate	*awaiting airport manager response
	T-Hangar	17
	Condo	3
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Monthly
	Fuel Type	100 LL/ Jet A
	Aircraft De-/Anti-Icing Services	Hangar De-Icing;
	Maintenance	Yes – Airframe Turbine and Piston, PP Turbine and Piston
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Milling company ▪ South – Agricultural land and slough ▪ East – Slough ▪ West – Agricultural land

Figure 2-18. Harvey Field Surrounding Land Use



2.1.7 Vashon Municipal Airport

Vashon Municipal Airport is a basic general aviation airport per NPIAS, with a single turf runway and is on Vashon Island, which is west of Sea-Tac. No services are provided at this airport, and based aircraft are housed in small conventional hangars lining the runway. Transient operations comprise flight training, medical transport and evacuation, and charter services. It is an ADG A-I airport, with the Cessna 182 as the critical aircraft. The airport is the only way to enter/exit Vashon Island when ferry service is disrupted. The airport is not in an urban growth boundary, and neither the city nor county appear to have any regulations to protect the airport from incompatible land use development. Kitsap County has zoned the area around Vashon Municipal as “Rural Area” (Figure 2-21).

Figure 2-19. Vashon Municipal Airport

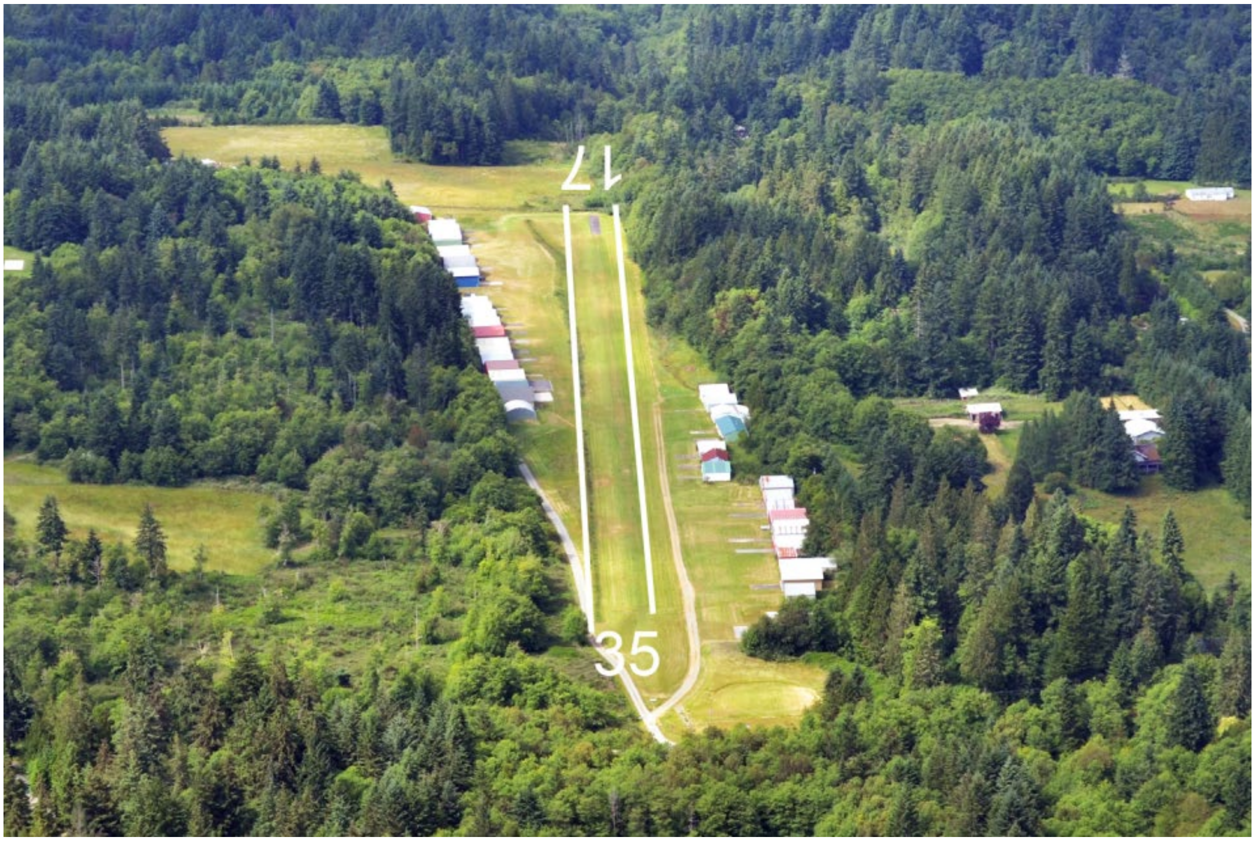
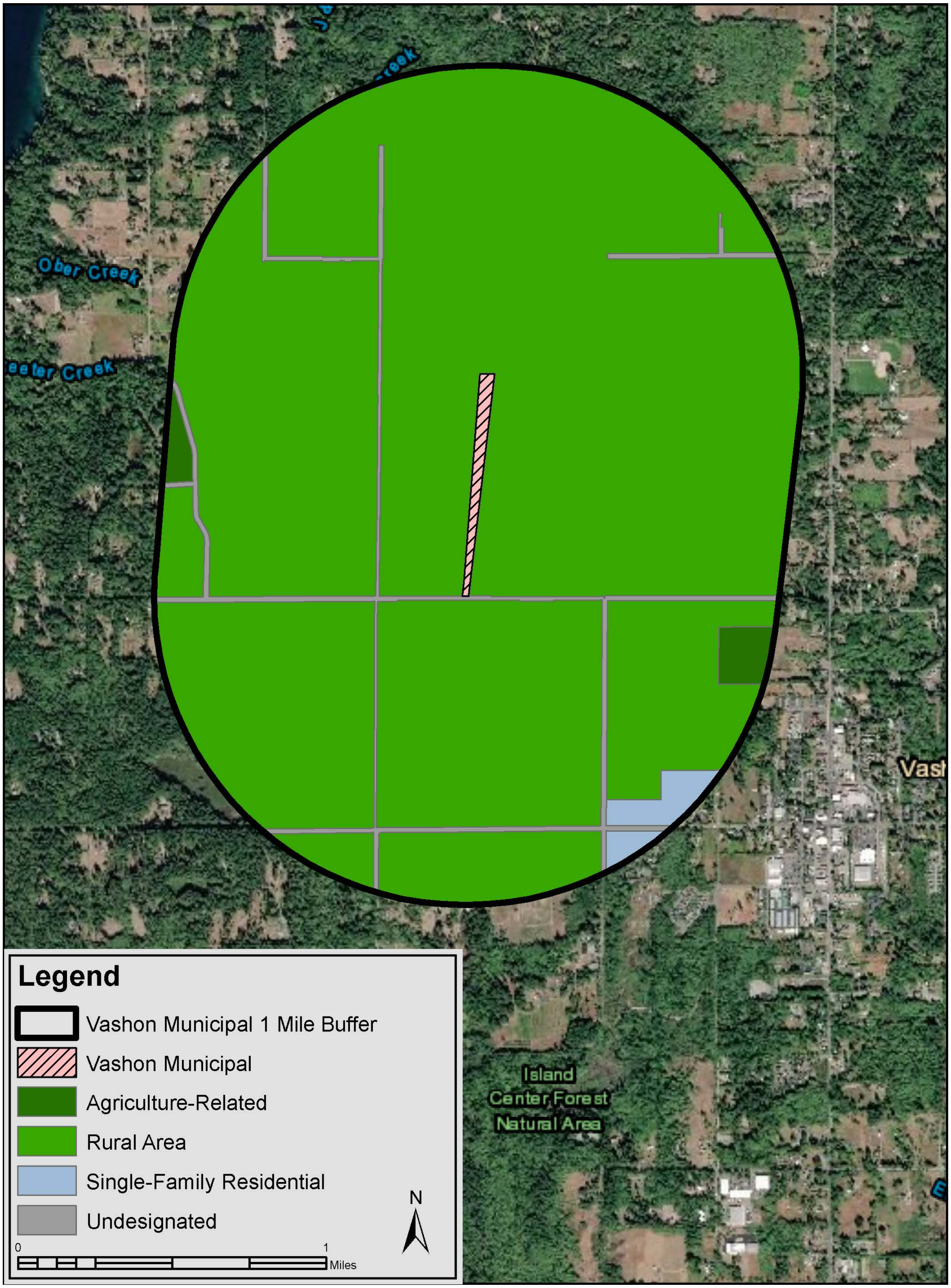


Figure 2-20. Vashon Municipal Runway Protection Zones

Table 2-7. Vashon Municipal Airport Statistics

Airport Statistics	2017 Aircraft Operations	2,000
	2017 Based Aircraft	32
Airside	Runway(s)	17-35; 2,001 feet; turf
	Taxiway(s)	None
	Tie-Downs	4 (turf)
Terminal	Fixed-base Operator (FBO)	None
Landside	Vehicle Parking	Unknown
	Ground Transportation	No
	Business Park	No
Hangars	Conventional	38 spaces for aircraft – 67,200 SF
	T-Hangar	2 spaces for aircraft - one hangar
Aviation Services	Flight School/Instruction Activity	Yes; Monthly
	Military Activity	No
	Emergency Operations	Yes; Weekly
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No
	Maintenance	No
Land Use Compatibility	Runway Protection Zone	Rwy 17 RPZ: not compliant - public roadway Rwy 35 RPZ: not compliant - public roadway
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential ▪ South – Residential ▪ East – Residential ▪ West – Residential

Figure 2-21. Vashon Municipal Surrounding Land Use



2.1.8 Bremerton National Airport

Bremerton National Airport is classified by NPIAS as a regional general aviation airport. The airport is owned by the Port of Bremerton and is the largest airport on the Kitsap Peninsula. The airport is strategically placed for operations that support naval facilities, which explains the level of military operations at the airport. A Civil Air Patrol Composite Squadron (auxiliary of the U.S. Air Force) is based at the airport. In a natural disaster affects bridge and ferry access to Kitsap County, the airport provides a corridor of transportation for emergency response management. In 2017, the FAA funded and approved a pavement maintenance project to extend the life of the airport's runway. Bremerton National is surrounded by land available for aeronautical and non-aeronautical development, featuring 520 acres of ready-to-build industrial land with Free-Trade Zone designation. The airport is located within an urban growth boundary and has avigation easements. City zoning policies discourage incompatible land use development around the airport. Kitsap County has zoned the area around Bremerton National as "Incorporated City" with adjacent "Business Center" zoning (Figure 2-24).

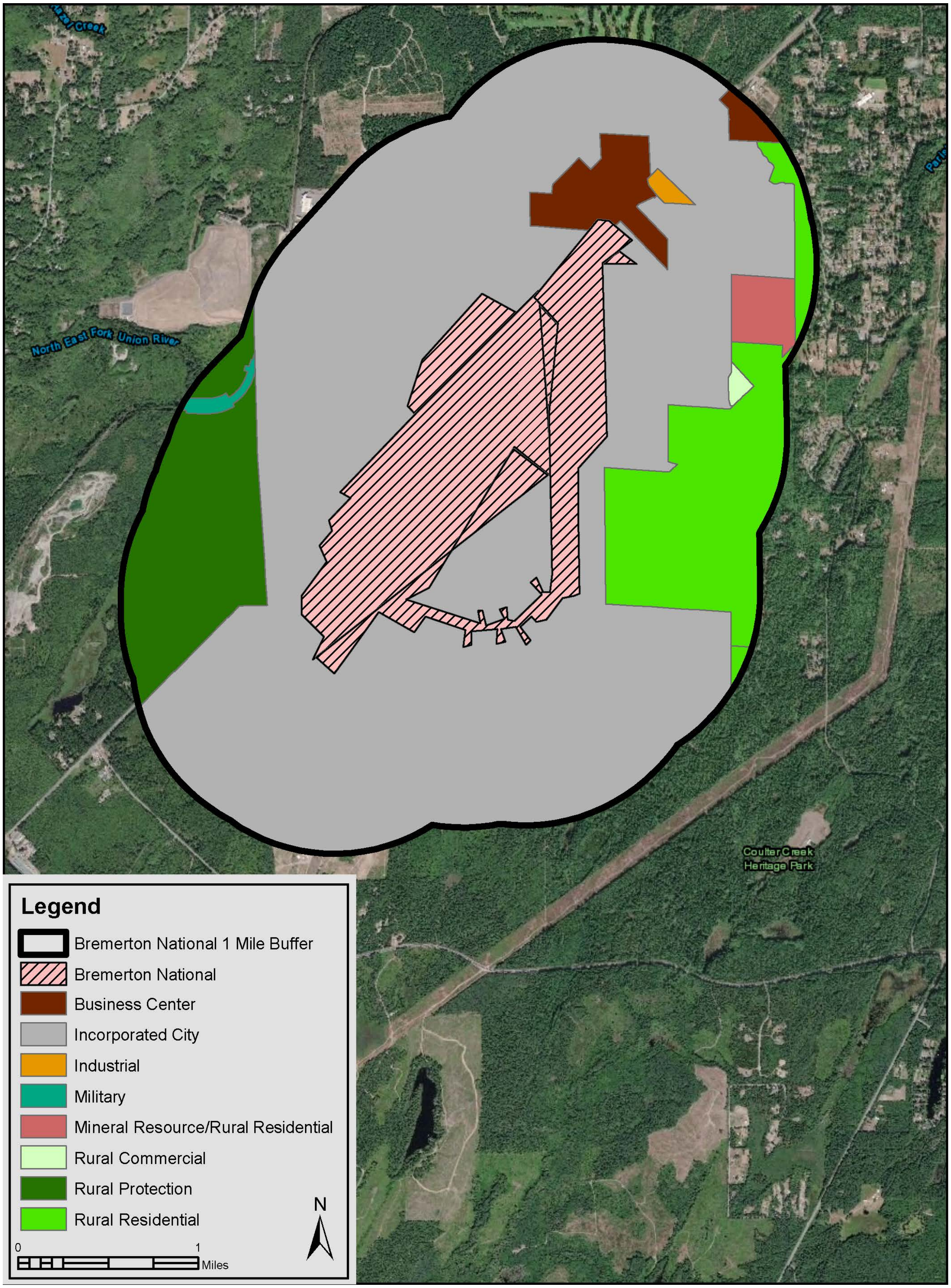
Figure 2-22. Bremerton National Airport

Figure 2-23. Bremerton National Runway Protection Zones

Table 2-8. Bremerton National Airport Statistics

Airport Statistics	2017 Aircraft Operations	66,000
	2017 Based Aircraft	170
Airside	Runway(s)	2/20; 6,000 feet; Asphalt
	Taxiway(s)	Full Parallel
	Apron	9.3 acres
Terminal	Fixed-Base Operator (FBO)	1 as of 2010 *awaiting airport manager response
Landside	Vehicle Parking	Yes – number not provided *awaiting airport manager response
	Ground Transportation	Yes – Courtesy/Crew Car, Taxi
	Business Park	No – Restaurants and accommodation nearby
Hangar	Corporate	*awaiting airport manager response
	T-Hangar	143
	Condo	19
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Daily
	Fuel Type	100 LL/ Jet A
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	Yes – Airframe Piston, PP Piston
Land Use Compatibility	Runway Protection Zone	Compliant
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Commercial businesses and forest ▪ South – Forest ▪ East – Forest ▪ West – Forest

Figure 2-24. Bremerton National Surrounding Land Use



2.1.9 Pierce County Airport

Pierce County Airport is, per the NPIAS, a local general aviation airport located 25 miles northwest of Mount Rainier. Aside from the spectacular views, the convenient location near Mount Rainier makes Pierce County Airport a frequent base for search and rescue efforts and emergency response efforts in the national park. Pierce County Airport is the sixth busiest airport in Washington state, with approximately 105,000 annual operations, three active flight schools, and charter and business flight services. Clover Park Technical School, one of the three Maintenance Report Operations training centers in the central Puget Sound region, is based at this airport with a through-the-fence agreement for access. The airport carries the Employment Center zoning designation from Pierce County, which permits future commercial uses that support employment growth and opportunities to expand their runways, though lacks the funding necessary to repair existing infrastructure. Approximately $9.7 million in annual economic impact drives nearly 200 full-time jobs and 14 businesses directly related to aviation activities at the airport. Significant airport services at Pierce County Airport include three flight training facilities with daily activities, along with monthly military operations. Pierce County has zoned the area around Pierce County Airport as “Employment Center” with adjacent “Mixed Use District” and “Urban Village” zoning (Figure 2-27).

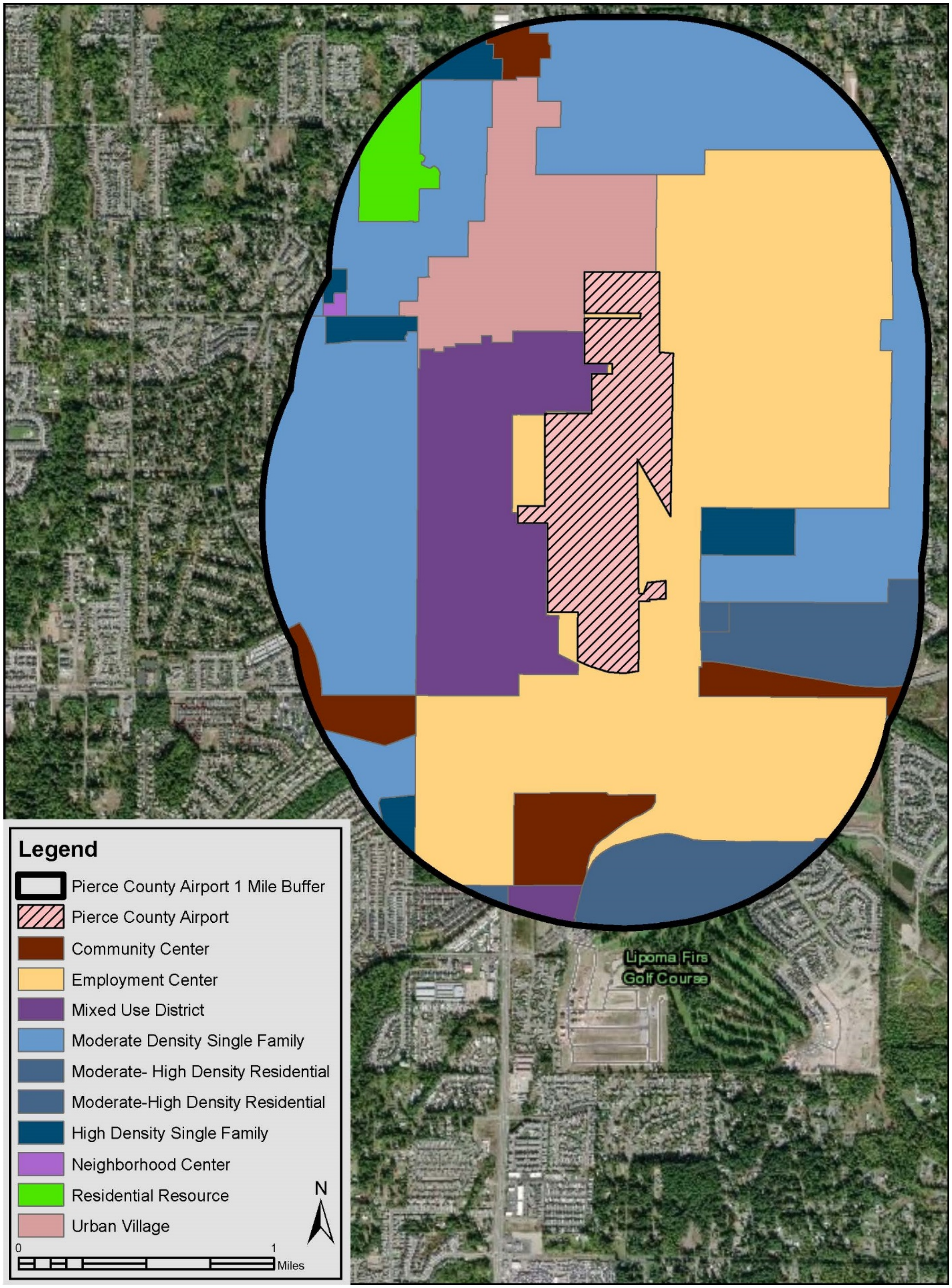
Figure 2-25. Pierce County Airport

Figure 2-26. Pierce County Airport Runway Protection Zones

Table 2-9. Pierce County Airport Statistics

Airport Statistics	2017 Aircraft Operations	100,000
	2017 Based Aircraft	252
Airside	Runway(s)	17/35; 3,650 feet; Asphalt
	Taxiway(s)	Full Parallel
	Apron	13.63 Acres
Terminal	Fixed-Base Operator (FBO)	0 as of 2010 *awaiting airport manager response
Landside	Vehicle Parking	*awaiting airport manager response
	Ground Transportation	Yes – Courtesy/Crew Car, Taxi, and Public Transit
	Business Park	Yes – aviation repair shop, flight school, technical college, restaurant, and hotel.
Hangar	Corporate	*awaiting airport manager response
	T-Hangar	200
	Condo	20
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Monthly
	Fuel Type	100LL
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	Yes – airframe piston, PP piston, Avionics shop
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential ▪ South – Sportsman club and golf course ▪ East – Self storage business and forest ▪ West – Commercial businesses

Figure 2-27. Pierce County Airport Surrounding Land Use



2.1.10 Tacoma Narrows Airport

Tacoma Narrows Airport is classified per NPIAS as a local general aviation airport located in Tacoma and supports corporate air travel for businesses in Tacoma. The airport has a control tower and is a training facility for student pilots and some military operations. Furthermore, the airport plays a vital role in regional emergency response if a major earthquake occurs. This airport is also the airport of choice for golfers during the United States Golf Association tournament at Chambers Bay and becomes very busy during that event. It is an ADG C-II airport. The critical aircraft is the Cessna Citation X, and the future critical aircraft is the Gulfstream IV. Significant airport services at Tacoma Narrows Airport include two flight training facilities with daily activities, weekly military operations, and weekly emergency management operations. Tacoma Narrow Airport has avigation easements. City zoning regulations prohibit penetration of Part 77 surfaces, and county policies and zoning discourage incompatible land use development around the airport and zoning to regulate height hazards. Pierce County has zoned the area around Tacoma Narrows Airport as "Ess. Public Facility Rural Airport" (Figure 2-30).

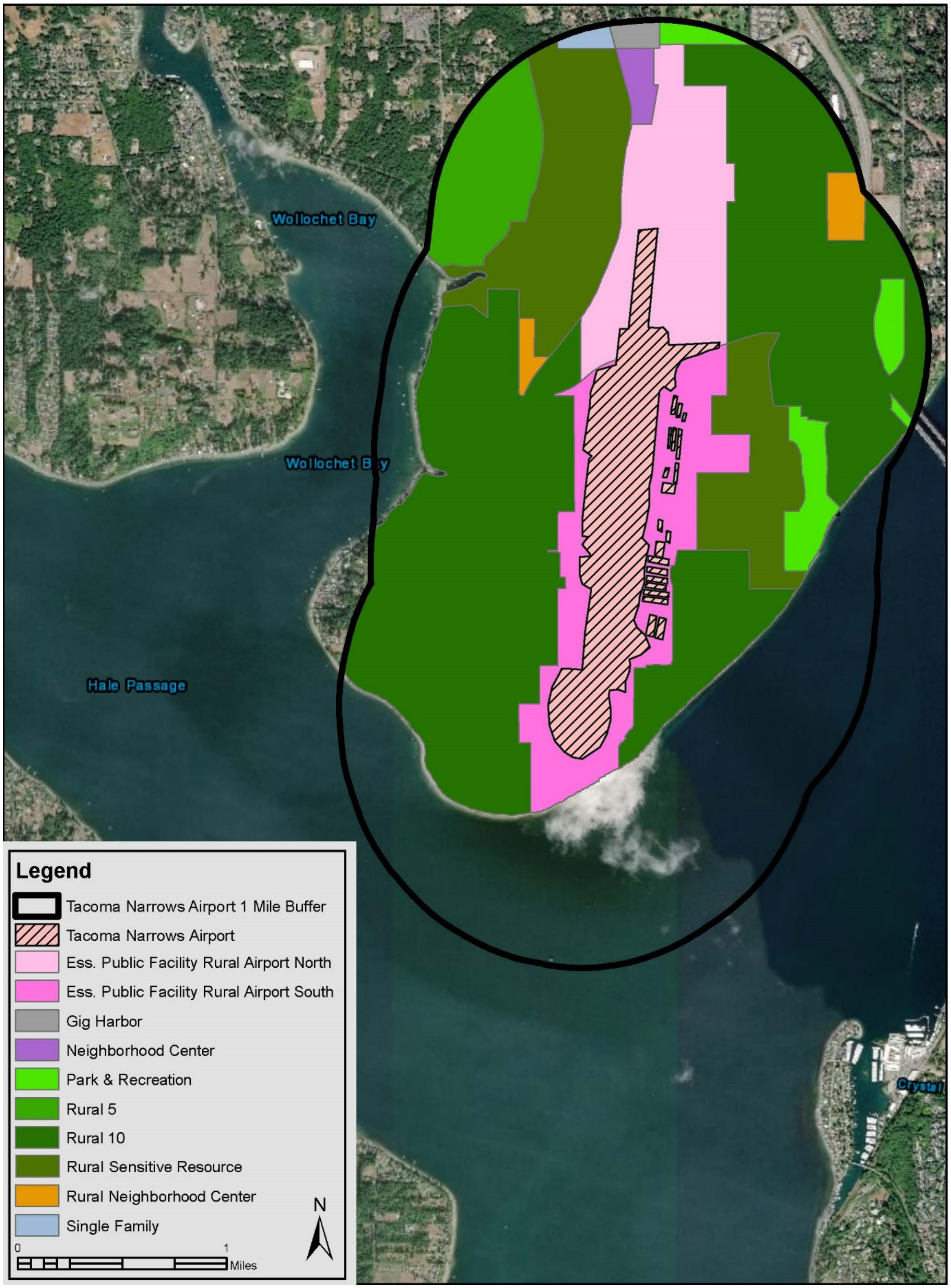
Figure 2-28. Tacoma Narrows Airport

Figure 2-29. Tacoma Narrow Airport Runway Protection Zones

Table 2-10. Tacoma Narrows Airport Statistics

Airport Statistics	2017 Aircraft Operations	88,617
	2017 Based Aircraft	64
Airside	Runway(s)	17-35; 5,002 feet; Asphalt
	Taxiway(s)	Full Parallel
	Apron	88,900 square yards
Terminal	Fixed-Base Operator (FBO)	3,600 square feet
Landside	Vehicle Parking	89 parking spaces
	Ground Transportation	Yes
	Business Park	No
Hangars	Corporate	35 aircraft units
	T-Hangar	170 aircraft units
	Condo	Unknown
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Weekly
	Emergency Operations	Yes; Weekly
	Fuel Type	100LL and Jet A
	Aircraft De-/Anti-Icing Services	No
	Maintenance	Yes
Land Use Compatibility	Runway Protection Zone	▪ Runway 17-end: not compliant portion of Stone Drive Northwest and some houses are within the RPZ ▪ Runway 35-end: compliant
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Dense Forest ▪ South – Water ▪ East – Residential/Forest ▪ West – Residential/Forest

Figure 2-30. Tacoma Narrows Airport Surrounding Land Use



2.1.11 Arlington Municipal Airport

Arlington Municipal is a regional general aviation airport, per NPIAS. As the economic center of the city of Arlington, the airport possesses a strong grass-roots aviation presence, contributing approximately 6,000 aviation-related jobs and approximately 133,552 aircraft based at the airport and within the community. Significant activities include aircraft-cover manufacturing, emergency parachute manufacturing, historic and decommissioned aircraft restoration, and hosting one of the Pacific Northwest's largest fly-ins every year in July. The City of Arlington recognizes this importance and continues to support Arlington Municipal through city planning, financing, and development. City zoning discourages incompatible land use development around the airport and regulates height hazards, and has regulations prohibiting penetration of Part 77 surfaces. The airport averages approximately 365 aircraft operations per day. Of those activities, 98 percent are general aviation, 2 percent are air taxi, and less than 1 percent are military activities. The largest aircraft that uses the facility at least once a day is the Beechcraft King Air 350. Snohomish County has zoned the area around Arlington Municipal as "City" (Figure 2-33).

Figure 2-31. Arlington Municipal Airport

Figure 2-32. Arlington Municipal Airport Runway Protection Zones

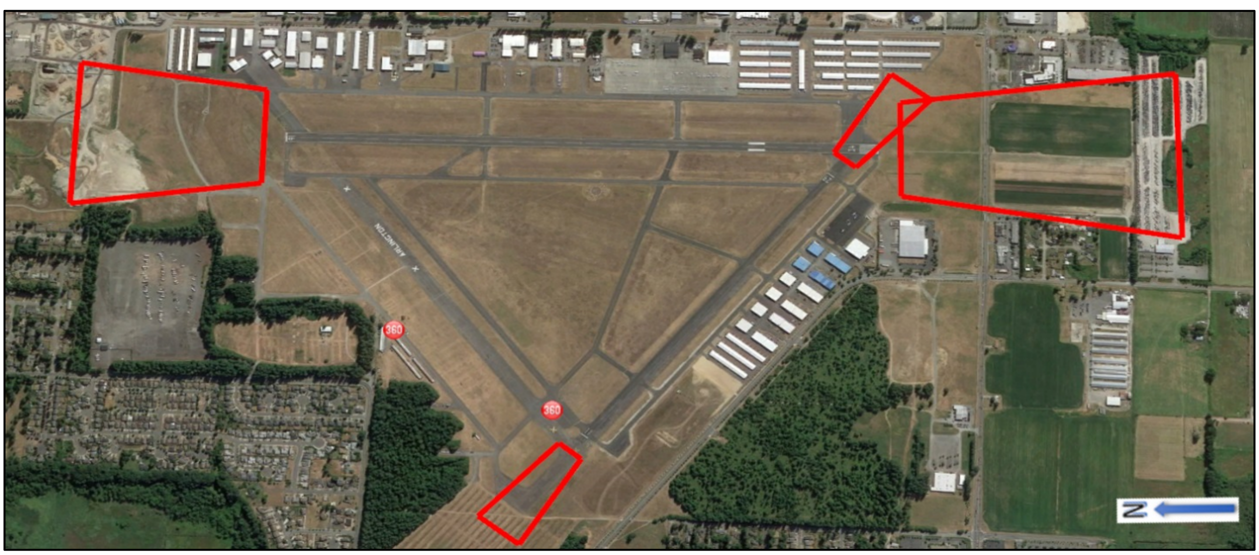
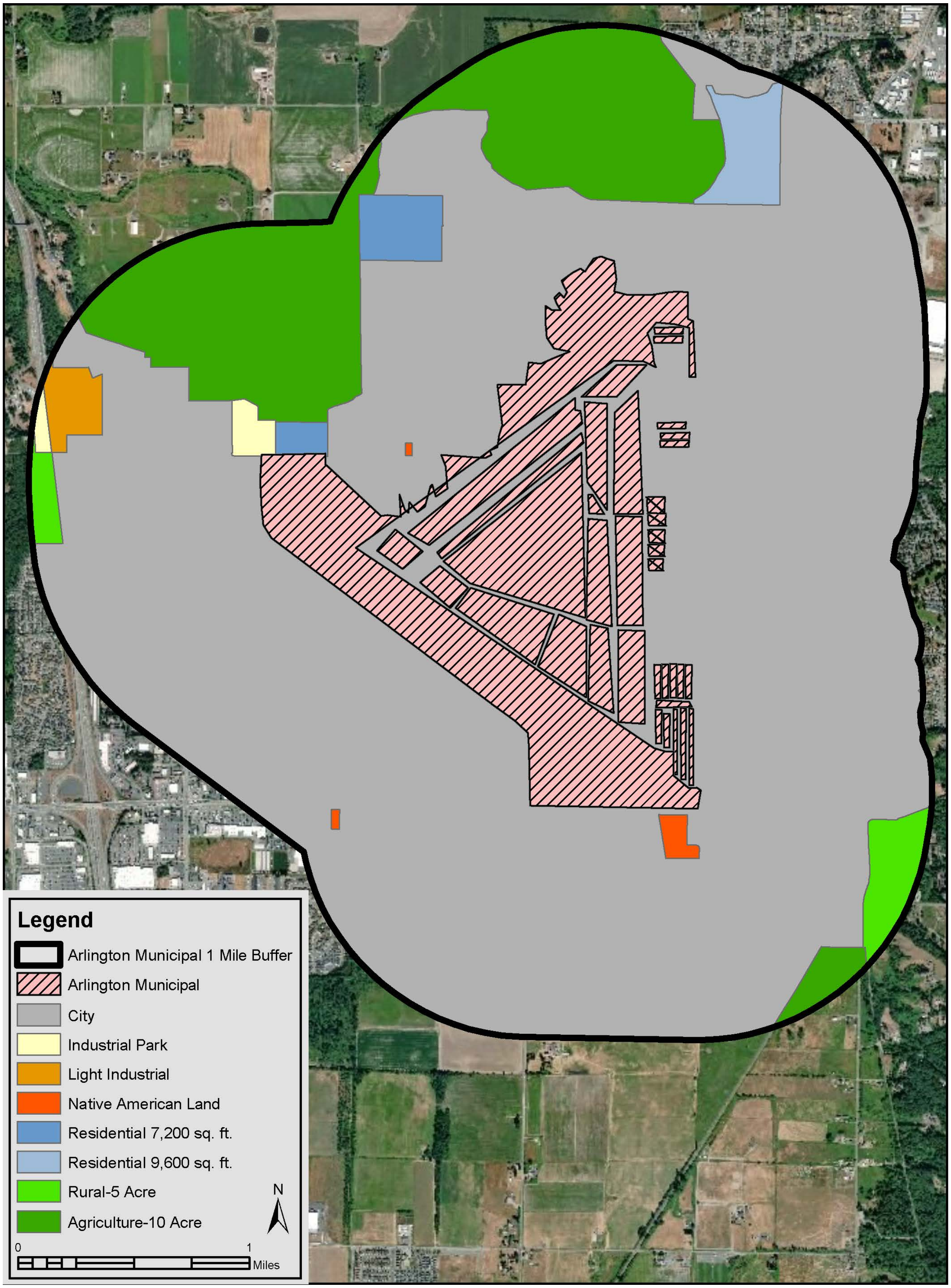


Table 2-11. Arlington Municipal Airport Statistics

Airport Statistics	2017 Aircraft Operations	133,552
	2017 Based Aircraft	321
Airside	Runway(s)	▪ 16/34; 5,332 feet; Asphalt ▪ 11/29; 3,498 feet; Asphalt
	Taxiway(s)	Full Parallel
	Apron	1.4 acres
Terminal	Fixed-Base Operator (FBO)	19 as of 2010 *awaiting airport manager response
Landside	Vehicle Parking	Yes – number not provided *awaiting airport manager response
	Ground Transportation	Yes – Courtesy/Crew Car
	Business Park	Yes – 3 restaurants, 2 hotels
Hangar	Corporate	*awaiting airport manager response
	T-Hangar	350
	Condo	35
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Seasonal
	Fuel Type	100 LL/Jet A/Mogas
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	Yes – Airframe Turbine, PP Piston, Avionics Shop
Land Use Compatibility	Runway Protection Zone	Compliant
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential area and forest ▪ South – Agricultural land ▪ East – Commercial businesses and residential area ▪ West – Residential area and highway

Figure 2-33. Arlington Municipal Airport Surrounding Land Use



2.1.12 Bandera State Airport

Bandera State Airport is a state-managed, non-NPIAS general aviation airfield and is generally open June 1 to October 1. Located at an elevation of 1,636 feet in the scenic upper Snoqualmie Valley, Bandera State Airport was originally constructed in 1948 as one of the first state airports in Washington state. Key activities for the airport include the following:

- Supporting emergency management functions
- Supporting forest firefighting activities
- Providing access for emergency medical operations
- Providing recreational access to remote communities
- Supporting military training activities

Planned emergency and recreational access improvements are expected to support the local economy of the community and enhance the overall level of safety for users of Bandera State Airport, but construction plans on the adjacent highway and limited funding for the airport could affect the airport's ability to implement future improvements.

Figure 2-34. Bandera State Airport

Figure 2-35. Bandera State Airport Runway Protection Zones

Table 2-12. Bandera State Airport Statistics

Airport Statistics	2017 Aircraft Operations	300
	2017 Based Aircraft	0
Airside	Runway(s)	8/26; 2,344 feet; Turf* (*8/26 generally closed Oct. 1st-May 31st)
	Taxiway(s)	None
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	0
	Ground Transportation	None
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Seasonal
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use Incompatibility (within ~500 feet of airport boundary)	▪ North – Highway and dense forest/Mountain ▪ South – Dense forest/Mountain ▪ East – Dense forest ▪ West – Dense forest

2.1.13 Lester State Airport

Lester State Airport is a state-managed, non-NPIAS general aviation airport. The facility is currently closed and is declared to the pilots as available only for emergencies. Before its closure, Lester State Airport was generally open seasonally from June to October. Located at an elevation of 1,693 feet about 10 miles southwest of Stampede Pass, Lester State Airport was constructed in 1948 to provide access to this remote area of Washington state. The airport incurred significant erosion caused by flooding along the bank of the Green River that turned most of the air strip into a river bed. However, WSDOT has recently requested to keep Lester State Airport open because the airport has enough space for emergency helicopter takeoff and landing and could continue to be used for natural resource management. Lester State Airport activities have included supporting emergency management functions, forest firefighting activities, and law enforcement operations.

Figure 2-36. Lester State Airport

Table 2-13. Lester State Airport Statistics

Airport Statistics	2017 Aircraft Operations	N/A
	2017 Based Aircraft	N/A
Airside	Runway(s)	N/A
	Taxiway(s)	None
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	0
	Ground Transportation	None
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	No
	Emergency Operations	Yes; Seasonal
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	Not Fully Compliant
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Remote Access Road and dense forest ▪ South – Dense forest/River ▪ East – Dense forest/River Bank ▪ West – Dense forest

2.1.14 Skykomish State Airport

Skykomish State Airport is a state-managed, non-NPIAS general aviation airport that is generally open from June to October. Located at an elevation of 1,002 feet approximately 1 mile east of the town of Skykomish, the airport is within walking distance of a charming small-town atmosphere. Key activities for Skykomish State Airport include supporting emergency management functions, forest firefighting activities, and providing access for emergency medical operations and recreational access to remote communities. Planned emergency and recreational access improvements are expected to support the local economy of the community and enhance the overall level of safety for users of the airport. However, expansion is constrained by leased space adjacent to Skykomish State Airport, which accommodates the town of Skykomish's public wastewater system and the surrounding environmentally sensitive and critical areas.

Figure 2-37. Skykomish State Airport

Figure 2-38. Skykomish State Airport Runway Protection Zones

Table 2-14. Skykomish State Airport Statistics

Airport Statistics	2017 Aircraft Operations	300
	2017 Based Aircraft	0
Airside	Runway(s)	6/24; 2,050 feet; Turf* (*6/24 generally closed Oct. 1st-May 31st)
	Taxiway(s)	None
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	0
	Ground Transportation	None
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Seasonal
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Highway and dense forest ▪ South – Dense forest ▪ East – Dense forest and U.S. ranger station ▪ West – Town

2.1.15 Norman Grier Field

Norman Grier Field is a family-owned, non-NPIAS general aviation airport located approximately 5 miles southeast of the central business district of the city of Kent. As a 141-certified flight school, Norman Grier Field conducts flight training primarily for the nearby Green River Community College. The airport experiences an average of 312 aircraft operations per day. Transient general aviation comprises 89 percent of the aircraft operations and local general aviation comprises 11 percent. Based on the field are 327 single-engine airplanes and 5 multi-engine airplanes. Hills, trees, and private residences surround the airport. Most of the residents who live nearby can hangar an aircraft that can be taxied to the runway, though several schools and neighborhoods in the area do not want the airport to grow, and private ownership with limited funding hinders the ability to make improvements. While the city does not appear to have policies that protect the airport, county zoning regulates height hazards.

Figure 2-39. Norman Grier Field

Figure 2-40. Norman Grier Field Runway Protection Zones

Table 2-15. Norman Grier Field Statistics

Airport Statistics	2017 Aircraft Operations	113,850
	2017 Based Aircraft	332
Airside	Runway(s)	15/33; 3,288 feet; Asphalt
	Taxiway(s)	Full Parallel
	Apron	*awaiting airport manager response
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	0 (parking nearby privately owned)
	Ground Transportation	Yes – Taxi
	Business Park	No
Hangar	Corporate	0
	T-Hangar	72
	Condo	*awaiting airport manager response
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Seasonal
	Fuel Type	100 LL
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	Yes – Airframe piston
Land Use Compatibility	Runway Protection Zone	Compliant
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Forest and highway ▪ South – Forest ▪ East – Forest and residential area ▪ West – Residential area

2.1.16 Kenmore Air Harbor Seaplane Base (S60)

Kenmore Air Harbor SPB (Kenmore Air Harbor SPB S60) is a privately owned SPB classified as a general aviation airport, per NPIAS, and serves as the Kenmore Air Harbor SPB S60 main base of operations. This facility is located at the north point of Lake Washington. Another "Kenmore Air Harbor Sea Plane Base (W55)" is located on Lake Union. At the north end of Lake Washington, Kenmore Air Harbor SPB (S60) has 100 single-engine based seaplanes, averages 16,000 aircraft operations annually, and is one of the only SPBs in Washington state with two waterways.

Kenmore Air Harbor SPB S60 provides service to over 40 scheduled destinations throughout Washington state and the inside passage of British Columbia's Vancouver Island, including the San Juan Islands and mainland Canada. Kenmore Air Harbor SPB S60 transports approximately 80,000 passengers annually and is under increasing pressure from the growing popularity and usage of Lake Washington. The City of Kenmore is currently exploring the development of apartments buildings on the property directly adjacent to Kenmore Air Harbor SPB S60, which threatens to exacerbate the increasing pressure from adjoining real estate development. King County has zoned the area around Kenmore Air Harbor SPB S60 as "General Commercial" with adjacent "Park/Golf Course/Trail/Open Space" zoning (Figure 2-41).

Figure 2-41. Kenmore Air Harbor Seaplane Base (S60)

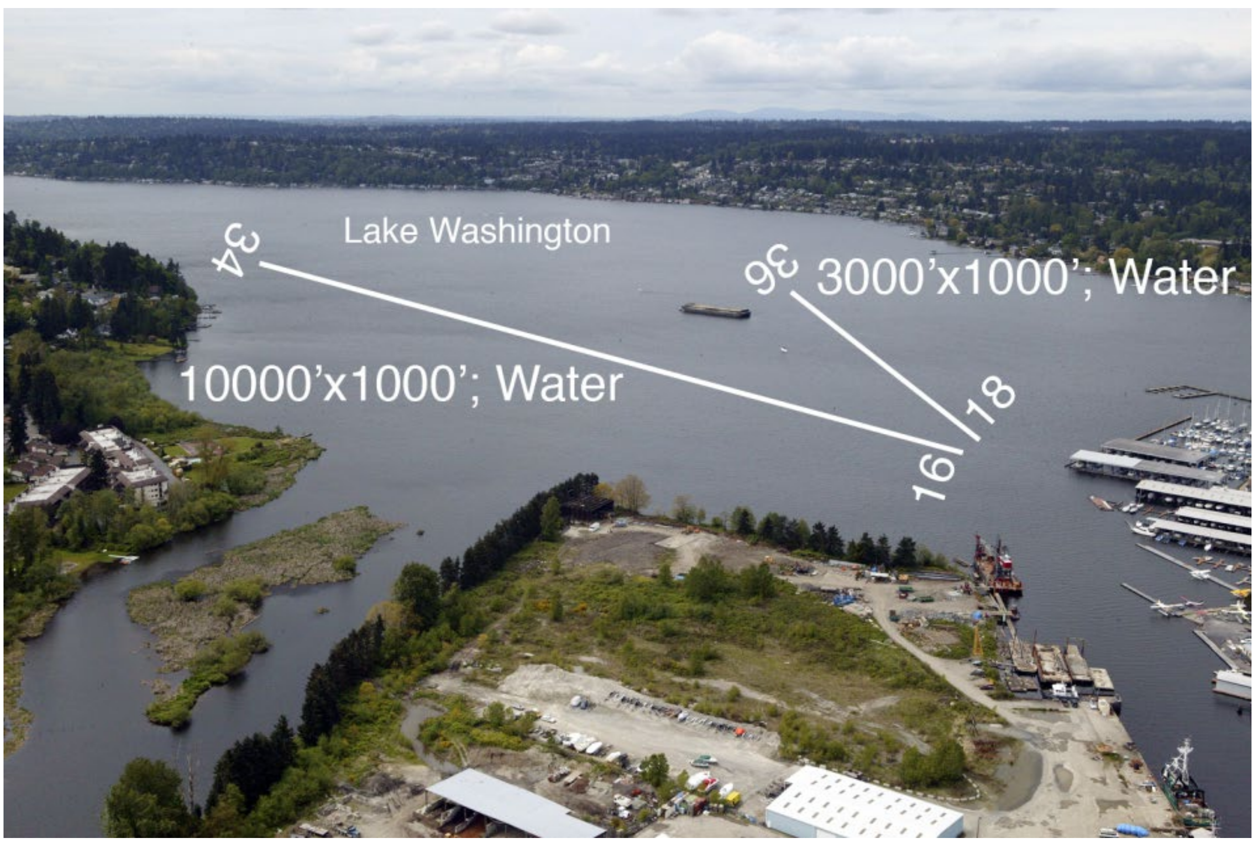
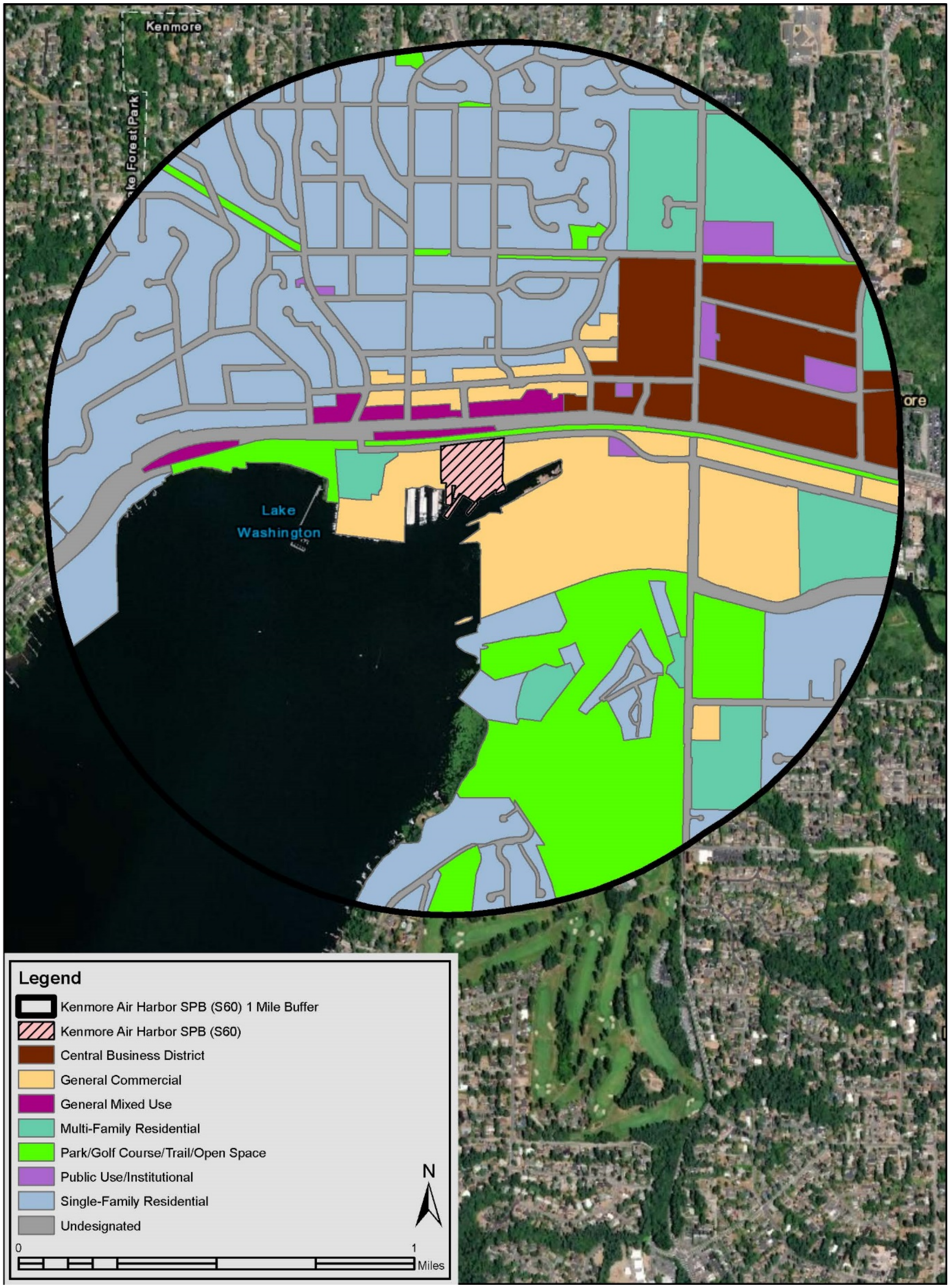


Table 2-16. Kenmore Air Harbor Seaplane Base (S60) Statistics

Airport Statistics	2017 Aircraft Operations	43,000
	2017 Based Aircraft	24
Airside	Runway(s)	▪ Waterway 16W/34W; 10,000 feet; Water ▪ Waterway 18W/36W; 3,000 feet; Water
	Taxiway(s)	N/A
	Apron	1.6 acres
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	▪ 0 parking at seaplane base ▪ Private and public parking available at Marina and other lots nearby
	Ground Transportation	Yes – Taxi, public transit
	Business Park	No
Hangar	Corporate	0
	T-Hangar	3 (Maintenance only)
	Condo	2 (Maintenance only)
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	No
	Emergency Operations	No
	Fuel Type	100 LL/ Jet A
	Aircraft De-/Anti-Icing Services	None
	Maintenance	Yes – Airframe Turbine and Piston, PP Turbine and Piston, Avionics Shop
Land Use Compatibility	Runway Protection Zone	N/A
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential area and Highway ▪ South – Water (Lake Washington) ▪ East – Commercial businesses ▪ West – City park

Figure 2-42. Kenmore Air Harbor Seaplane Base (S60) Surrounding Land Use



2.1.17 Kenmore Air Harbor Seaplane Base (W55)

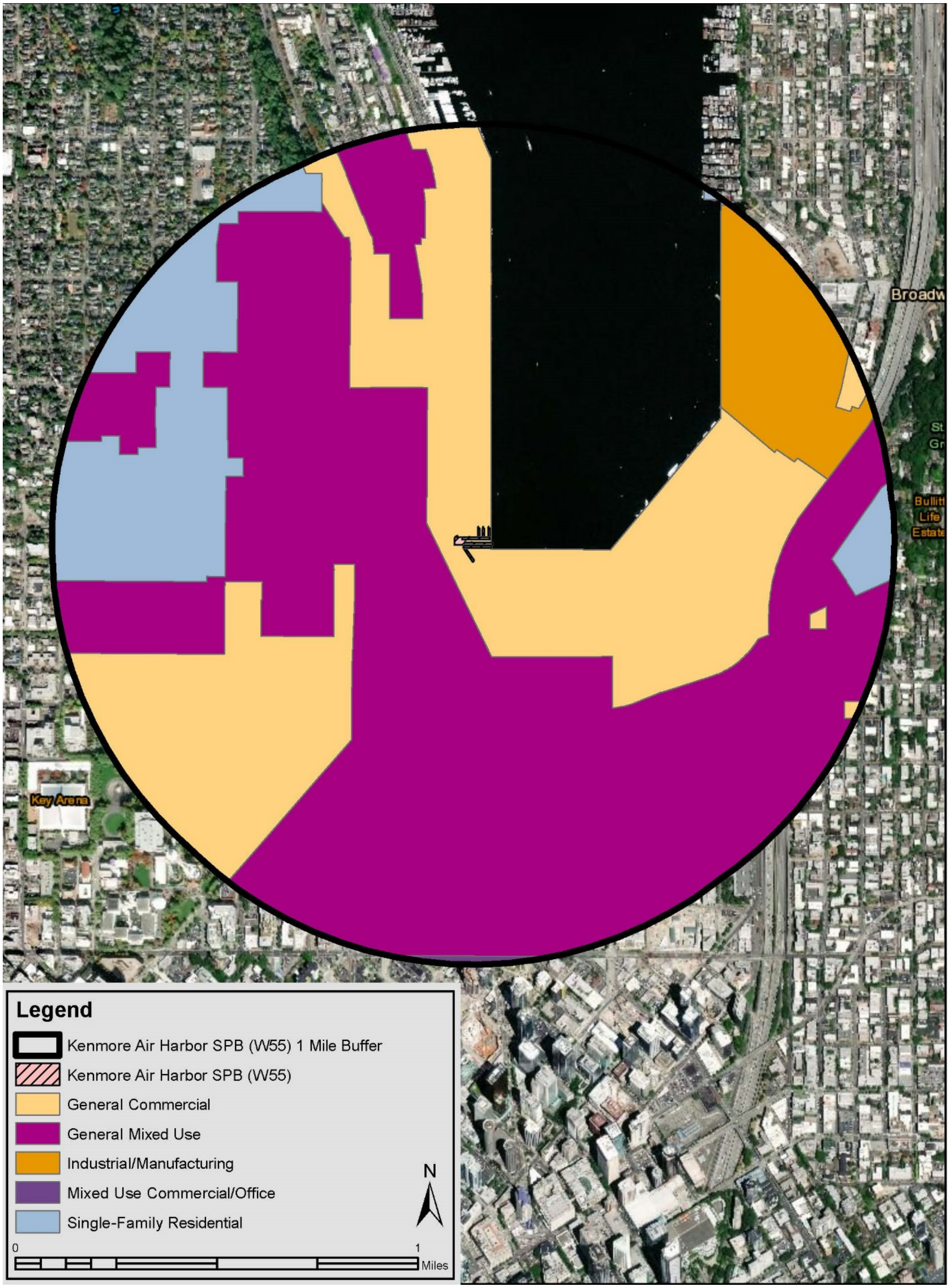
Kenmore Air Harbor SPB (W55) (Kenmore Air Harbor SPB W55) is a non-NPIAS general aviation airport located on Lake Union in Seattle. It serves as downtown passenger terminal for Kenmore Air to connect its 80,000 annual passengers to destinations throughout Washington state and British Columbia. Kenmore Air Harbor SPB W55 also has a location at the north point of Lake Washington. The airport is constrained by the growing popularity of Lake Union, which has seen increased usage by all vessel types. In 2018, the airport received approval to place five seaplane advisory buoys to provide separation between aircraft and other vessels, but this does not restrict use of the area to only seaplanes; all vessels operating on the lake are free to operate in the area. King County has zoned the area around Kenmore Air Harbor SPB W55 as "General Commercial" (see figure 43).

Figure 2-43. Kenmore Air Harbor Seaplane Base (W55)

Table 2-17. Kenmore Air Harbor Seaplane Base Statistics

Airport Statistics	2017 Aircraft Operations	43,500
	2017 Based Aircraft	0
	2017 Total Passengers	80,000
Airside	Runway(s)	Waterway 16W-34W; 5,000 feet; Water
	Taxiway(s)	N/A
	Apron	None
Terminal	Fixed-base Operator (FBO)	Terminal: 1,700 sq. ft.
Landside	Vehicle Parking	10 spaces
	Ground Transportation	Taxi, Airport Shuttle, Public Transit
	Business Park	No
Hangars	Corporate	0
	T-Hangar	0
	Dock Positions	8
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	No
	Emergency Operations	No
	Fuel Type	100LL/Jet A for Kenmore Air only
	Aircraft De-/Anti-Icing Services	No
	Maintenance	No
Land Use Compatibility	Runway Protection Zone	N/A
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential ▪ South – Residential ▪ East – Residential ▪ West – Residential

Figure 2-44. Kenmore Air Harbor SPB (W55) Surrounding Land Use



2.1.18 Will Rogers-Wiley Post Memorial Seaplane Base

Will Rogers-Wiley Post Memorial SPB is a non-NPIAS general aviation seaplane base on Lake Washington and owned by the City of Renton. Co-located with the Renton Municipal Airport, Will Rogers—Wiley Post Memorial SPB is one of the only sea plane bases in the country that is adjacent to a public airport. Will Rogers—Wiley Post Memorial SPB uniquely serves seaplane and floatplane traffic to Renton Municipal Airport and supports economic vitality, tourism, and emergency management. Although the largest users of Will Rogers—Wiley Post Memorial SPB are on-demand sightseeing tours, floatplane instruction and charters, the airport is capable of accommodating military aircraft and marine vessels. The airport's seaplane ramp is accessible from Renton Municipal Airport, with its fixed-base operators providing Will Rogers—Wiley Post Memorial SPB with seaplane maintenance, float install/removal, and float truck service. Significant airport services at this airport include five flight training facilities with daily activities (shared with Renton Municipal Airport). Will Rogers-Wiley Post Memorial SPB does not have military operations or emergency management operations but does possess the capability.

Figure 2-45. Will Rogers-Wiley Post Memorial Seaplane Base

Table 2-18. Will Rogers-Wiley Post Memorial Seaplane Base Statistics

Airport Statistics	2017 Aircraft Operations	2,387
	2017 Based Aircraft	0
Airside	Runway(s)	Waterway 12W/30W; 5,000 feet; Water
	Taxiway(s)	N/A
	Apron	0 (no longer have access to Renton Municipal Airport aprons due to compliance standards)
Terminal	Fixed-Base Operator (FBO)	2 as of 2010*awaiting airport manager response (shared with Renton Municipal Airport)
Landside	Vehicle Parking	0 (parking lots privately owned)
	Ground Transportation	Courtesy/Crew Car, Taxi, and TNC (shared with Renton Municipal Airport)
	Business Park	No – Restaurant and two hotels nearby, not on-airport property
Hangar	Corporate	*awaiting airport manager response
	T-Hangar	64 (shared with Renton Municipal Airport)
	Condo	19 (shared with Renton Municipal Airport)
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	No (capability noted)
	Emergency Operations	No (capability noted)
	Fuel Type	100 LL/Jet A (shared with Renton Municipal Airport)
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	Yes – Airframe turbine and piston, PP turbine and piston, and Avionics shop (shared with Renton Municipal Airport)
Land Use Compatibility	Runway Protection Zone	N/A
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Water (Lake Washington) and Mercer Island ▪ South –Renton Municipal Airport and Renton city center ▪ East –Renton Municipal Airport and highway ▪ West – Residential area

2.1.19 Apex Airpark

Apex Airpark is a private, non-NPIAS general aviation airstrip that recently became open to public use. Still privately owned, Apex Airpark is primarily a residential airpark. Built in 1946, the local community claims this is the first residential airpark in the United States. The airpark is uniquely situated approximately 2 miles south of the P-51 Prohibited Airspace over the Naval Submarine Base Bangor and the Intercontinental Ballistic Missile facility, and approximately 2 miles west of the Kitsap Mall in Silverdale. Apex Airpark supports locally based light civil aircraft with daily recreational flights, weekly aerial photography and tourism activities, and seasonal firefighting and military operations.

Figure 2-46. Apex Airpark

Figure 2-47. Apex Airpark Runway Protection Zones

Table 2-19. Apex Airpark Statistics

Airport Statistics	2017 Aircraft Operations	21,330
	2017 Based Aircraft	73
Airside	Runway(s)	17/35; 2,500 feet; Asphalt
	Taxiway(s)	Full Parallel
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	0
	Ground Transportation	None
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	Yes; Seasonal
	Emergency Operations	Yes; Seasonal
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential area ▪ South – recycling and landfill site ▪ East – forest ▪ West – Residential area

2.1.20 Port of Poulsbo Seaplane Base

Port of Poulsbo SPB is a non-NPIAS general aviation seaplane base at the north end of the Poulsbo Marina. It remains active in the community as a popular destination for seasonal recreational flights, corporate and business flights, aerial photography and tourism activities, and a host for annual events. Port of Poulsbo SPB is poised to expand its seaplane operations and aims to build a commercial seaplane terminal. Port of Poulsbo SPB has witnessed a growing demand for charter flights to and from Bainbridge Island, Kitsap County, Lake Union, and the San Juan Islands. Current plans include replacing the existing infrastructure with a new floating breakwater, pushing the seaplane dock away from the shoreline, and effectively removing low-tide and piling concerns.

Figure 2-48. Port of Poulsbo Seaplane Base

Table 2-20. Port of Poulsbo Seaplane Base Statistics

Airport Statistics	2017 Aircraft Operations	300
	2017 Based Aircraft	0
Airside	Runway(s)	Waterway 13W/31W; 12,000 feet; Water
	Taxiway(s)	N/A
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	56 spots
	Ground Transportation	Yes – Taxi
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	No
	Emergency Operations	No
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	N/A
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential ▪ South – Water (Liberty Bay) ▪ East – Residential and commercial businesses ▪ West – Water (Liberty Bay) and residential houses on shore nearby

2.1.21 Ranger Creek State Airport

Ranger Creek State Airport is a state-managed, non-NPIAS general aviation airport and is generally open June 1 to October 1. Located at an elevation of 2,650 feet in the White River Valley (not far from Mount Rainier), Ranger Creek State Airport is surrounded by sheer cliffs and towering ridges. Key activities for the airport include the following:

- Supporting emergency management functions
- Supporting forest firefighting activities
- Providing access for emergency medical operations
- Providing recreational access to remote communities

Planned emergency and recreational access improvements are expected to support the local economy of the community and enhance the overall level of safety for users of Ranger Creek State Airport. However, the airport's location within the Snoqualmie National Forest limits the ability to implement improvements and limited funds are available to dedicate toward identified needs.

Figure 2-49. Ranger Creek State Airport

Figure 2-50:. Ranger Creek State Airport Runway Protection Zones

Table 2-21. Ranger Creek State Airport Statistics

Airport Statistics	2017 Aircraft Operations	450
	2017 Based Aircraft	0
Airside	Runway(s)	15/33; 2,875 feet; Asphalt* (*15/33 generally closed Oct. 1 through May 31[t])
	Taxiway(s)	None
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	0
	Ground Transportation	None
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	Yes; Monthly
	Emergency Operations	Yes; Seasonal
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Highway and dense forest/Mountain ▪ South – Highway and dense forest/Mountain ▪ East – Highway and dense forest/Mountain ▪ West – Dense forest/Mountain

2.1.22 Swanson Field

Swanson Field is a public, non-NPIAS general aviation airport in the town of Eatonville, located on the Mashel River about 25 miles west of Mount Rainier. It is the nearest airport on the western slope of Mount Rainier. To capitalize on the airport's proximity to nearby recreational opportunities, the Town of Eatonville is drafting plans to implement a visitor shuttle service from the airport to Mount Rainier National Park. Swanson Field provides significant economic contributions to the town, with an estimated total impact of $639,000 reported in 2012. Other 2012 figures report that Swanson Field houses 22 single-engine aircraft, provides five full-time aviation jobs, and hosts approximately 5,579 annual operations. Operations and management at Swanson Field have been accomplished primarily by the donation of time, tools, and labor from the residents of Eatonville. Significant airport services at Swanson Field include Flight and Aircraft maintenance instruction with daily activities, weekly military operations (both air and ground) for military training for Army Active Duty, and weekly disaster relief and emergency management operations.

Figure 2-51. Swanson Field

Figure 2-52. Swanson Field Runway Protection Zones

Table 2-22. Swanson Field Airport Statistics

Airport Statistics	2017 Aircraft Operations	5,579 (as of 2011)
	2017 Based Aircraft	22 Single-Engine (as of 2011)
Airside	Runway(s)	16/34; 2,990 Ft; Asphalt
	Taxiway(s)	Unknown
	Apron	0 Sq Ft
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	Unknown
	Ground Transportation	None
	Business Park	Unknown
Hangar	Corporate	Unknown
	T-Hangar	0
	Condo	14
Aviation Services	Flight School/Instruction Activity	Yes; Daily
	Military Activity	Yes; Weekly
	Emergency Operations	Yes; Weekly
	Fuel Type	100 LL/ Jet A/ Mogas
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	Yes – Airframe piston, PP piston
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North- Residential/Forest ▪ South- Residential ▪ East- Residential ▪ West- Residential/Forest

2.1.23 American Lake Seaplane Base

American Lake SPB is a non-NPIAS general aviation seaplane base 7 miles south of Tacoma and is owned by the City of Lakewood. Key aviation activities include seasonal aircraft charters, aerial photography and tourism activities, and medical aircraft operations. American Lake SPB has an average of 700 aircraft operations per year, and its total economic contribution is approximately $721,000 annually. Although 15 single-engine seaplanes are based at the airport, there is no dry storage, fuel, or means to pull a seaplane out of the water or to launch a seaplane into the lake. Regardless, American Lake SPB provides a way to transport emergency supplies to the local community in case of a major incident or emergency.

Figure 2-53. American Lake Seaplane Base

Table 2-23. American Lake Seaplane Base Statistics

Airport Statistics	2017 Aircraft Operations	50
	2017 Based Aircraft	0
Airside	Runway(s)	Waterway 02W/20W; 5,500 feet; Water
	Taxiway(s)	N/A
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	0 Parking designated for American Lake SPB
	Ground Transportation	Yes – Taxi
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	No
	Emergency Operations	Yes; Seasonal
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	N/A
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential area ▪ South – Water (American Lake) and Silcox Island ▪ East – Residential area ▪ West – Residential area and forest

2.1.24 Darrington Municipal Airport

Darrington Municipal Airport is a non-NPIAS general aviation airport in the town of Darrington. The airport is implementing plans to offer an aviation program to further educate children in the community. The airport is working toward becoming a local hub for hosting daily student aviation classes, eventually offering pre-mechanic, pre-welding, and flight instruction classes as an effort to continue introducing community members into the aviation industry. Although constrained by the 35-mile distance from the Interstate 5 corridor, Darrington Municipal Airport is nestled in the foothills of the Cascade Mountains and is surrounded by leasable land. Most of the leasable land is toward the north end of the airport, while the town of Darrington is situated toward the south end. The airport owns 1,200 feet on the west end that is ready to be developed. The county has zoning regulations for height hazards around the airport.

Figure 2-54. Darrington Municipal Airport

Figure 2-55. Darrington Municipal Airport Runway Protection Zones

Table 2-24. Darrington Municipal Airport Statistics

Airport Statistics	2017 Aircraft Operations	2,310
	2017 Based Aircraft	11
Airside	Runway(s)	10/28; 2,491 feet; Asphalt
	Taxiway(s)	Full Parallel
	Apron	1.43 Acres
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	No on-site parking lot nearby
	Ground Transportation	Yes – Public Transit
	Business Park	No
Hangar	Corporate	0
	T-Hangar	0
	Condo	2
Aviation Services	Flight School/Instruction Activity	No
	Military Activity	Yes; Seasonal
	Emergency Operations	Yes; Seasonal
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	No De-Icing; No Chemical Pad
	Maintenance	None
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Forest ▪ South – Town ▪ East – Airport-owned undeveloped land and residential area ▪ West – Airport-owned undeveloped land and forest

2.1.25 Seattle Seaplanes SBP

Seattle Seaplanes Seaplane Base (Seattle Seaplanes SPB) is a non-NPIAS general aviation seaplane base at the southeast corner of Lake Union in Seattle. Kenmore Air Harbor SPB W55 is on the south point of Lake Union and utilizes a different waterway configuration than the Seattle Seaplanes SPB. For over 30 years, Seattle Seaplanes SPB has offered scenic flights around Western Washington and parts of Puget Sound. Currently, Seattle Seaplanes SPB offers charter flights and tours to Mount Rainier, Mount St. Helens, the San Juan Islands, and Victoria. Key activities also include providing private pilot training in a seaplane, where future pilots can complete a private pilot certificate in as little as 7 weeks with personalized training. Seattle Seaplanes SPB has been privately owned by Jim Chrysler for over 15 years. No information regarding economic impact is publicly available.

Figure 2-56. Seattle Seaplanes Seaplane Base

Table 2-25. Seattle Seaplanes Seaplane Base Statistics

Airport Statistics	2017 Aircraft Operations	Unknown
	2017 Based Aircraft	Unknown
Airside	Runway(s)	Waterway 18W/36W; 9,500 Ft; Water
	Taxiway(s)	N/A
	Apron	0
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	Privately Owned Lots Nearby
	Ground Transportation	Unknown
	Business Park	Unknown
Hangar	Corporate	0
	T-Hangar	0
	Condo	0
Aviation Services	Flight School/Instruction Activity	Unknown
	Military Activity	Unknown
	Emergency Operations	Unknown
	Fuel Type	Unknown
	Aircraft De-/Anti-Icing Services	Unknown
	Maintenance	Unknown
Land Use Compatibility	Runway Protection Zone	N/A
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North- Residential/ Commercial ▪ South- Residential/ Commercial ▪ East- Residential/ Interstate Highway ▪ West- Water (Lake Union)

aircraft

2.1.26 Shady Acres Airport

Shady Acres Airport is a privately owned, non-NPIAS general aviation airport in the city of Spanaway and is available for public use. Figures from 2008 indicate that 30 aircraft were based at Shady Acres Airport, including 28 single-engine aircraft and 2 multi-engine aircraft. No information regarding economic impact is publicly available, and current ownership of the airport could not be verified despite extensive internal efforts and research by WSDOT aviation contacts.

Figure 2-57. Shady Acres Airport

Figure 2-58. Shady Acres Airport Runway Protection Zones

Table 2-26. Shady Acres Airport Statistics

Airport Statistics	2017 Aircraft Operations	4,000 (as of 2008)
	2017 Based Aircraft	28 Single-Engine (as of 2008) 2 Multi-Engine (as of 2008)
Airside	Runway(s)	16/34; 1,800 Ft; Asphalt
	Taxiway(s)	None
	Apron	Unknown
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	Unknown
	Ground Transportation	Unknown
	Business Park	Unknown
Hangar	Corporate	Unknown
	T-Hangar	Unknown
	Condo	Unknown
Aviation Services	Flight School/Instruction Activity	Unknown
	Military Activity	Unknown
	Emergency Operations	Unknown
	Fuel Type	Unknown
	Aircraft De-/Anti-Icing Services	Unknown
	Maintenance	Unknown
Land Use Compatibility	Runway Protection Zone	Not Compliant – incompatible uses
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North- Residential/ Industrial ▪ South- Residential ▪ East- Residential ▪ West- Residential

2.1.27 First Air Field

First Air Field is privately owned, non-NPIAS general aviation facility available for public use and is 2 miles outside the city of Monroe. Daryl Habich is the owner and airport manager. Figures from 2012 indicate that First Air Field experiences approximately 18,169 annual aircraft operations and is home to 73 based aircraft, including 68 single-engine aircraft and 4 multi-engine, piston-powered aircraft. No information regarding economic impact is publicly available, aside from a WSDOT study conducted in 2001, which reported that First Air Field's total economic contributions were approximately $3.27 million annually, with approximately 50 jobs supported by both direct and indirect aviation activities.

Figure 2-59. First Air Field

Figure 2-60. First Air Field Runway Protection Zones

Table 2-27. First Air Field Airport Statistics

Airport Statistics	2017 Aircraft Operations	18,169 (as of 2008)
	2017 Based Aircraft	68 Single-Engine (as of 2008) 4 Multi-Engine (as of 2008) 1 Ultralight (as of 2008)
Airside	Runway(s)	7/25; 2,087 Ft; Asphalt
	Taxiway(s)	Partial Parallel
	Apron	Unknown
Terminal	Fixed-Base Operator (FBO)	0
Landside	Vehicle Parking	Unknown
	Ground Transportation	Unknown
	Business Park	Unknown
Hangar	Corporate	Unknown
	T-Hangar	Unknown
	Condo	Unknown
Aviation Services	Flight School/Instruction Activity	Unknown
	Military Activity	Unknown
	Emergency Operations	Unknown
	Fuel Type	None
	Aircraft De-/Anti-Icing Services	Unknown
	Maintenance	Unknown
Land Use Compatibility	Runway Protection Zone	Compliant
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North- Forest/ Residential ▪ South- Commercial ▪ East- Commercial/ Fair Ground ▪ West- Residential/ Commercial

2.1.28 McChord Field

McChord Field is a U.S. Air Force Base located in Pierce County. McChord Field is host to the 62nd Airlift Wing of the Air Force, which is composed of more than 7,200 active duty military and civilian personnel and tasked with supporting worldwide combat and humanitarian airlift contingencies. Original plans to establish this airfield date as far back as 1917. The McChord facility was consolidated with the U.S. Army's Fort Lewis on February 1, 2010, to become part of the Joint Base Lewis-McChord complex. This initiative was driven by the 2005 Defense Base Closure and Realignment Commission Report and is designed to combine current infrastructure into one maximizing war fighting capability, and operational and cost efficiency.

Both Gray Army Airfield and McChord Field bases serve as critical infrastructure that safeguard national security and are closed to the public. The bases contribute approximately $6.085 billion annually in economic impact to the region.

Figure 2-61. McChord Field

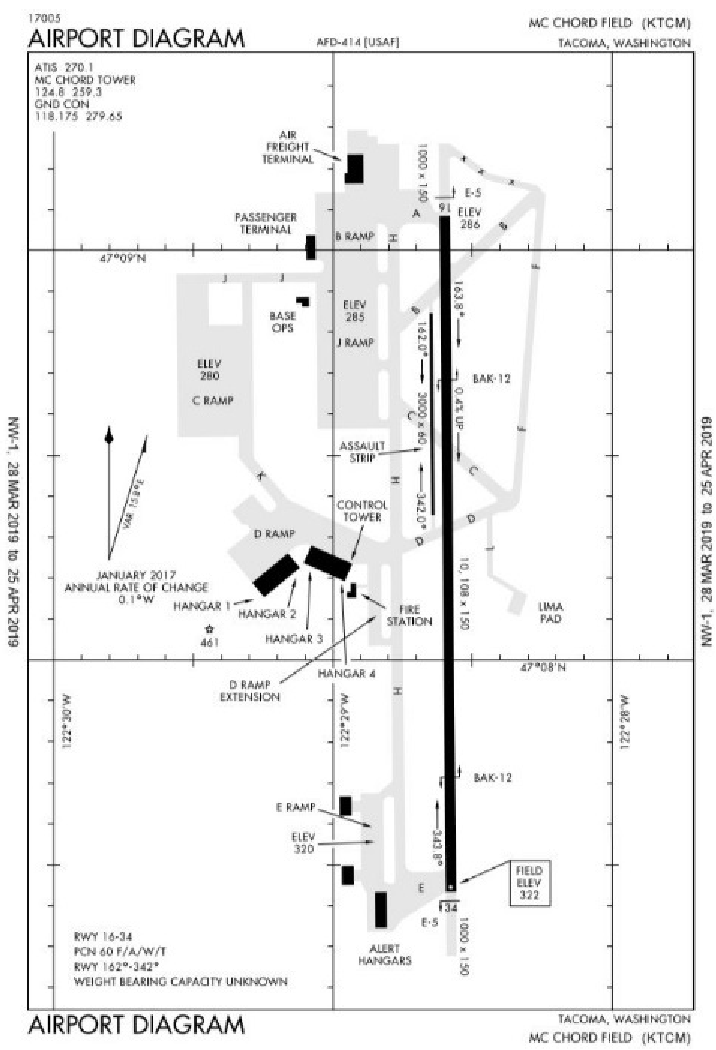


Figure 2-62. McChord Field Runway Clear Zones and Accident Potential Zones

Table 2-28. McChord Field Airport Statistics

Airport Statistics	2018 Aircraft Operations	24,503
	2018 Based Aircraft	42
	2018 Total Passengers	DoD PAX only
Airside	Runway(s)	16/34; 10,108 feet; Asphalt/Concrete
	Taxiway(s)	1 Full Parallel 2 Partial Parallel
Terminal	▪ Airlines ▪ Fixed-Base Operator	▪ No ▪ No
Landside	Vehicle Parking ▪ Public On-Airport ▪ Public Off-Airport ▪ Employee	 ▪ No ▪ No ▪ No
	Ground Transportation	No
	Business Park	No
Hangars	Airline Maintenance	No
	Cargo	No
	Corporate	No
	T-Hangar	No
	Condo	No
Aviation Services	Fuel Type	JP-8
	De-Icing/Chemical Pad	No
	Maintenance	Yes (Unit Aircraft Maintenance)
Land Use Compatibility*	Runway Protection Zone	▪ Rwy 16 RPZ: Fully Compliant ▪ Rwy 34 RPZ: public roadways and buildings
* An RPZ that is not compliant has incompatible land uses, which include public roadways, buildings, parking lots, and railroad tracks	Surrounding Land Use	▪ North – Commercial & Residential ▪ South – Military Reservation ▪ East – Residential ▪ West – Residential

2.1.29 Gray Army Airfield

Gray Army Airfield is operated by the U.S. Army and is part of the Joint Base Lewis-McChord. Gray Army Airfield resides at an elevation of 300 feet above mean sea level in Pierce County. Original plans to establish the airfield date as far back as 1921. During the 1990s, three aviation combat units served at Gray Army Airfield. These units carried out assistance missions such as firefighting and local disaster relief and would later serve in Iraq. Since 2005, the airfield has experienced major expansions with the activation of a Special Operations Aviation Battalion and a new complex. Gray Army Airfield also supports Fort Lewis and has provided U.S. Army helicopters for medical evacuations at Mount Rainier National Park on numerous occasions.

Both Gray Army Airfield and McChord Field bases serve as critical infrastructure that safeguard national security and are closed to the public. The bases contribute approximately $6.085 billion annually in economic impact to the region.

Figure 2-63. Gray Army Airfield

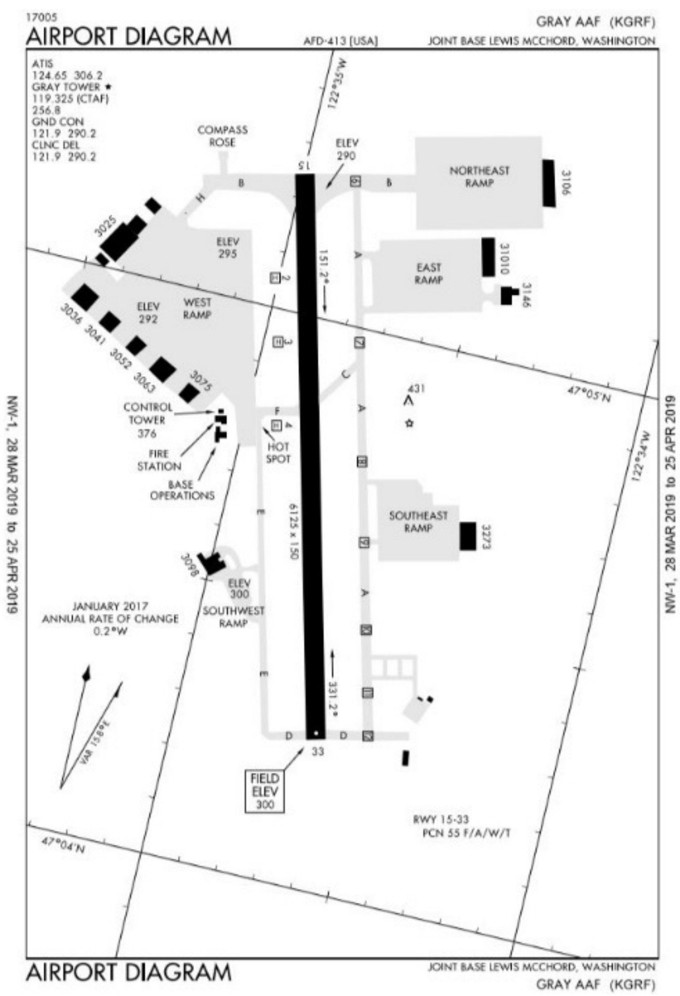


Figure 2-64. Gray Army Airfield Runway Clear Zone and Accident Potential Zone (APZ)

Table 2-29. Gray Army Airfield Airport Statistics

Airport Statistics	2018 Aircraft Operations	34,763
	2018 Based Aircraft	156
	2018 Total Passengers	0
Airside	Runway(s)	▪ 15-33; 6,125 feet; Asphalt
	Taxiway(s)	▪ Twy A: full-length parallel for Rwy 15-33 ▪ Twy E: partial-length parallel to Rwy 15-33
	Apron	117.4 Acres
Terminal	▪ Airlines ▪ Fixed-Base Operator	▪ No ▪ No
Landside	Vehicle Parking ▪ Public On-Airport ▪ Public Off-Airport ▪ Employee	 ▪ No ▪ No ▪ No
	Ground Transportation	No
	Business Park	No
Hangars	Airline Maintenance	No
	Cargo	No
	Transiplex	No
	Corporate	No
	T-Hangar	No
	Condo	No
Aviation Services	Fuel Type	F-24
	De-Icing/Chemical Pad	No
	Maintenance	Yes (Unit Aircraft Maintenance)
Land Use Compatibility	Runway Protection Zone	▪ Rwy 16R RPZ: public roadways ▪ Rwy 16C RPZ: public roadways ▪ Rwy 16L RPZ: public roadways ▪ Rwy 34L RPZ: public roadways, distribution center ▪ Rwy 34C RPZ: public roadways ▪ Rwy 34R RPZ: public roadways
	Surrounding Land Use (within ~500 feet of airport boundary)	▪ North – Residential ▪ South – Residential ▪ East – Residential ▪ West – Residential

Regional Aviation Baseline Study:
Working Paper 1

Chapter 3
Economic and Socioeconomic Context

June 12, 2019

Prepared for

Puget Sound Regional Council

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Contents

3. Economic and Socioeconomic Context ... 3-1
3.1 NATIONAL ECONOMIC TRENDS ... 3-1
3.1.1 Gross Domestic Product and Consumer Price Index ... 3-1
3.1.2 Unemployment ... 3-3
3.2 REGIONAL SOCIOECONOMIC TRENDS ... 3-3
3.2.1 Population ... 3-3
3.2.2 Employment ... 3-7
3.3 AEROSPACE MANUFACTURING SECTOR ... 3-13
3.3.1 Economic Overview ... 3-13
3.3.2 Key Firms ... 3-14
3.3.3 Aerospace Manufacturing Clusters ... 3-17
3.4 CONCLUSION ... 3-25

Tables

Table 3-1. Historical and Forecast Gross Real GDP and CPI for United States ... 3-2
Table 3-2. Population of Washington State and the Central Puget Sound Region ... 3-4
Table 3-3. Firms in Aerospace Sectors by Central Puget Sound Region County ... 3-15
Table 3-4. Employees in Aerospace Sectors by Central Puget Sound Region County ... 3-16
Table 3-5. Annual Sales Volume in Aerospace Sectors by Central Puget Sound Region County ($millions) ... 3-16
Table 3-6. Top 20 Firms in Aerospace Manufacturing ... 3-17

Figures

Figure 3-1. Historical Unemployment Rates by Quarter for United States ... 3-3
Figure 3-2. Population Distribution for Central Puget Sound Region Counties and Washington State ... 3-4
Figure 3-3. Comparison of Population Growth for Unites States, Washington State, and Central Puget Sound Region ... 3-5
Figure 3-4. Causes of Population Growth for Central Puget Sound Region, Washington State, and the United States ... 3-5
Figure 3-5. Causes of Population Growth for King County and Other Central Puget Sound Region Counties (2010–2017) ... 3-6
Figure 3-6. Birth and Death Rates for United States, Washington State, and Central Puget Sound Region (per 1,000 people) ... 3-6
Figure 3-7. Educational Attainment for the Population 25 Years and Older in the United States, Washington State, and Central Puget Sound Region ... 3-7
Figure 3-8. Total Nonfarm Employment Index for United States, Washington State, Central Puget Sound Region (year 2000 = 100) ... 3-8
Figure 3-9. Total Nonfarm Employment for Central Puget Sound Region (thousands) ... 3-9
Figure 3-10. Civilian Labor Force with Unemployment Rate for Central Puget Sound Region ... 3-9

Figure 3-11. Total and Employed Labor Force Index for United States, Washington State, and Central Puget Sound Region (year 2000 = 100) 3-10
Figure 3-12. Annual Average Unemployment Rate of Labor Force 16 Years and Over for United States, Washington State, and Central Puget Sound Region....3-10
Figure 3-13. Historical Per-Capita Personal Income for United States, Washington State, and Seattle-Tacoma-Bellevue, WA, MSA....3-11
Figure 3-14. Nonfarm Employment by Super Sector for Seattle-Tacoma-Bellevue, WA MSA (thousands)....3-12
Figure 3-15. Nonfarm Employment Share by Industry Sector for United States, Washington State, and Central Puget Sound Region....3-12
Figure 3-16. Boeing Employment in Washington State (1998 – 2018) 3-15
Figure 3-17. Map of Aerospace Manufacturers....3-18
Figure 3-18. Paine Field Cluster 3-19
Figure 3-19. Redmond Cluster 3-20
Figure 3-20 Duwamish Cluster....3-21
Figure 3-21. Map of Renton Municipal Airport....3-23
Figure 3-22. South Sound Cluster 3-24
Figure 3-23. Companies that Serve Aerospace Sector 3-26

Acronyms

CPI ....Consumer Price Index
GDP .... Gross Domestic Product
MSA....Metropolitan Statistical Area

3. Economic and Socioeconomic Context

Aviation is closely tied to economic trends at a national level as well as to the regional economy and demographics. This chapter describes national and regional economic and socioeconomic trends that influence the aviation in the Puget Sound region. This context is critical to understanding the specific trends and forecasts for each aviation sector in Chapters 4 through 6.

3.1 NATIONAL ECONOMIC TRENDS

This section describes national economic trends that have implications on aviation. It discusses recent changes in Gross Domestic Product (GDP), Consumer Price Index (CPI), and unemployment at the national level.

3.1.1 Gross Domestic Product and Consumer Price Index

Table 3-1 presents the historical and forecasted GDP and CPI for the United States. GDP is a measure of overall economic incomes and CPI is a measure of economic inflation (how the purchasing power of the dollar changes from year to year). Real GDP accounts for inflation by discounting dollar amounts to a base year, which is typically defined as 2009 following convention from the Federal Reserve. As shown in the table, real GDP increased at a compound annual growth rate of 2.1 percent from 2010 to 2017. This growth follows a decrease in GDP in 2008 and 2009 because of an economic recession (the Great Recession), which began in December 2007 and ended in June 2009.

Recovery from the Great Recession was slower than from other recessions that have occurred in the United States. Based on the data from the U.S. Federal Reserve Economic Data, many key economic indicators did not reach pre-Great Recession levels until late 2012 through mid-2014. For instance, real GDP per-capita and nonfarm employment did not reach pre-Great Recession levels until the fourth quarter of 2013 and May 2014, respectively. Because of the Great Recession, United States aviation activity, which is closely tied to the nation's economy, also did not reach pre-Great Recession levels until the same period.

Real GDP is estimated to have increased by 2.6 percent from 2017 to 2018 and is projected to increase at an average annual rate of 2.0 percent from 2018 to 2038, with year-over-year increases ranging from 1.8 to 2.1 percent from 2021 to 2038.

Table 3-1 also presents the CPI. CPI increased at an average annual rate of 1.7 percent from 2010 to 2017. CPI is projected to increase at an annual compound rate of 2.4 percent from 2018 to 2028. These projected increases in CPI follow the same pattern as the projected increases in GDP; however, they lag several years with the largest year-over-year increase (2.7 percent) anticipated to occur from 2019 to 2020 and 2020 to 2021. These anticipated changes in CPI are factored in the GDP forecasts.

Table 3-1. Historical and Forecast Gross Real GDP and CPI for United States

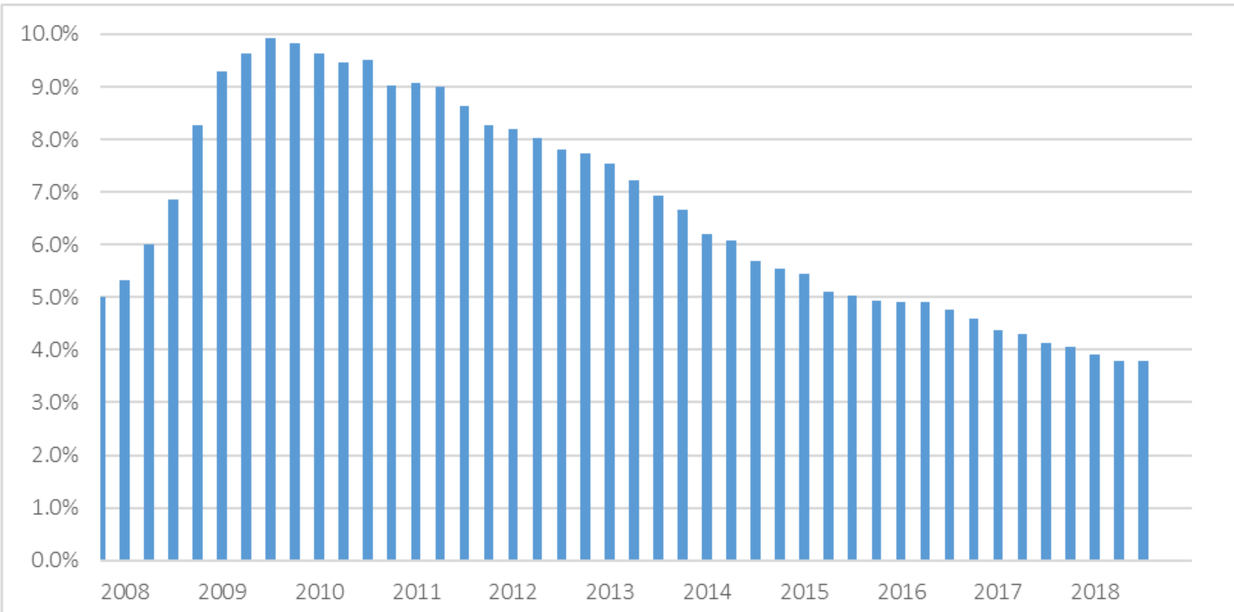
FEDERAL FISCAL YEAR	REAL GDP (BILLIONS 2009 $)	REAL GDP % CHANGE	CPI (1982-84=1.00)	CPI % CHANGE
Historical				
2010	14,684.5	1.8%	2.2	3.5%
2011	14,957.8	1.9%	2.2	2.6%
2012	15,306.1	2.3%	2.3	2.4%
2013	15,509.8	1.3%	2.3	1.6%
2014	15,906.7	2.6%	2.4	1.6%
2015	16,389.7	3.0%	2.4	0.3%
2016	16,640.2	1.5%	2.4	0.9%
2017	16,987.4	2.1%	2.4	2.1%
Forecast				
2018	17,432.9	2.6%	2.5	1.9%
2019	17,889.2	2.6%	2.5	1.7%
2020	18,280.1	2.2%	2.6	2.7%
2021	18,610.7	1.8%	2.7	2.7%
2022	18,972.0	1.9%	2.7	2.4%
2023	19,343.5	2.0%	2.8	2.4%
2024	19714.2	1.9%	2.9	2.5%
2025	20,078.9	1.8%	2.9	2.5%
2026	20,443.0	1.8%	3.0	2.5%
2027	20,809.1	1.8%	3.1	2.5%
2028	21,188.4	1.8%	3.2	2.5%
2029	21,598.9	1.9%	3.2	2.6%
2030	22,025.6	2.0%	3.3	2.5%
2031	22,471.4	2.0%	3.4	2.5%
2032	22,920.5	2.0%	3.5	2.4%
2033	23,379.1	2.0%	3.6	2.4%
2034	23,863.7	2.1%	3.7	2.4%
2035	24,334.2	2.0%	3.7	2.4%
2036	24,822.0	2.0%	3.8	2.4%
2037	25,324.5	2.0%	3.9	2.4%
2038	25,839.8	2.0%	4.0	2.4%
COMPOUND ANNUAL GROWTH RATE				
2010-17	2.1%		1.7%	
2017-18	2.6%		1.9%	
2018-28	2.0%		2.4%	
2018-38	2.0%		2.4%	

Source: IHS Global Insight, via Federal Aviation Administration Aerospace Forecasts

3.1.2 Unemployment

As can be seen in Figure 3-1, unemployment nationwide increased significantly during the Great Recession, reaching almost 10 percent late 2009. Given the nature of the recession and its magnitude, the recovery has been slower than previous recessions, causing the unemployment rate to improve at a slower rate, and only reaching pre-recession levels until the fourth quarter of 2015, eight years after the Great Recession began.

Figure 3-1. Historical Unemployment Rates by Quarter for United States



Source: US Bureau of Labor Statistics

3.2 REGIONAL SOCIOECONOMIC TRENDS

This section describes population and employment trends in the central Puget Sound region and compares these trends to the state and national level. The population trends covered are population growth and educational attainment.

3.2.1 Population

As the population in a region increases, so does the number of workers and consumers. This leads population growth to be closely related to GDP growth. Population growth also tends to increase the demand for travel across all modes of transportation, including air. As is described below, the central Puget Sound region has experienced steady growth in population, from both natural causes (births minus deaths) and domestic and international migration.

3.2.1.1 CURRENT POPULATION

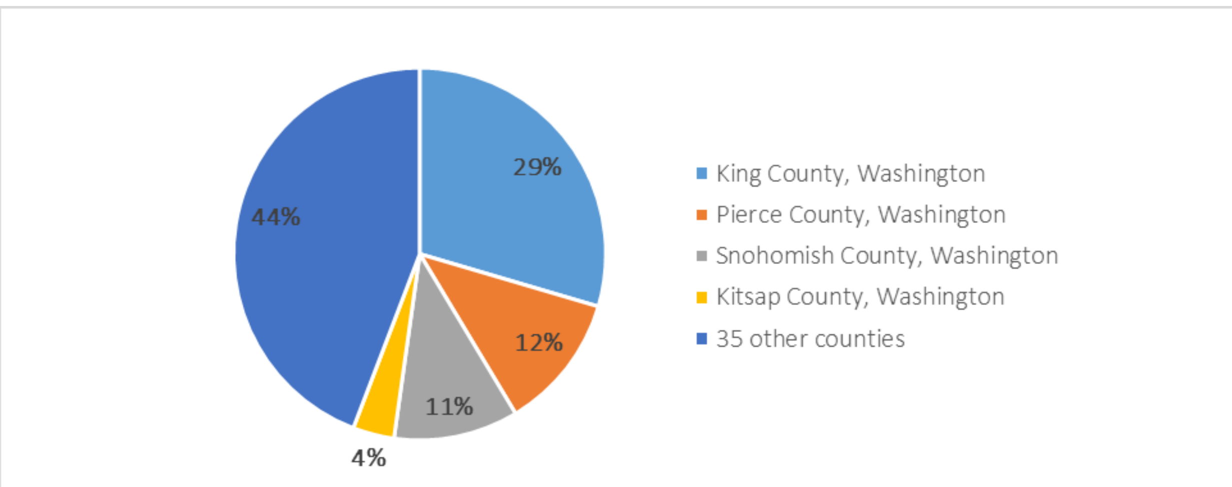
The four Washington counties that make up the central Puget Sound region are King, Pierce, Snohomish, and Kitsap. Together these counties encompass more than half the state population (Table 3-2 and Figure 3-2). King County is home to the most populous city, Seattle, and is the most populous county in the state (approximately 29 percent of the state's population) with more than two million residents. The three other counties in the region rank second (Pierce), third (Snohomish), and seventh (Kitsap) in population statewide.

Table 3-2. Population of Washington State and the Central Puget Sound Region

GEOGRAPHY	POPULATION	SHARE OF STATE POPULATION	STATE POPULATION RANK
Washington	**7,405,743**		
Central Puget Sound Region Counties	**4,133,460**	**56%**	
King County	2,188,649	29%	#1
Pierce County	876,764	12%	#2
Snohomish County	801,633	11%	#3
Kitsap County	266,414	4%	#7

Source: U.S. Census Bureau, 2017 American Community Survey 1-year Estimates.

Figure 3-2. Population Distribution for Central Puget Sound Region Counties and Washington State



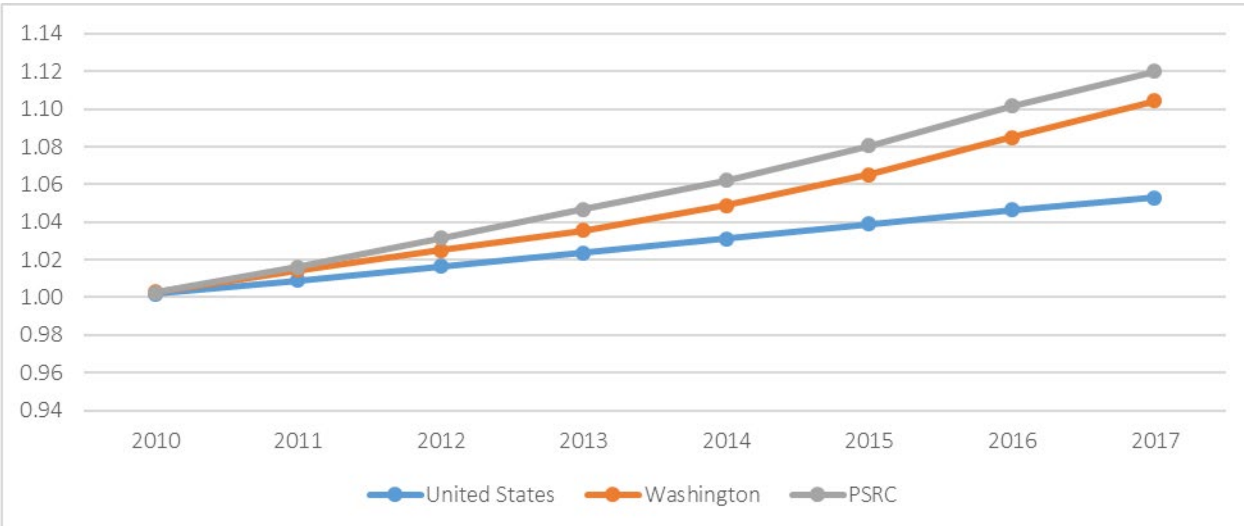
Source: US Census Bureau, 2017 American Community Survey 1-year Estimates.
Note: Percentages are rounded to the nearest whole number.

The Seattle-Tacoma-Bellevue, WA Metropolitan Statistical Area (MSA) consists of the three most populous of the four central Puget Sound counties: King, Pierce, and Snohomish. The U.S. Census Bureau estimates it was the 15th largest MSA in 2017. Estimates from the U.S. Census Bureau report that in 2017 the Seattle-Tacoma-Bellevue, WA, MSA was sixth in population increase from 2016 to 2017, with approximately 64,386 residents added in one year.

3.2.1.2 POPULATION GROWTH TRENDS

From 2010 to 2017, the four central Puget Sound counties grew at a faster rate than the Washington state and the United States (Figure 3-3). The population growth trend of Washington state more closely resembles the trend of the central Puget Sound counties than the entire United States.

Figure 3-3. Comparison of Population Growth for United States, Washington State, and Central Puget Sound Region

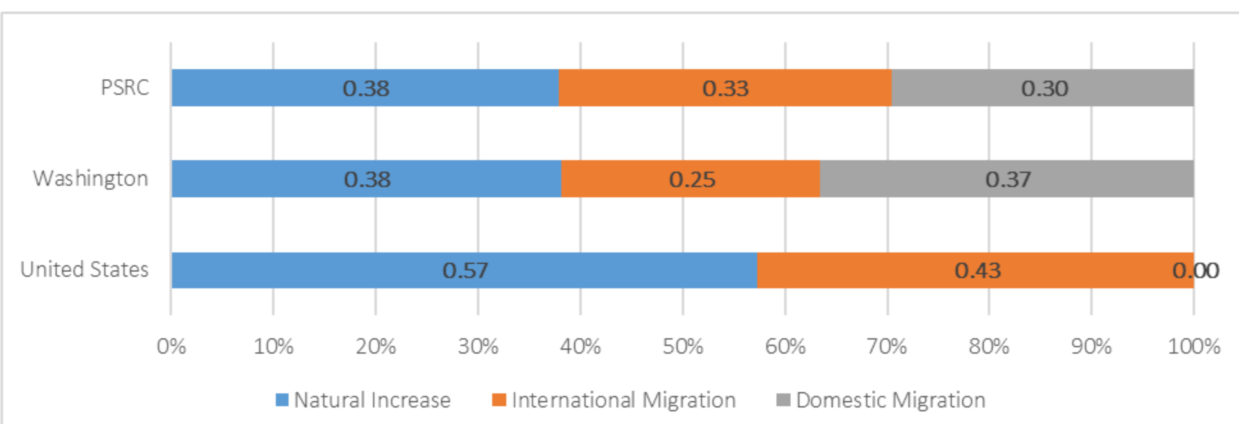


Source: U.S. Census Bureau, Annual Estimates of the Resident Population: April 1, 2010, to July 1, 2017

3.2.1.3 CAUSE OF POPULATION GROWTH

International migration is a larger cause of population growth in the central Puget Sound region than in Washington state (Figure 3-4). In contrast, domestic migration is a larger cause of growth at the state level. The share of natural increase (births minus deaths) is similar in both geographies.

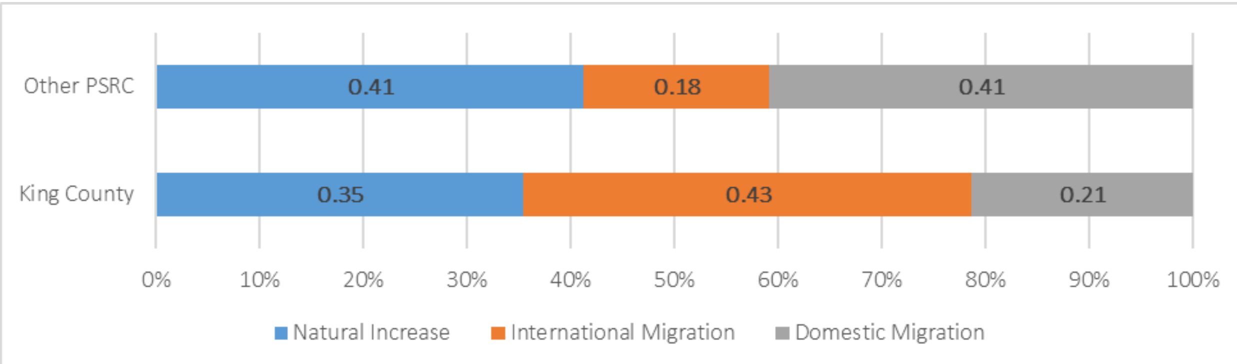
Figure 3-4. Causes of Population Growth for Central Puget Sound Region, Washington State, and the United States



Source: U.S. Census Bureau, Cumulative Estimates of the Components of Population Change: April 1, 2010 to July 1, 2017

The large share of international migration in central Puget Sound counties is attributed largely to King County. International migration represents 43 percent of King County's population growth, while this share among the three other central Puget Sound counties (Pierce, Snohomish, and Kitsap) is smaller than that of Washington state (Figure 3-5). Seattle, like other regional population and economic centers in the United States, is home to ethnic and international enclaves. However, growth in the three other central Puget Sound counties together is less attributable to international migration than in Washington state as a whole.

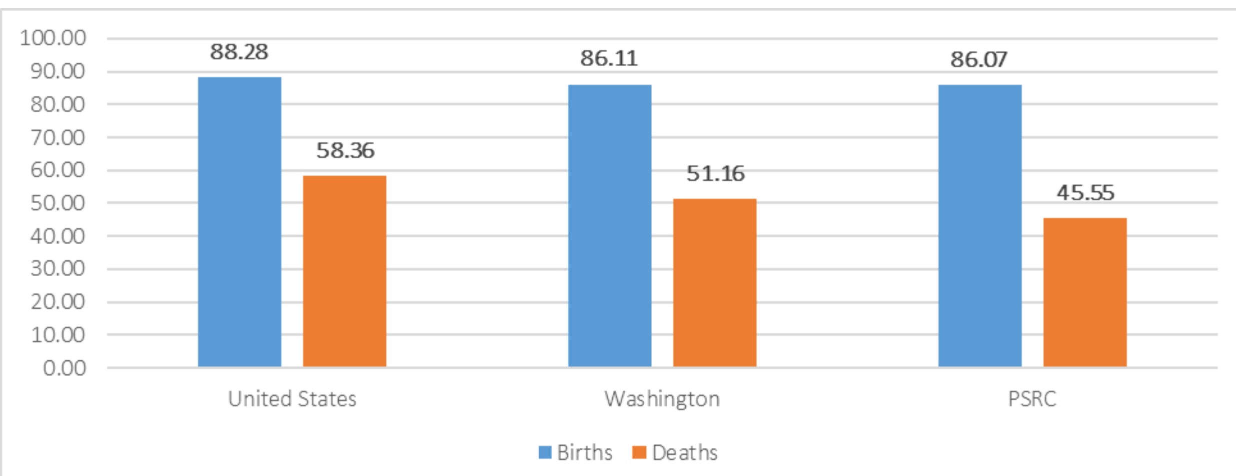
Figure 3-5. Causes of Population Growth for King County and Other Central Puget Sound Region Counties (2010–2017)



Source: U.S. Census Bureau, Cumulative Estimates of the Components of Population Change: April 1, 2010 to July 1, 2017

Birth rates are similar at the Washington state and central Puget Sound scales, and only slightly higher at the national scale (Figure 3-6). Death rates vary more at these three geographic levels, because they are lowest in central Puget Sound counties and highest nationwide with Washington state in-between.

Figure 3-6. Birth and Death Rates for United States, Washington State, and Central Puget Sound Region (per 1,000 people)

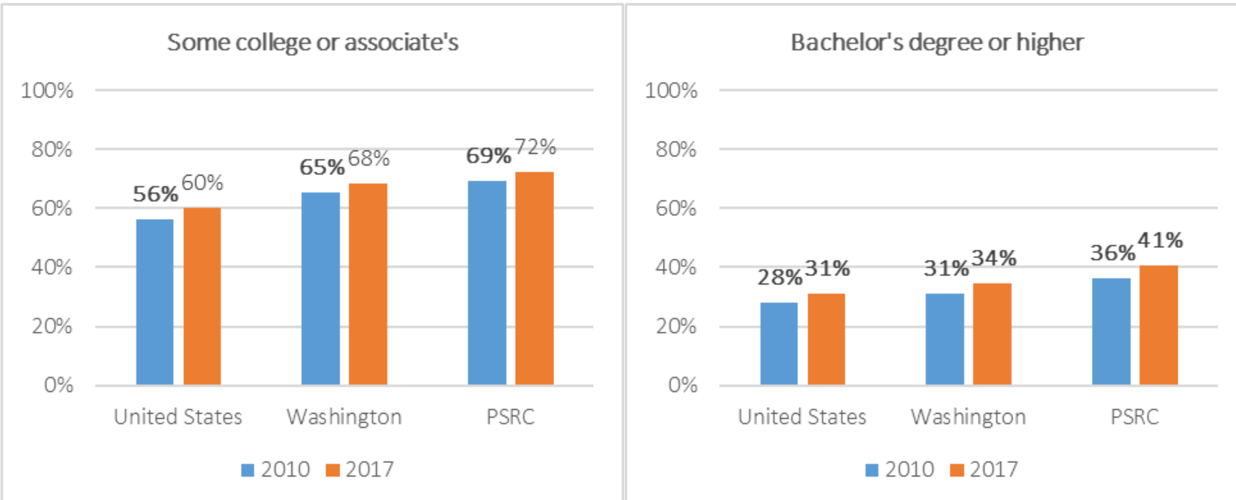


Source: U.S. Census Bureau, Cumulative Estimates of the Components of Population Change: April 1, 2010 to July 1, 2017

3.2.1.4 EDUCATIONAL ATTAINMENT

Educational attainment in terms of degrees awarded is greater in the central Puget Sound counties than statewide, which is higher than national rates (Figure 3-7). This relationship is true for attending some college as well as earning a bachelor's degree or higher. The shares of the population with at least some college attendance and with bachelor's degrees increased from 2010 to 2017 at each of these geographic levels.

Figure 3-7. Educational Attainment for the Population 25 Years and Older in the United States, Washington State, and Central Puget Sound Region



Source: U.S. Census Bureau, 2006-2010 and 2013-2017 American Community Survey 5-year Estimates

3.2.2 Employment

This section presents employment trends of the central Puget Sound region and offers a comparison to the state and national scale. Trends discussed include large employers, employment rate, labor force size, per-capita income, and industry sectors.

3.2.2.1 LABOR MARKET

A growing labor market leads to economic prosperity in a region, which will have a positive effect on air travel demand. Higher levels of employment and potentially higher median incomes mean residents have more disposable income and are more likely travel by air. Additionally, when the labor market expands to include an increased and diversified portfolio of industries, there are more reasons for business travel to the region.

The services sector is a major driver to the central Puget Sound region's job growth, and is by far the sector with the largest growth. The sector includes jobs related to information technology, business services, recreation and food services, and others.

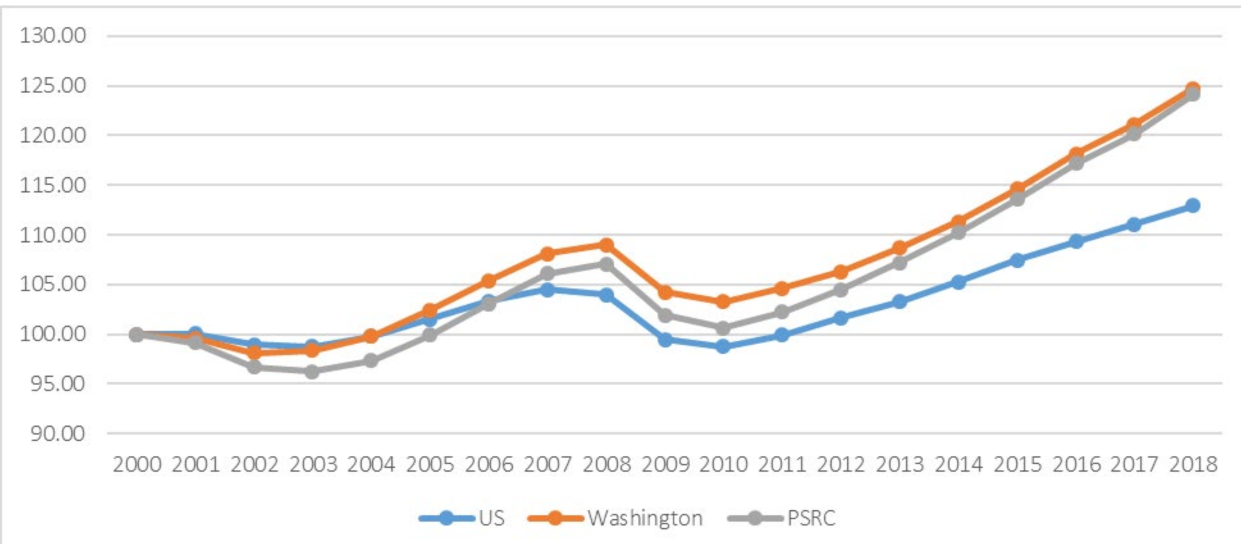
3.2.2.2 LARGEST EMPLOYERS IN THE CENTRAL PUGET SOUND REGION

The Boeing Company is the largest employer in the central Puget Sound region, with over 70,000 employees statewide as of 2019[1]. Boeing is followed in employee count by Joint Base Lewis-McChord with approximately 54,000. This count, however, includes active duty, civilian, and National Guard personnel. Two of the world's most valuable companies—Amazon.com Inc. and Microsoft Corporation—are headquartered in the region and each employ close to 50,000 people statewide.[2] The fifth largest employer in the region is the University of Washington, with approximately 25,000 employees.

3.2.2.3 TOTAL NONFARM EMPLOYMENT

Total nonfarm employment, like other economic metrics, was negatively affected by the Great Recession. The central Puget Sound region and Washington state experienced similar nonfarm employment growth rates since the mid-2000s that exceeded growth at the national scale. Figure 3-8 shows the rapid growth of nonfarm employment in Washington region and the central Puget Sound region relative to growth at the national scale.

Figure 3-8. Total Nonfarm Employment Index for United States, Washington State, Central Puget Sound Region (year 2000 = 100)

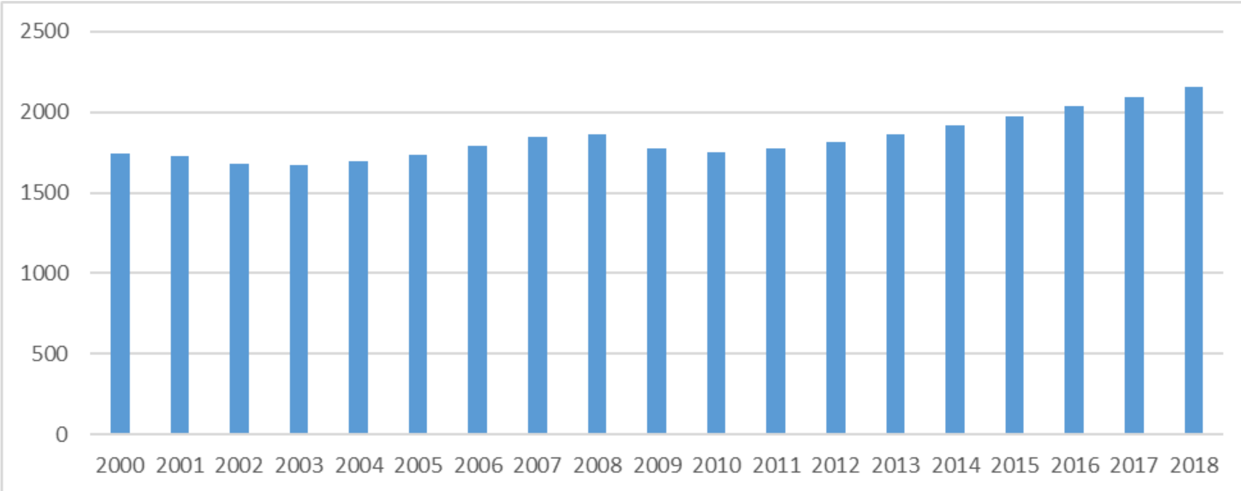


Source: U.S. Bureau of Labor Statistics, 2019

Figure 3-9 shows total nonfarm employment growth (in thousands) in the central Puget Sound region since 2000. The region experienced a decrease in total employment from 2000 to 2003 and again from 2008 to 2010 during the Great Recession. Growth occurred from 2003 to 2008 and from 2010 through 2018.

[1] https://www.boeing.com/company/general-info/index.page#/employment-data
[2] https://www.bizjournals.com/seattle/subscriber-only/2018/06/15/largest-employers.html

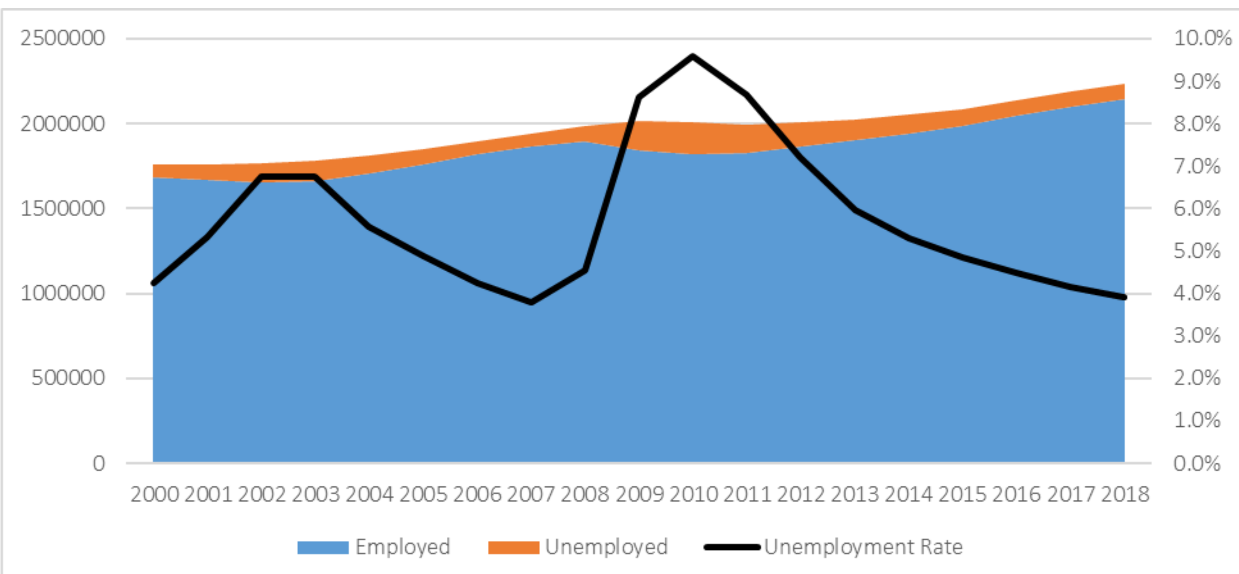
Figure 3-9. Total Nonfarm Employment for Central Puget Sound Region (thousands)



Source: U.S. Bureau of Labor Statistics, 2019

Figure 3-10 shows the total size of the employed and unemployed labor force in the central Puget Sound region overlaid on the unemployment rate. While the unemployment rate rose steeply from 2008 to 2010 and declined gradually afterward, the size of the labor force remained constant throughout the Great Recession before returning to growth.

Figure 3-10. Civilian Labor Force with Unemployment Rate for Central Puget Sound Region

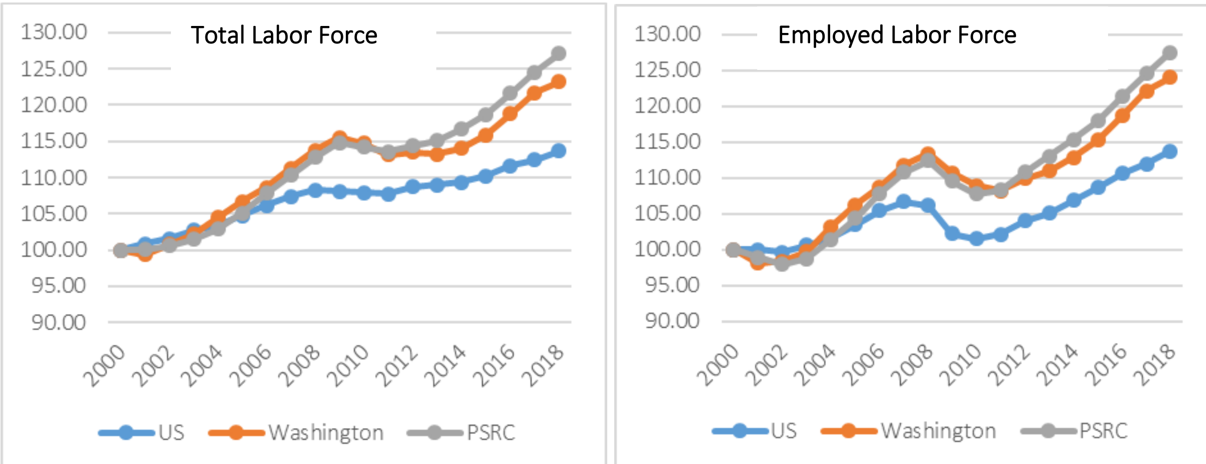


Source: U.S. Bureau of Labor Statistics, 2019

3.2.2.4 LABOR FORCE

The labor force tends to grow at the regional, state, and national scale, and drop during recessions. Labor force growth in Washington state and the central Puget Sound region were similar before and during the Great Recession; however, the central Puget Sound region was quicker to recover and continues to trend at a faster rate. Figure 3-11 are indexes of the total and employed labor force, respectively, where the values at year 2000 are equal to 100.

Figure 3-11. Total and Employed Labor Force Index for United States, Washington State, and Central Puget Sound Region (year 2000 = 100)

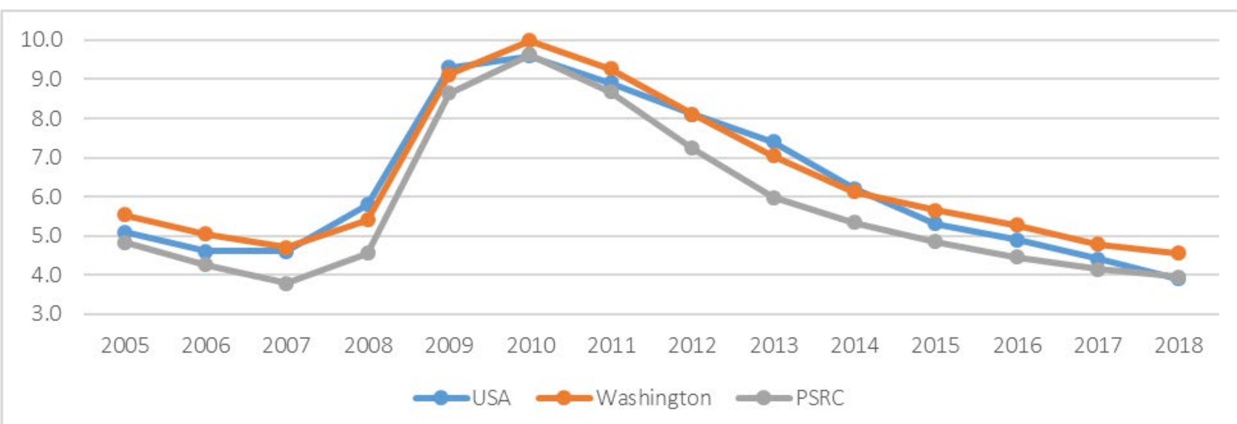


Source: U.S. Bureau of Labor Statistics, 2019

3.2.2.5 UNEMPLOYMENT RATE

The Great Recession quickly took a toll on employment at the regional, state, and national scales. Annual unemployment rates peaked in 2010 and have recovered each year since, approaching or surpassing pre-recession levels in the past couple of years (Figure 3-12).

Figure 3-12. Annual Average Unemployment Rate of Labor Force 16 Years and Over for United States, Washington State, and Central Puget Sound Region



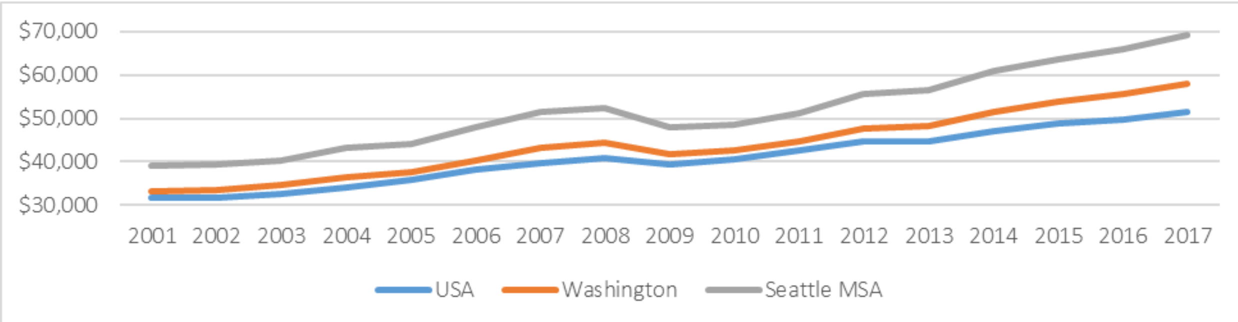
Source: U.S. Bureau of Labor Statistics, 2019

3.2.2.6 PER-CAPITA INCOME

The Seattle-Tacoma-Bellevue, WA, MSA consistently has a higher per-capita income than that of Washington state and the rest of the country (Figure 3-13). The per-capita income of Washington state in 2017 was $57,896, which was closer to the national average of $51,631 than it was to the MSA average of

$69,214. The Great Recession negatively affected income at all three geographic levels, although the trend was generally upward.

Figure 3-13. Historical Per-Capita Personal Income for United States, Washington State, and Seattle-Tacoma-Bellevue, WA, MSA



Source: Federal Reserve Bank of St. Louis, 2018
Note: Seattle-Tacoma-Bellevue MSA does not include Kitsap County.

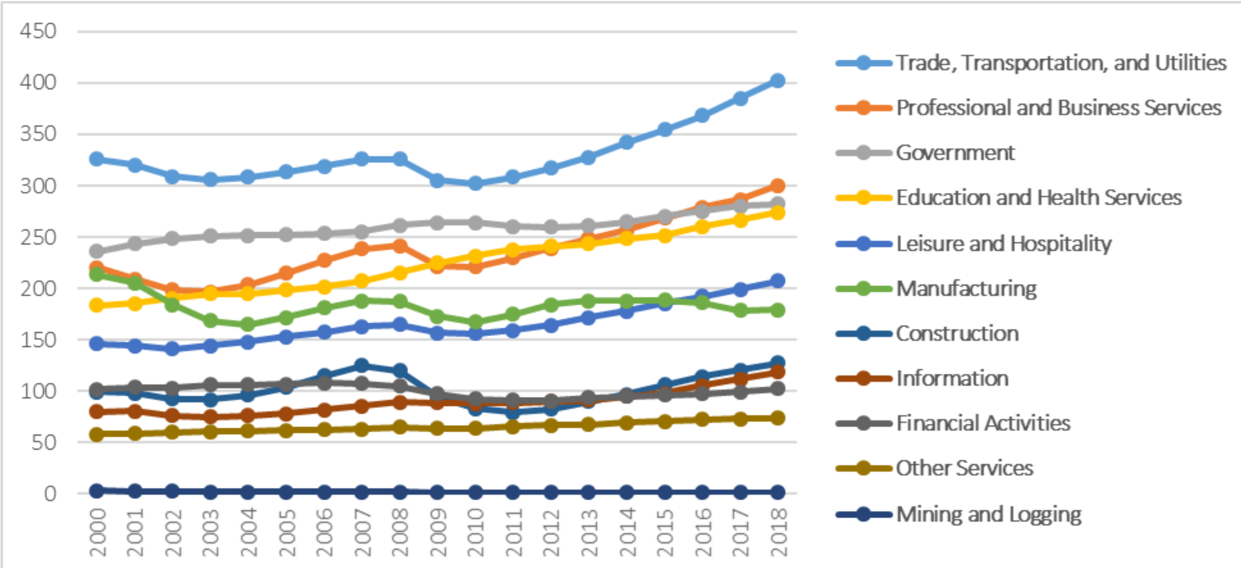
3.2.2.7 NONFARM EMPLOYMENT BY SECTOR IN THE SEATTLE-TACOMA-BELLEVUE, WA MSA

Complete sector data is available for the Seattle-Tacoma-Bellevue, WAMSA, which excludes only Kitsap County from the central Puget Sound region. The five largest sectors in the Seattle-Tacoma-Bellevue, WA MSA based on share of total nonfarm employment are the following:

- Trade, Transportation, and Utilities .... 19.5 percent
- Professional and Business Services .... 14.5 percent
- Government (Non-Military) .... 13.6 percent
- Education and Health Services .... 13.3 percent
- Leisure and Hospitality .... 10.0 percent

Not only is the Trade Transportation, and Utilities sector the largest in the Seattle-Tacoma-Bellevue, WA MSA, it has grown the most in employment since the end of the Great Recession. Professional and Business Services climbed from fourth largest to second largest between 2010 and 2018, as Seattle experienced a renaissance of corporate office growth with major technology sector companies like Amazon. Although Washington state is one of the largest producers of forest products, mining and logging combined account for only approximately 1,100 jobs in the MSA.

Figure 3-14. Nonfarm Employment by Super Sector for Seattle-Tacoma-Bellevue, WA MSA (thousands)

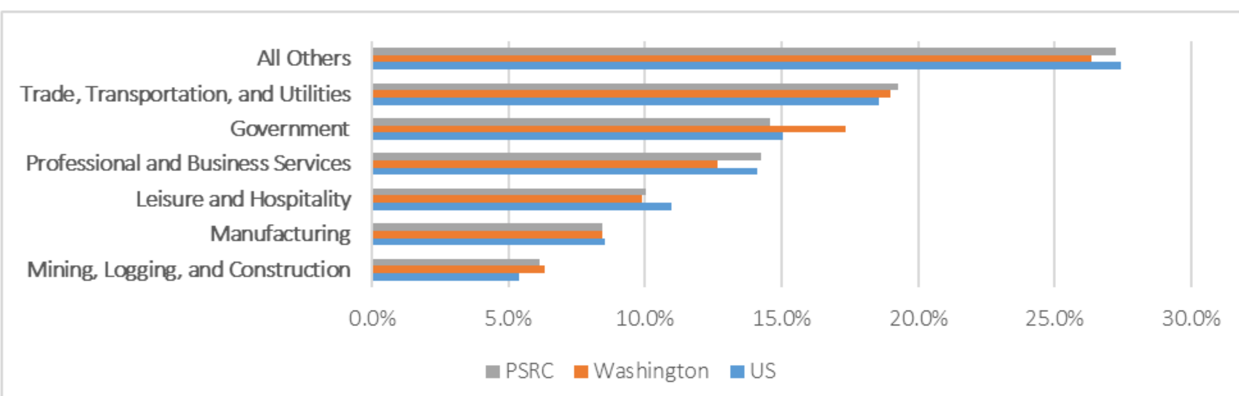


Source: U.S. Bureau of Labor Statistics, 2019
Note: Seattle-Tacoma-Bellevue, WA, MSA does not include Kitsap County.

3.2.2.8 NONFARM EMPLOYMENT BY INDUSTRY SECTOR

Nonfarm employment data was not available for the Bremerton-Silverdale, WA MSA (Bremerton MSA) for the following sectors: Education and Health Services, Financial Activities, Information, and Other Services. Additionally, the Mining and Logging sector and Construction sector are combined for the Bremerton MSA but not for other geographies. Figure 3-15 compares employment in the six sectors for which data was available for the Bremerton MSA, which are each smaller than the share of employment not attributable to a sector.

Figure 3-15. Nonfarm Employment Share by Industry Sector for United States, Washington State, and Central Puget Sound Region



Source: U.S. Bureau of Labor Statistics, 2019
Note: "All Others" includes Education and Health Services, Financial Activities, Information, and Other Services

3.3 AEROSPACE MANUFACTURING SECTOR

The central Puget Sound region is home to the largest cluster of aerospace manufacturing anywhere in the world. As such, the sector drives a significant portion of the economy. In addition, the aerospace industry has a unique interdependence with other aviation sectors, such as air cargo. Finally, portions of the manufacturing process, final assembly and testing, depend on airport locations in the region. Because of these interrelationships, this section explores the aerospace manufacturing industry in the central Puget Sound region in greater detail.

3.3.1 Economic Overview

The aerospace industry in the central Puget Sound region plays a key role in the regional economy, as a significant employer, a contributor to local and state tax bases, and an innovator in the fields of aeronautical technology and advanced manufacturing. The Boeing Corporation, the largest employer in the industry, with three main production and development facilities, serves as the foundation for hundreds of local firms supplying parts, materials, qualified labor, and production services in the central Puget Sound Region (King, Pierce, Snohomish and Kitsap Counties). The aerospace manufacturing industry is concentrated in four clusters: the Paine Field Cluster, the Sea-Tac Cluster, the Redmond Cluster, and the South Sound Cluster (described in greater detail below). Firms in these clusters manufacture aircraft components, navigation systems, engines and engine parts, and provide services to develop and produce aerospace vehicles. The Sea-Tac Cluster also provides services for civilian commercial airline operations.

The aerospace manufacturing sector in the central Puget Sound region is ranked as the largest concentration of aerospace vehicles and defense industry by employment in the nation.[3] Based on projections by the Washington State Employment Security Department, the employment in aerospace manufacturing will reach just below 80,000 in 2019 for Pierce, King and Snohomish Counties.[4] The concentration of the aerospace industry in the central Puget Sound region is over 11 times higher than the national average.[5] As a neighbor to global information technology giants such as Microsoft, Amazon and Google, Boeing has a proven record of innovation with over 3,600 patents submitted since 2000.[6] To support the labor needs of the aerospace manufacturing sector, several regional educational institutions provide technical courses in high schools and colleges and apprenticeship programs, such as the Aerospace Joint Apprenticeship Committee.

The impact of the aerospace industry and manufacturing sector can be measured in total labor income, retail sales, business and occupation tax revenues, and total sales receipts. Due to the demands on highly skilled labor, aerospace manufacturing supports an average annual wage of approximately $72,000 per

3 US Cluster Mapping, Seattle-Bellevue-Tacoma MSA, Aerospace Vehicles and Defense. https://clustermapping.us/region-cluster/aerospace_vehicles_and_defense/msa/seattle_tacoma_bellevue_wa

4 Washington State Employment Security Department. Short-term Industry Projections. https://esd.wa.gov/labormarketinfo/projections

5 US Cluster Mapping, Seattle-Bellevue-Tacoma MSA, Aerospace Vehicles and Defense. https://clustermapping.us/region-cluster/aerospace_vehicles_and_defense/msa/seattle_tacoma_bellevue_wa

6 US Cluster Mapping, Seattle-Bellevue-Tacoma MSA, Aerospace Vehicles and Defense. https://clustermapping.us/region-cluster/aerospace_vehicles_and_defense/msa/seattle_tacoma_bellevue_wa

employee. At the employment levels projected by the Washington State Employment Security Department, the direct labor income for regional aerospace manufacturing employees will be equal to $5.7 billion in 2019. In addition to directly supporting local communities through high-paying jobs, the aerospace manufacturing industry provides important local and state tax revenues for public programs and services. In 2017, the industry in the central Puget Sound region paid over $190 million in taxes on approximately $65 billion in sales revenue.[7]

3.3.2 Key Firms

3.3.2.1 BOEING

The Boeing Company, founded in 1916, is the largest private employer in Washington state with nearly 70,000 employees as of February 2019[8] and is the world's largest aerospace company. Although Boeing's corporate headquarters relocated from Seattle to Chicago in 2001, the central Puget Sound region remains the headquarters of the Commercial Airplanes division, as well as Boeing Capital Corporation.

As can be seen in Figure 3-16, Boeing's employment in the region has fluctuated considerably over the years. From 1998 to 2004, employment was almost halved, bottoming out at 53,000. This reduction was precipitated by the economic recession of the early 2000s; however, it continued a trend moving activity away from the region that started before. Employment at Boeing increased from 2004 to 2012, peaking at 86,500. The Great Recession had a negative impact on employment in 2009 and 2010; however, growth resumed in 2011. Since 2012, employment at Boeing in the region has been decreasing steadily, because Boeing has decided to shift production capacity to lower cost areas of the country, such as South Carolina.

A 2015 Commercial Revalue of all Boeing properties by the King County Department of Assessments identified 139 tax parcels valued at more than $1.2 billion.[9] The Snohomish County Assessor's Office assessed Boeing property at over $3.3 billion in its 2017 Consolidated Annual Financial Report, over 3 percent of the county's total taxable assessed value.[10]

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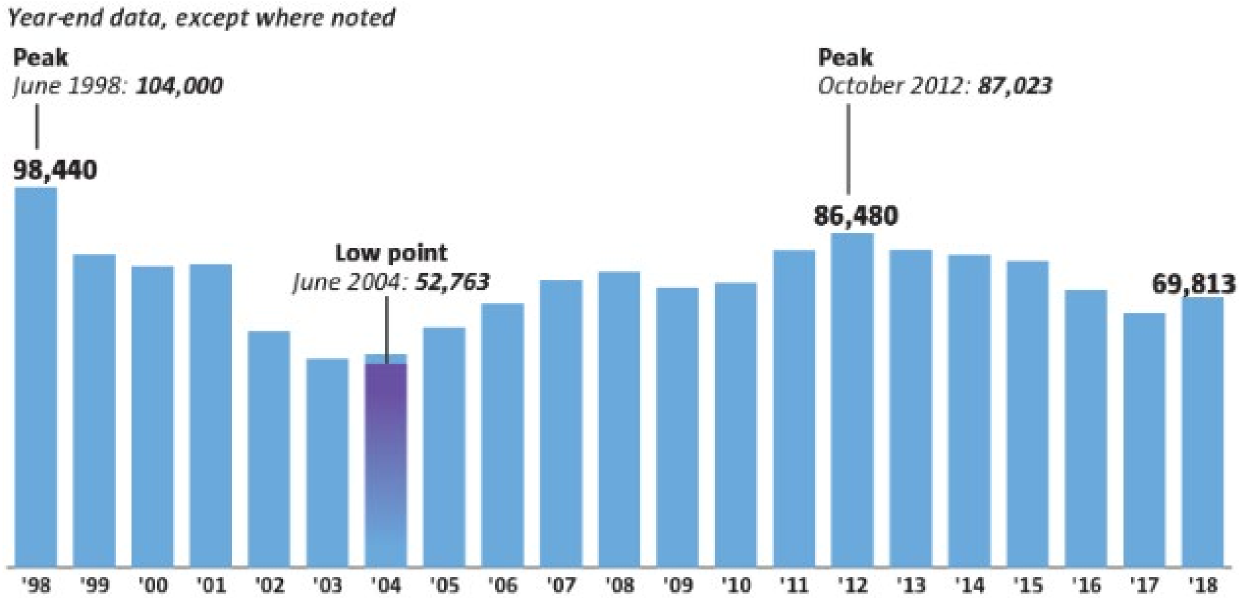
[7] Washington State Department of Revenue. https://dor.wa.gov/about/statistics-reports/detailed-tax-data-industry-and-tax-classfication

[8] https://www.boeing.com/company/general-info/index.page#/employment-data

[9] https://www.kingcounty.gov/depts/assessor/Reports/area-reports/2015/~/media/depts/Assessor/documents/AreaReports/2015/Commercial/625.ashx

[10] https://snohomishcountywa.gov/ArchiveCenter/ViewFile/Item/6030

Figure 3-16. Boeing Employment in Washington State (1998 – 2018)



Source: The Seattle Times

3.3.2.2 OTHER FIRMS

Information about other aerospace firms was obtained by analyzing records from the InfoUSA database. InfoUSA maintains a comprehensive record of companies around the U.S. in different sectors of the economy. For every company, this database describes its location, industry (6-digit SIC code), size (employees, estimate of sales volume, and square-footage), and other information. This database was queried to identify firms that operate in the aerospace sector, either in manufacturing or providing services. Other manufacturers that often provide products for the aerospace sector (such as electronic components and part fabricators) were also identified. As can be seen Table 3-3, this resulted in hundreds of firms in these industries.

Table 3-3. Firms in Aerospace Sectors by Central Puget Sound Region County

INDUSTRY TYPE	COUNTY				TOTAL
	KING	KITSAP	PIERCE	SNOHOMISH	
Aerospace Manufacturers	67	1	10	43	**121**
Aerospace Services	16	4	3	4	**27**
Air Cargo Services	19	-	5	-	**24**
Airline Companies	32	2	2	6	**42**
Airport Services	14	1	2	8	**25**
Airport Suppliers	1	-	1	-	**2**
Other Manufacturers Potentially Serving Aerospace	444	25	126	219	**814**

Source: InfoUSA data, limited coverage of Boeing's operations, estimates are approximate

The focus of this section will be on exploring aerospace manufacturers specifically, however interactions with firms in other sectors are also explored. This section focuses on firms other than Boeing, because the InfoUSA data provides a limited coverage of Boeing's operations in the Seattle region given that it spans multiple locations across many functions. Half of the employment estimates come from company interviews and the rest are modeled. Annual sales volume is modeled by InfoUSA using data from the U.S. Department of Commerce on the average sales per employee by county for each 6-digit NAICS code. Area estimates are modeled. This data represents a useful way to describe in approximate terms the size and location of firms that otherwise would be difficult to identify and quantify.

The number of employees can be used for a proxy of the amount of economic activity occurring at each of these firm. Table 3-4 shows that manufacturing employment is concentrated in King County, particularly in the aerospace sector, which is mirrored in the annual sales volume data (Table 3-5).

Table 3-4. Employees in Aerospace Sectors by Central Puget Sound Region County

INDUSTRY TYPE	COUNTY				TOTAL
	KING	KITSAP	PIERCE	SNOHOMISH	
Aerospace Manufacturers	11,134	10	440	2,094	**13,678**
Aerospace Services	426	10	9	25	**470**
Air Cargo Services	367	—	28	—	**395**
Airline Companies	24,402	12	4	44	**24,462**
Airport Services	2,010	1	13	75	**2,099**
Airport Suppliers	1	—	35	—	**36**
Other Manufacturers Potentially Serving Aerospace	26,524	151	2,483	7,871	**37,029**

Source: InfoUSA. Limited coverage of Boeing's operations.

Table 3-5. Annual Sales Volume in Aerospace Sectors by Central Puget Sound Region County ($millions)

INDUSTRY TYPE	COUNTY				TOTAL
	KING	KITSAP	PIERCE	SNOHOMISH	
Aerospace Manufacturers	4,010	5	179	544	**4,738**
Aerospace Services	152	1	1	3	**157**
Air Cargo Services	229	—	17	—	**246**
Airline Companies	8,823	2	1	13	**8,839**
Airport Services	241	0	2	10	**253**
Airport Suppliers	—	—	8	—	**8**
Other Manufacturers Potentially Serving Aerospace	5,001	23	515	1,572	**7,111**

Source: InfoUSA data; Limited coverage of Boeing's operations. Estimates are approximate.

The largest employers in aerospace manufacturing are listed in Table 3-6. Boeing is the largest, with tens of thousands of employees in the central Puget Sound region in a wide range of functions; however, the InfoUSA data shows operations for this company at only a few of its locations because of how employment is recorded within a corporate structure. There are five other firms with over 500 employees in this sector, spanning the manufacturing of engines and components.

Table 3-6. Top 20 Firms in Aerospace Manufacturing

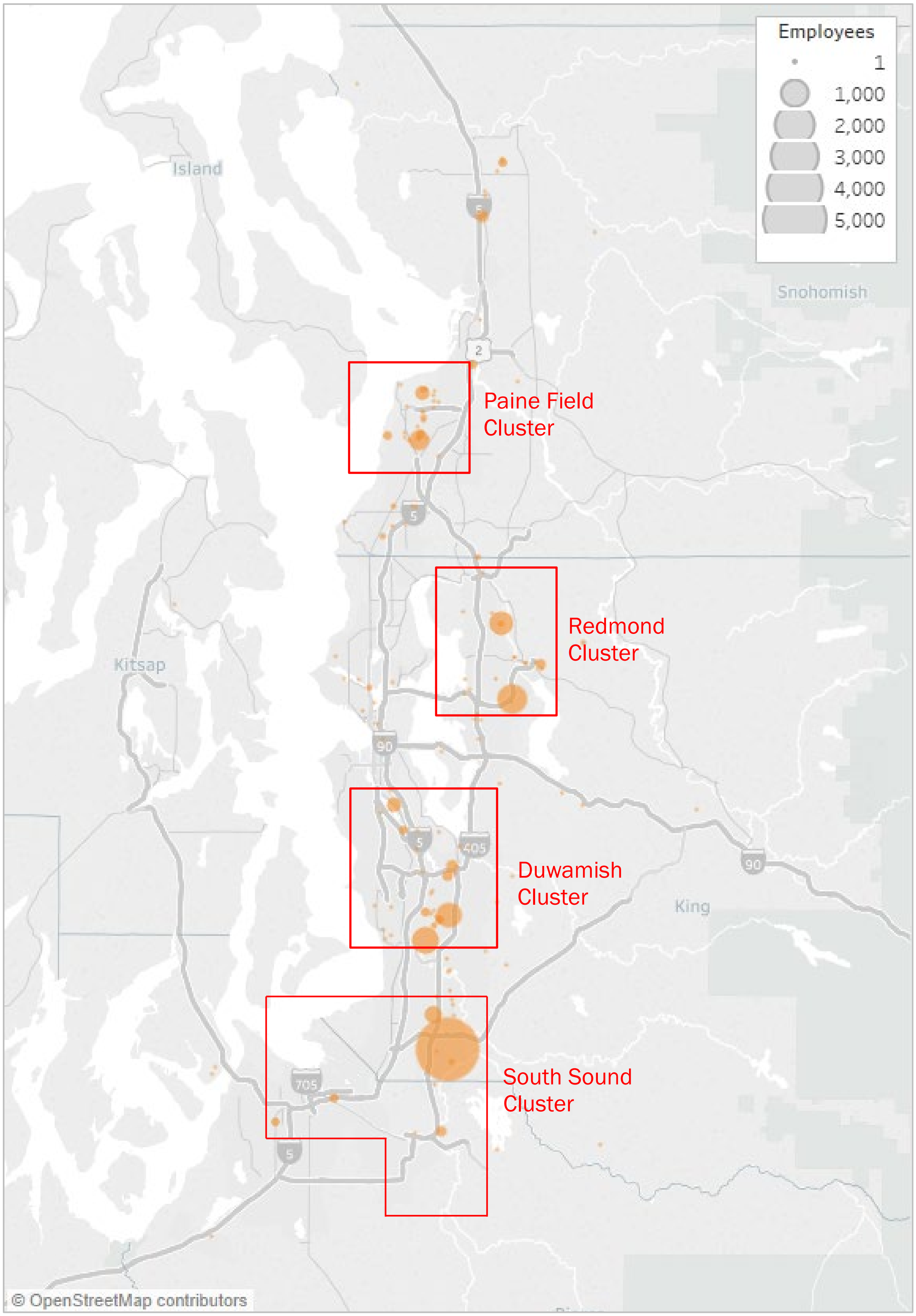
RANK	COMPANY NAME	SECTOR DESCRIPTION	SECTOR SIC CODE	ESTIMATED EMPLOYEES
1	Boeing Co	Aircraft-Manufacturers	372101	5,816
2	Honeywell Aerospace	Aerospace Industries (Mfrs)	381201	1,100
3	Exotic Metals Forming Co LLC	Aircraft Engines & Engine Parts-Mfrs	372498	900
4	Hexcel Structures	Aerospace Industries (Mfrs)	381201	801
5	Astronics Advanced Electronics	Aircraft Components-Manufacturers	372801	700
6	AIM Aerospace	Aircraft Components-Manufacturers	372801	513
7	Esterline Korry	Aircraft Components-Manufacturers	372801	500
8	Avtech Tye	Aircraft Components-Manufacturers	372801	260
9	Zodiac Aerospace	Aircraft Equipment Parts & Supls-Mfrs	372802	200
10	AIM Aerospace Inc	Aircraft Components-Manufacturers	372801	200
11	Collins Aerospace	Aircraft Components-Manufacturers	372801	185
12	Idd Aerospace Corp	Aerospace Industries (Mfrs)	381201	140
13	Smiths Aerospace	Aerospace Industries (Mfrs)	381201	110
14	Cadence Aerospace	Aircraft Components-Manufacturers	381201	20
15	Universal Aerospace Co	Aircraft Components-Manufacturers	372801	100
16	Tool Gauge	Aircraft Equipment Parts & Supls-Mfrs	372802	100
17	Aviation Partners Boeing	Aircraft-Manufacturers	372101	100
18	Royell Manufacturing Inc	Aerospace Industries (Mfrs)	381201	95
19	GE Aviation	Aircraft Components-Manufacturers	372801	90
20	Automatic Products Co Inc	Aircraft Components-Manufacturers	372801	80

Source: InfoUSA data, limited coverage of Boeing's operations, estimates are approximate

3.3.3 Aerospace Manufacturing Clusters

As shown in Figure 3-17, aerospace manufacturing activity is concentrated in four clusters: Paine Field Cluster, Redmond Cluster, Duwamish Cluster, and South Sound Cluster. Each cluster is described in greater detail in the following sections.

Figure 3-17. Map of Aerospace Manufacturers

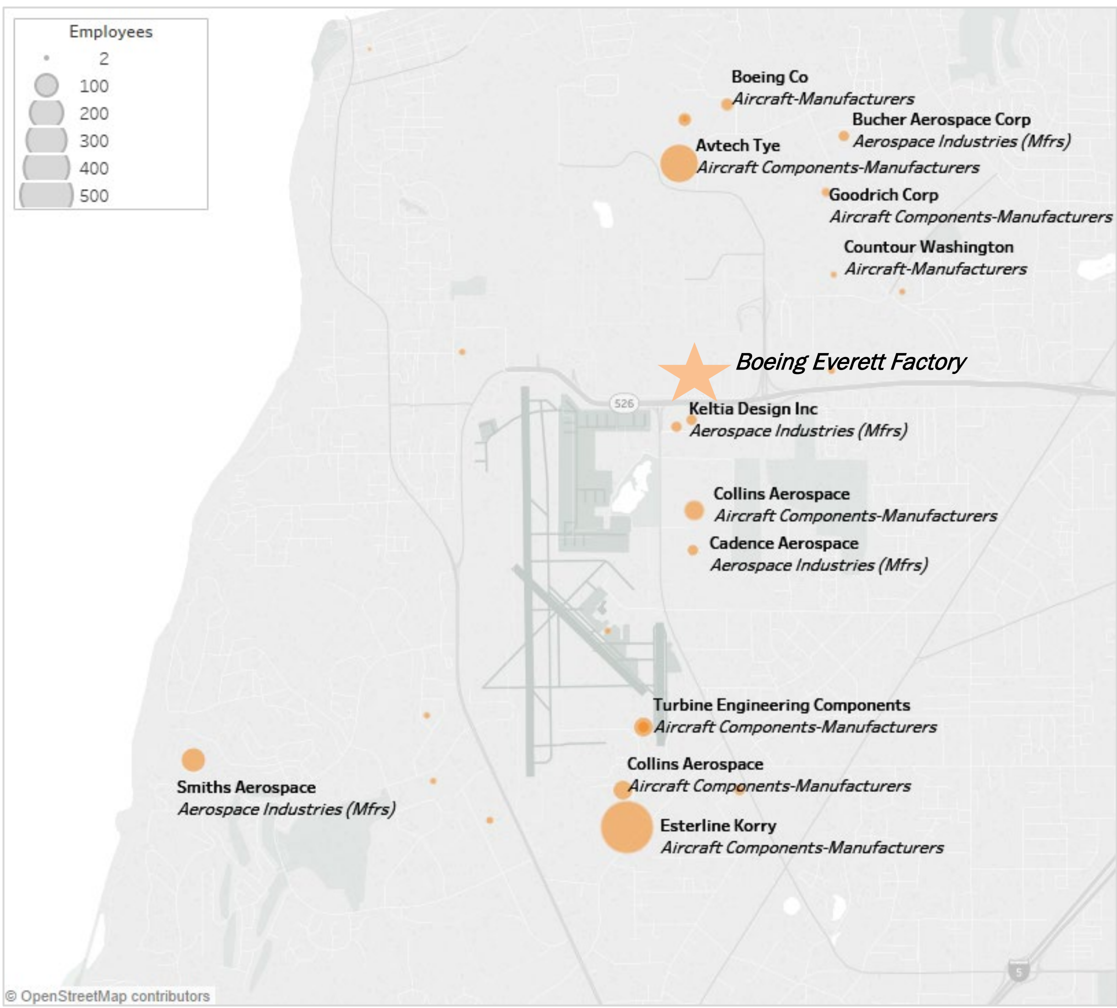


Source: InfoUSA data; Limited coverage of Boeing's operations. Estimates are approximate.

3.3.3.1 PAINE FIELD CLUSTER

The Paine Field Cluster consists of firms that surround Snohomish County Airport/Paine Field (Figure 3-18). Wide-body aircraft, including the 747, 767, 777, and 787 are assembled, outfitted for delivery, and modified at three facilities adjacent to this airport. Boeing reports that more than 30,000 employees work at Boeing Everett. In 2005, Snohomish County leased 20 percent of the Future of Flight Center to Boeing until 2030 for Boeing Tour Center related activities. In 2013, Boeing leased a 17-acre, $35 million operations center from Snohomish County for its Dreamlifter Operations Center, which was later relocated to South Carolina in 2018.[11] Boeing signed an option for 58 acres of undeveloped land at Paine Field in 2018 to potentially expand its Everett modification and delivery center.[12] The market value of the lease is estimated at $1.2 million.[13]

Figure 3-18. Paine Field Cluster



Source: InfoUSA data; Limited coverage of Boeing's operations. Estimates are approximate.

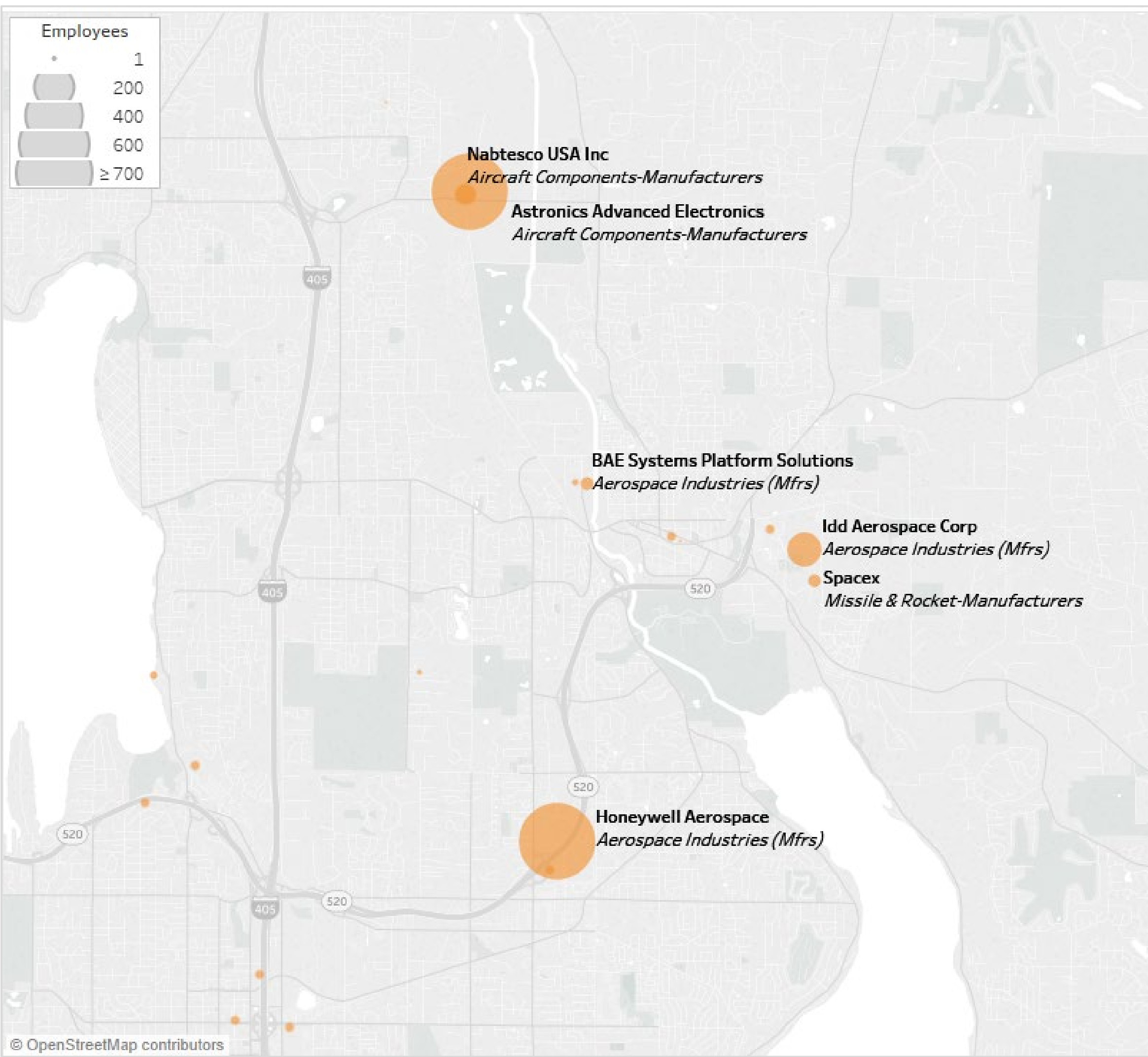
11 https://www.bizjournals.com/seattle/news/2018/03/28/boeing-747-dreamlifter-everett-move-south-carolina.html
12 https://www.seattletimes.com/business/boeing-aerospace/boeing-explores-potential-expansion-at-paine-field-could-it-be-for-the-797/
13 https://www.heraldnet.com/news/boeing-has-its-eye-on-58-acres-on-west-side-of-paine-field/

Boeing's presence has led this cluster to become a hub for aerospace manufacturing in the region. Many companies have moved to this area that supply products and services to Boeing and other aircraft manufacturers. The largest firms are Esterline Korry (a manufacturer of cockpit equipment), Avtech Tye (a manufacturer of aviation electronic systems), Collins Aerospace (a supplier of various aeronautic technologies), and Smiths Aerospace. The manufacturers at the Paine Field Cluster rely extensively on the proximity to the airport, either directly or indirectly.

3.3.3.2 REDMOND CLUSTER

The Redmond Cluster is anchored by three firms: Astronautics Advanced Electronics (a manufacturer of electronics equipment), Honeywell Aerospace (a manufacture of aircraft components), and Idd Aerospace Corp (a manufacturer of flight deck products). Companies in this cluster do not necessarily serve each other, instead they serve the wider regional market. This cluster is located between the Paine Field Cluster and Sea-Tac, providing access to the region's aerospace manufacturing capacity and potential customers.

Figure 3-19. Redmond Cluster

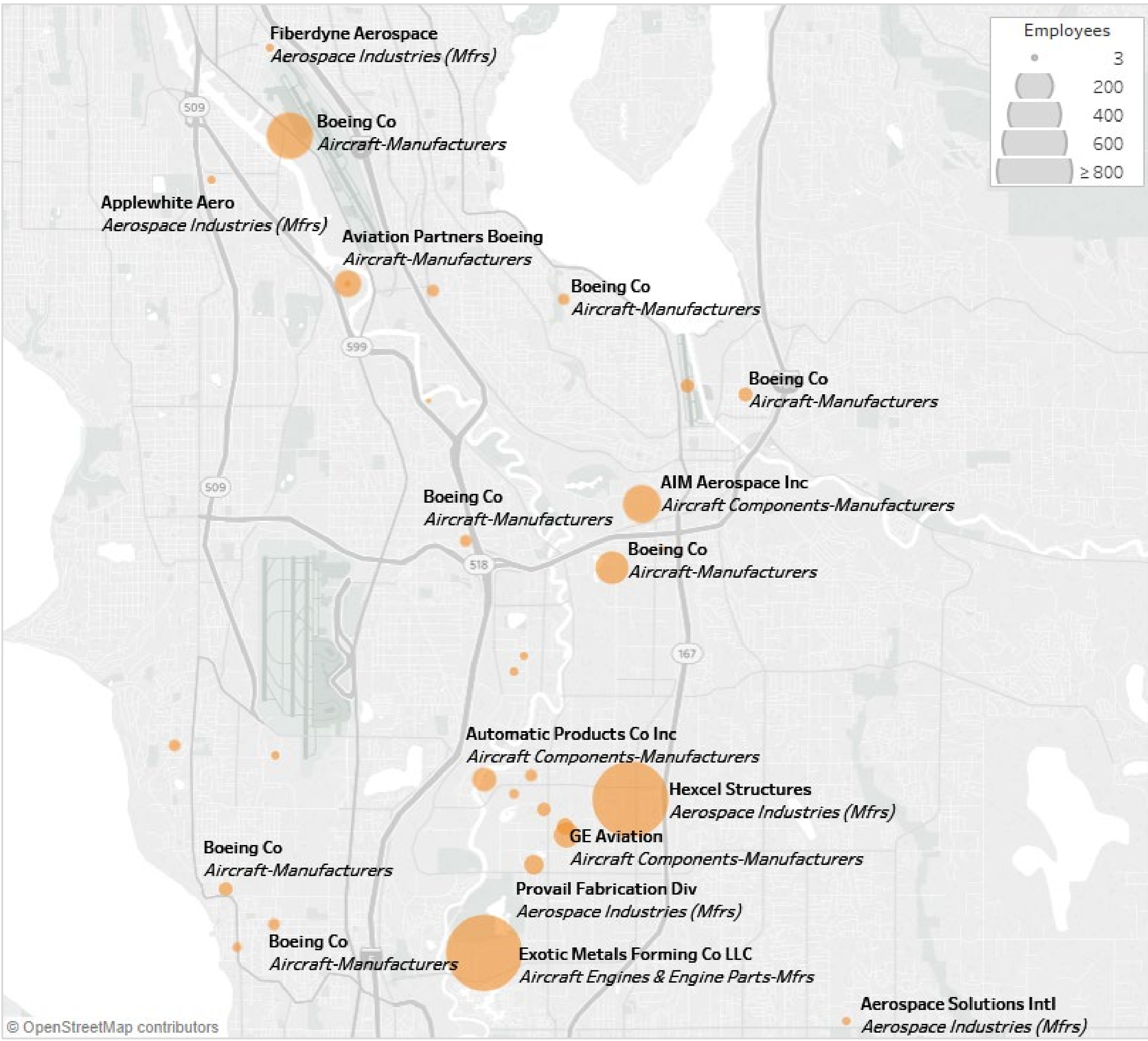


Source: InfoUSA data; Limited coverage of Boeing's operations. Estimates are approximate.

3.3.3.3 DUWAMISH CLUSTER

The area surrounding Sea-Tac Airport also has significant aerospace manufacturing capacity, as shown in Figure 3-20. The largest firms are Hexcel Structures (a manufacturer of composite materials primarily for the aerospace sector), Exotic Metals Forming (a firm that specializes in aerospace sheet metal fabrication), and a number of Boeing facilities.

Figure 3-20 Duwamish Cluster



Source: InfoUSA data; Limited coverage of Boeing's operations. Estimates are approximate.

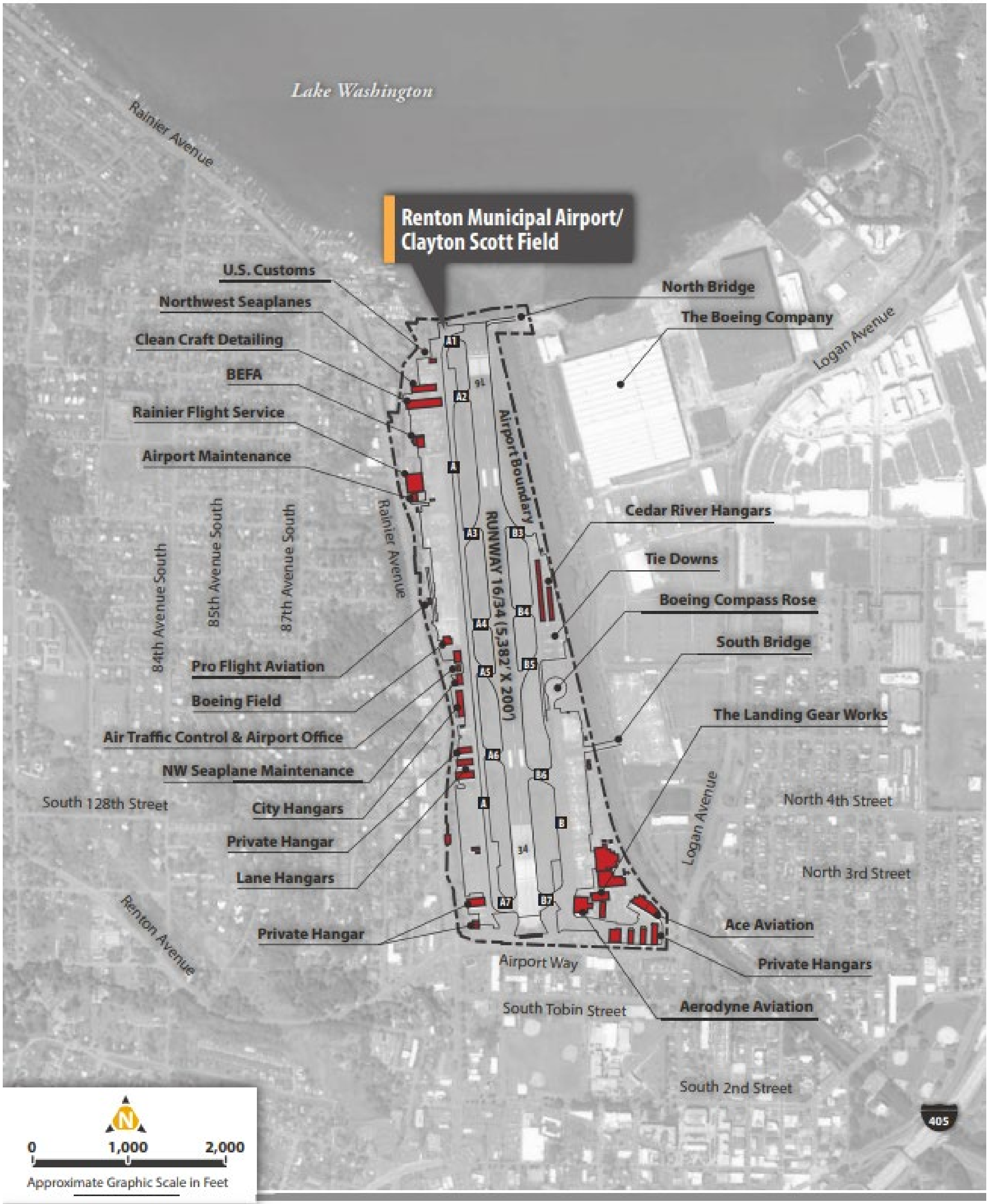
The Boeing 737 narrow-body aircraft is assembled adjacent to the Renton Municipal Airport/Clayton Scott Field in the east portion of this cluster. Boeing signed a 20-year lease with two 10-year options (for up to 40 total years) with the City of Renton in 2010 for a fee starting at $1.3 million per year and increasing every three years.[14] The draft Renton Airport Master Plan (2018) describes Boeing having through-the-fence access and two taxilane bridges over the Cedar River Commercial Waterway.[15] Once aircraft are assembled at Renton (Figure 3-21), they are flown to King County International Airport-Boeing Field (BFI) in this cluster for testing and delivery preparation. Boeing signed a 75-year lease with the airport in 1955. As of 2015, Boeing occupied over 106 acres at BFI and its lease generated over $5 million per year for the airport. The lease rate is adjusted every five years.[16] Boeing's Thompson Site is directly across Marginal Way from BFI and produces the P-8 anti-submarine version of the 737.

14 http://www.rentonreporter.com/news/boeing-to-sign-40-year-lease-of-renton-airport-wednesday/

15 https://rentonwa.gov/UserFiles/Servers/Server_7922657/File/City%20Hall/Public%20Works/Transportation%20Systems/Document%20Library/Master%20Plan%20-%20Working%20Paper%201.pdf

16 King County Airport Lease Framework Working Group Meeting, August 7, 2015

Figure 3-21. Map of Renton Municipal Airport



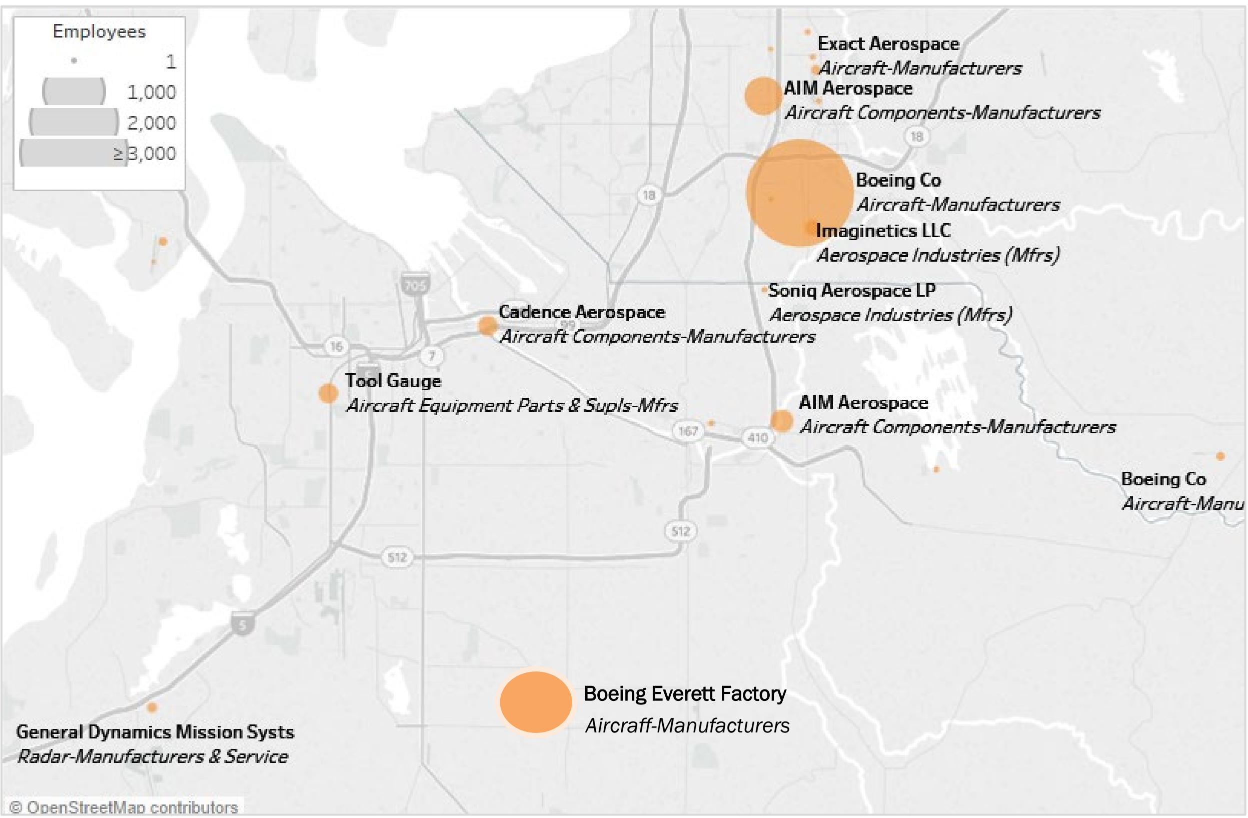
Source: Renton Municipal Airport/Clayton Scott Field Master Plan

3.3.3.4 SOUTH SOUND CLUSTER

The South Sound Cluster (Figure 3-22) was defined loosely to encompass manufacturing activity south of the central Puget Sound region. The biggest facility in this cluster is a Boeing manufacturing plant, which is 4.2 million square feet of aviation parts fabrication space located in Auburn, Washington, that employs about 5,300 people. In 2017, Boeing opened a $17 million, 71,000-square-foot Workforce Readiness Center in Auburn to train employees. The surrounding fabrication facility is a set of smaller yet significant facilities that focus primarily on aircraft component manufacturing. AIM Aerospace is the second-largest employer, focusing on composites engineering and thermoplastics. The other two major employers are Cadence Aerospace (a manufacturer of components and assemblies) and Toll Gauge (a plastics and metal assemblies manufacturer).

Boeing also has a manufacturing plant south of the cluster in Frederickson that employs about 1,750 making wings and tails for Boeing aircraft.

Figure 3-22. South Sound Cluster



Source: InfoUSA data; Limited coverage of Boeing's operations. Estimates are approximate.

3.3.3.5 PRODUCTS AND SERVICES SUPPORTING AEROSPACE SECTOR

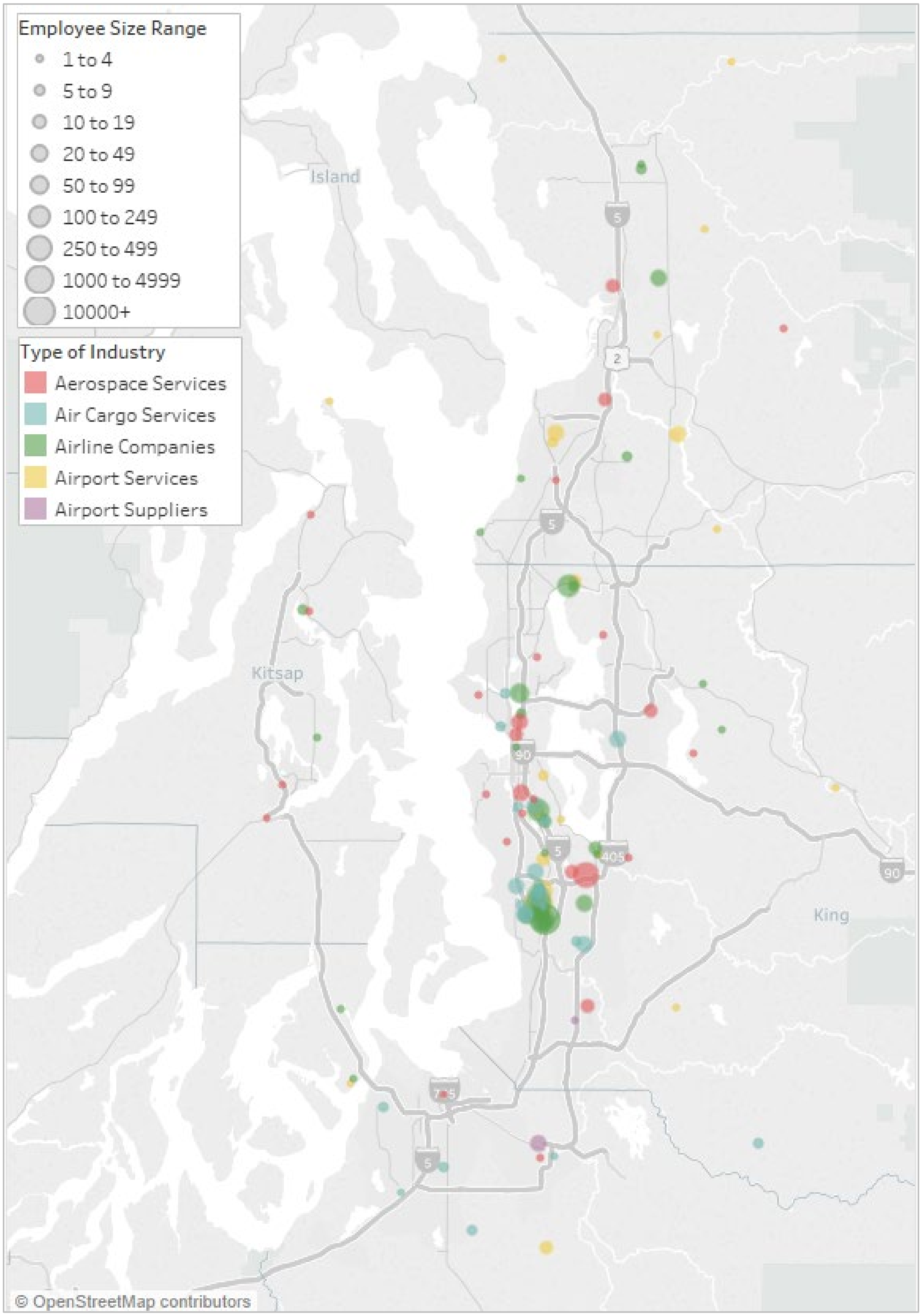
Many other industries support the aerospace manufacturing sector or provide aerospace services in general. As can be seen in Figure 3-23, they are distributed throughout the region, without congregating in clear clusters. The main exception to this is the cluster of firms around Sea-Tac airport, which is primarily composed of firms involved in the movement of passengers or freight (green and grey in Figure 3-23).

More generally, aerospace companies purchase products and services from many different types of firms, including the manufacturing of components that are used in aircrafts. This broader activity does not show up in maps that focus only on the aerospace manufacturing sector as defined by the industry classification system. The impacts of the aerospace sector go well beyond directly or indirectly generating employment throughout the regional economy.

3.4 CONCLUSION

While aviation was critically affected by the Great Recession, the economy in central Puget Sound region recovered more quickly than the rest of the country. The area has experienced significant population growth and these trends are expected to continue going forward. Area businesses and residents depend on the aviation system to keep up with anticipated demands. The aerospace industry plays a critical role in the regional economy and depends on a well-functioning aviation system. Portions of the aerospace manufacturing process depend on airports and it will be important to consider the future needs of the industry in planning for the regional aviation system.

Figure 3-23. Companies that Serve Aerospace Sector



Source: InfoUSA data; Limited coverage of Boeing's operations. Estimates are approximate.

REGIONAL AVIATION BASELINE STUDY
WORKING PAPER 1

Chapter 4
Commercial Aviation Trends and Forecast

July 10, 2019

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Puget Sound Regional Council

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Contents

4. Commercial Aviation Trends and Forecast 4-1
4.1 NATIONAL COMMERCIAL AVIATION TRENDS 4-1
4.1.1 Passenger Airline Activity 4-1
4.1.2 National Aviation Trends Impacting Future Aviation Demand 4-6
4.2 REGIONAL AVIATION TRENDS 4-6
4.2.1 Passenger Airline Activity 4-9
4.2.2 Regional Aviation Trends Impacting Future Aviation Demand 4-11
4.3 COMMERCIAL AVIATION FORECASTS 4-12
4.3.1 Forecast Methodology 4-13
4.3.2 FAA Terminal Area Forecasts and Other Study Forecasts 4-13
4.3.3 Regression Analysis 4-14
4.3.4 Commercial Activity Forecast 4-15

Tables

Table 4-1. Historical and Forecast Enplanements (in millions) (United States) 4-3
Table 4-2. Representative Aircraft by Category 4-5
Table 4-3. Historical and Projected Fleet Mix (United States) 4-7
Table 4-4. Historical Enplanements (Central Puget Sound Region compared to United States) 4-9
Table 4-5. Comparison of Activity Forecast Growth Rates 4-13
Table 4-6. Commercial Activity Forecast Results by Methodology 4-15

Figures

Figure 4-1. Historical and Forecast Available Seat Miles and Revenue Passenger Miles (in billions) (United States) 4-4
Figure 4-2. Historical and Forecast Load Factors (United States) 4-4
Figure 4-3. Historical and Forecast Commercial Aircraft Operations (in thousands) (United States) 4-5
Figure 4-4. Historical Share of U.S. Enplanements (Central Puget Sound Region) 4-10
Figure 4-5. Historical Commercial Aircraft Operations (Central Puget Sound Region) 4-10
Figure 4-6. Passenger Market Share (Seattle-Tacoma International Airport) 4-11
Figure 4-7. Projected U.S. Enplanement Market Share (Central Puget Sound Region) 4-14
Figure 4-8. Selected Enplanement Forecast Range Domestic vs. International - 2050 (Central Puget Sound Region) 4-16
Figure 4-9. Selected Aircraft Operations Forecast Range by Aircraft Type – 2050 (Central Puget Sound Region) 4-17

Acronyms

ASM .... Available Seat Miles
FAA .... Federal Aviation Administration
RPM .... Revenue Passenger Miles
SAMP .... Seattle-Tacoma International Airport Sustainable Airport Master Plan

4. Commercial Aviation Trends and Forecast

This chapter presents commercial aviation trends for the U.S., as well as trends for the central Puget Sound region. In addition, the methodology used to develop the Regional Aviation Baseline Study's commercial aviation forecast is presented. Finally, the forecasts developed from the methodology used are described. National trends and forecasts for the general aviation and air cargo sectors are presented in subsequent Chapters 5 and 6, respectively. The Federal Aviation Administration (FAA) Aerospace Forecasts, 2019-2038 (FAA Aerospace Forecasts)[1] and the FAA Terminal Area Forecast (FAA TAF) have been utilized to prepare this analysis and demand forecasts. These forecasts are prepared annually by the FAA and are the standard utilized by aviation consultants for these types of studies nationwide.

4.1 NATIONAL COMMERCIAL AVIATION TRENDS

This section presents historical and projected aviation trends for passenger enplanements, available seat miles (ASM), revenue passenger miles (RPM), load factor, and aircraft operations for the United States.

4.1.1 Passenger Airline Activity

Air carrier aviation activity trends and projections in the FAA Aerospace Forecasts are divided into two categories—mainline carriers and regional carriers. Mainline carriers are defined as those providing service via aircraft with 90 or more seats and regional carriers are carriers that provide service via aircraft with 89 or fewer seats and whose routes serve mainly as feeders to the mainline carriers. At Sea-Tac, U.S. mainline carriers including Alaska Airlines, Delta Air Lines, United Airlines, American Airlines and Southwest Airlines; affiliate carriers such as Horizon, Compass, and SkyWest; foreign-flag carriers including British Airways, Lufthansa, and Emirates. Using their regional affiliates, mainline carriers typically cater to business segments such as the short-range air shuttle, low-cost, or premium-service flights that normally would not support the traffic or revenue yield needed for the traditional operation of larger mainline aircraft with over 100 seats between selected city pairs, as well as feed their operations at major hub airports.

Table 4-1 presents the historical and projected passenger enplanements forecasted by the FAA from 2010 to 2038 in the United States. As shown in the table, enplanements have fluctuated in the last decade primarily due to the Great Recession and general uncertainty. The recovery in enplanements in the United States is similar to the timing of the recovery from the Great Recession and enplanements did not reach their 2008 levels until the year 2015. The FAA Aerospace Forecasts indicate that total U.S. enplanements will increase at a compound annual growth rate of 1.9 percent from 2018 to 2038, with the largest year-over-year increases corresponding with the gross domestic product and consumer price index increases discussed previously. As also shown in the table, international enplanements are projected to increase at an average annual growth rate of 3.6 percent through 2022 and 3.4 percent through 2038, compared to

[1] The FAA Aerospace Forecasts (2018-2038) provide historical data through 2017. Forecasted data begins with Federal fiscal year 2018 continuing through 2038.

increases in domestic enplanements of 2.3 percent and 1.8 percent during the same time periods, respectively.[2]

Other factors that influence the projections of aviation demand include assumptions related to ASMs, RPMs, and load factors. Figure 4-1 presents a comparison of historical and projected ASMs and RPMs for the United States. As shown in the chart, ASMs (a measure of capacity or the availability of seats) decreased approximately 20 percent in 2009 from 2008 levels. ASMs increased back to 2008 levels in 2015 and are projected to increase from approximately 1,200 billion in 2018 to approximately 1,884 billion in 2038 representing a compound annual growth rate of 1.7 percent during the same period. RPMs (a measure of demand or the seat miles that were utilized system wide) also decreased by approximately 20 percent in 2009 from 2008 levels; however, it was not until 2015 that they were back to the level experienced in 2008. RPMs are projected to increase from approximately 970 billion in 2017 to 1,596 billion in 2038, representing a compound annual growth rate of 1.7 percent.

Load factor is a measure of what proportion of seats are filled in an aircraft. An increase in load factor means that the airlines are moving a higher number of passengers with the same aircraft. Given the recent trend with the increase in average seats per departure seen in the United States, both higher load factors and an increase in the average seats per departure have contributed to passenger growth. Figure 4-2 presents a historical and forecast average load factor from 2010 to 2038 for the United States. As shown, load factors increased rapidly until 2014 and remained at approximately 84 percent through 2017. Average annual load factors are expected to increase again, gradually approaching 85 percent and remaining at that level from 2034 to 2038. While the average annual load factor is maximized at 85 percent, there are peak periods in an airport's annual activity that will result in load factors that are greater than 85 percent, sometimes at levels of more than 95 percent. Conversely, load factors can also be lower than the average of 85 percent. Increasing load factors, with the same number of aircraft operations indicate that growth in commercial service aircraft operations is slower than growth in passenger demand. This trend may result in the need for additional passenger terminal facilities to support more passengers, while need for additional airfield facilities (i.e., runways, taxiways, etc.) may be delayed or not required.

As previously discussed, increased load factors with the same size aircraft results in a greater number of passengers. Figure 4-3 graphically presents the historical and forecast commercial service aircraft operations (air carrier and air taxi aircraft operations combined). As shown, aircraft operations have remained relatively stable since 2010; however, the share of air carrier aircraft operations has shifted from 57 percent to 69 percent of total commercial aircraft operations, with that trend expected to continue through 2038, when the FAA forecasts air carrier operations to be approximately 80 percent of total commercial aircraft operations. This trend is consistent with the overall decline in smaller commercial service aircraft that is expected to occur during the forecast period.

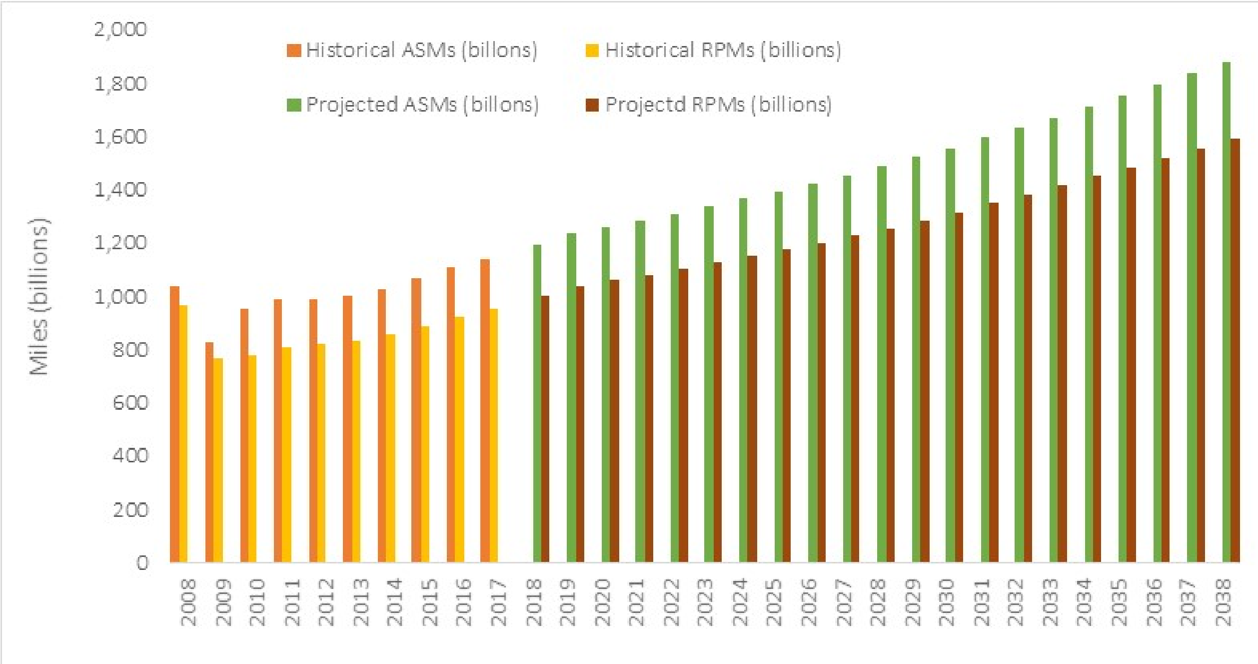
[2] In early 2019, the FAA released its *FAA Aerospace Forecast for 2019-2039*. In this document, the long-term growth rates for GDP and total U.S. passengers reflect a compound annual growth rates of 1.8 percent and 1.8 percent respectively. These growth rates are similar to the long-term growth rates projected by the FAA in the FAA Forecast, which was used as the base for this analysis, since it began prior to the release of the *FAA Aerospace Forecast for 2019-2039*.

Table 4-1. Historical and Forecast Enplanements (in millions) (United States)

FEDERAL FISCAL YEAR	DOMESTIC	% CHANGE	INTERNATIONAL	% CHANGE	TOTAL	% CHANGE
Historical						
2010	628.5	-0.4%	77.3	4.5%	705.8	0.3%
2011	644.2	2.5%	81.0	4.8%	725.2	2.7%
2012	649.8	0.9%	82.9	2.3%	732.7	1.0%
2013	654.4	0.7%	85.1	2.6%	739.5	0.9%
2014	668.9	2.2%	88.0	3.5%	756.9	2.4%
2015	696.3	4.1%	90.2	2.5%	786.5	3.9%
2016	726.1	4.3%	93.4	3.6%	819.6	4.2%
2017	743.5	2.4%	96.9	3.7%	840.4	2.5%
Forecast						
2018	778.1	4.7%	101.8	5.0%	879.9	4.7%
2019	803.6	3.3%	105.1	3.2%	908.7	3.3%
2020	814.8	1.4%	108.4	3.2%	923.2	1.6%
2021	822.3	0.9%	111.8	3.1%	934.1	1.2%
2022	832.3	1.2%	115.4	3.2%	947.8	1.5%
2023	844.3	1.4%	119.2	3.3%	963.5	1.7%
2024	856.6	1.5%	123.2	3.4%	979.9	1.7%
2025	869.4	1.5%	127.4	3.4%	996.8	1.7%
2026	882.0	1.5%	131.7	3.4%	1,013.7	1.7%
2027	894.7	1.4%	136.0	3.3%	1,030.7	1.7%
2028	909.1	1.6%	140.4	3.2%	1,049.5	1.8%
2029	925.3	1.8%	145.0	3.3%	1,070.3	2.0%
2030	941.3	1.7%	149.7	3.3%	1,091.0	1.9%
2031	958.6	1.8%	154.5	3.2%	1,113.1	2.0%
2032	976.3	1.8%	159.6	3.2%	1,135.8	2.0%
2033	994.6	1.9%	164.9	3.3%	1,159.4	2.1%
2034	1,013.8	1.9%	170.4	3.3%	1,184.2	2.1%
2035	1,031.8	1.8%	176.0	3.3%	1,207.7	2.0%
2036	1,049.8	1.8%	181.7	3.3%	1,231.6	2.0%
2037	1,069.4	1.9%	187.6	3.3%	1,257.0	2.1%
2038	1,090.0	1.9%	194.0	3.4%	1,284.0	2.1%
COMPOUND ANNUAL GROWTH RATE						
2010–2017	2.3%		3.3%		2.4%	
2017–2018	4.7%		5.0%		4.7%	
2018–2028	1.6%		3.3%		1.8%	
2018–2038	1.7%		3.3%		1.9%	

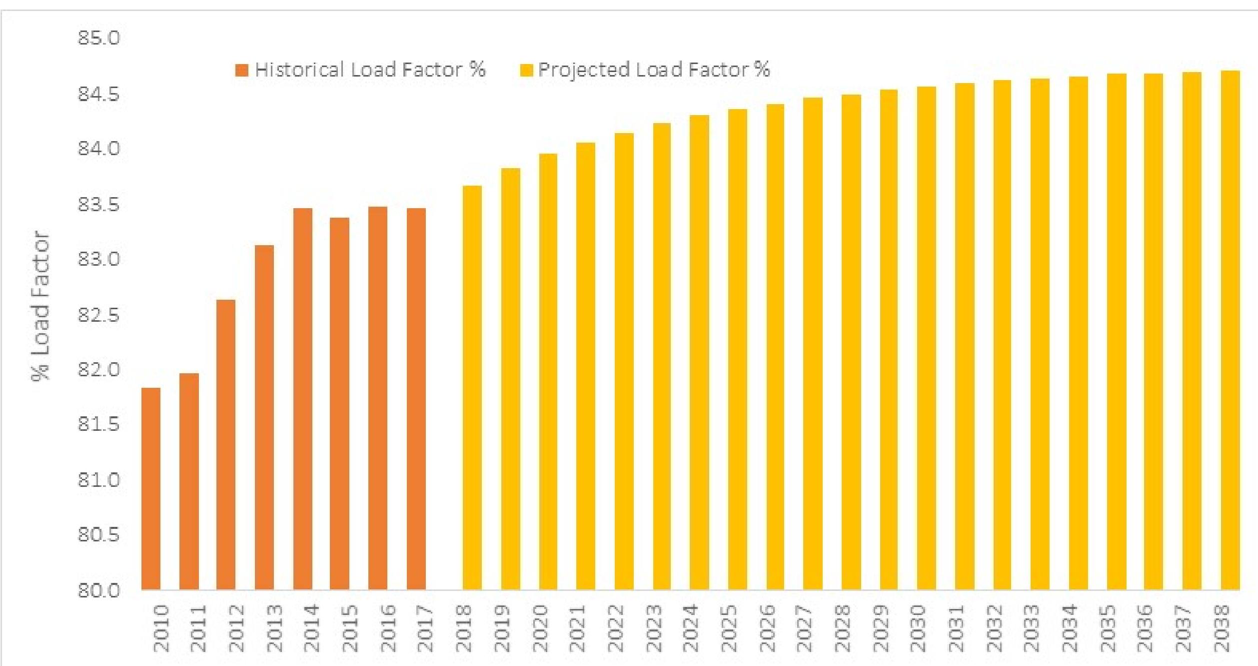
Source: FAA Aerospace Forecasts, 2018

Figure 4-1. Historical and Forecast Available Seat Miles and Revenue Passenger Miles (in billions) (United States)



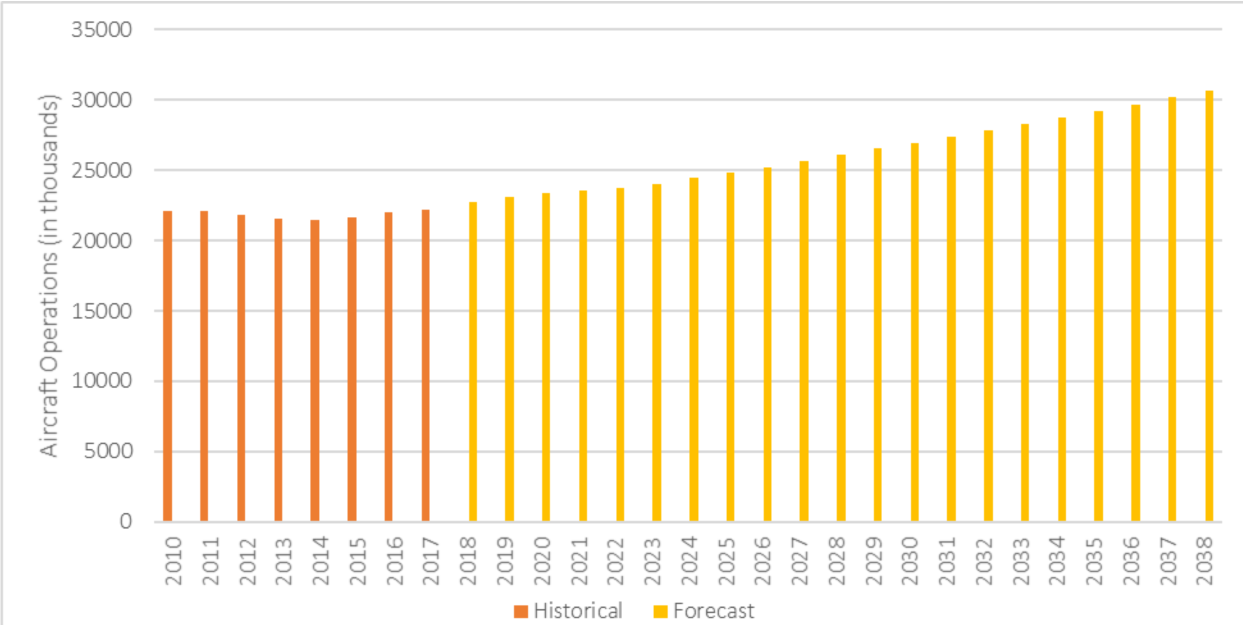
Source: Historical (2008-2017); Forecast (2018-2038); FAA Aerospace Forecasts, 2018

Figure 4-2. Historical and Forecast Load Factors (United States)



Source: Historical (2010-2017); Projected (2018-2038); FAA Aerospace Forecasts, 2018

Figure 4-3. Historical and Forecast Commercial Aircraft Operations (in thousands) (United States)



Source: Historical (2010-2017); Projected (2018-2038); FAA Aerospace Forecasts, 2018

The FAA Aerospace Forecast includes fleet mix projections for aircraft in the United States, including mainline (including low-cost), international, and regional aircraft, as well all-cargo aircraft. The fleet mix for mainline and cargo carriers is delineated by narrow- and wide-body aircraft and the regional carrier fleet mix is divided into categories for non-jet and jet aircraft. Table 4-2 presents a summary of representative aircraft for each category.

Table 4-2. Representative Aircraft by Category

AIRCRAFT CATEGORY	REPRESENTATIVE AIRCRAFT
Wide-body	Boeing 747, Boeing 767, Boeing 777, Boeing 787, Airbus 340, Airbus 350, Airbus 380
Narrow-body	Boeing 727, Boeing 737, Boeing 757, Airbus 320, MD 88
Regional Jet > 50 Seats	Canadair Regional Jet 700, Canadair Regional Jet 900, Canadair Regional Jet 1000 Embraer 170, Embraer 175
Regional Jet < 50 Seats	Canadair Regional Jet 200, Embraer 135, Embraer 145
Regional Non-Jet	Bombardier Q400, Saab 340

4.1.2 National Aviation Trends Impacting Future Aviation Demand

This section presents an overview of several trends that have recently occurred in the United States that could have a significant impact on future commercial service aviation demand. These trends are described in the following paragraphs.

4.1.2.1 UBERAIR

Uber is developing UberAIR, which will provide short on-demand flights using vertical take-off and landing aircraft. The aircraft, which is not yet beyond the preliminary test stage, would carry multiple passengers and a pilot at speeds up to 150 miles per hour between helipads within a region. After development, the aircraft requires FAA approval and a "Next Gen" air traffic control system.

Dallas was selected as UberAIR's first test market, followed by Los Angeles as the second, and then by a not-yet announced international market that will be in Australia, Brazil, France, India, or Japan. As of late 2018, Uber hopes to begin demonstrator flights in 2020 and commercial operations in 2023.

Uber would likely need to purchase all aircraft and hire pilots and may face a shortage of trained pilots.[3]

4.1.2.2 NEW AIRFRAMES

The Airbus A220 (formerly the Bombardier C-series) is a family of small, narrow-body jetliners for the 100-160 seat market garnering attention for their fuel efficiency, passenger comfort and quieter flying, among other things. At least five airlines have taken A220 deliveries and others have made aircraft orders. Among these airlines Delta, Lufthansa, Korean Air, and JetBlue serve Sea-Tac. The airframe is considered a "gamechanger" much like the Boeing 787 was. The A220 is manufactured outside Montréal, Quebec, and will soon also be manufactured in Mobile, Alabama.[4]

4.2 REGIONAL AVIATION TRENDS

There are currently two Puget Sound Region airports that have scheduled commercial service with air carriers that have an FAA Part 121 operating certificate for regularly scheduled or air carrier air service: Sea-Tac, Paine Field. This section provides information on the historical commercial service passenger traffic at these two airports, as well as summarizes several trends in the region that may have an impact on future aviation demand. While King County International Airport has scheduled operations, these operations are with Kenmore Air, which has an FAA Part 135 certificate, which classifies its aircraft operations as air taxi, or non-scheduled/charter service. The primary data source used for the compilation of the central Puget Sound region's trends was the FAA TAF, FY 2017-FY 2044, which was released in the early part of 2018.

[3] https://www.wired.com/2016/10/uber-flying-cars-elevate-plan/; https://www.uber.com/info/elevate/cities/

[4] https://www.forbes.com/sites/tedreed/2019/01/17/the-airbus-a220-is-the-aircraft-worlds-new-star-ten-years-after-the-first-boeing-787-flight/#a7de33a3a1ab

Table 4-3. Historical and Projected Fleet Mix (United States)

FEDERAL FISCAL YEAR	MAINLINE AIRCRAFT > 50 SEATS				REGIONAL AIRCRAFT <50 SEATS			CARGO AIRCRAFT		
	NARROW-BODY	WIDE-BODY	REGIONAL JET	TOTAL MAINLINE	NON-JET	JET	TOTAL REGIONAL	NARROW-BODY	WIDE-BODY	TOTAL CARGO
Historical										
2010	3,129	522	71	**3,722**	857	1,756	**2,613**	288	562	**850**
2011	3,135	519	76	**3,730**	857	1,710	**2,567**	291	580	**871**
2012	3,130	523	82	**3,735**	758	1,582	**2,340**	266	573	**839**
2013	3,164	522	93	**3,779**	571	1,642	**2,213**	213	535	**748**
2014	3,226	512	98	**3,836**	555	1,602	**2,157**	235	533	**768**
2015	3,321	523	99	**3,943**	516	1,628	**2,144**	252	537	**789**
2016	3,459	517	97	**4,073**	519	1,637	**2,156**	256	554	**810**
2017	3,540	517	98	**4,155**	487	1,644	**2,131**	261	594	**855**
Forecast										
2018	3,617	526	98	**4,241**	429	1,651	**2,080**	263	595	**858**
2019	3,653	539	90	**4,282**	410	1,641	**2,051**	264	588	**852**
2020	3,673	550	80	**4,303**	397	1,646	**2,043**	265	593	**858**
2021	3,687	573	80	**4,340**	378	1,668	**2,046**	265	597	**862**
2022	3,701	586	80	**4,367**	367	1,688	**2,055**	267	604	**871**
2023	3,711	601	80	**4,392**	351	1,716	**2,067**	267	621	**888**
2024	3,735	598	80	**4,413**	332	1,741	**2,073**	268	628	**896**
2025	3,759	605	80	**4,444**	312	1,733	**2,045**	269	635	**904**
2026	3,787	611	80	**4,478**	296	1,717	**2,013**	268	645	**913**
2027	3,821	615	80	**4,516**	277	1,690	**1,967**	267	661	**928**
2028	3,844	619	79	**4,542**	266	1,663	**1,929**	267	677	**944**
2029	3,876	634	78	**4,588**	249	1,661	**1,910**	267	700	**967**
2030	3,909	642	78	**4,629**	234	1,664	**1,898**	268	720	**988**

Table 4-3. Historical and Projected Fleet Mix (United States) (continued)

FEDERAL FISCAL YEAR	MAINLINE AIRCRAFT > 50 SEATS				REGIONAL AIRCRAFT <50 SEATS			CARGO AIRCRAFT		
	NARROW-BODY	WIDE-BODY	REGIONAL JET	TOTAL MAINLINE	NON-JET	JET	TOTAL REGIONAL	NARROW-BODY	WIDE-BODY	TOTAL CARGO
2031	3,939	667	78	**4,684**	214	1,681	**1,895**	269	741	**1,010**
2032	3,977	692	78	**4,747**	199	1,708	**1,907**	270	761	**1,031**
2033	3,617	718	78	**4,808**	187	1,756	**1,943**	270	787	**1,057**
2034	3,653	741	78	**4,879**	167	1,785	**1,952**	271	805	**1,076**
2035	3,673	763	78	**4,945**	152	1,802	**1,954**	272	829	**1,101**
2036	3,687	786	78	**5,007**	136	1,834	**1,970**	272	854	**1,126**
2037	3,701	809	78	**5,053**	121	1,869	**1,990**	272	880	**1,152**
2038	3,711	833	78	**5,101**	101	1,910	**2,011**	272	906	**1,178**
COMPOUND ANNUAL GROWTH RATE										
2010–2017	1.8%	-0.1%	4.7%	**1.6%**	-7.8%	-0.9%	**-2.9%**	-1.4%	0.8%	**0.1%**
2017–2018	2.2%	1.7%	0.0%	**2.1%**	-11.9%	0.4%	**-2.4%**	0.8%	0.2%	**0.4%**
2018–2028	0.6%	1.6%	-2.1%	**0.7%**	-4.7%	0.1%	**-0.8%**	0.2%	1.3%	**1.0%**
2018–2038	0.7%	2.3%	-1.1%	**0.9%**	-7.0%	0.7%	**-0.2%**	0.2%	2.1%	**1.6%**

Source: FAA Aerospace Forecasts, 2018

4.2.1 Passenger Airline Activity

Table 4-4 presents a comparison of historical enplanements for the airports in the central Puget Sound region compared to the United States. As shown, enplanements have increased in the central Puget Sound region at an average annual growth rate of 5.7 percent from 2010 to 2017, compared to 2.5 percent for the United States during the same time period. This growth for the region is due in part to the recovery from the Great Recession,[5] as well as airline competition. The region's share of total U.S. enplanements has increased from approximately 2.2 percent in 2010 to approximately 2.7 percent in 2017.

Table 4-4. Historical Enplanements (Central Puget Sound Region compared to United States)

FEDERAL FISCAL YEAR	CENTRAL PUGET SOUND REGION ENPLANEMENTS	%CHANGE	UNITED STATES (IN MILLIONS)	% CHANGE	REGION SHARE OF UNITED STATES
2010	15,218,187	-0.1%	705.8	0.3%	2.16%
2011	15,867,722	4.3%	725.2	2.7%	2.19%
2012	16,081,829	1.3%	732.7	1.0%	2.19%
2013	16,542,305	2.9%	739.5	0.9%	2.24%
2014	17,414,049	5.3%	756.9	2.4%	2.30%
2015	19,632,241	12.7%	786.5	3.9%	2.50%
2016	21,500,676	9.5%	819.6	4.2%	2.62%
2017	22,450,083	4.4%	840.4	2.5%	2.67%
2010–2017	5.7%		2.5%		

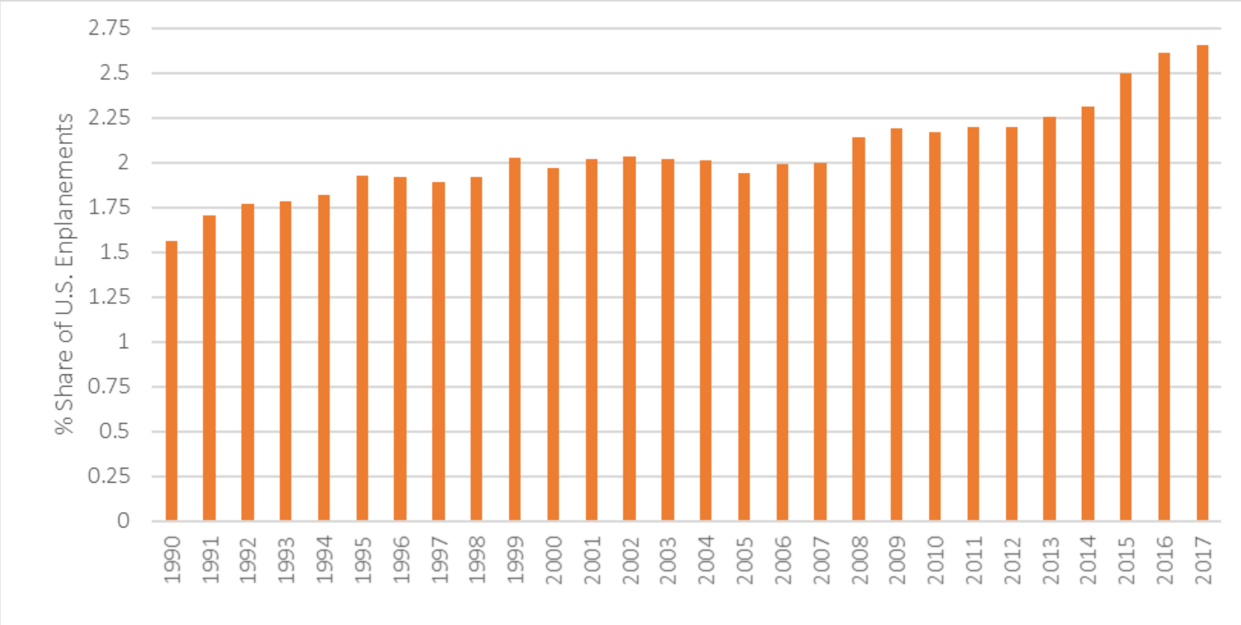
Sources: FAA TAF; FAA Aerospace Forecasts, 2018; Compiled by WSP.

The central Puget Sound region's share of the nation's enplanements has been on the upward trend since 1990 (Figure 4-4). In 1990 the region's share of U.S. enplanements was approximately 1.6 percent compared to 2017 when the region's share increased to approximately 2.7 percent.

Commercial service (air carrier and air taxi as reported in the FAA TAF) aircraft operations fluctuated, reflecting the cyclical nature of aviation demand, which is closely tied to periods of economic growth and recession. from 1990 to 2010. These fluctuations are similar to the trends experienced for the United States as a whole during the same time period. However, in recent years, commercial aircraft operations for the region have increased, given the increased presence of Delta Air Lines at Sea-Tac and Alaska Airlines' response to that increased activity (this trend is discussed in further detail in a subsequent section of this chapter). From 2012 to 2017, the central Puget Sound region's commercial annual aircraft operations increased from 314,300 to 416,600 or approximately 33 percent, which compares to an increase of 2 percent for the United Stated during the same time period. The competition between these two airlines at Sea-Tac has resulted in increased connecting passengers at Sea-Tac on both airlines, which is complemented by the strength of the origin and destination demand generated by the local economy. Figure 4-5 presents central Puget Sound region's historical share of U.S. enplanements from 1990 to 2017.

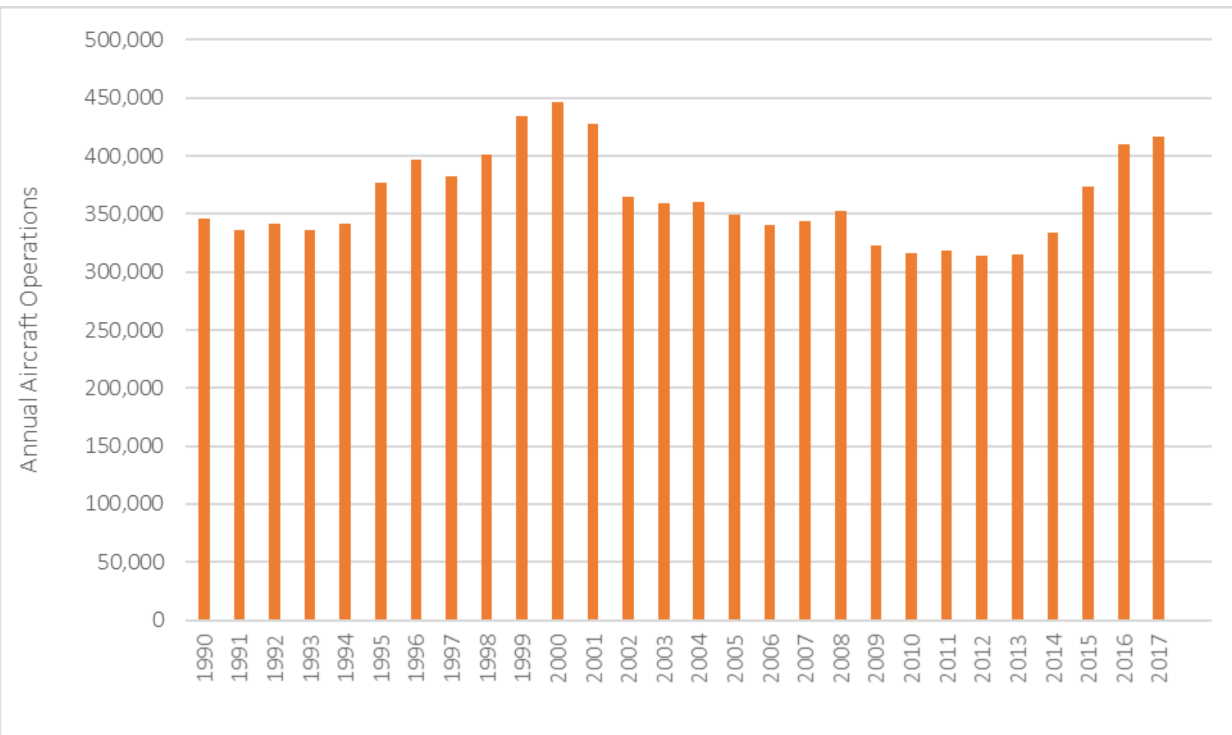
[5] Additional information regarding socioeconomic trends is provided in Chapter 3 of this working paper. However, in general, the central Puget Sound Region recovered from the Great Recession faster than the nation, and at the same rate as the State of Washington.

Figure 4-4. Historical Share of U.S. Enplanements (Central Puget Sound Region)



Source: FAA TAF, FAA Aerospace Forecasts, 2018; Compiled by WSP USA

Figure 4-5. Historical Commercial Aircraft Operations (Central Puget Sound Region)



Source: FAA TAF; Compiled by WSP USA

4.2.2 Regional Aviation Trends Impacting Future Aviation Demand

This section presents some trends that are specific to the central Puget Sound region, such as growth of major airline hubs at Seattle-Tacoma International Airport (Sea-Tac), new passenger service at Paine Field/Snohomish County Airport (Paine Field), and increased passenger traffic from Canadian and Chinese visitors.

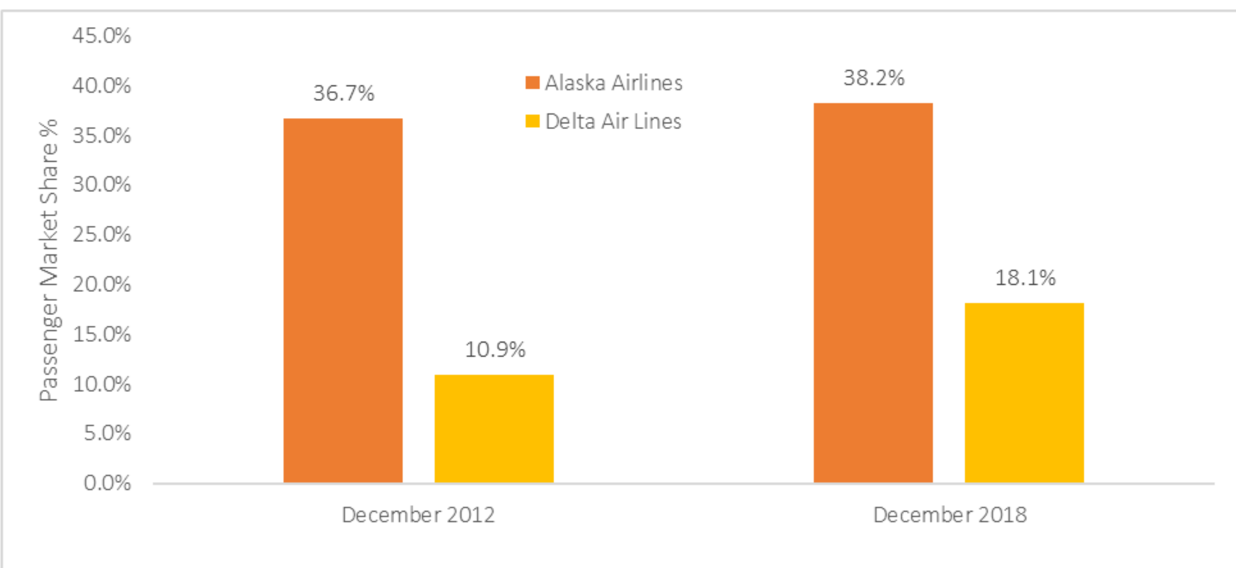
4.2.2.1 THE BATTLE FOR SEATTLE

Although Sea-Tac served as Alaska Airlines' major hub for many decades, "The Battle for Seattle" is a name for the recent competition between Seattle-based Alaska Airlines and Delta Air Lines. Ranked by revenue, Delta Air Lines and Alaska Airlines are the second-largest and fifth-largest airlines in the United States,[6] respectively. Sea-Tac serves as the major Alaska Airlines hub, and Delta established a connecting hub there in 2014. .

The two airlines ended their partnership in May 2017, which included a codeshare agreement and reciprocal mileage benefits. Delta Air Lines cited a commitment to growth in the Pacific Northwest in a 2016 announcement of the partnership termination. In addition, Delta has increased its direct international service from Sea-Tac creating a gateway for connections to Asia.

Both airlines have been growing tremendously at Sea-Tac. Figure 4-6 presents a comparison of Alaska Airlines' and Delta Air Lines' passenger market share at Sea-Tac for 2012 and 2018. As shown, Delta's share of passengers increased 7.2 percent from 10.9 percent to 18.1 percent, while Alaska's share increased 1.5 percent from 36.7 percent to 38.2 percent. Note, that the comparison presented below is only for mainline carrier traffic and does not include partner/feeder carrier traffic.

Figure 4-6. Passenger Market Share (Seattle-Tacoma International Airport)



Source: Sea-Tac Total Passengers by Airline, 2012, 2018

6 https://www.worldatlas.com/articles/the-largest-airlines-in-the-united-states.html

4.2.2.2 PAINE FIELD AIRPORT

At Paine Field Airport, near Everett in Snohomish County, Washington, Propeller Investments opened a privately-owned passenger terminal in March 2019 and has begun supporting commercial service to nine destinations in Oregon, California, Nevada, Arizona, and Colorado. Alaska Airlines and United Airlines are the first two carriers to serve the two-gate terminal for a combined 24 daily departures. Paine Field is attractive to carriers due to the potential for easier roadway access and because of its located in the north part of the central Puget Sound Region. The Boeing Company's Everett Factory, the largest factory by floor area in the world, is also located directly adjacent to the airport. The airport is home to Boeing, Aviation Technical Services and other aviation company facilities, and several aviation museums.

4.2.2.3 CANADIAN PASSENGERS AT U.S. AIRPORTS

A unique characteristic about aviation in the central Puget Sound region is the proximity to Canada and its third-most populous metropolitan area, Vancouver, British Columbia. Air travelers based in Canada and the United States have the option of crossing for cheaper airfare where it is time- and cost-effective. This practice is common from coast to coast along the world's longest international border. Factors affecting ticket prices include lower airline taxes in the United States, differences in airline competition at airports, lower costs for domestic flights, and the presence of discount airlines in the United States.

Bellingham, Washington is closer to Vancouver, British Columbia, than it is to Seattle, and 65 percent of their passenger traffic is comprised of Canadian travelers. Washingtonians can also potentially save money on international travel by flying out of Vancouver International Airport, Canada, due to varying demands and supplies for flights between cities.

4.2.2.4 CHINESE TOURISM

Visit Seattle, the official destination marketing organization for Seattle and King County, reported in 2018 that the city saw its eighth consecutive year of record tourism, and that although international tourists account for 7.1 percent of the city's tourist volume, they represent 16.3 percent of visitor spending. Much of this is attributed to the 196,000 Chinese visitors who spent $236.7 million during their visits (more than $1,200 per person). China became Seattle's top international inbound visitor market in 2010. The number of Chinese visitors has experienced significant growth since 2010 and is expected to continue to grow in the future. Visit Seattle also helped to secure Seattle as the host for the 2019 United States – China Tourism Leadership Summit in September 2019.

4.3 COMMERCIAL AVIATION FORECASTS

This section presents a description of the methodology used to develop the forecast for the region, as well as the forecast results. Aviation forecasts used for planning purposes typically project demand for 20 years; however, for this study the long-range forecast was prepared for 2050 to match the PSRC forecast period used for other studies. It should be noted that this forecast assumes the central Puget Sound Region will continue to grow and historical market trends will continue. It is an unconstrained forecast that does not considered infrastructure or operational limitations. Short-term downturns and disruptions in aviation would not impact the overall long-term activity projections for the region presented in this chapter.

However, with such a long-term forecast, certain factors could impact projected growth. These factors potentially include rapid technological enhancements, climate change, and major geo-political shifts, which could affect the industry or market in ways that are hard to predict.

4.3.1 Forecast Methodology

The forecasts for commercial aviation for the Regional Aviation Baseline Study were developed using both a top down and bottom up methodologies. The bullets below provide additional details regarding the methodologies utilized.

- The top down methodology looked at the share of historical enplanement traffic at the commercial service airports in the region to the activity of the United States. This methodology also looked at the forecasts prepared for commercial service airports in the region by the FAA, as well as the activity forecasts prepared for individual airport studies.
- The bottom up methodology used statistical analyses, specifically regression analyses, that were prepared comparing historical aviation activity to historical socioeconomic factors for the region that influence aviation demand. These key factors included both regional per capita income and employment.

4.3.2 FAA Terminal Area Forecasts and Other Study Forecasts

The FAA TAF is released annually and provides forecasted aviation activity data for individual airports. The FAA TAF used for this analysis was dated March 2018 and includes data for both Sea-Tac and Paine Field. In addition, Sea-Tac completed the forecasts for its Sustainable Airport Master Plan (SAMP) in September 2015.

Table 4-5 presents a comparison of the growth rates from the SAMP demand forecast to the FAA TAF for the short-term (five years) growth, mid-term (10 years) growth, and long-term (20 years) growth for enplanements and airport operations. As shown, while there is some variance in the percentage change in activity for the short-, mid-, and long-term periods, overall the 20-year average annual growth rates for the FAA TAF and the SAMP are similar for both enplanements and aircraft operations.

Table 4-5. Comparison of Activity Forecast Growth Rates

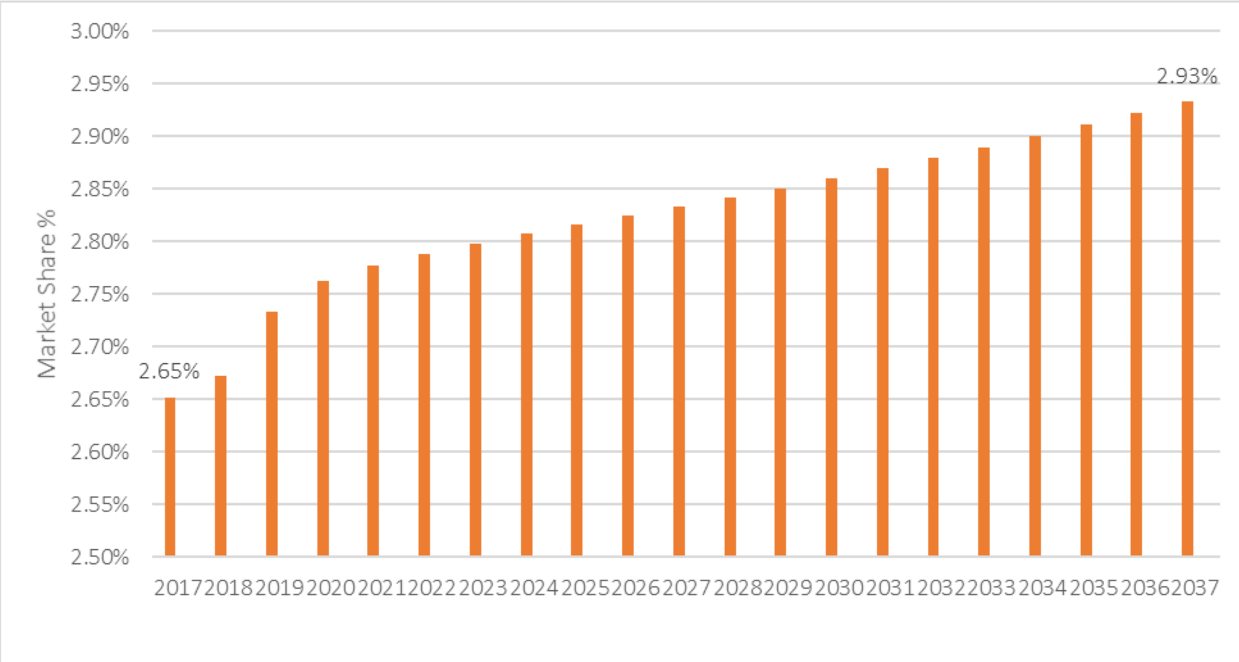
FORECAST	SHORT-TERM % CHANGE (2017-2023)	MID-TERM % CHANGE (2017-2028)	LONG-TERM % CHANGE (2017-2038)	20-YEAR AVERAGE ANNUAL GROWTH
Enplanements				
SAMP	19.7%	38.5%	75.4%	2.8%
FAA TAF	23.6%	37.9%	71.1%	2.7%
Aircraft Operations				
SAMP	17.2%	32.2%	59.6%	2.4%
FAA TAF	20.1%	33.7%	64.7%	2.5%

Source: Sea-Tac Sustainable Airport Master Plan, FAA TAF; Compiled by WSP.

4.3.2.1 MARKET SHARE ANALYSIS

When comparing the FAA TAF enplanements for the central Puget Sound region to the U.S. enplanement forecast from the FAA Aerospace Forecast, the central Puget Sound region's future market share is projected to increase from 2.7 percent in 2017 to 2.9 percent in 2037. This trend indicates that the FAA anticipates sustained enplanement growth at rates higher than the United States for at least the next 20 years. The central Puget Sound region's projected U.S. enplanement market share is presented in Figure 4-7.

Figure 4-7. Projected U.S. Enplanement Market Share (Central Puget Sound Region)



Source: FAA TAF; FAA Aerospace Forecasts, 2018; compiled by WSP

4.3.3 Regression Analysis

Statistical regression analyses were developed to compare historical enplanements for the region to socioeconomic factors that could potentially be good predictors of enplanement activity. These factors included employment and per capita income. For regression analyses, the closer the correlation coefficient is to the value of one, the more closely two variables are dependent on each other. When performing a single-variable regression analysis with enplanements as the dependent variable on either per capita income or employment, the correlation coefficient was .91 and .89, respectively. A multi-variate regression analysis with enplanements being dependent on both per capita income and the correlation coefficient was .91. The results of this analysis indicate that either per capita income or per capita income and employment taken together are slightly better predictors of future enplanement activity than just employment.

4.3.4 Commercial Activity Forecast

Table 4-6 presents the projected enplanements and operations using the three methodologies described above. The following bullets detail how these methods were applied to 2017 the central Puget Sound region enplanements and operations to develop the long-term 2050 forecast:

- For the long-term growth rate method, the average of the average annual growth rates for both enplanements and aircraft operations from the SAMP and the FAA TAF (see Table 4-5) was applied to 2017 enplanements for the 2050 forecast.
- Using the market share method, the long-term growth rate for U.S. enplanements used to develop the 2050 U.S. enplanement forecast to which the region's market share from 2037 was applied to develop the 2050 the central Puget Sound region enplanement forecast. To develop operations, the number of enplanements per operation from the FAA TAF for the region was applied to the 2050 enplanement forecast using the market share method.
- For the regression analysis, the equation developed from the multi-variate analysis was used. Puget Sound Regional Council's socioeconomic forecast for employment and per capita income[7] were used as variables in the equation to calculate future enplanements. The ratio of enplanements to commercial aircraft operations for 2037 from the FAA TAF was applied to generate the number of commercial aircraft operations.

Table 4-6. Commercial Activity Forecast Results by Methodology

FORECAST METHODOLOGY	2017	2022	2027	2050	AVERGE ANNUAL GROWTH
ENPLANEMENTS (MILLONS)					
Growth Rate	22.5	26.0	29.6	55.6	2.4%
Market Share	22.5	25.4	31.1	49.3	2.1%
Regression Analysis	22.5	24.4	28.1	39.9	1.4%
AIRCRAFT OPERATIONS (THOUSANDS)					
Growth Rate	416.6	470.1	521.1	914.0	2.4%
Market Share	416.6	458.9	499.2	809.9	2.1%
Regression Analysis	416.6	442.4	467.0	656.3	1.4%

Source: WSP USA Analysis

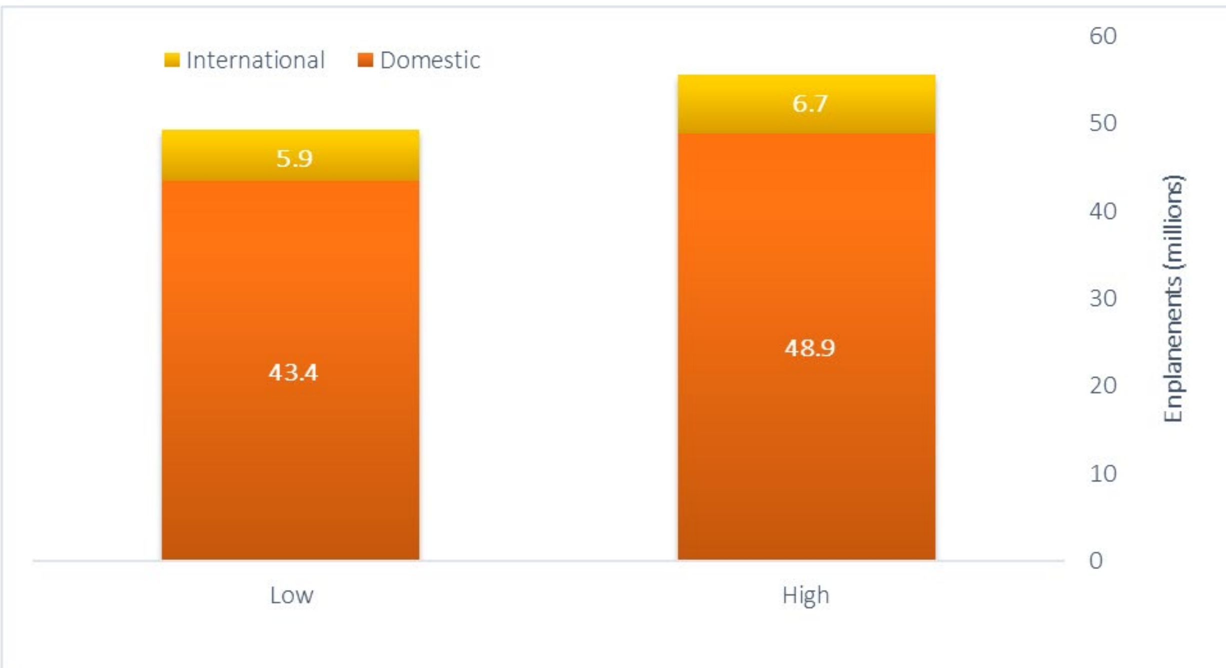
The selected forecast is a range that uses the results from the Growth Rate and the Market Share forecast methodologies. In recent years, Sea-Tac has seen higher than growth due to airline decisions, related to the commitment of Delta Air Lines to the region, and Alaska Airlines competitive response to Delta's presence in the market. In addition, local economic factors such as employment and income have driven the growth in origin-and-destination passengers. The Growth Rate and Market Share forecasts take these factors into account.

[7] https://www.psrc.org/regional-macroeconomic-forecast

The regression analysis forecast methodology, produces a forecast that, while statistically sound, is based entirely on history and projections for socioeconomic factors that do not consider the market-specific factors of the central Puget Sound region, such as the increased airline competition at Sea-Tac and the initiation of service at Paine Field described above and in previous sections.

The final range of forecasts for both enplanements and aircraft operations for the central Puget Sound Region are shown in Figure 4-8 and Figure 4-9, respectively. Figure 4-8 presents enplanements for the forecast range for both domestic and international and Figure 4-9 presents the distribution of aircraft operations by type of aircraft for the range of the forecast.

Figure 4-8. Selected Enplanement Forecast Range Domestic vs. International - 2050 (Central Puget Sound Region)



Source: WSP USA Analysis

Figure 4-9. Selected Aircraft Operations Forecast Range by Aircraft Type – 2050 (Central Puget Sound Region)

Source: WSP USA Analysis

REGIONAL AVIATION BASELINE STUDY:
WORKING PAPER 1

Chapter 5
General Aviation Trends and Forecast

July 11, 2019

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Contents

5. General Aviation Trends and Forecast 5-1
5.1 OVERVIEW OF GENERAL AVIATION 5-1
5.1.1 General Aviation Background 5-1
5.1.2 General Aviation Data Collection 5-2
5.1.3 Application to Trends and Forecast 5-3
5.2 GENERAL AVIATION TRENDS 5-3
5.2.1 General Aviation Aircraft Production 5-4
5.2.2 Hours Flown by General Aviation Aircraft 5-5
5.2.3 General Aviation Pilot Population and Shortage 5-7
5.2.4 Aircraft Maintenance Technician Shortage 5-11
5.2.5 Summary 5-12
5.3 TECHNOLOGY TRENDS 5-12
5.3.1 Automatic Dependent Surveillance-Broadcast Implementation 5-13
5.3.2 Future of Aviation Gasoline 5-14
5.3.3 Electric-Powered Aircraft 5-15
5.3.4 Unmanned Aerial Vehicles 5-15
5.3.5 Summary 5-16
5.4 GENERAL AVIATION FORECAST 5-17
5.4.1 Review of Industry Forecasts 5-18
5.4.2 Puget Sound Regional Council Baseline Data 5-19
5.4.3 Forecast Methodology and Development 5-20
5.4.4 General Aviation Forecast Results 5-22
5.4.5 Summary 5-26

Tables

Table 5-1. Based Aircraft and Operations at Central Puget Sound Region Airports (2017) 5-20
Table 5-2. Based Aircraft Forecast at Central Puget Sound Region Airports 5-23
Table 5-3. Forecasted Based Aircraft Comparison to Terminal Area Forecast 5-24
Table 5-4. Operations Forecast at Central Puget Sound Airports 5-25
Table 5-5. Forecasted Operations Comparison to Terminal Area Forecast 5-27

Figures

Figure 5-1. General Aviation Aircraft Manufactured in the United States 5-5
Figure 5-2. General Aviation Hours Flown by Activity 5-6
Figure 5-3. Pilot Trends by Certificate (National) 5-8
Figure 5-4. Pilot Trends by Certificate (Washington State) 5-9
Figure 5-5. Pilot Trends by Certificate (Central Puget Sound Region) 5-10
Figure 5-6. Student Pilot Trends (National, Central Puget Sound Region, Washington State) 5-10
Figure 5-7. Maintenance Technician Trends (Washington State and Central Puget Sound Region) 5-11

Acronyms

ATADS .... Air Traffic Activity Data System
CAGR .... Compound Annual Growth Rate
FAA .... Federal Aviation Administration
NBAIP .... National Based Aircraft Inventory Program
NFDC .... National Flight Data Center
PAFI .... Piston Aviation Fuels Initiative
TAF .... Terminal Area Forecast
UAV .... Unmanned Aerial Vehicles
WASP .... Washington Airport System Plan
WSDOT .... Washington State Department of Transportation

5. General Aviation Trends and Forecast

5.1 OVERVIEW OF GENERAL AVIATION

5.1.1 General Aviation Background

General aviation is defined as the aircraft operations that occur outside of scheduled airline service and military flights. This can lead to confusion because almost any aircraft can operate as a general aviation aircraft. Large airliners owned and operated by individuals or charter companies are considered general aviation aircraft because they do not operate in scheduled airline service. This broad community that falls under general aviation consists of different types of aircraft, operations, and pilots. General aviation serves the needs of different communities around the United States. Through a network of airports located throughout the country, general aviation helps transport individuals, groups, and goods quickly and efficiently. Examples of general aviation aircraft in the central Puget Sound region include the following:

- Single-engine aircraft with propellers are used for recreational, business, flight training, or other uses.
- Seaplanes are stored and operate from one of the five seaplane bases.
- Multi-engine aircraft may be used for longer trips and at airports with more activity.
- Jets may be used for charter or business use and require longer runways for operation, including large transport aircraft such as Boeing 747s that can be used for air cargo charter or firefighting missions.
- Rotorcraft such as helicopters are used for local news stations or medical purposes.

GENERAL AVIATION TERMINOLOGY

Like any specialty field, general aviation has terminology tailored to its unique needs. Understanding this terminology helps to understand general aviation. For example, based aircraft are typically grouped as the following:

- **Single-engine aircraft** are fixed-wing aircraft with a single powerplant that drives a propeller. Typically, these are piston-powered engines, but turboprop aircraft (turbine engines that drive a propeller) are also included.
- **Multi-engine aircraft** are fixed-wing aircraft with two powerplants that each drive a propeller. Typically, these are piston-powered engines, but turboprop aircraft are also included.
- **Jet aircraft** are fixed-wing aircraft that are powered by one or more turbine engines.
- **Helicopters** use a rotating wing to achieve flight. They may be powered by one or more engines.
- **Gliders** are fixed-wing aircraft that are not equipped with a means of propulsion.
- **Ultralights** are single-engine aircraft that are classified separately because FAA airworthiness criteria treats them differently.

General aviation operates in every state, serving many different purposes. Smaller aircraft such as helicopters and propeller planes allow for remote access while also maintaining the capability to land at major airports often served by commercial and cargo service. The variety of pilot certificates, aircraft, and operation types provides the general aviation community with nearly unlimited possibilities in taking advantage of flight.

5.1.2 General Aviation Data Collection

General aviation operations in the United States take place from nearly 20,000 landing areas. This includes every aviation facility in the United States—privately and publicly owned facilities; airports; heliports; and seaplane bases. At most of these facilities, general aviation aircraft operate independently, with no outside monitoring. Approximately 500 of these facilities—a mere fraction of the total—have an aircraft control tower that monitors, tracks, and records aircraft landings and take offs. Similarly, air traffic controllers following flights enroute generally monitor and track only those aircraft that are on a filed flight plan. While every scheduled airline flight is on a flight plan, there is no requirement for general aviation flights to file a flight plan, and most do not. This freedom is part of the appeal of general aviation, but also results in limited data availability for general aviation.

Information on general aviation-based aircraft and pilots is somewhat more available, but still limited in certain aspects. Details on the general aviation data available follow.

5.1.2.1 BASED AIRCRAFT

The Federal Aviation Administration (FAA) keeps several sets of detailed records on aircraft in the United States. One set of records tracks aircraft registrations. This data is available to the public and lists the type of aircraft, its identification number (i.e., tail number), its powerplant type, and the registered owner's name and address. This data is useful for tracking aircraft ownership and large-scale trends, but it does not track at which airport the aircraft is based.

Another FAA database, the National Based Aircraft Inventory Program, includes an aircraft's tail number and the airport at which it is based. However, the public has only limited access to this database. The public may access total aircraft count at individual airports, but no additional details are available, such as the type of aircraft, or who owns it.

The FAA also maintains an estimated count of based aircraft by general type (single-engine, multi-engine, jet, and helicopter). These estimates are found in the FAA's National Flight Data Center database. The FAA has found these estimates were sometimes not accurate because the estimated number did not need to be verified against currently registered aircraft.

These databases have advantages and disadvantages, but one notable aspect of all of them is that there is no indication of how these aircraft are used. There is no data gathered on whether an aircraft is used for business, for flight instruction, recreational flying, or some other use.

5.1.2.2 AIRCRAFT OPERATIONS

As explained previously, general aviation operations predominately take place at airports that lack air traffic control towers and do not record aircraft operations. Even at those airports where operations are recorded, the data collected is limited, with no recorded number of passengers, no indication as to the purpose of the flight, and limited information on the type of aircraft and its origin and destination. At airports without towers, data is severely limited with annual estimates of operations from airport managers serving as the best available information. The FAA compiles data from air traffic control towers and estimates of operations at non-towered airports in its Terminal Area Forecast (TAF), which provides an estimate of operations for every airport included in the National Plan of Integrated Airport Systems (NPIAS). Data estimates for non-NPIAS airports can be found in the FAA's National Flight Data Center database.

Since neither of these databases track how many hours the aircraft flew or for what purpose (e.g., charter, flight instruction, etc.), the FAA relies on surveys or estimates to provide the best data on the number and types of general aviation operations. To protect an individual's privacy, the results of these surveys do not provide information below the national level.

5.1.2.3 PILOTS AND MECHANICS

Pilot and mechanic data are provided monthly by the FAA through the Civil Airmen database, which can be an inaccurate representation of the total number and type of pilot because the data relies on medical certificates that are renewed only periodically. Medical certificates are required for all types of pilot except for glider, sport, and balloon pilots. The mailing address provided by the airmen is used in this database. By law, the FAA is unable to retain historical pilot databases, so the historical information that the FAA provides on pilots and mechanics is aggregated at the state and national levels.

5.1.3 Application to Trends and Forecast

Available data through the FAA has been used as inputs for tracking trends in general aviation across the United States, Washington state, and the central Puget Sound region and for forecasting the future impacts of the sector on the region. The study uses a baseline year of 2017 and uses best available data in instances where 2017 data was not available.

5.2 GENERAL AVIATION TRENDS

The general aviation industry has undergone changes and experienced challenges in recent years, with new technology coming to the forefront and the growing need for new sources of labor to adapt to future aviation needs. The overall trend in new aircraft deliveries has flattened out after the 2008 recession, affecting a shift in needs from production of new aircraft to maintenance of an active aircraft fleet that continues to age. Aside from the maintenance and production of aircraft, the industry is also subject to the change in demand for pilots and maintenance technicians. Based on industry indicators, an influx of new pilots and technicians is needed to serve the changing general aviation landscape. New changes and challenges provide interesting topics for analyzing recent trends in the general aviation industry and how they might affect the central Puget Sound region.

The industry has made several attempts to increase accessibility and interest of general aviation. In 1994, President Clinton signed the General Aviation Revitalization Act into law to limit liability of aircraft manufacturers, in an effort to boost sagging general aviation production, and make general aviation more affordable. The act eliminated aircraft manufacturers liability once an aircraft was older than 18 years. Manufacturing increased immediately afterwards, with Cessna resuming production of single-engine piston aircraft, a product they had not built since 1986. Nevertheless, rising prices and liability still pose significant issues for the industry.

The advent of Light Sport Aircraft (a special category of aircraft created by the FAA) around 2005 introduced a more cost-effective alternative to traditional aircraft but has gained limited acceptance. Cessna ceased production of their Light Sport Aircraft model in 2014 following several years of poor sales. Finally, the industry made attempts at making diesel-powered piston aircraft a more available option, but there have been obstacles to their success. Many diesel engines have a higher cost and lower performance for the same weight, offering no benefit to flyers. Jet A, the diesel fuel used by these types of engines, is also distributed at fewer airports than aviation gasoline (avgas), the predominant fuel used by a large number of general aviation aircraft. Despite these efforts, the general aviation industry continued to decline in number of users and active aircraft. These attempted improvements have failed to make a significant difference in the trajectory of general aviation, with alternatives and innovations still being sought to change the industry.

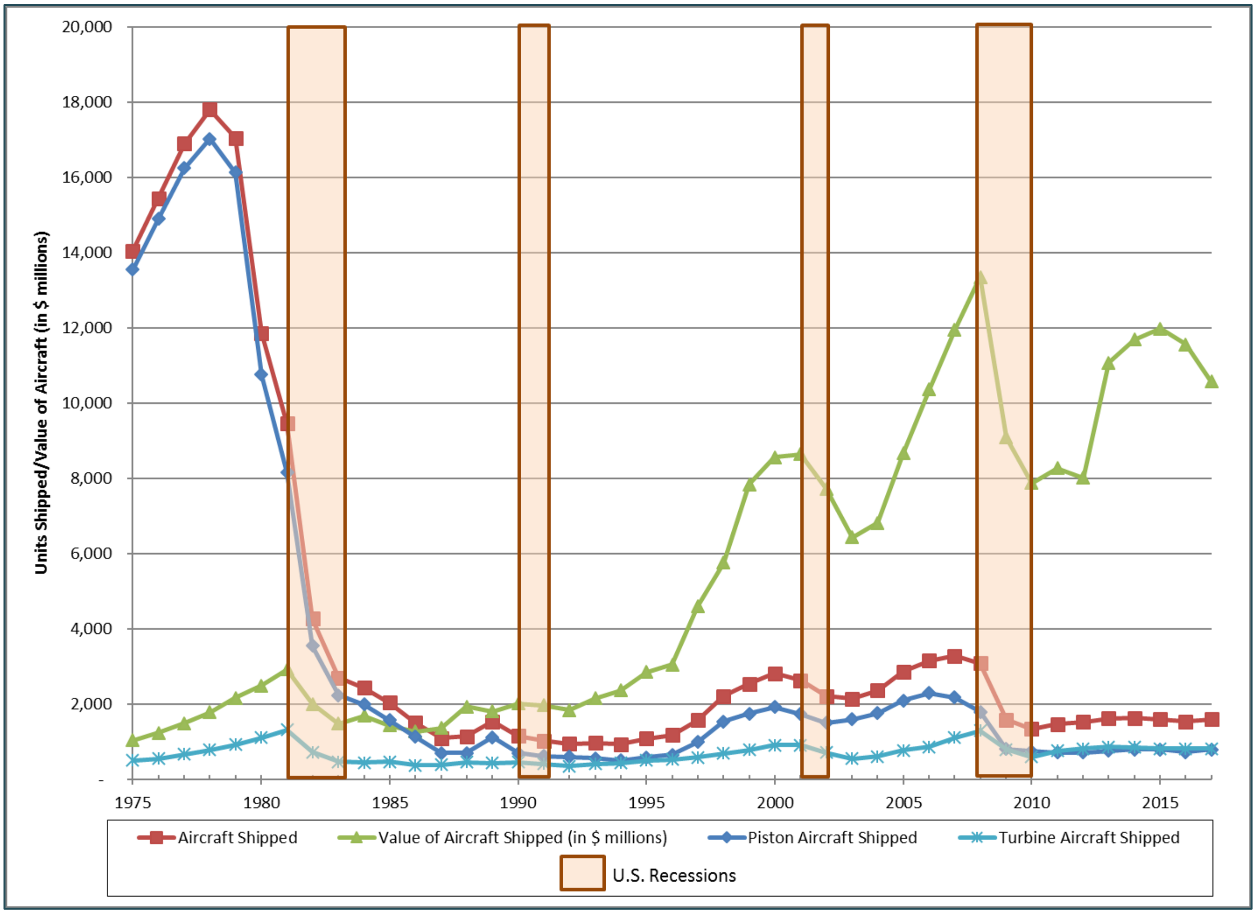
The future of general aviation is also threatened by its dependence on avgas, which is the only remaining transportation fuel still containing lead. Even though the general aviation industry is moving toward a lead-free fuel solution, the long timeline and uncertainty of the outcome act as additional barriers to entry for would-be aviators.

Trends in general aviation are broadly felt at the national level and trickle down to localities where certain impacts will have different effects. Trends that have developed on a national scale, and their resulting effect on the central Puget Sound region are explored in the following Section 5.2 subsections. An overview of aircraft entering the general aviation fleet in the United States, the total number of hours flown, and the active number of pilots and mechanics provides a starting point to analyze trends in the central Puget Sound region through the lens of the national general aviation industry.

5.2.1 General Aviation Aircraft Production

A general indicator often used to gauge the health of the general aviation industry is the number of aircraft produced. Active production, or lack of, indicates the number of aircraft produced annually, which directly corelates to pilots and activity. To evaluate general aviation aircraft production, data from the General Aviation Manufacturers Association from 1975 to 2017 was analyzed for significant events and trends that have affected the production of general aviation aircraft. Figure 5-1 illustrates the total number of general aviation aircraft manufactured and shipped to buyers annually in the United States, the value of those aircraft, and the split between piston and turbine aircraft. Since 2011, turbine-aircraft production has gained a slight edge over piston aircraft, which explains the overall increase in value over that same time-period.

Figure 5-1. General Aviation Aircraft Manufactured in the United States



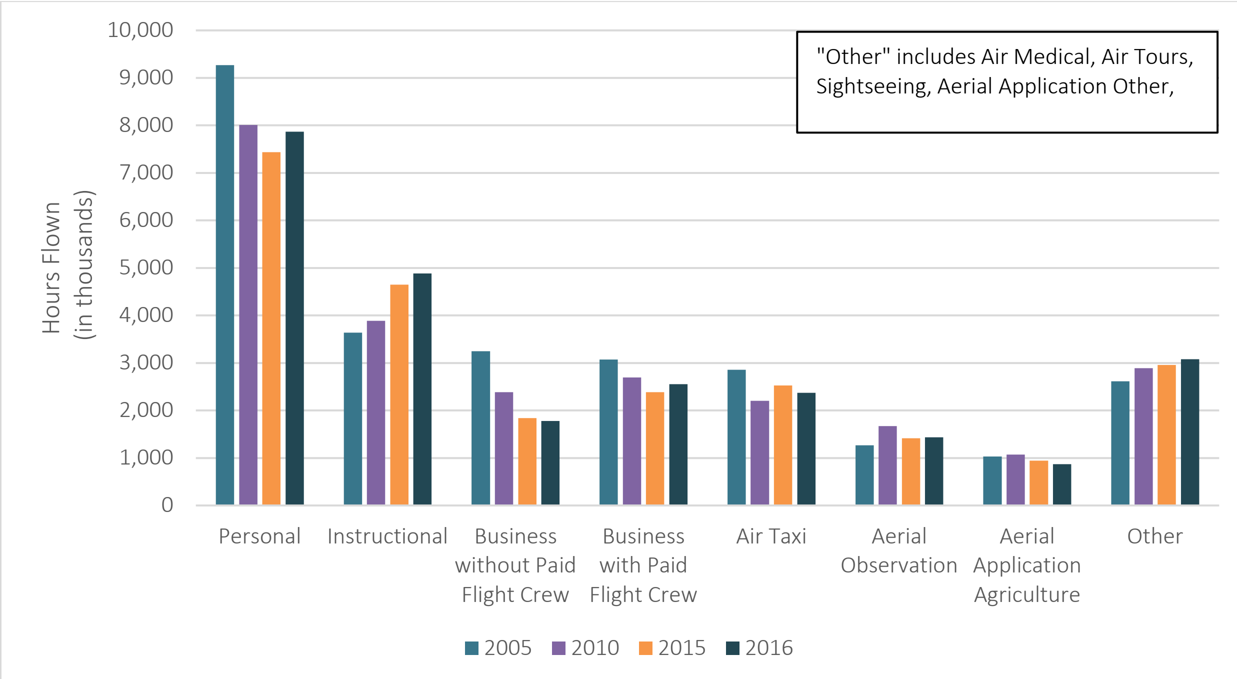
Source: 2017 General Aviation Manufacturers Association Annual Report

The production of general aviation aircraft greatly mirrors the prospects of the nationwide economy, with production plummeting prior to and during recessions, the most recent of which ended in 2010. The conclusion of the last recession also coincided with the first year of turbine-aircraft production surpassing piston aircraft, which in part can be attributed to an increase in business jet usage and the durability of piston aircraft. The total value of aircraft has also been on a slight decline in the past few years but is overall similar to pre-recession values. Value remains a useful indicator for the types of aircraft being produced, because turbine-powered jets are much more expensive purchases then piston-powered aircraft.

5.2.2 Hours Flown by General Aviation Aircraft

Monitoring the activity level of different sectors provides valuable information in regard to usage, as well as the types of aircraft and pilots flying. The FAA tracks the total number of hours flown by use through an annual survey of general aviation aircraft owners, allowing for the identification of useful trends in separate sectors of general aviation. The most recent published results for this survey analyze aircraft use in 2016. Important sectors that are tracked include personal, business, instructional, aerial application, sightseeing, and air medical. Figure 5-2 outlines hours flown by sector in 2005, 2010, 2015, and 2016 to illustrate recent trends.

Figure 5-2. General Aviation Hours Flown by Activity



Source: FAA General Aviation and Part 135 Activity Surveys CY 2016

Many of the sectors have stagnated, with an obvious exception of instructional flight hours. An explanation for the uptick in instructional use can be found in legislation from 2010 mandating that only flight crew members holding an airline transport pilot certificate (generally requiring 1,500 flight hours) were qualified to fly scheduled airline flights. Prior to this legislation, pilots holding a commercial pilot certificate (requiring only 250 flight hours) could act as a first officer on scheduled airline flights. By implementing a higher certification standard, pilots seeking an airline position needed to accumulate substantially more flight hours. Serving as a flight instructor is the most practical way to quickly acquire flight hours in terms of time and cost. Studies have found that most private pilots average less than 100 hours per year of flight time, meaning it would take new pilots more than 15 years to accumulate the necessary flight hours on their own. Other flying positions, such as cargo pilots or charter pilots, may impose minimum flight time requirements that exceed those required for flight instructors, or a minimum amount of flight time with certain equipment, such as turbine-powered aircraft. Either of these conditions are costly to obtain. Flight instruction, however, typically requires only the 250-hour minimum associated with a commercial pilot certificate. With enough students, a new flight instructor can accumulate the necessary 1,500 flight hours in several years or less.

Outside of instructional activity, many areas have experienced slight declines—such as personal flight time, which decreased about one million hours, and air taxi, which declined about half a million hours—as well as dips in both business categories. While these sectors have experienced an overall decline, personal use and business use with a paid flight crew rose from 2015 to 2016, indicating potential growth.

Airports in the central Puget Sound region serve different sectors of the aviation community—such as business, recreation, flight instruction, or medical—with each sector favoring certain facilities. A business user may favor an airport with close proximity to commercial and industrial areas as well as airports with longer runways that support jet use. A recreational user may favor an airport that is more isolated with easier access to the outdoors. Depending on the needs of the user, different airports meet the needs of the varying interests within general aviation.

Airport manager surveys conducted for this Regional Aviation Baseline Study provide a snapshot of the type of uses occurring at each airport. Corporate and business flights are popular at Boeing Field, Paine Field, and Renton Municipal—three of Boeing's main aircraft delivery centers in the United States. Boeing Field, Arlington Municipal, and Bremerton National host air ambulance bases, indicating their importance for medical transport and evacuation. Flight instruction, both based and non-based, is popular at many airports of different size and function, ranging from Paine Field with commercial service, to recreationally focused airports such as Norman Grier Field. Smaller, more remote airports (such as Bandera State and Port of Poulsbo) offering unique flight experiences such as grass or water runways, experience seasonal use. Overall, the central Puget Sound region offers a wide array of general aviation experiences that may allow for the growth of different sectors of the industry. Chapter 2, "Data Collection and Inventory" offers detailed information as reported in the airport manager survey.

5.2.3 General Aviation Pilot Population and Shortage

Pilots with different backgrounds and interests make up the U.S. pilot population and attain different levels of certification providing certain capabilities. Similar to the breakdown of hours flown by sector, pilot certificates serve different purposes in the general aviation realm. The FAA separates pilot certificates into six different classifications, each with its own set of privileges.

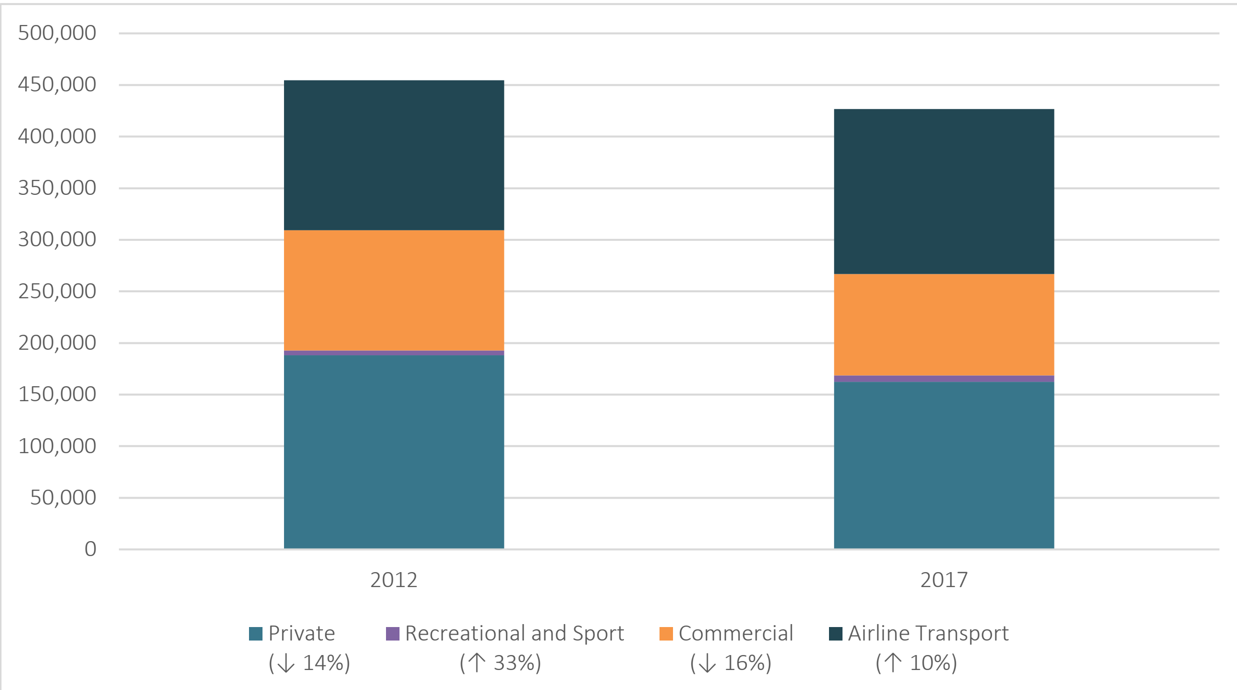
- **Student Pilots** are pilots in training. Student pilots may fly aircraft solo when properly authorized by a flight instructor.
- **Recreational Pilots** are certified to fly aircraft with up to 180 horsepower and four seats but may only carry one passenger.
- **Sport Pilots** are certified to fly Light Sport Aircraft, which are limited to two seats and day-time flying only.
- **Private Pilots** are certified to fly aircraft, as long as it is not for compensation or hire.
- **Commercial Pilots** are certified to fly for compensation or hire and are required to have 250 hours of flight time.
- **Airline Transport Pilots** are required to be certified to fly as pilot in command or first officer for a scheduled airline. They are generally required to have 1,500 hours of flight time.

PILOT CERTIFICATE: SOME BASIC REQUIREMENTS

- **Student**: 16 years of age, pass a knowledge test
- **Recreational**: 17 years of age, 30 hours of flight time
- **Sport**: same as student, log 20 hours of flight time
- **Private**: 17 years of age, obtain a medical certificate, 40 hours of flight time
- **Commercial**: 18 years of age, private pilot certificate, 250 hours of flight time
- **Airline Transport Pilot**: 1,500 hours of flight time

In addition to these basic pilot certifications, additional pilot ratings and endorsements are added to these certificates that provide additional flight privileges or specify existing privileges. Examples include privileges such as land versus water operations, single versus multi-engine operations, and flight in poor weather conditions. What is important is that these pilot certifications determine which pilots may fly for schedule airlines (only those with an airline transport pilot certificate), and which may fly for a living, such as a charter pilot or flight instructor (anyone with a commercial or airline transport pilot certificate). According to FAA Civil Airmen statistics, a database published at the end of each year, the national pilot population has decreased across multiple important categories. Figure 5-3 outlines notable pilot trends from 2012 to 2017 by certificate.

Figure 5-3. Pilot Trends by Certificate (National)



Source: FAA Civil Airmen Statistics, 2012 and 2017
Note: Percentages in legend indicate change from 2012 to 2017.

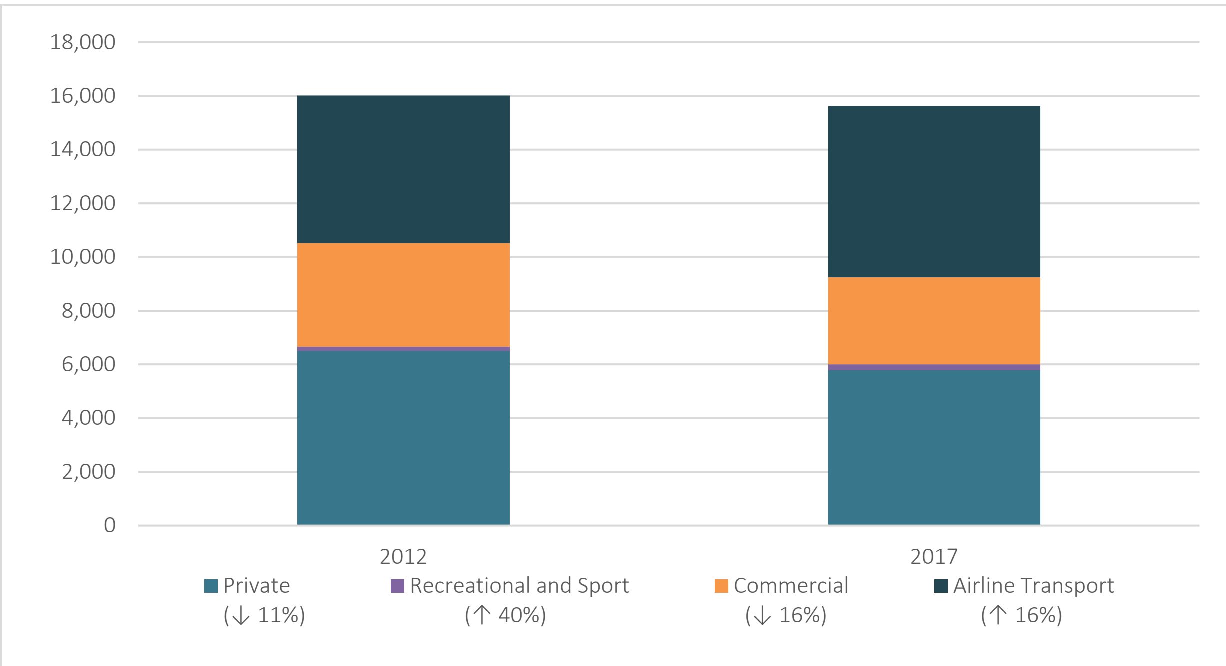
A major inhibitor to the growth of the pilot population is the cost associated with becoming a pilot. Being a pilot means there are costs for training, liability, and flying an aircraft that impose a significant cost on the potential pilot. Flight training alone is an expensive initial barrier—one that requires a significant investment of time and money. The Aircraft Owners and Pilots Association provides estimated costs for different certificate and instrument levels; to get a private pilot certificate which allows for personal and business flights, training costs about $7,000 and takes four months and an additional $3,000 and two months to get instrument rated.[1] Once a pilot, there are more costs that make flying inaccessible to many. Hypothetical costs from the Aircraft Owners and Pilots Association are estimated at $1,200 per year for insurance, $3,000 per year for a hangar, and $40 per hour for fuel. Other major costs include the price of

[1] Aircraft Owners and Pilots Assocation. 2019. *Aircraft Owners and Pilots Assocation.* February 19. https://www.aopa.org/training-and-safety/learn-to-fly.

using an aircraft (whether owned or rented), maintenance, and avionics upgrades, which can quickly add up and limit flying to a select group of people.

Washington state has seen a slight decrease in the total number of pilots over the last five years. Figure 5-4 shows that private and commercial pilots are the primary contributor to the decline. The decline in these specific categories could significantly affect the general aviation industry if they continue.

Figure 5-4. Pilot Trends by Certificate (Washington State)

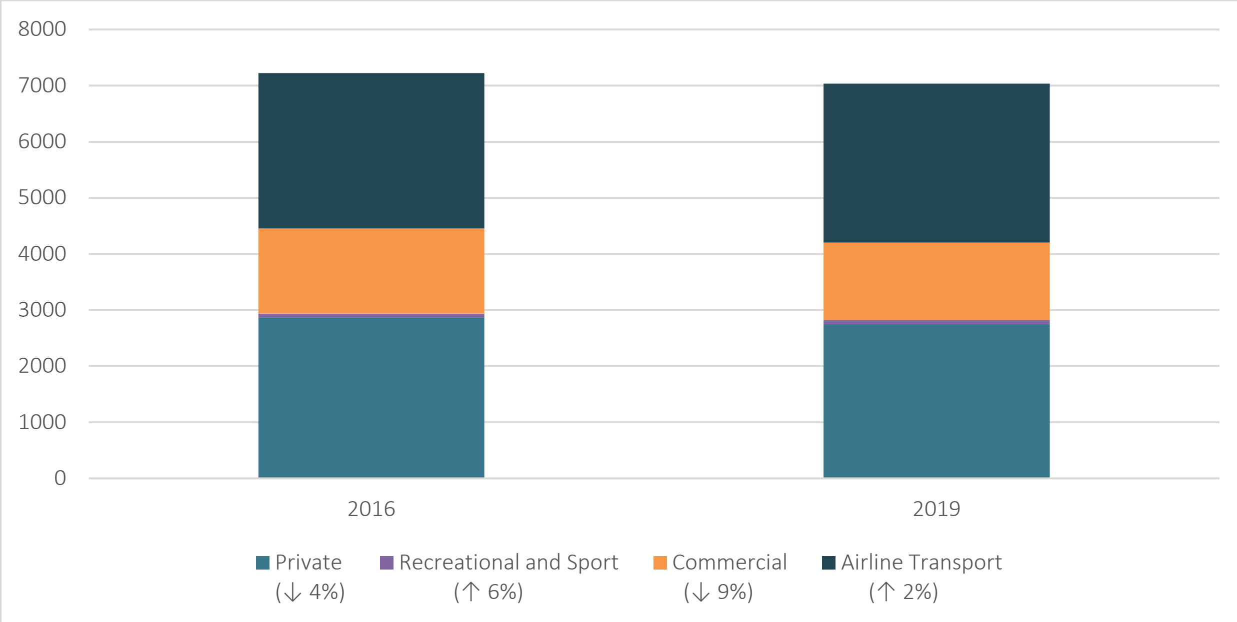


Source: FAA Civil Airmen Statistics, 2012 and 2017
Note: Percentages in legend indicate change from 2012 to 2017.

Using the FAA Airmen database, data specific to the central Puget Sound region can be extracted to provide insight into the makeup of the regional pilot population. This database differs from the FAA Civil Airmen statistics in that the database is updated monthly as a running total, rather than a yearly issuance.

Figure 5-5 illustrates the central Puget Sound region's changes in the number and type of pilot certificates, indicating similar trends seen at the state level. Close to half of the pilots in the state hail from the central Puget Sound region, signifying the importance of the region to aviation in Washington state. While the increase in airline transport pilots is likely due to commercial airlines such as Alaska and Delta increasing their pilot bases at Seattle-Tacoma International Airport (Sea-Tac), private and commercial pilots, which make up a large percentage of general aviation users, experienced decreases.

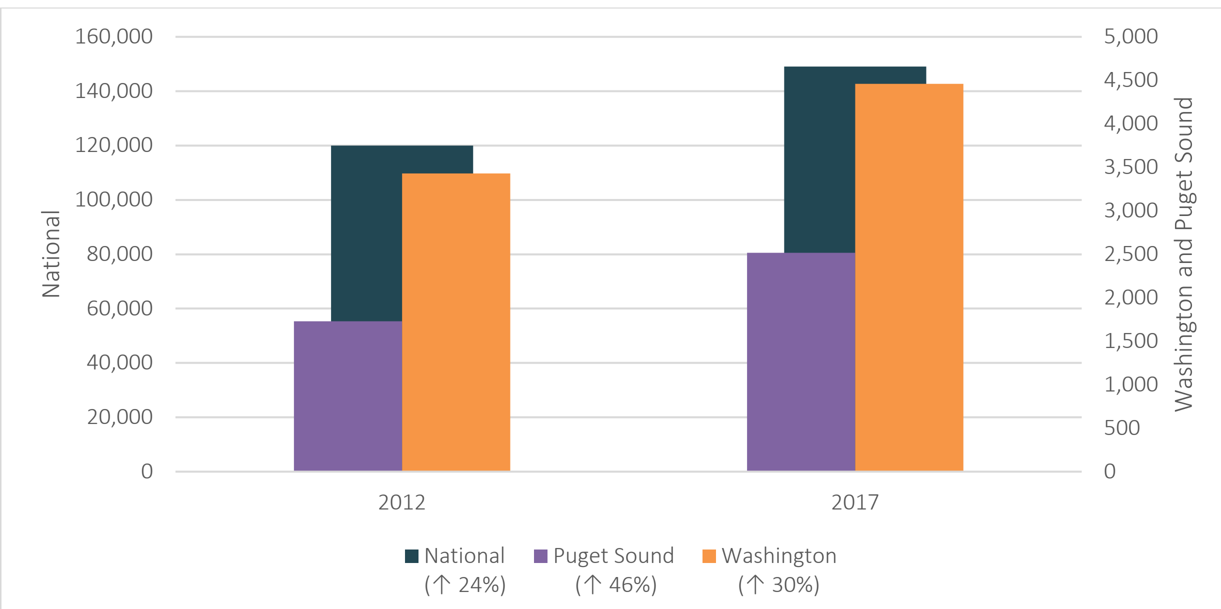
Figure 5-5. Pilot Trends by Certificate (Central Puget Sound Region)



Source: FAA Airmen Database, August 2016 and February 2019
Note: Percentages in legend indicate change from 2016 to 2019.

Figure 5-6 shows the upward trend of student pilot certificates at the national, state, and regional levels.

Figure 5-6. Student Pilot Trends (National, Central Puget Sound Region, Washington State)



Source: FAA Civil Airmen Statistics, 2012 and 2017, FAA Airmen Database, August 2016 and February 2019
Note: Due to availability, 2016 and 2019 data were used for the central Puget Sound region student pilots. As of 2016, student pilot certificates no longer expire, which could impact the number of certificates going forward. Percentages in legend indicate change from 2012 to 2017 for national and Washington student pilots and from 2016 to 2019 for central Puget Sound region student pilots.

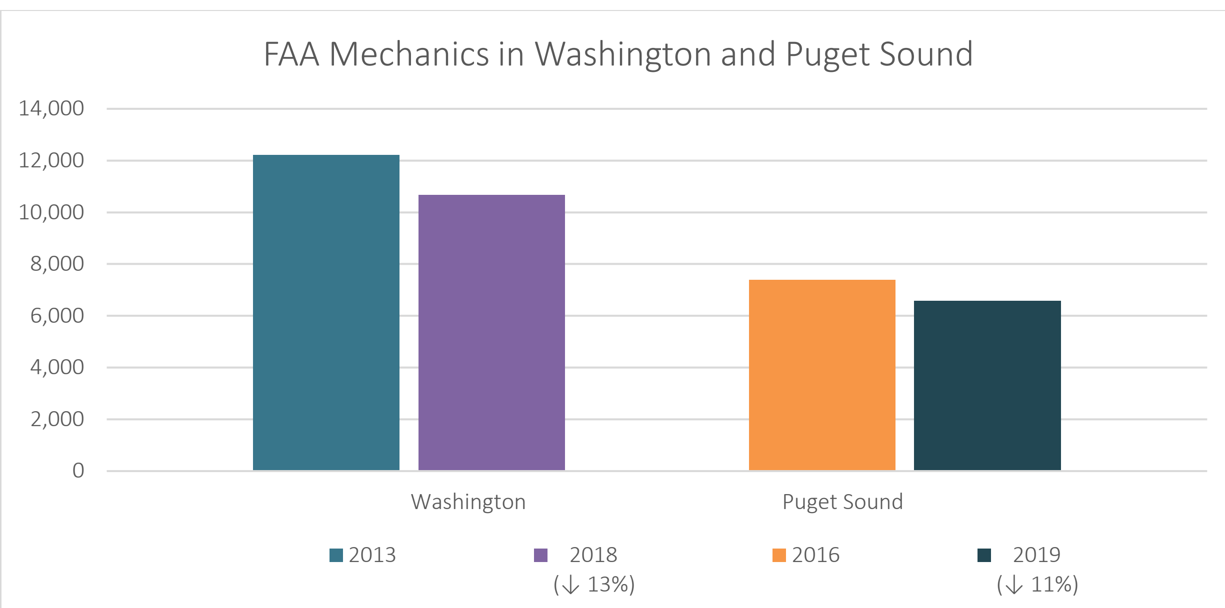
Both the state and the region are outpacing the national trend by adding new student pilots to the population while also mitigating losses in the private pilot population. As the number of private pilots has declined over the past five years, increasing the student pilot base remains important. Student pilot growth will remain a key trend to monitor as students gain additional certification and move into different certificate categories.

5.2.4 Aircraft Maintenance Technician Shortage

Nationwide, aircraft maintenance technician numbers have been slowly dwindling, dropping from 308,367 in 2010 to 286,268 by 2017. As technicians are retiring or leaving the workforce, new employees are not entering the industry at a fast-enough rate to replace losses. A lack of aircraft maintenance technicians creates a ripple effect throughout the aviation industry, with major airlines consistently searching for experienced mechanics and directly competing with the smaller general aviation community in the workforce.

Data from the FAA Civil Airmen database provides evidence as to how important aircraft maintenance is in the central Puget Sound region, with more than two-thirds of the mechanics in Washington state working in the area. Mechanics in the central Puget Sound region make up 2 percent of the total number of mechanics nationwide. While many mechanics based locally likely work in the commercial aircraft industry for Boeing, many others support the 29-airport system in the central Puget Sound region by working for aircraft maintenance shops that help to keep general aviation aircraft safe and operational. While the state and region have overall strong numbers, Figure 5-7 outlines the downward trend in aircraft maintenance technicians in Washington state and the central Puget Sound region.

Figure 5-7. Maintenance Technician Trends (Washington State and Central Puget Sound Region)



Source: FAA Civil Airmen Statistics 2013 and 2018, FAA Airmen Database, August 2016 and February 2019
Note: Percentages in legend indicate change from earlier year.

The central Puget Sound region benefits from being home to three maintenance schools approved by the FAA. South Seattle College, Everett Community College, and Clover Park Technical College offer versions of two-year aviation maintenance programs, which prepare students to become certified to take the FAA Airframe and Powerplant exams. The presence of three schools provides the region with an ideal base of students to draw into the workforce. Enrollment at the institutions should be followed and encouraged to help populate the aircraft maintenance technician field with new workers.

5.2.5 Summary

The general aviation trends evaluated in this section provide insight at the national, state, and regional levels. Nationally, the shipment of general aviation aircraft has yet to return to pre-recession levels, with turbine aircraft experiencing a marginally better recovery than piston aircraft. General aviation aircraft activity at the national level has also been shown to be stagnant for most categories. The exceptions are personal flight (which has suffered a decline) and flight instruction (which has increased over the past few years). The increase in flight instruction is tied to a regulatory increase in flight hours needed for professional pilots, which gives a temporary increase to piston operations, but ultimately benefits turbine-aircraft operations. Personal flight, which is dominated by piston aircraft, is expected to continue its decline.

With the central Puget Sound region having a greater proportion of piston aircraft than what is found at the national level, the conclusion is that the region's aviation future is more closely tied to piston aircraft trends than turbine-aircraft trends. In the central Puget Sound region, the overall pilot population is remaining steady while the private pilot population is experiencing a slow decline similar to trends at the state and national levels. This trend will likely affect many of the non-commercial service airports in the central Puget Sound region, resulting in little or no growth in general aviation activity. This is due in part to piston aircraft being versatile; they are used for recreation, flight training, and other popular local uses that are available at airports without scheduled activity. Aircraft maintenance technician numbers in the region are also declining, affecting the services and necessary time for repairs to general aviation aircraft. Finally, a decrease in nationwide personal flight hours stems from the decline in pilots and mechanics available to service and fly general aviation aircraft—an important trend that could affect the future of the central Puget Sound region airports.

5.3 TECHNOLOGY TRENDS

Technology has rapidly affected the aviation industry over the past years with different projects and practices involving new technology becoming increasingly available throughout the country. In this section, the effects of Automatic Dependent Surveillance-Broadcast (ADS-B) implementation, the future of avgas, the advent of unmanned aerial vehicles, and new electric-powered aircraft will be discussed within national and regional contexts as a means of understanding how the aviation industry has been adapting to current trends in technology.

5.3.1 Automatic Dependent Surveillance-Broadcast Implementation

The national airspace establishes different classes of airspace for the operations of certain aircraft and to aid in keeping aircraft apart. The FAA controls airspace in the United States and has introduced ADS-B as a requirement for aircraft operating in highly-controlled areas. Communication is a major component for keeping the airspace safe, which ADS-B will help improve through increased visibility and knowledge of aircraft in the different classes of airspace.

ADS-B is a key component of FAA's NextGen program and has two systems: ADS-B Out and ADS-B In. Using a combination of ground stations, aircraft avionics, and the satellite global positioning system (GPS), ADS-B Out provides air traffic controllers with an aircraft's position, altitude, airspeed, and other information critical to ensuring aircraft separation. Because it relies on satellites instead of ground-based radars, ADS-B Out improves the coverage and situational awareness of air traffic controllers, including tracking of aircraft while taxiing at airports with adequate surveillance equipment, making ground movements safer for all aircraft.

ADS-B In allows properly equipped aircraft to receive weather and aircraft position information (for collision avoidance) while in flight. This benefits both general aviation and commercial airlines with enhanced safety by giving pilots an improved ability to avoid hazardous weather and augment their responsibility to see and avoid other aircraft.

After the FAA-established deadline of January 1, 2020, any aircraft operating in most controlled airspaces needs to be equipped with ADS-B Out avionics. (The FAA does not require aircraft to be equipped with ADS-B In.) The cost to equip and install ADS-B Out is several thousand dollars per aircraft, which is manageable for commercial airlines but can be a substantial cost for private aircraft owners. Furthermore, the biggest advantage for general aviation aircraft is from ADS-B In, which imposes additional equipment and costs on the aircraft owner if equipped.

To help offset the burden of equipping with ADS-B, the FAA has offered two programs with a $500 rebate specifically for single-engine piston owners. The initial rebate program ran from September 2016 to September 2017 with more than 10,000 rebate payments processed. The FAA reinstituted the rebate program in October 2018, offering 9,792 rebates; as of February 2019, about 5,000 rebates remain.

According to the FAA, the total number of general aviation fixed wing aircraft equipped with ADS-B as of February 2019 was 52,039, with 49,337 of the installations verified as good installs. Data from the FAA shows that the number of aircraft equipping with ADS-B is continuing at a steady pace, albeit one that is projected to fall short of the January 1, 2020, deadline, with just under 7,000 aircraft equipped between September 2018 and February 2019. As of 2016, there were 211,793 active general aviation aircraft in the United States, indicating that much of the fleet still requires the update to ADS-B Out. *Business Aviation* in November 2018 projected that only 46.2 percent of the total U.S. aircraft fleet will meet the deadline.

Besides the slow equipage rate, other issues with ADS-B implementation stem from the stress placed on avionics suppliers this late in the process. Duncan Aviation has informed customers that they may not be able to meet requests in time, while other companies in the industry are experiencing shortages in the necessary equipment. This issue is especially relevant for the central Puget Sound region general aviation users as nearly all of the study airports are under the Mode C veil[2] of Sea-Tac, which requires aircraft to have ADS-B to operate in that airspace after January 1, 2020. Statistics in 2017 indicate that 89 percent, or about 2,700 of the 3,044-based aircraft in the region, are located at airports within the Mode C veil. Six of the system airports fall outside the veil, with Arlington Municipal being the largest by number of based aircraft. Furthermore, any aircraft based outside of the Mode C veil that want to make use of airports inside the Mode C veil will need to be equipped with ADS-B by the deadline, which means that 89 percent is the lower bound of aircraft in the central Puget Sound region that are expected to be equipped with ADS-B by 2020.

5.3.2 Future of Aviation Gasoline

Aviation gasoline, or avgas, is the primary aviation fuel used by piston-powered aircraft. It is notable for being the only remaining transportation fuel still containing lead, which is used to protect against engine detonation, also known as knocking. It is generally acknowledged that avgas will not be available in the future, for a number of reasons. For starters, the only western manufacturer of the lead additive is Innospec, a U.S. specialty chemical company that could choose to cease production for liability, financial, or other reasons. Another factor is pressure from environmental groups that want to eliminate the use of leaded fuel because of the hazard lead poses to the environment. The U.S. Environmental Protection Agency is being lobbied to eliminate the use of lead in avgas through regulation.

In light of these factors, the general aviation industry is collaborating with the FAA to develop a replacement for avgas. Efforts to find a replacement for avgas involve extensive research by fuel companies and collaboration between aviation stakeholders—such as aircraft manufacturers, fuel refiners, and aviation associations—and the FAA and U.S. Environmental Protection Agency. A key component of this collaboration takes the form of the Piston Aviation Fuels Initiative (PAFI), an industry-government initiative started in 2013. PAFI is working toward developing a viable unleaded aviation fuel. At the end of March 2016, the PAFI process selected two fuels out of 17 submitted in the first phase of testing. Shell and Swift Fuels each submitted one of the two selected fuels and have undergone two phases of testing. As of September 2018, Swift decided to suspend development of its fuel to research other alternatives, with Shell continuing its program. The FAA announced a delay for flight and engine testing, which is now estimated to be completed by mid-2020. Even though the general aviation industry is moving toward a lead-free fuel solution, the long timeline and uncertainty of the outcome act as additional barriers to entry for would-be aviators.

Locally, Sea-Tac is involved in an initiative to fuel every flight from the airport with sustainable aviation fuel by 2028. While this will greatly affect commercial aviation, other flights using jet fuel are included in the goal, meaning that a corporate flight leaving from Sea-Tac would have access to eco-friendly fueling

[2] The Mode C veil is the airspace from the surface up to 10,000 feet within 30 miles of any airport designated in Appendix D to Part 91 of the Federal Aviation Regulations. Aircraft operating within this airspace are required to operate a transponder with a Mode C capability, which transmits pressure altitude information.

alternatives. With the major commercial service airport in the region looking to reduce its environmental impacts, other airports with frequent jet activity could find sustainable aviation fuel to be a viable alternative to traditional jet fuel in the future.

5.3.3 Electric-Powered Aircraft

With an uncertain future for avgas, the prospect of electric-powered aircraft succeeding in the general aviation industry is more realistic than ever before. Multiple companies (such as Siemens, Pipistrel, and Bye Aerospace) have developed general aviation electric-powered aircraft that are currently undergoing testing and certification through the FAA. Electric-powered aircraft offer an eco-friendly alternative to traditional general aviation aircraft, which operate on avgas. Besides the low emissions from electric-powered aircraft, the other benefit is operational cost, which ranges from $3 to $30 per hour based on estimates from manufacturers. Compared to popular avgas-powered general aviation aircraft such as the Cessna 172 and 182 with hourly operating costs ranging between $90 and $220, the new electric-powered aircraft can significantly alter the cost, potentially allowing for an increase in accessibility to more users.

Notable accomplishments in the electric-powered aircraft sector include Pipistrel (which received an airworthiness certification from the FAA in 2018 for the first all-electric training plane) and Bye Aerospace (which received an order from the Aspen Flying Club for 30 Sun Flyer 2 models). Looking to the future, Siemens eAircraft division demonstrated their new all-electric-powered plane at the 2018 Innovation Day in Chicago, where officials predicted that electric propulsion would be a standard option by 2050.

5.3.4 Unmanned Aerial Vehicles

The growth in unmanned aerial vehicles (UAV) has been spurred by improvements in engine technology, battery life, and miniaturization of components, all of which have driven down the costs of these easy-to-operate vehicles. As a result, recreational and especially business uses of UAVs have proliferated. The following industries are just a sample of the businesses that expect to capitalize on UAV growth:

- **Agriculture** – UAV operations can provide farmers with information on how their crops are performing and provide the ability to apply pesticides, fertilizer, and seed to specific areas.
- **Infrastructure** – Currently, pipeline and powerline inspections are carried out by manned aircraft. UAV operations could conduct these inspections for reduced costs. Bridge inspections are also traditionally done by humans but are moving toward UAVs to increase safety and efficiency.
- **Retailing** – Companies such as Amazon and Walmart are exploring how UAVs can be used to deliver products ordered online. Google's subsidiary, Wing, received the first FAA approval in the United States for operations as an air carrier, paving the way for drone deliveries.
- **Film Industry** – The movie and TV industry expect to make use of UAVs as aerial filming platforms.
- **Insurance** – UAV operations can provide the insurance industry with information more quickly and efficiently than current methods. For example, UAVs can be used to inspect roofs to evaluate a homeowner's policy, or survey damage from a tornado to speed claims.

- **Real Estate** – UAV use is expected be a boon for the real estate industry, giving the ability to view hard-to-reach areas of properties and provide views that are inaccessible to those on the ground.
- Transportation Management – Use of UAVs can improve system recovery from accidents by clearing them faster.
- **Law Enforcement** – Police departments are interested in using UAVs to aid in tracking suspects and monitoring for illegal activity.
- **Search and Rescue** – UAV operations are ideal for when search and rescue is undertaken in remote areas where access is limited.

Safely integrating UAV operations into the national airspace system remains a challenge. Congress directed the FAA to develop rules for UAV operations by September 2015. The FAA published regulations in June 2016 for the commercial operation of UAVs that weigh up to 55 pounds under Part 107. Part 107 requires that operators understand the Part 107 rules, become an FAA-certified drone pilot by passing a knowledge test, and register the drone with the FAA. Currently, registration is extremely accessible, with the approval lasting for three years and costing $5. The FAA also implemented in December 2015 a UAV registration process for all UAVs weighing more than 0.55 pound.

As UAVs become accepted by the FAA, they will also begin to change the economic landscape. Major industries in the central Puget Sound region in terms of job concentration and growth include information technology, aerospace, maritime, and military, all of which will be affected by the growing popularity of UAVs. Aerospace and military specifically offer areas with the most room for growth and utilization of the technology. In aerospace, companies in the central Puget Sound region will look to incorporate drone technology into new products, especially in areas where an operation typically performed by a human (such as flying an aircraft) could be replaced with remote use. Boeing has demonstrated its interest in UAVs by investing in two unmanned aerial operations—Matternet and Kittyhawk—through their HorizonX Ventures investment arm. UAV use by the military allows for remote monitoring and intelligence gathering, providing new perspectives while keeping users out of harm's way. UAVs have already begun to be adopted in the region, with Puget Sound Energy using drones to inspect electrical lines as well as map infrastructure through LiDAR. These potential changes brought about by UAV use will alter traditional jobs occupied by pilots and technicians, translating them into positions that require new skills with additional knowledge of drone operation, maintenance, and regulation.

5.3.5 Summary

The technological trends influencing general aviation today are important qualitative areas of the industry that are also highly unpredictable, with new regulations and improvements affecting how they are implemented. Increasing regulatory requirements in the form of mandatory ADS-B could dampen demand for general aviation aircraft. Additionally, the shortage of aviation technicians coupled with the looming deadline for ADS-B implementation, could result in a portion of the general aviation fleet being denied use of certain airspace, although that denial should last only until the avionics industry can catch up with ADS-B installation requests.

In the central Puget Sound region, the replacement of avgas and the advent of electric-powered aircraft could increase the types of aircraft and number of pilots, with cheaper and more user- and environmentally friendly options becoming available. However, uncertain certification processes and unknown regulatory hurdles could hamper the implementation of these future technologies. UAVs also offer a different aviation experience and provide options to traditional employers involved in the aviation industry to replace pilots, which could lead to the need for fewer pilots. New investment in the region could also add new technical positions, through companies like Boeing that have a large presence in the central Puget Sound region. In short, it is difficult to predict which direction these technology trends will push general aviation activity; however, given the slow growth general aviation has historically experienced, it is not anticipated that these technology trends will significantly alter the future expectation of little or no general aviation growth.

5.4 GENERAL AVIATION FORECAST

The forecast prepared for the Regional Aviation Baseline Study for general aviation activity addresses two areas: based aircraft and operations. The two indicate which airports will see changes in capacity, usage, and visitors in the future. Additionally, forecasts are a helpful planning tool to identify the timeline and type of growth to best address future facility needs at airports to maintain a successful system in the central Puget Sound region.

The forecasts detailed in this chapter are unconstrained by existing conditions, allowing for a holistic view of the system prior to future facility planning. While the forecasts are unconstrained, it is important to be cognizant of the potential impacts that natural disasters can pose to the aviation system. Disasters such as earthquakes, fires, floods, and volcanic activity are capable of causing short-term, immediate impacts while climate change is a potential long-term impact that could affect the forecast and perhaps viability of some airports. Based on efforts to create a resilient aviation system, the forecast may not reflect future implications and the potential roles of airports within the system during and after natural disasters.

The forecasts were developed through a top-down approach, where the total regional system number of based aircraft and operations from the base year were projected out to the forecast year, then allocated to system airports based on different factors which are explained in-depth.

The following sections describe the full forecast process:

- **Review of Industry Forecasts** summarizes the FAA's two primary published forecasts, the TAF and the FAA Aerospace Forecasts. The Washington State Department of Transportation (WSDOT) system plan forecast was also reviewed.
- **Puget Sound Regional Council Baseline Data** describes the data sources used to establish baseline 2017 data for each of the airports in the PSRC system. Baseline data for based aircraft and general aviation operations is presented.
- **Forecast Methodology and Development** describes the top-down forecasting methodology and forecast process.

- **General Aviation Forecast Results** analyzes and summarizes forecast results within the context of the future landscape of aviation in the region, as well as nationwide.

5.4.1 Review of Industry Forecasts

Each year, the FAA develops two sets of forecasts for a variety of aviation activities. For activity at individual airports, the FAA develops the TAF, which forecasts such factors as aircraft operations, based aircraft, and passenger enplanements. The FAA Aerospace Forecast is a comprehensive analysis of the aviation industry as a whole, focusing on many more factors than the TAF, but not at the individual airport level. The following sections describe these forecasts in greater detail while summarizing results that are relevant to the forecasting process for this study.

5.4.1.1 FAA TERMINAL AREA FORECAST

The TAF is the FAA's official forecast of aviation activity at U.S. airports, forecasting activity at all airports in the NPIAS. The TAF produces demand-driven forecasts that use local and national economic conditions as inputs for their forecasting model. The forecast for an airport is developed independent of that airport's capacity to handle forecasted growth; current constraints of possible future activity are not considered. However, historic constraints are often reflected in the TAF as they have affected historic activity. It should be noted that the historical operations data that the TAF relies on comes from air traffic control tower counts at the minority of airports where available. Otherwise, at the majority of airports, historical operations data are actually estimates made by the airport manager and have a corresponding level of uncertainty.

Items forecasted in the TAF include commercial passenger enplanements, commercial and general aviation aircraft operations, military operations, and based aircraft. In very rare cases, the TAF may forecast negative growth, but is more likely to forecast no growth at airports. This is especially the case at general aviation airports without recent master plans or air traffic control towers, where, as described previously, historical operations data has a greater degree of uncertainty.

5.4.1.2 FAA AEROSPACE FORECAST

The FAA publishes its comprehensive Aerospace Forecasts each year. The edition available for this analysis is the FAA Aerospace Forecast Fiscal Years 2018-2038. The Aerospace Forecast analyzes far more facets of the aviation industry than does the TAF, and also includes forecasts of international activity. Forecasts of aviation activity are based on economic forecasts derived from U.S. and international gross domestic product, disposable income, and oil prices. The FAA Aerospace Forecast employs a variety of forecasting methodologies where appropriate, including market share analysis, econometric model/regression analysis, trends analysis, time series analysis, and simulation. For each item being forecasted, pessimistic, baseline, and optimistic results are produced.

As stated, the FAA Aerospace Forecast analyzes a vastly larger set of aviation activity data than does the TAF. For commercial activity, the Aerospace Forecast offers future projections of operations, enplanements, load factors, demand, capacity, revenue, seat miles, trip length, and fleet mix, among others. General aviation activity forecasted in the Aerospace Forecast includes operations, aircraft manufacturing and shipments, fleet mix and active aircraft, hours flown, pilots, and training. The Aerospace

Forecast also projects activity in air cargo, unmanned aircraft systems, and commercial space transportation.

5.4.1.3 WASHINGTON AVIATION SYSTEM PLAN FORECAST

WSDOT completed a forecast as part of the 2017 Washington Aviation System Plan (WASP) with a 2014 baseline year. For the purpose of this forecast, the growth rates for the 20-year forecast created as part of the WASP were used for reference in determining the growth rates applied to data in the PSRC Aviation Baseline Study forecast. As it relates to general aviation, the WASP forecasted based aircraft and operations from 2014 to 2034.

5.4.2 Puget Sound Regional Council Baseline Data

General aviation includes all facets of aviation other than scheduled commercial service activity and military activity. There are 29 airports and seaplane bases that are considered part of the central Puget Sound region airport system. This forecast accounts for 26 of those facilities. Two airfields are military—Gray Army Airfield and McChord Field—and were excluded from the forecast since they are not open to civilian operations. The Lester State Ultralight Flightpark is closed due to river erosion and is not expected to reopen, so it was also excluded from the forecast.

Forecasts of general aviation activity include projections of both based aircraft and general aviation operations, as defined below:

- **Based Aircraft** – The total number of general aviation aircraft that are operational, airworthy and stored at an airport for the majority of the year, either in hangars or on apron tie-downs.
- **General Aviation Operations** – A single aircraft operation is defined as either a takeoff or landing. When an aircraft lands at and takes off from an airport, it counts as two aircraft operations. Touch-and-go operations, which also include both a takeoff and landing, also count for two total aircraft operations.

Forecasting based aircraft and operations requires accurate base year data. For this forecast, 2017 is used as the base year, with data from multiple sources evaluated for their validity and application in the forecast process. Sources and their use in determining the base year for each category are summarized in this section, followed by Table 5-1, which illustrates the 2017 base year data used in the forecast.

5.4.2.1 BASED AIRCRAFT BASE YEAR

Based aircraft data for airports in the central Puget Sound region was collected from the FAA's National Based Aircraft Inventory Program (NBAIP), National Flight Data Center (NFDC), and TAF and evaluated for validity to create the 2017 base year numbers. Airports with based aircraft data listed with the NBAIP were assumed to be most accurate as these reports come directly from airports and are then validated by the FAA. The NFDC was used as a secondary data source to fill in estimates at airports not included in the NBAIP.

5.4.2.2 AIRCRAFT OPERATIONS BASE YEAR

Similar to based aircraft, operations data was collected from several sources, including the FAA's Air Traffic Activity Data System (ATADS), NFDC, and TAF. ATADS data is only available from towered airports, limiting the use of this source to five airports in the region. At airports without towers, NFDC data was used as this data covers all airports being studied and allows for the use of a consistent data source. Table 5-1 illustrates the 2017 base year data used for based aircraft and operations at airports in the central Puget Sound region.

Table 5-1. Based Aircraft and Operations at Central Puget Sound Region Airports (2017)

ASSOCIATED CITY	AIRPORT NAME	BASED AIRCRAFT	GENERAL AVIATION OPERATIONS
Arlington	Arlington Municipal	321	133,552
Auburn	Auburn Municipal	315	164,539
Bandera	Bandera State	0	300
Bremerton	Bremerton National	170	66,000
Darrington	Darrington Municipal	11	2,310
Eatonville	Swanson Field	13	7,000
Everett	Paine Field	484	108,350
Greenwater	Ranger Creek State	0	450
Kenmore	Kenmore Air Harbor Seaplane Base (SPB) S60	24	43,000
Kent	Norman Grier Field	332	113,850
Lakewood	American Lake	0	50
Monroe	First Air Field	74	18,169
Poulsbo	Port of Poulsbo SPB	0	300
Puyallup	Pierce County	252	100,000
Renton	Renton Municipal	246	135,287
Renton	Will Rogers-Wiley Post Memorial SPB	0	2,387
Seattle	King County International	384	184,182
Seattle	Kenmore Air Harbor SPB W55	2	43,500
Seattle	Seattle-Tacoma International	2	11,087
Seattle	Seattle Seaplanes	4	2,600
Silverdale	Apex Airpark	73	21,330
Skykomish	Skykomish State	0	300
Snohomish	Harvey Field	206	100,220
Spanaway	Shady Acres	36	2,000
Tacoma	Tacoma Narrows	64	88,617
Vashon	Vashon Municipal	32	2,000
TOTAL		**3,044**	**1,351,380**

Source: ATADS, NBAIP, NFDC

5.4.3 Forecast Methodology and Development

There are multiple ways to develop a forecast, with top-down and bottom-up methodologies being two of the most common. For the purpose of this study, a top-down methodology was used. A benefit to using this particular methodology is that growth is accounted for regionally, rather than by individual airport. Individual airport forecasts can lead to an inaccurate portrayal of growth where the same activity in the region could theoretically be claimed by multiple airports, resulting in double counting. Additionally, this methodology allows for realistic forecasted growth compared to individual airport forecasts developed from a bottom-up methodology that tend to be more aggressive in projecting growth. Downsides to the top-down approach is the lack of detail included in individual airport forecasts as well as the low availability of consistent data for every airport in the system.

The determination of forecast growth rates and how future growth is allocated as part of the top-down methodology is discussed in the following section.

5.4.3.1 TOP-DOWN METHODOLOGY

The top-down methodology incorporates a collective view of the region's projected growth and requires distribution of the growth to the region's airports based on industry factors, historic data, and other individual factors. In this forecast, total based aircraft and operations were projected out to 2050 using a growth rate determined by analyzing historic growth, the WASP forecast, operations per based aircraft, and the FAA Aerospace Forecast.

5.4.3.2 DETERMINING GROWTH RATE AND ALLOCATION

Based Aircraft

The 2050 forecast of based aircraft was created using the compound annual growth rate (CAGR) from the FAA Aerospace Forecast and the WASP. This growth rate provided a snapshot of projections at the national and state levels to guide the forecast of central Puget Sound region's growth. The FAA Aerospace Forecast projects a CAGR of 0.00 percent while the WASP projects a CAGR of 1.10 percent, averaging out to a CAGR of 0.55 percent. Applying this growth rate annually to the number of based aircraft in 2017 out to 2050 yielded the number of based aircraft that were to be allocated to the 26 system airports.

The decision to use the average of the FAA aerospace and WASP growth rates stems from the benefits and scale each offers to the forecast prepared for the Regional Aviation Baseline Study. The FAA Aerospace Forecast is a national-level forecast that provides a broad outlook on general aviation activity. Overall, the forecast projects that piston aircraft activity will decline while turbine-aircraft activity will grow. The WASP forecast provides a state-level look at activity and projects aggressive growth, partially due to the socioeconomic growth in the central Puget Sound region and the state as a whole. The average of these two forecasts pulls from differing trends at the national and state levels that reflect the central Puget Sound region's large base of piston-powered aircraft and increasing student pilot population.

To begin allocating the total growth from 2017 to 2050, the forecasted number of based aircraft were allocated to each airport based upon their proportional share of the 2017 total. For example, an airport that had 3 percent of the total based aircraft in 2017 was assigned 3 percent of the total based aircraft forecasted for 2050. Next, airports identified with zero or negative growth from historic TAF data were held constant, so that their number of based aircraft in 2050 matched what they had in 2017. Finally, airports responding to the study survey that identified having a waiting list of aircraft seeking hangar space were compiled, with based aircraft allocated by the percentage of total aircraft on waiting lists. The forecast in this instance assumes steady growth at many of the region's airports with proportionally more growth at airports where there is current demand for aircraft storage.

<u>Aircraft Operations</u>

Forecasted aircraft operations in 2050 were developed using the same method as based aircraft, with a minor difference in how operations were allocated. The 2050 year was grown from the 2017 base year data at the average CAGRs of the FAA Aerospace Forecast and the WASP. The FAA Aerospace Forecast projected a CAGR of 0.83 percent while the WASP projected a CAGR of 0.93 percent, resulting n an average CAGR of 0.88 percent. While the growth rate for based aircraft is lower, operations can reflect activity from aircraft based outside the region. Operations per based aircraft also indicate airports that may see more activity from non-based aircraft and further augment the growth rate of operations. Airports with high numbers of operations per based aircraft include Tacoma Narrows with more than 1,400 in 2017 and the two Kenmore Air Harbor seaplane bases at Kenmore and Seattle Lake Union that mostly store Kenmore Air aircraft.

Airports were allocated a share of the total growth based on their base year percentage of total operations, with airports that experienced zero or negative growth in historic TAF data held constant. For certain airports with more frequent turbine activity, a qualitative assessment was used to allocate operations based on reported activity from airport manager survey results. Overall results of the operations forecast indicate growth at many airports in the region, with airports experiencing heavy turbine-aircraft operations projected to see increased operations.

5.4.4 General Aviation Forecast Results

The based aircraft and operations forecasts are summarized in the following sections, providing insight into the projected growth of general aviation in the central Puget Sound region.

Additionally, as part of the forecasting process, the FAA scrutinizes any projections that fall outside of 10 percent of the TAF forecast five years out from the base year and 15 percent 10 years out from the base year. For this study, this means that 2022 and 2027 projections will be evaluated to see if they fall within these parameters.

5.4.4.1 GENERAL AVIATION-BASED AIRCRAFT

<u>Based Aircraft Forecast</u>

Table 5-2 shows the forecasted growth in based aircraft from 2017 to 2050. Notable airports that are projected to experience growth include Harvey Field, Tacoma Narrows, and Bremerton National. These airports are smaller, recreationally focused airports that would see growth in the basing of single-engine piston aircraft, which make up 85 percent of the fleet in the region.

<u>Based Aircraft Comparison to TAF</u>

Guidance in Advisory Circular 150/5070-7, *The Airport System Planning Process*, calls for comparisons of the system plan forecast to other forecasts, and specifically mentions the FAA's TAF. As described previously, there is an element of uncertainty in the TAF data, especially at non-towered airports. However, because the FAA relies on the TAF as indicated in Advisory Circular 150/5070-7, this section compares the results of the forecast to the TAF and provides explanations for those airports where the results fall outside of the expected parameters.

Table 5-2. Based Aircraft Forecast at Central Puget Sound Region Airports

ASSOCIATED CITY	AIRPORT NAME	2017	2050	CAGR
Arlington	Arlington Municipal	321	385	0.6%
Auburn	Auburn Municipal	315	378	0.6%
Bandera	Bandera State	0	0	0.0%
Bremerton	Bremerton National	170	227	0.9%
Darrington	Darrington Municipal	11	13	0.5%
Eatonville	Swanson Field	13	16	0.6%
Everett	Paine Field	484	580	0.5%
Greenwater	Ranger Creek State	0	0	0.0%
Kenmore	Kenmore Air Harbor SPB S60	24	24	0.0%
Kent	Norman Grier Field	332	398	0.6%
Lakewood	American Lake	0	0	0.0%
Monroe	First Air Field	74	89	0.6%
Poulsbo	Port of Poulsbo SPB	0	0	0.0%
Puyallup	Pierce County	252	252	0.0%
Renton	Renton Municipal	246	309	0.7%
Renton	Will Rogers-Wiley Post Memorial SPB	0	0	0.0%
Seattle	King County International	384	435	0.4%
Seattle	Kenmore Air Harbor SPB W55	2	2	0.0%
Seattle	Seattle-Tacoma International	2	2	0.0%
Seattle	Seattle Seaplanes	4	4	0.0%
Silverdale	Apex Airpark	73	87	0.5%
Skykomish	Skykomish State	0	0	0.0%
Snohomish	Harvey Field	206	291	1.1%
Spanaway	Shady Acres	36	43	0.5%
Tacoma	Tacoma Narrows	63	83	0.8%
Vashon	Vashon Municipal	32	32	0.0%
TOTAL		**3,044**	**3,650**	**0.6%**

Source: FAA NBAIP, NFDC, FAA Aerospace Forecast, and WASP

In comparison to the TAF forecast, the forecast prepared for the Regional Aviation Baseline Study of based aircraft falls within the parameters for all airports except for three, which can be explained based on the choice of available base year data. As seen in Table 5-3, Arlington Municipal Airport, Pierce County – Thun Field, and Harvey Field all fall outside the FAA's guidance due to the decision to use data from the NBAIP for base year data. Because data from the NBAIP is reported by the airports and validated by inspection, this data was considered more accurate compared to the available data from the TAF. In the case of Arlington Municipal and Harvey Field, both have significantly less base year aircraft than what is reported in the TAF for 2017, differing by 33 and 23 percent, respectively when compared to the TAF. Pierce County – Thun Field experienced a dramatic swing in TAF estimates from 2016 to 2017 dropping from 220 to 60 based aircraft, while the base year data shows 252 based aircraft in 2017. It should be noted that not all system airports are part of the TAF, so the totals shown in Table 5-2 do not match the totals in Table 5-1.

Table 5-3. Forecasted Based Aircraft Comparison to Terminal Area Forecast

ASSOCIATED CITY	AIRPORT NAME	2017			2022			2027		
		BASE YEAR	TAF	CHANGE	FORECAST	TAF	CHANGE	FORECAST	TAF	CHANGE
Arlington	Arlington Municipal	321	479	33%	331	495	33%	340	512	34%
Auburn	Auburn Municipal	315	314	0%	328	356	8%	342	404	15%
Bremerton	Bremerton National	170	172	1%	179	191	7%	187	210	11%
Everett	Paine Field	484	530	9%	497	544	9%	509	559	9%
Kenmore	Kenmore Air Harbor SPB S60	24	24	0%	24	24	0%	24	24	0%
Puyallup	Pierce County	252	60	-320%	252	72	-250%	252	83	-204%
Renton	Renton Municipal	246	270	9%	256	272	6%	265	275	4%
Seattle	King County International	384	369	-4%	390	387	-1%	396	408	3%
Seattle	Seattle-Tacoma International	2	2	0%	2	2	0%	2	2	0%
Snohomish	Harvey Field	206	266	23%	219	277	21%	232	287	19%
Tacoma	Tacoma Narrows	63	64	2%	66	64	-3%	69	64	-8%
Vashon	Vashon Municipal	32	34	6%	32	35	9%	32	35	9%
TOTAL		2,499	2,584	3%	2,574	2,719	5%	2,649	2,863	7%

Source: FAA NBAIP, NFDC, and TAF

5.4.4.2 GENERAL AVIATION OPERATIONS

Operations Forecast

Table 5-4 shows the forecasted growth in operations from 2017 to 2050. Airports with significant use by turbine-powered aircraft are projected for growth due to the predicted increase in business usage and the trend that shows turbine-powered aircraft surpassing piston aircraft production. Tacoma Narrows, Bremerton National, and Arlington Municipal are all predicted to grow at CAGRs exceeding 1.0 percent.

Operations Comparison to TAF

Similar to the comparison of based aircraft, the forecast prepared for the Regional Aviation Baseline Study of general aviation operations meets FAA guidance for comparison to the TAF, with Seattle-Tacoma International being the only airport outside parameters. Sea-Tac data was taken from ATADS, an accurate source of operations from a control tower, which results in a discrepancy with TAF data, as shown in Table 5-5. In 2017, the TAF reported 49 percent fewer general aviation operations than what was reported in ATADS. The number of general aviation operations was held constant through the forecast period, so the gap between the two data sources closed somewhat. Nevertheless, by 2027, the TAF was still forecasting 27 percent fewer general aviation operations than the forecast prepared for the Regional Aviation Baseline Study. It should be noted that not all system airports are part of the TAF, so the totals shown in Table 5-4 do not match the totals in Table 5-3.

Table 5-4. Operations Forecast at Central Puget Sound Airports

ASSOCIATED CITY	AIRPORT NAME	2017	2050	CAGR
Arlington	Arlington Municipal	133,552	195,440	1.2%
Auburn	Auburn Municipal	164,539	164,540	0.0%
Bandera	Bandera State	300	400	0.9%
Bremerton	Bremerton National	66,000	107,260	1.5%
Darrington	Darrington Municipal	2,310	3,090	0.9%
Eatonville	Swanson Field	7,000	9,360	0.9%
Everett	Paine Field	108,350	182,620	1.6%
Greenwater	Ranger Creek	450	600	0.9%
Kenmore	Kenmore Air Harbor SPB S60	43,000	61,610	1.1%
Kent	Norman Grier Field	113,850	152,190	0.9%
Lakewood	American Lake	50	70	1.0%
Monroe	First Air Field	18,169	24,290	0.9%
Poulsbo	Port of Poulsbo SPB	300	400	0.9%
Puyallup	Pierce County	100,000	120,300	0.6%
Renton	Renton Municipal	135,287	180,840	0.9%
Renton	Will Rogers-Wiley Post Memorial SPB	2,387	3,190	0.9%
Seattle	King County International	184,182	238,450	0.8%
Seattle	Kenmore Air Harbor	43,500	62,270	1.1%
Seattle	Seattle-Tacoma International	11,087	11,090	0.0%
Seattle	Seattle Seaplanes	2,600	3,180	0.6%
Silverdale	Apex Airpark	21,330	28,510	0.9%
Skykomish	Skykomish State	300	400	0.9%
Snohomish	Harvey Field	100,220	100,220	0.0%
Spanaway	Shady Acres	2,000	2,670	0.9%
Tacoma	Tacoma Narrows	88,617	151,470	1.6%
Vashon	Vashon Municipal	2,000	2,000	0.0%
TOTAL		**1,351,380**	**1,806,460**	**0.9%**

Source: FAA ATADS, NFDC, FAA Aerospace Forecast, and WASP

5.4.5 Summary

The forecasting process helps identify airports expected to experience growth and require planning efforts to maintain levels of service. The based aircraft forecast indicates growth at some airports (see Table 5-5) that may see more piston engine operations, as the majority of aircraft in use fall under this category. Examples of these airports include the following:

- Bremerton National
- Norman Grier Field
- Harvey Field
- Tacoma Narrows

For other airports, general aviation activity is expected to exhibit little or no growth, reflecting the stagnation in piston aircraft activity predicted by the FAA. Forecasted operations growth will rely more on the increased usage of turbine aircraft for business, charter, and medical operations. Notable airports that are forecasted for operational growth include the following:

- Bremerton National
- Tacoma Narrows
- Arlington Municipal

Both forecasts reflect current trends in the general aviation industry, as turbine-powered aircraft surpass piston aircraft production and the increased number of student pilots continue to learn and work with piston-powered aircraft located at local airports.

Table 5-5. Forecasted Operations Comparison to Terminal Area Forecast

ASSOCIATED CITY	AIRPORT NAME	2017 BASE YEAR	2017 TAF	2017 CHANGE	2022 FORECAST	2022 TAF	2022 CHANGE	2027 FORECAST	2027 TAF	2027 CHANGE
Arlington	Arlington Municipal	133,552	133,552	0%	142,929	139,384	-3%	152,306	145,479	-5%
Auburn	Auburn Municipal	164,539	164,539	0%	164,539	178,613	7%	164,539	190,045	13%
Bremerton	Bremerton National	66,000	66,000	0%	72,251	77,129	6%	78,503	90,164	13%
Everett	Paine Field	108,350	99,245	-9%	119,603	117,517	-2%	130,855	118,869	-10%
Kenmore	Kenmore Air Harbor SPB S60	43,000	43,000	0%	45,819	43,000	-7%	48,638	43,000	-13%
Puyallup	Pierce County	100,000	100,000	0%	103,076	109,579	6%	106,152	120,086	12%
Renton	Renton Municipal	135,287	128,961	-5%	142,190	148,938	5%	149,092	152,637	2%
Seattle	King County International	184,182	170,736	-8%	192,404	174,376	-10%	200,627	177,561	-13%
Seattle	Seattle-Tacoma International	11,087	7,434	-49%	11,087	8,292	-34%	11,087	8,614	-29%
Snohomish	Harvey Field	100,220	100,220	0%	100,220	102,396	2%	100,220	104,343	4%
Tacoma	Tacoma Narrows	88,617	87,596	-1%	98,140	92,617	-6%	107,662	93,662	-15%
Vashon	Vashon Municipal	2,000	2,000	0%	2,000	2,117	6%	2,000	2,240	11%
TOTAL		**1,136,834**	**1,103,283**	**-3%**	**1,194,258**	**1,192,158**	**0%**	**1,251,681**	**1,246,700**	**0%**

Source: FAA ATADS, NFDC, and TAF

REGIONAL AVIATION BASELINE STUDY: WORKING PAPER 1

Chapter 6
Air Cargo Trends and Forecast

June 10, 2019

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Contents

6. Air Cargo Trends and Forecast 6-1
- 6.1 AIR CARGO MARKET PROFILE 6-1
  - *6.1.1 Introduction 6-1*
  - *6.1.2 Air Cargo Industry Background 6-1*
  - *6.1.3 Air Cargo Carriers 6-2*
  - *6.1.4 Third-Party Logistics Companies 6-3*
  - *6.1.5 Freight Forwarders 6-4*
  - *6.1.6 Air Truckers 6-5*
  - *6.1.7 Air Cargo Activity (North America, West Coast, and Regional) 6-5*
  - *6.1.8 Summary 6-17*
- 6.2 AIR CARGO TRENDS 6-19
  - *6.2.1 Recent Air Cargo Market Trends 6-19*
  - *6.2.2 Global Economic Trends 6-21*
  - *6.2.3 Washington State Economic Trends 6-22*
- 6.3 COMMERCIAL AIR CARGO FORECAST (CENTRAL PUGET SOUND REGION) 6-29
  - *6.3.1 Introduction 6-29*
  - *6.3.2 Factors Affecting Industry Growth 6-30*
  - *6.3.3 Inhibitors to Growth 6-30*
  - *6.3.4 Forecast of Air Cargo Tonnages 6-31*
  - *6.3.5 Forecast of Freighter Aircraft Operations 6-38*
  - *6.3.6 Forecast Summary 6-43*

Tables

Table 6-1. Select Historical Air Cargo Activity (metric tons) (West Coast) 6-7
Table 6-2. Commercial Air Cargo Airports (Year 2017 metric tons) (Central Puget Sound Region) 6-8
Table 6-3. Historical Air Cargo (metric tons) (Seattle-Tacoma International Airport) 6-10
Table 6-4. Recent Year Belly and Freighter Cargo (metric tons) (Seattle-Tacoma International Airport) 6-12
Table 6-5. Market Share of Top 20 Air Cargo Airlines by weight (Seattle-Tacoma International Airport) 6-13
Table 6-6. All-Cargo Fleet Mix (2017) (Seattle-Tacoma International Airport) 6-14
Table 6-7. Air Cargo Trends (King County International Airport) 6-15
Table 6-8. Freighter Fleet Mix (2017) (King County International Airport) 6-16
Table 6-9. General Aviation Air Cargo Trends for Paine Field Airport (metric tons) 6-17
Table 6-10. Freighter Fleet Mix (2017) (Paine Field Airport) 6-17
Table 6-11. Commercial Air Cargo Trends (metric tons) (Central Puget Sound Region) 6-18
Table 6-12. Air Cargo Forecast (metric tons) (Central Puget Sound Region) 6-30
Table 6-13. Air Cargo Projections (metric tons) (Seattle-Tacoma International Airport) 6-33
Table 6-14. Air Cargo Projections (King County International Airport) 6-37
Table 6-15. World Freighter Fleet Size Categories 6-38
Table 6-16. Forecast of Air Cargo Freighter Operations (Seattle-Tacoma International Airport) 6-40
Table 6-17. Forecast of Air Cargo Freighter Operations (King County International Airport) 6-42
Table 6-18. Commercial Air Cargo Tonnage Forecast 6-44
Table 6-19. Forecast of Air Cargo Freighter Aircraft Operations 6-46

Figures

Figure 6-1. Top 20 Air Cargo Airports 2017 (United States)....6-6
Figure 6-2. Historical Air Cargo Trends (metric tons) (Seattle-Tacoma International Airport) 6-11
Figure 6-3. Air Cargo Trends (King County International Airport) 6-15
Figure 6-4. World GDP Forecast 2018-2037 (Asian Economies Will Lead Economic Growth)....6-19
Figure 6-5. Air Imports and Exports (Washington State)....6-23
Figure 6-6. Air Exports and Imports by Region (Washington State) 6-23
Figure 6-7. Key Regional Export Industry Job Growth (2010–2015)....6-24
Figure 6-8. Air Cargo Projections (Seattle-Tacoma International Airport) 6-35
Figure 6-9. Air Cargo Tonnage Forecast 6-45

Acronyms

ATI .... Air Transport International
ATS .... Aviation Technical Services
CAAGR .... Compounded Average Annual Growth Rate
EMDE .... Emerging market and developing economies
FTK .... Freight Ton Kilometers
GDP .... Gross Domestic Product
IATA .... International Air Transport Association
KCIA .... King County International Airport
RFS .... Road Feeder Service
RTK .... Revenue Ton Kilometers
SAMP .... Seattle-Tacoma International Airport Sustainable Airport Master Plan
YOY .... Year-over-year

6. Air Cargo Trends and Forecast

6.1 AIR CARGO MARKET PROFILE

6.1.1 Introduction

This report profiles the air cargo market in the central Puget Sound region, which comprises King, Pierce, Kitsap, and Snohomish Counties. The four-county region, described in detail in Chapter 1, Introduction, is in the central Puget Sound region of Washington state, which is approximately half way between Portland, Oregon, to the south, and Vancouver, Canada, to the north. The region has a population of over 4.1 million in an area of 6,300 square miles.

Problematic to this effort is the lack of reliable historical air cargo data for individual airports. Air cargo data for many airports within the boundaries of the central Puget Sound region does not exist, or the data is often incomplete or inconsistent.

To remedy this situation, this report relies on historical air cargo data published by the U.S. Department of Transportation Bureau of Transportation Statistics in Form 41 T-100 Market and Segment data for King County International Airport (KCIA) and Paine Field Airport. The Port of Seattle provided historical data for Seattle-Tacoma International Airport (Sea-Tac). Air cargo tonnages for other airports cited in this report utilizes data collected by Airports Council International. Air cargo tonnages used in this report are in metric tons unless otherwise noted.

6.1.2 Air Cargo Industry Background

Economic growth, international trade, and air transport are inextricably linked. Air cargo services enable global marketing of goods and services, providing a competitive transportation medium, especially for time-sensitive products and trade with distant markets. According to the industry group Airlines for America, U.S. airlines transport over 50,000 tons of cargo every day.

According to a survey by the Air Transport Action Group, an independent coalition of air transport organizations and companies, over 80 percent of businesses reported that air services are sometimes important for their impact on sales, with almost 60 percent considering them either vital or very important. Companies reported that on average, 25 percent of all sales depend on air services. In addition, approximately 25 percent of businesses report that air transport services have a substantial impact on their ability to exploit economies of scale, and over 40 percent report an impact to some extent.

Air cargo service, specifically, comprises the following:

- Provides fast and reliable delivery of high-value products, which is especially relevant to central Puget Sound region industries such as the pharmaceutical/biotechnology, aircraft assembly, and aerospace equipment sectors
- Improves companies' handling of returns and complaints, which allows a quick turnaround of repairs or delivery of replacement parts
- Facilitates the development of electronic commerce (e-commerce), enabling companies to transport online shopping orders quickly and reliably between countries, and allowing products to be stored in large fulfillment centers, which reduces retail and distribution costs
- Facilitates improved stock management and production techniques, which reduces companies' storage costs, losses due to stock outages, and disruption caused by failure of machinery on production lines
- Facilitates the development of the express carrier industry, which provides guaranteed, rapid, door-to-door delivery services and increasingly offers logistics support for companies

With air cargo typically outpacing Gross Domestic Product (GDP) growth by a factor of two, The Boeing Company predicts that the volume of global air cargo will at least double in two decades.

6.1.3 Air Cargo Carriers

In its simplest form, the air cargo market is made up of freight and mail. Air mail in the United States is contracted out by the U.S. Postal Service and travels in the belly hold of commercial passenger aircraft and on freighters operated by contractors. Air freight refers to all cargo other than mail. Air cargo carriers can be divided into the following components: passenger airlines, traditional all-cargo carriers, and service-oriented integrated/express all-cargo carriers.

Air cargo carriers generally operate under two distinct business models: door-to-door and airport-to-airport. Each model is based on distinctly differing characteristics, varies in its deployment of resources, has differing levels of required capitalization, and yields significantly different levels of return on investment.

The more traditional air cargo business model is the airport-to-airport service. As the name implies, this model is based on the carriage of freight from an originating airport to a destination airport. Freight is delivered to the originating airport from the shipper's dock by a third-party service—typically a freight forwarder—who will then tender it to the airline. At the destination airport, a third-party service—typically an agent of the originating freight forwarder—will take possession of the freight for delivery to the consignee. This type of airport-to-airport carriage is provided by both the passenger and all-cargo airlines.

The cargo carrying passenger airlines (e.g., American Airlines and Delta Air Lines) emphasize the use of lower deck (or "belly space") of their scheduled passenger aircraft, while the traditional air cargo airlines (e.g., Polar Air Cargo, Cargolux, and Nippon Cargo Airlines) have entire fleets dedicated to air cargo and have few limits on cargo size or type. Some passenger carriers (e.g., Alaska Airlines, China Airlines, and Korean Air) also have dedicated freighter aircraft, and others may operate “combis" (i.e., aircraft that are designed to carry a combination of both cargo and passengers on the main deck).

The carriers using the door-to-door model are referred to as the integrator/express carriers because they integrate the complete line of services in the air cargo logistics chain from initial pick up from the shipper’s dock to final delivery at the consignee’s door into one complete package. Unique to the integrator/express carriers is that they typically own and operate their own aircraft, ground transport, and IT systems, and essentially provide complete custodial control of the shipment and offer real time shipment tracking. These assets, all under control of one organization, make possible the seamless flow of goods that provide shippers with substantial reductions in their lead times—a critical service element for most of the industries around the world. The integrator/express carriers fly more than half of the world’s wide-body freighters and generated 43 percent of the air cargo industry revenue in 2017.

Within the past few years, a new air cargo airline model has begun to emerge, referred to as “middle-mile” air cargo carriers. The most obvious example is Amazon Air. Middle-mile cargo carriers (e.g., Amazon Air) play an important role in the air logistics chain by focusing on the rapid transport of e-commerce shipments between ports of entry and regionally based e-commerce fulfillment centers. That is, rather than focusing on last-mile delivery to the consignee—whether to a freight forwarder, business, or household—the middle-mile air cargo carrier focuses on supporting supply chain velocity, or in more simpler terms, the speedier delivery of packages within the retailers’ internal distribution system. Last-mile delivery is then often sourced out to companies such as UPS, FedEx, DHL, or the U.S. Postal Service.

The distinction between express and general air cargo is beginning to blur. Traditional providers are expanding their time-definite offerings, and express carriers, freight airlines, and postal authorities are consolidating. Ultimately, the air cargo customer benefits from increased service options and lower prices as market pressure brings competing products into the market.

In all airline business models, third-party logistics services are provided both in-house and by contract management companies. For the traditional air cargo carrier, the freight forwarder is the primary customer. In the case of the integrator/express carrier, the shipper is the primary customer and the integrator airline offers supply chain management services as a core competency and a significant part of their business.

6.1.4 Third-Party Logistics Companies

As with the airlines, third-party logistics providers (3PLs) or contract logistics management companies (sometimes referred to as 4PLs) offer a variety of services based on differing business models. Within the air cargo industry, freight forwarders (sometimes referred to as indirect carriers) are the core of 3PL providers. As freight forwarders attempt to compete with the integrator/express airlines for yield and market share, many forwarders are offering value added services to the list of services they have traditionally offered.

The 3PL concept has been evolving for many years, but the basic premise remains unchanged: provide outsourced logistics services, freeing the client to focus on running core operations.

6.1.5 Freight Forwarders

Freight forwarders are 3PL companies that concentrate on originating traffic from shippers. They serve both the shipper and air carrier by consolidating small shipments into larger consignments, palletize or containerize shipments for intermodal movement, issue their own documents for the intermodal haul, take legal responsibility for the goods being moved, provide through rates, perform pickup and delivery services, and render other useful functions to simplify the intermodal process and to move freight expeditiously. They rely on the airlines to provide line-haul carriage, and in some cases, other 3PLs for customs clearance and final delivery. Under the new Transportation Security Administration security regime, freight forwarders can also provide air cargo screening and inspection as a regulated Certified Cargo Screening Facility.

The basic forwarder's business model is based on obtaining a wholesale rate from the airline by consolidating many small shipments into single containers. By obtaining a lower container rate from the air carrier, forwarders maximize the spread between the charges they pay the carriers and the charges they collect on each individual shipment they load into the container. This spread is their operating margin.

However, not all air freight forwarders' terminal locations produce large consolidations. Smaller cities often do not have a large enough market to produce the required volume to build consolidations for a single destination. For this reason, forwarders will move some individual shipments from smaller cities to a larger city in their system. At the larger airport cities (sometimes known as gateway or hub cities), these small shipments are included into the consolidation being built at that location. The ability to move these smaller shipments in another terminal's larger consolidation is an important advantage for air freight forwarders' operation.

Many forwarders (e.g., Panalpina, Kuehne & Nagel, Expeditors International of Washington, and Schenker) have large multinational networks, while others (e.g., Alaska Freight Forwarding and Pacific Alaska Freightways) specialize in specific local markets.

Many multinational and regional air freight forwarders have a physical presence in the central Puget Sound region, including Alaska Air Forwarding, Castle Logistics, CEVA Logistics, DHL Global Forwarding, FedEx Trade Networks, Hellmanns, UPS Supply Chain Logistics, Panalpina, Kuehne & Nagel, Schenkers/Bax Global, and Expeditors International of Washington.

To be discussed in a later section, the future for air cargo growth in Washington state relies to a significant extent on the perceptions of the international forwarder community toward Seattle as a cost effective and efficient place to do business.

6.1.6 Air Truckers

Trucking is an important component of the air cargo industry. As with the all-cargo airlines, air truckers provide a variety of services. Some air truckers specialize in local pickup and delivery, while others provide nationwide long-haul service. Some air trucking companies (such as Jet Airways of the U.S. Inc.) are registered airlines but do not operate any aircraft. Rather, they provide regularly scheduled service between North American city pairs using air waybills. This service is referred to as road feeder service (RFS). More than 1,000 city pairs in the United States and Canada are served by RFS.

Many foreign flag air carriers use RFS to expand their operational capability in the United States. This allows the air carrier to fly to a limited number of gateways but provide service to many other cities using a combination of scheduled air and truck service. The air carriers publish schedules showing the arrival and departure times of both airplanes and RFS truck service for the cities they serve. The fastest growing segment of air cargo within the United States is the trucking of air shipments between airports.

6.1.7 Air Cargo Activity (North America, West Coast, and Regional)

6.1.7.1 AIR CARGO MARKET (UNITED STATES)

According to Boeing, air cargo moving to, from, and within the United States and Canada grew 4.4 percent in 2016 and 10 percent in 2017, reflecting a full recovery from the global economic downturn.

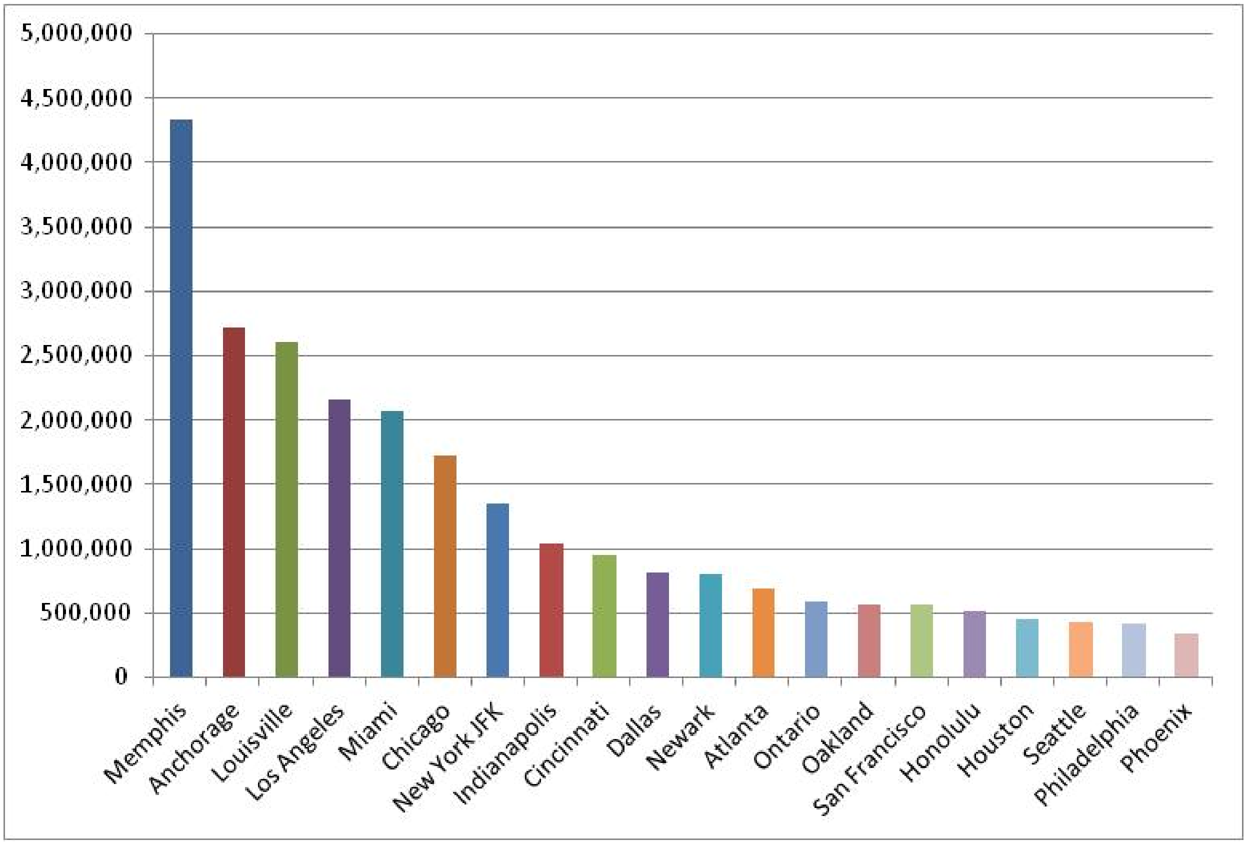
Figure 6-1 shows the top 20 U.S. air cargo airports for 2017. As can be observed in this figure, the U.S. air cargo market is dominated by the integrator hub airports of Memphis and Louisville and by the international passenger gateway airports of Miami, Los Angeles, Chicago, and New York City (John F. Kennedy International). Anchorage International Airport has minimal enplaned and deplaned air cargo, but acts as a transshipment hub for air cargo freighters serving the Asia–North America market. Other cargo airports depicted in Figure 6-1 such as Cincinnati (DHL), Indianapolis and Oakland (FedEx), and Ontario (UPS) have generated significant air cargo volumes in their roles as regional hubs.

Much of the growth in air cargo at U.S. airports over the past five years has been in the international market. Domestic air cargo in United States has undergone a significant decline since year 2000 as passenger airlines downsized the size of their aircraft and the exit of scheduled traditional domestic air freight airlines from the U.S. market.

Continuing the trend of past years, passenger carriers continue to rely on trucks to offset the loss of domestic air capacity that has resulted from reduced fleet size and the shift of wide-body airplanes from domestic to international markets. Truck flights allow passenger airlines to offer service comparable to that of pure cargo carriers.

With the decline in domestic passenger lower deck (belly) cargo capacity, the express/integrator share of the U.S. domestic air cargo market has grown to 90 percent, up from 71 percent in 2006. In the past year or so, the emergence of e-commerce as a market force has given rise to a new type of airline represented by Prime Air that focuses on a purely domestic express delivery.

Figure 6-1. Top 20 Air Cargo Airports 2017 (United States)



Source: Airports Council North America

6.1.7.2 AIR CARGO MARKET (U.S. WEST COAST)

The U.S. West Coast air cargo markets are well served by a combination of passenger carriers offering both lower deck and full freighter capacity, by the integrated/express and traditional all-cargo carriers providing both door-to-door service and line-haul airport-to-airport service, and by an extensive network of freight forwarders, consolidators, customs brokers, and air trucking firms.

Air cargo volumes at most major West Coast gateway airports declined after year 2000 due to modal shift from domestic air to truck and the downsizing of passenger aircraft. Due to the impact of globalization, air cargo growth has recovered, spurred by international shipments at large international gateway airports and by express cargo driven by e-commerce. The West Coast air cargo market has grown approximately 6 percent per year over the past five years.

Table 6-1 provides historical air cargo activity at select West Coast airports.

Table 6-1. Select Historical Air Cargo Activity (metric tons) (West Coast)

AIRPORT	2000	2007	2012	2017	2017 MARKET SHARE
Los Angeles (LAX)	2,038,784	1,884,317	1,780,998	2,158,324	43%
Ontario (ONT)	464,164	483,309	412,661	593,947	12%
Oakland (OAK)	685,425	647,594	481,280	567,356	11%
San Francisco (SFO)	869,839	562,933	380,791	561,805	11%
Seattle (SEA)	455,997	319,013	283,500	425,856	8%
Vancouver (YVR)	251,771	255,412	227,203	313,437	6%
Portland (PDX)	282,019	254,754	199,129	236,822	5%
Seattle (BFI)	145,000	128,777	103,014	113,718	2%
Spokane (GEG)	61,009	47,696	55,706	65,396	1%

Source: LAX, OAK, SFO, ONT, PDX, YVR: ACI-NA; BFI year 2000 is estimated, year 2007 the KBFI Strategic Plan-BFI, year 2012 and 2017 from DOT T-100 form; SEA from Port of Seattle records; GEG from airport records.

As can be seen in Table 6-1, the dominant air cargo airport on the West Coast is Los Angeles International Airport with a 43 percent market share. Ontario International is a distant second followed closely by Oakland, San Francisco, and Seattle. Los Angeles International ranks as the 13th largest air cargo airport in the world and the fourth largest in the United States behind Memphis International Airport (the primary hub for FedEx), Louisville International (the primary hub for UPS), and Miami International.

Los Angeles International Airport dominates the West Coast in air cargo due to several factors. The most significant reasons include the size of the local Southern California market; the number of wide-body aircraft (both passenger and freighter) in service; the variety of destinations served; the frequency of departures and arrivals; the large investment in infrastructure and facilities; and the network of air freight forwarders that has developed in the immediate vicinity of the airport. Secondary reasons why Southern California air cargo market dominates the West Coast include the large presence of warehouse, distribution centers and logistics company operators located in the Inland Empire of San Bernardino and Riverside Counties that service both the Los Angeles/Long Beach seaports and Los Angeles International Airport.

The air cargo markets at Ontario International, Oakland International, KCIA, and Spokane International are dominated by the integrator/express airlines. Ontario International is the West Coast hub for UPS, and Oakland International is the West Coast hub for FedEx. King County International Airport is the UPS gateway airport for western Washington, and Spokane is a transload hub for the Pacific Northwest for both UPS and FedEx. Sea-Tac is the western Washington gateway for FedEx, DHL, and Amazon Air.

Ted Stevens Anchorage International Airport (not included in Table 6-1) ranks second in air cargo in the United States according to Airports Council International. It is a unique airport in that it has a very small local market but serves as a technical stop and transfer hub for air cargo carriers serving the trans-Pacific market and represents an important link for air cargo from Washington state.

Secondary West Coast airports competing within the Seattle air cargo market shed include Portland, Vancouver BC, Boise Air Terminal, Salt Lake City International, Reno-Tahoe International, and San Jose International.

6.1.7.3 AIR CARGO (WASHINGTON STATE AND THE CENTRAL PUGET SOUND REGION)

As documented in the recently completed Washington State Legislature Joint Transportation Committee (JTC) report *Washington State Air Cargo Movement Study*, air cargo in Washington state is primarily generated by activity at Sea-Tac, KCIA, and Spokane International Airport (located in eastern Washington state). Small commercial passenger airports within the state account for less than 4 percent of the total air cargo volumes moved in 2017.

The Seattle air cargo market is by far the largest in the state. Sea-Tac and KCIA combined have an over 85 percent share of the total Washington state market. Spokane International, the third-largest cargo airport in the state, represents an approximately 11 percent share of the Washington state market.

Sea-Tac dominates the state air cargo. It handles two-thirds of the cargo tonnage and has the greatest variety of cargo offerings in the central Puget Sound with a mix of domestic and international belly cargo, domestic and international freighter cargo, as well as integrator/express cargo generated by FedEx, DHL and Amazon Air. Air cargo at KCIA is generated almost exclusively by the integrator all-cargo carrier UPS.

Paine Field generated approximately 19,300 metric tons of air cargo in 2017. Almost all the air cargo at Paine Field is entirely related to the Boeing aircraft assembly process and for all intents and purposes should be considered general aviation rather than commercial activity. Freighter aircraft utilizing Paine Field include the specially modified 747 Dreamlifter as a part of the Boeing Company's 787 airplane manufacturing and assembly program, as well as large specialized aircraft for oversized parts such as the Antonov 124. Origin and destination cities for cargo generated at Paine Field included Anchorage (a trans-Pacific transload point); Charleston, SC; Nagoya, Japan and Wichita, KS. The commercial air cargo demand in Snohomish County is served through Sea-Tac.

Table 6-2 presents the 2017 air cargo tonnage for the central Puget Sound region's two commercial service airports.

Table 6-2. Commercial Air Cargo Airports (Year 2017 metric tons) (Central Puget Sound Region)

AIRPORT	METRIC TONS OF AIR CARGO	MARKET SHARE
Seattle-Tacoma International	425,856	79%
King County International	113,718	21%
Total Air Cargo	539,574	100%

Source: SEA from Port of Seattle; KCIA from BTS/DOT T-100 forms

According to available statistics, 539,574 metric tons of air cargo flew through Sea-Tac and KCIAs in 2017. Of this total, approximately 82 percent is considered domestic cargo and 18 percent is classified as international air cargo. The share of international air cargo market in the central Puget Sound region is somewhat under reported because the integrator all-cargo carriers (FedEx, UPS, DHL, etc.) fly both inbound and outbound international air cargo as domestic air cargo to and from their primary hub airports. All-cargo commercial freighter aircraft operations totaled 19,206 takeoffs and landings within the central Puget Sound region.

Seattle-Tacoma International Airport

Sea-Tac is owned and operated by the Port of Seattle. The Port of Seattle is a special purpose government entity established to foster regional economic activity, to provide transportation facilities for cargo and passengers by air, water, and land, and to provide a home for the North Pacific fishing industry.

First adopted December 4, 2014, and last revised April 26, 2018, the Port of Seattle has identified four strategies as a part of its Century Agenda Vision, Strategies, and Objectives (Century Agenda) related to air cargo:

- Position the central Puget Sound region as a premier international logistics hub.
- Advance this region as a leading tourism destination and business gateway.
- Use its influence as an institution to promote small business growth and workforce development.
- Be the greenest, and most energy efficient port in North America.

The Port of Seattle's strategy is to "Position the Puget Sound region as a premier international logistics hub" and its objective is to "Triple air cargo volume to 750,000 metric tons." To achieve this objective, Sea-Tac must double its existing air cargo tonnage and significantly increase the air cargo capacity of the airport.

Air Cargo Activity (Seattle-Tacoma International Airport)

In 2017, Sea-Tac accommodated 46.9 million passengers and enplaned and deplaned freight and mail that totaled 425,856 metric tons. Table 6-3 and Figure 6-2 show airport historical air cargo activity trends.

As can be seen in Figure 6-2, air cargo at Sea-Tac has fluctuated from year to year. Since 1990 air cargo at the airport has averaged 1.1 percent per year. Over the past five years, the average annual growth rate has been 8.5 percent.

Except for the past few years, inbound and outbound cargo volumes are fairly even, which indicates a balanced market. Figure 6-2 shows the trends among domestic and international freight and mail.

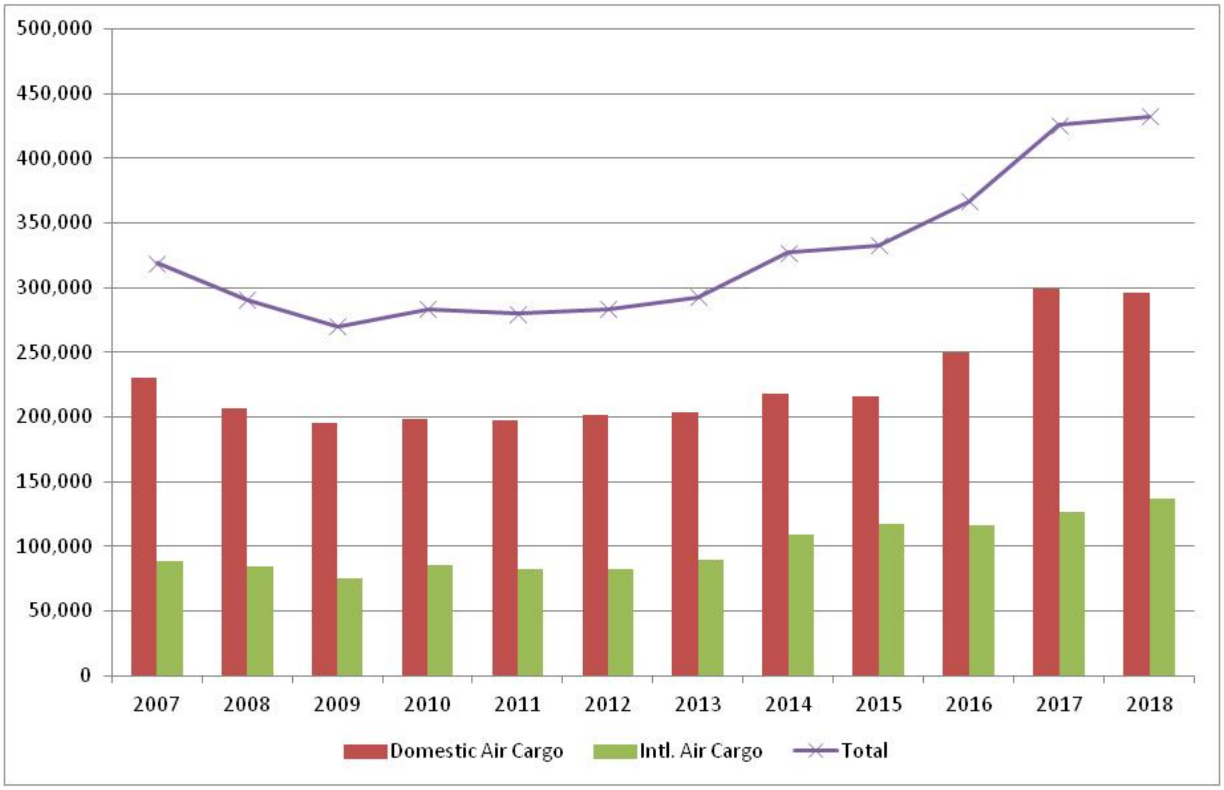
The increase of air cargo at Sea-Tac over the past few years can be attributed to two primary factors: 1) the increase in international wide-body passenger traffic, resulting in a corresponding increase in international belly cargo; and 2) the super-charged growth in the e-commerce market propelled by the relocation of DHL from KCIA to Sea-Tac in mid-2016.

Table 6-3. Historical Air Cargo (metric tons) (Seattle-Tacoma International Airport)

YEAR	INBOUND	OUTBOUND	TOTAL CARGO	PERCENTAGE CHANGE
1990	139,650	173,810	313,460	N.A.
1991	159,831	187,835	347,666	10.91%
1992	169,751	191,857	361,608	4.01%
1993	181,520	200,022	381,542	5.51%
1994	198,196	211,940	410,136	7.49%
1995	195,120	213,078	408,198	-0.47%
1996	181,502	206,716	388,218	-4.89%
1997	184,263	209,523	393,786	1.43%
1998	207,249	221,078	428,327	8.77%
1999	220,936	223,288	444,224	3.71%
2000	230,530	226,390	456,920	2.86%
2001	199,337	202,198	401,535	-12.12%
2002	185,463	189,290	374,753	-6.67%
2003	175,871	175,547	351,418	-6.23%
2004	173,649	173,868	347,517	-1.11%
2005	175,193	163,469	338,662	-2.55%
2006	173,136	168,904	342,040	1.00%
2007	161,566	157,527	319,093	-6.71%
2008	142,501	148,346	290,847	-8.85%
2009	131,952	138,263	270,215	-7.09%
2010	140,715	142,576	283,291	4.84%
2011	138,337	141,556	279,893	-1.20%
2012	142,235	141,374	283,609	1.33%
2013	152,234	140,475	292,709	3.21%
2014	169,816	157,424	327,240	11.80%
2015	168,400	164,236	332,636	1.65%
2016	186,513	179,918	366,431	10.16%
2017	221,413	204,443	425,856	16.2%

Source: Port of Seattle

Figure 6-2. Historical Air Cargo Trends (metric tons) (Seattle-Tacoma International Airport)



Source: Port of Seattle

Other factors related to the increase of air cargo at Sea-Tac include an increase in seasonal international freighter cherry charters in 2017 and the growth of the local economy. Sea-Tac also received a large boost in air cargo in 2014 due to an eight-month protracted waterfront labor dispute that closed or slowed down most U.S. West Coast seaports. In November 2014, the airport handled four to five additional freighters each week in an effort to move freight for the Christmas holiday buying season. In 2015, air cargo returned to a more sustainable 1.7 percent annual average growth rate reaching 332,636 metric tons. In 2016, the air cargo growth rate jumped to over 10 percent from the previous year with the introduction of additional international wide-body passenger service, the growth of e-commerce, and the move of DHL from King County International to Sea-Tac Airport. In 2017 air cargo increased over 16 percent from 2016.

Recently released year-to-date statistics, show that in 2018 air cargo tonnages totaled 432,315 tons, a 1.5 percent year-over-year (YOY) increase from 2017. The drop in the YOY air cargo growth rate can most likely be attributed to two factors, both related to the 2018 cherry season: a 40 percent tariff imposed on cherries by the Chinese government and the absence of Nippon Cargo Airlines from the cherry market due to a regulatory grounding by the Japanese government.

Mail tonnages as a percentage of total cargo is fairly steady and is dominated by domestic mail. The mail is delivered to the airport by the U.S. Postal Service and tendered to the designated Terminal Handling Supplier, which scans and containerizes the mail and then delivers the containers of bags to the airlines. The reverse is true for inbound mail. Most of the air mail at Sea-Tac is handled by FedEx as domestic shipments. Because the Port of Seattle publishes freight data separately from mail data in their public statistics, the total volume of air cargo carried by FedEx is often underestimated.

Air Cargo by Type (Seattle-Tacoma International Airport)

Sea-Tac has both domestic and international passenger air service. The domestic passenger carriers servicing Sea-Tac include Alaska Airlines, American Airlines, Delta Air Lines, Frontier, Hawaiian, JetBlue Airways, Southwest Airlines, Sun Country, United Airlines, and US Airways. International combination carriers include Air Canada, All Nippon Airways, Asiana Airline, British Airways, Condor, Emirates, EVA Airlines, Hainan Airlines, Korean Air, and Lufthansa Airlines.

The passenger aircraft fleet mix at Sea-Tac is a combination of regional turboprops, regional jets and both small narrow-body and wide-body transport jets. The largest passenger planes used are Boeing 747-8s. Air carriers that also utilize freighter aircraft are sometimes referred to as mixed-use carriers. The two largest air cargo carriers among the passenger airlines are Alaska Airlines and Delta Air Lines, both with approximately 8.5 percent market share.

Similar to passenger service, domestic and international airlines use a variety of aircraft to provide air cargo freighter service at Sea-Tac. The largest all-cargo airlines operating at Sea-Tac are FedEx, ABX Air, Air Transport International (ATI), and Cargolux.

Some airlines, such as Alaska Airlines, Asiana, EVA Air, and Korean Air operate freighter aircraft in addition to passenger aircraft. Table 6-4 presents recent-year lower-deck passenger air cargo and freighter air cargo tonnages at Sea-Tac.

Table 6-4. Recent Year Belly and Freighter Cargo (metric tons) (Seattle-Tacoma International Airport)

YEAR	TOTAL CARGO	FREIGHTER CARGO	PAX LOWER DECK (BELLY) CARGO	PERCENTAGE FREIGHTER
2014	327,239	182,599	144,640	55.8%
2015	332,636	180,954	151,682	54.4%
2016	366,430	220,591	145,839	60.2%
2017	425,856	264,254	161,602	62.1%
2018	432,304	284,957	147,347	65.9%

Source: Port of Seattle

The percentage of air cargo carried in freighters (referred to hear as freighter cargo) at Sea-Tac can vary, depending on the strength of the cherry season that tends to generate a significant amount of ad-hoc charter flights. It should also be noted that the Port of Seattle publishes freight data separately from mail data in their public statistics so that the total volume of air cargo carried by a particular airline may be misinterpreted.

Table 6-5 shows the top airlines for air cargo by weight at Sea-Tac for 2017 and 2018.

As can be determined from Table 6-5, FedEx dominates the air cargo market at Sea-Tac. Data from 2018 indicates that ATI, operating for both Amazon and DHL, after their first full year at Sea-Tac, is increasing their share of the air cargo market.

Table 6-5. Market Share of Top 20 Air Cargo Airlines by weight (Seattle-Tacoma International Airport)

AIRLINE	YEAR 2017	YEAR 2018	2018 MARKET SHARE
FedEx	135,888	139,007	32.3%
Air Transport Int'l	24,799	55,605	12.9%
Alaska Airlines	39,619	40,708	9.5%
ABX Air	35,810	35,126	8.2%
Delta Air Lines	36,370	33,042	7.7%
China Airlines	12,679	11,754	2.7%
EVA Air	14,657	10,993	2.6%
Korean Air	11,016	10,817	2.5%
Cargolux	9,163	10,203	2.4%
Asiana Airlines	8,234	9,005	2.1%
British Airways	8,627	8,541	2.0%
Hainan Airlines	10,675	8,394	1.9%
All Nippon Airways	8,745	7,914	1.8%
United Airlines	7,394	6,451	1.5%
Hawaiian Airlines	5,288	5,435	1.3%
Southwest Airlines	5,160	4,682	1.1%
Lufthansa Airlines	5,239	4,400	1.0%
Emirates	4,761	4,338	1.0%
American Airlines	4,508	3,632	0.8%
Kalitta Air, LLC	4,830	2,725	0.6%

Source: Port of Seattle data

Air Cargo Aircraft Operations and Fleet Mix

In 2017 there were 14,314 landings and takeoffs at Sea-Tac by all-cargo freighter aircraft, resulting in an average of 18.46 tons of cargo payload per freighter aircraft operation. Transport sized aircraft represented 79 percent of the freighter aircraft operations, while air taxi feeder aircraft made up the remaining 21 percent of landings. In 2018, the airport experienced 15,736 all-cargo freighter operations—an increase of almost 10 percent.

Table 6-6 shows the fleet mix of freighter aircraft at Sea-Tac.

Of the transport sized all-cargo freighter fleet mix, large wide-body aircraft, as represented by the MD11/10 and Boeing 747, make up approximately 49 percent of the fleet mix, followed by medium widebodies (B767 and A300–600) at 33 percent and narrow-body aircraft (B757) at approximately 8 percent. The dominant air taxi feeder aircraft is the Cessna 208.

Data from 2018 indicates that the use of air taxi feeder aircraft is declining from 21 percent of the aircraft operations at Sea-Tac to 18 percent. Another change is the increasing use of medium wide-body aircraft, growing from 33 percent in 2017 to 40 percent of all-cargo freighter operations in 2018. The average payload per all-cargo freighter operations was 18.11 tons (39,926 pounds) per flight.

Table 6-6. All-Cargo Fleet Mix (2017) (Seattle-Tacoma International Airport)

AIRCRAFT	AIRCRAFT TYPE	PERCENTAGE OF FLEET MIX
Boeing 767	Medium wide-body	22.2%
Air Taxi Feeders	Single-/multi-engine turboprops	20.6%
MD10/11	Wide-body	18.7%
Boeing 747/2/3/4	Wide-body	10.6%
Boeing 757	Narrow-body	7.9%
Boeing 737	Narrow-body	6.5%
Boeing 747-8	Wide-body	5.1%
Boeing 777	Wide-body	4.2%
Airbus A300-600	Medium wide-body	4.0%
Boeing 727	Narrow-body	0.0%
IL76	Narrow-body	0.0%
DC9	Narrow-body	0.0%
C130	Medium wide-body	0.0%

King County International Airport

Introduction

King County International Airport is a mixed-use general aviation, commercial service and industrial airport located just south of the SODO (South of Downtown) District in Seattle. The highly constrained airport is bounded on the east by U.S. Interstate 5 (I-5), to the west by East Marginal Way and the Duwamish Waterway, to the north by the community of Georgetown and to the south by a cluster of private warehouses and truck terminals.

Final preparations for delivery of Boeing 737 aircraft are made at KCIA, and Boeing facilities also include a paint hangar and flight test facilities.

Due to its inner-city location and access to I-5, the airport is attractive to domestic express air cargo operators. Air cargo at KCIA is generated exclusively by the integrator all-cargo carriers. The dominant air cargo carrier at KCIA is UPS, which has essentially a 100 percent market share in 2017 because DHL relocated their operation to Sea-Tac in June 2016.

In 2017, enplaned and deplaned air cargo at KCIA totaled 113,718 metric tons. The top inbound and outbound market was the UPS primary hub of Louisville, KY. Other top inbound and outbound markets in 2017 included Ontario, CA; Spokane, WA; and Vancouver, BC.

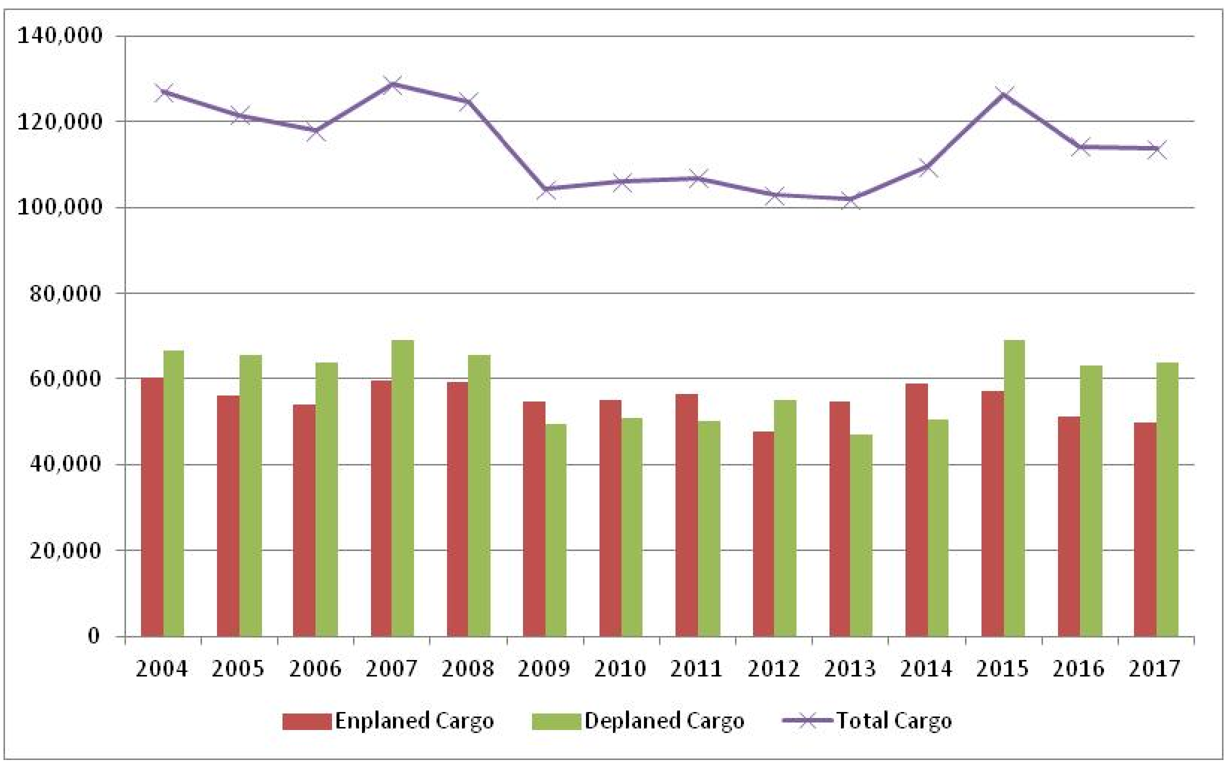
The historical trend of air cargo activity at KCIA is presented in Table 6-7 and shown graphically in Figure 6-3.

Table 6-7. Air Cargo Trends (King County International Airport)

YEAR	ENPLANED CARGO	DEPLANED CARGO	TOTAL CARGO	PERCENTAGE CHANGE
2007	59,664	69,113	**128,777**	9.2%
2008	59,145	65,616	**124,761**	-3.1%
2009	54,727	49,575	**104,302**	-16.4%
2010	55,269	50,905	**106,174**	1.8%
2011	56,619	50,313	**106,932**	0.7%
2012	47,867	55,147	**103,014**	-3.7%
2013	54,933	46,951	**101,884**	-1.1%
2014	59,047	50,606	**109,653**	7.6%
2015	57,306	68,960	**126,266**	15.2%
2016	51,220	63,144	**114,364**	-9.4%
2017	49,981	63,737	**113,718**	-0.6%

Source: U.S. DOT T100 Market Data

Figure 6-3. Air Cargo Trends (King County International Airport)



The air cargo average annual growth rate for KCIA over the past 10 years is -1.24 percent. The significant decline in air cargo from 2015 to 2016 reflects the relocation of DHL and Amazon Air from KCIA to Sea-Tac in mid-year 2016. U.S. DOT Bureau of Transportation Statistics for KCIA for the first six months of 2018 indicates a 6.7 percent increase of air cargo volumes over the first six months of 2017.

Air Cargo Aircraft Operations and Fleet Mix

Freighter aircraft types used on a regular basis at KCIA include the A300-600, B767-200/300ER, MD11, MD DC-10, and B757-200. Table 6-8 shows the freighter fleet mix for KCIA for 2017.

Table 6-8. Freighter Fleet Mix (2017) (King County International Airport)

AIRCRAFT	AIRCRAFT TYPE	PERCENT OF FLEET MIX
Boeing 767	Medium wide-body	57.6%
Boeing 757	Narrow-body	36.7%
MD11	Wide-body	3.0%
Airbus A300-600	Medium wide-body	1.4%
Lockheed L-100	Medium wide-body	0.4%
Boeing 727	Narrow-body	0.3%
Cessna 208	Air Taxi feeder	0.2%
DC9	Narrow-body	0.2%
B747-400	Wide-body	0.1%
Falcon jet	Air Taxi Feeder	<0.1%

According to the U.S. Department of Transportation Bureau of Transportation Statistics T-100 Segment data there were 2,446 all-cargo freighter aircraft landings at KCIA in 2017 for a total of 4,892 total freighter operations. Based upon the number of all-cargo freighter aircraft landings and tons of air cargo moved in 2017, the average payload per was 23.25 metric tons (51,257 pounds) per freighter operation.

Paine Field Airport

Introduction

Paine Field is owned and operated by Snohomish County. Located approximately 30 miles north of downtown Seattle, the airport is a mixed-use general aviation, commercial, and industrial airport. It is home to the Boeing assembly plant for 747, 767, 777, and 787 aircraft. Paine Field is also home to Aviation Technical Services (ATS), one of the nation's largest aviation maintenance facilities. ATS operates a 950,000-square-foot (88,000 m^2) facility that Goodrich (formerly known as Tramco) operated and then sold to ATS in fall 2007. ATS performs "heavy" checks for several airlines and cargo companies. According to ATS's web page, it averages 443 aircraft redeliveries each year.

Air cargo activity at Paine Field is generated by a mix of specialized/modified wide-body freighters as a part of the Boeing Company's 787 airplane manufacturing and assembly program. For all intents and purposes, air cargo activity at Paine Field should be considered general aviation activity. No commercial air cargo flights are available for use by the general public. Commercial air cargo demand in Snohomish County is served through Sea-Tac and KCIA. Table 6-9 presents general aviation air cargo trends for Paine Field.

Table 6-9. General Aviation Air Cargo Trends for Paine Field Airport (metric tons)

YEAR	ENPLANED CARGO	DEPLANED CARGO	TOTAL CARGO	PERCENTAGE CHANGE
2007	344	364	**708**	N.A.
2008	661	836	**1,497**	111.4%
2009	1,587	2,327	**3,914**	161.5%
2010	2,243	3,450	**5,693**	45.5%
2011	616	3,865	**4,481**	-21.3%
2012	1,279	6,259	**7,538**	68.2%
2013	908	6,957	**7,865**	4.3%
2014	1,035	12,604	**13,639**	73.4%
2015	837	11,788	**12,625**	-7.4%
2016	3,424	11,986	**15,410**	22.1%
2017	5,852	13,479	**19,331**	25.4%

Paine Field began limited commercial passenger air service in early Q2 of 2019. The number of proposed commercial flights from Paine Field is anticipated to be 24 departures and arrivals each day utilizing small narrow-body aircraft and two gates. Due to the aggressive arrival and departure schedule, small aircraft capacity, limited gate and terminal facilities, and type of markets to be served, little or no belly cargo is anticipated to be generated at Paine Field in the foreseeable future.

Freighter Fleet Mix and Aircraft Operations

There were 690 takeoff and landings by all-cargo freighter aircraft at Paine Field in 2017. The type of freighters operating at the airport are limited to specialized heavy lift aircraft not used in scheduled commercial service. Table 6-10 presents the fleet mix.

Table 6-10. Freighter Fleet Mix (2017) (Paine Field Airport)

AIRCRAFT	PERCENTAGE FLEET MIX
B747-400/B747 Dreamlifter	97%
Antonov 124	3%

6.1.8 Summary

Commercial air cargo activity in the four-county central Puget Sound region is accommodated at Sea-Tac and KCIA. Table 6-11 presents the regional trend for air cargo.

Reflecting trends in the general economy, as well as systemic changes in the air cargo industry, air cargo volumes in the central Puget Sound region has fluctuated over the past 10 years from 447,872 metric tons in 2007 to a low of 386,625 tons following the Great Recession of 2008/2009 to a new high of 539,574 tons in 2017.

Table 6-11. Commercial Air Cargo Trends (metric tons) (Central Puget Sound Region)

YEAR	SEA-TAC AIR CARGO	KING COUNTY INTERNATIONAL AIRPORT AIR CARGO	TOTAL CENTRAL PUGET SOUND REGION AIR CARGO	YEAR-OVER-YEAR PERCENTAGE CHANGE	SEA-TAC MARKET SHARE
2007	319,095	128,777	**447,872**	N.A.	71%
2008	290,847	124,761	**415,608**	-7.20%	70%
2009	270,216	104,302	**374,518**	-9.89%	72%
2010	283,291	106,174	**389,465**	3.99%	73%
2011	279,893	106,932	**386,825**	-0.68%	72%
2012	283,611	103,014	**386,625**	-0.05%	73%
2013	292,709	101,884	**394,593**	2.06%	74%
2014	327,239	109,653	**436,892**	10.72%	75%
2015	332,646	126,266	**458,912**	5.04%	72%
2016	366,430	114,364	**480,794**	4.77%	76%
2017	425,856	113,718	**539,574**	12.23%	79%

Most of the growth in air cargo within the region has been driven by the increase in international wide-body aircraft air service at Sea-Tac and the growth of e-commerce. Air cargo at Sea-Tac increased by 16 percent from 2016 to 2017, although preliminary data from 2018 indicates a moderation of this growth to less than 2 percent YOY due to a significant drop in the cherry export season.

Of the total tonnages of air cargo in the central Puget Sound region in 2017, over 60 percent is generated by the integrator/express airlines Amazon Air, DHL, FedEx, and UPS. An estimated 77 percent of the region's air cargo is domestic with the remaining 23 percent being international, primarily from the Asian market. It can be assumed that the volume of international cargo is somewhat under reported by as much as 10 to 20 percent because cargo to and from international destinations carried by the integrator airlines is reported as domestic due to the unique hub and spoke system used by DHL, FedEx, and UPS.

Over 70 percent of the air cargo moving through the central Puget Sound region was by all-cargo freighters. There were 19,206 aircraft operations (one takeoff and one landing equals two aircraft operations) by all-cargo freighter aircraft in 2017 with 75 percent of the freighter aircraft activity generated by Sea-Tac. The dominant freighter aircraft type in use in the region is the medium wide-body freighter exemplified by the Boeing 767 and Airbus A300-600. Small single- and twin-engine air taxi feeder aircraft comprise less than 2 percent of the freighter fleet.

There is no commercial air cargo activity at Paine Field, and the existing air cargo operations can be considered as general aviation activity related exclusively to the Boeing aircraft assembly plant.

The following section presents international, national, and regional trends in air cargo and a central Puget Sound region forecast of air cargo.

6.2 AIR CARGO TRENDS

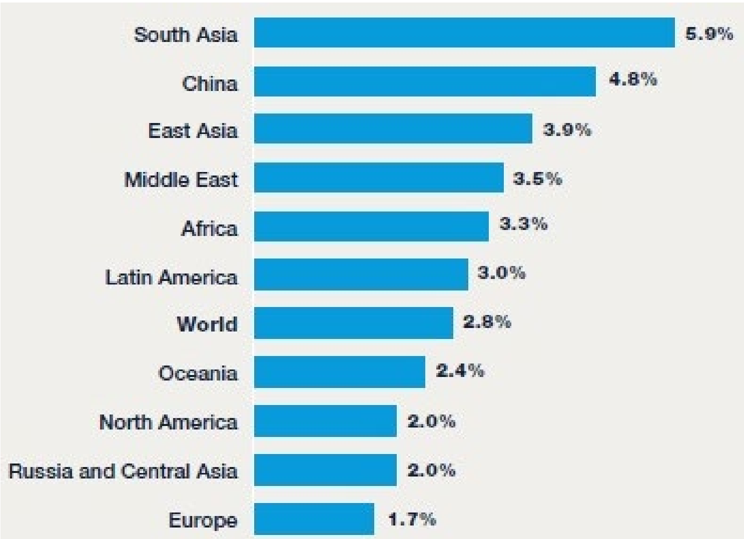
6.2.1 Recent Air Cargo Market Trends

Globalization of world markets has expanded trade activity. Global economies are interdependent, and global integration is at a stage that is unprecedented since the late 19th century and early 20th century. In 2015 over $16 billion of goods traveled by air each day—one-third of all world trade by value.

Figure 6-4 presents the world GDP forecast. Historically, air cargo activity has moved in sync with GDP, influenced by fuel price volatility, movement of real yields, and globalization. Over the past five years, however, profound structural changes have occurred in the air cargo industry including the following:

- Air cargo security regulations issued by the United States and Europe regulators
- Market maturation of the domestic express market
- Domestic U.S. modal shift from air to other modes (especially truck)
- A significant decrease in the cost of oil
- Growth in international trade from Open Skies agreements
- Increased use of mail substitutes and the emergence of the cross-border e-commerce market

Figure 6-4. World GDP Forecast 2018-2037 (Asian Economies Will Lead Economic Growth)



Source: HIS Market

The air cargo market is undergoing dramatic changes, and the airports reviewed in this paper are reacting in various ways in the structuring of their air cargo marketing and facility development programs to meet these new challenges.

The change in the structure of the air cargo industry is a result of the following:

- Increases in urban consumption by the growing consumer class: By 2025 there will be 1.8 billion more people in the consumer class, and global consumption is expected to surpass $30 trillion—an increase from $22 trillion today.
- A growth in worldwide demand for perishables, such as fresh fruit, vegetables, seafood, flowers, and pharmaceuticals.
- Manufacturing shifting away from traditional passenger hubs (to areas such as Chongqing and Zhengzhou in China and to Hanoi in Vietnam, Subang and Jakarta in Indonesia, the Eastern Seaboard of Thailand, Penang in Malaysia, etc.) and the seasonality and directionality is requiring the use of non-integrator freighters.
- Change in buying behaviors – the growth of buying or selling online (i.e., e-commerce).

Of all the major trends, the popularity and growth of e-commerce is causing major structural changes to supply chain management and the physical movement of commodities and products between suppliers, manufacturers, distributors, warehouse operators, and consumers. Although cross-border e-commerce has many characteristics of domestic e-commerce, the main difference is in the complexity of the cross-border logistics services to complete international business transactions.

Many larger e-commerce companies are finding traditional logistics services lack the capability to accommodate their demand and are establishing their own logistics capabilities. Companies such as Amazon and JD.com have abandoned a significant portion of their external logistics services and have developed their own internal logistics systems.

Since 2017, JD Logistics has established more than 110 overseas warehouses on five continents and provides overseas brands with cross-border logistics services, including overseas warehousing, international transportation, cross-border bonded warehouses, and domestic distribution. Amazon is now operating a fleet of 40 medium wide-body freighters and over 20 narrow-body freighters to move goods around its fast-growing internal logistics network.

These changes in supply chain management have resulted in a shift from the traditional complex retail supply chain of factory to seaport to intermodal center to distribution center to retail store with a much slimmer supply chain from factory to e-commerce fulfillment center to consumer. The impact of these structural changes to the physical movement of commodities and products between suppliers, manufacturers, distributors, warehouse operators, and consumers is that airports will see stronger peaks with smaller shipments of less value and increased frequencies of shipments to meet short cycle times required for online fulfillment. This situation will result in the need for the following:

- A simplified clearance process for immediate processing upon a shipment's arrival
- Extensive on-apron handling facilities to expedite tail-to-tail transfers

- Modern air cargo terminals with specialized handling capabilities (temperature-controlled rooms, dangerous goods storage, bonded and secure storage, etc.)
- Connectivity to off-airport facilities and services that support the on-airport air cargo operations

These changes to the air cargo industry will have an impact on the way that an airport assesses and constructs its value proposition, creates its marketing program, and implements its marketing strategy.

6.2.2 Global Economic Trends

According to the World Bank, in the short term, global growth is moderating as the recovery in trade and manufacturing activity loses steam. Despite ongoing negotiations, trade tensions among major economies remain elevated. These tensions—combined with concerns about softening global growth prospects—have weighed on investor sentiment and contributed to declines in global equity prices. Borrowing costs for emerging market and developing economies (EMDE) have increased, in part as major advanced-economy central banks continue to withdraw policy accommodation in varying degrees. A strengthening U.S. dollar, heightened financial market volatility, and rising risk premiums have intensified capital outflow and currency pressures in some large EMDEs, with some vulnerable countries experiencing substantial financial stress. Energy prices have fluctuated markedly, mainly caused by supply factors, with sharp falls toward the end of 2018. Other commodity prices—particularly metals—have also weakened, posing renewed headwinds for commodity exporters.

In all, according to the World Bank, global growth is projected to moderate—from a downwardly revised 3 percent in 2018 to 2.9 percent in 2019 and 2.8 percent in 2020-21—as economic slack dissipates, monetary policy accommodation in advanced economies is removed, and global trade gradually slows.

In the longer term, the global consulting firm PwC predicts that the world economy could more than double in size by 2050—far outstripping population growth—due to continued technology-driven productivity improvements. Emerging markets could grow around twice as fast as advanced economies (G7) on average. As a result, PwC predicts that six of the seven largest economies in the world are projected to be emerging economies in 2050 led by China (1st), India (2nd) and Indonesia (4th). The United States could be down to 3rd place in the global GDP rankings while the EU27's share of world GDP could fall below 10 percent by 2050.

6.2.3 Washington State Economic Trends

According to the Washington State Economic and Revenue Forecast, Washington state real GDP growth and personal income growth led the nation in 2017. Washington state posted top GDP numbers of all U.S. states of 3.6 percent for the first quarter of 2018 against 1.8 percent nationwide. This comes after Washington state having led annual GDP growth in both 2016 and 2017. The Governor's Council of Economic Advisors forecast for real GDP growth in Washington state averages 2.2 percent per year over the six-year interval through 2023.

6.2.3.1 WASHINGTON STATE EXPORTS

According to the November 2018 Washington State Economic Climate Study, in 2017 Washington state ranked 3rd in the United States in foreign exports as a percentage of personal income. Washington state's foreign exports were 18.33 percent of personal income in 2017. The state's rate remains well above the national average of 4.51 percent. Washington state is 3rd in its five-year ranking with 22.16 percent, with Texas ranked 2nd and Louisiana ranked 1st. Louisiana ranks high in this category largely owing to its exports of refined petroleum products.

Washington state's perennially strong performance in foreign exports as a percentage of personal income is due mainly to the presence of Boeing and PACCAR—two of the world's leading manufacturers of commercial aircraft and trucks, respectively. Exports of transportation equipment from these and other Washington state manufacturers account for over half of the state's exports.

It must be noted that the trade data used for this indicator, obtained from the U.S. Census Bureau, only include trade in goods, ignoring trade in service exports, which are difficult to track and credit to specific states. Software, one of Washington state's main exports, is classified as a service when it is not exported on physical media and is therefore not included in the census measure. Because software giant Microsoft contributes greatly to state personal income while most of its exports are not included in the trade data, the measure of Washington state exports as a percentage of personal income understates the contribution of trade to Washington state's economy.

As shown in Figure 6-5, air exports from Washington state accounted for $8.6 billion in 2017, and air imports to Washington states were $7.5 billion, with air imports and exports totaling 167,810 metric tons.

As presented in Figure 6-6, the largest market for air exports from the Washington state as measured by weight was Asia, followed by Europe, North American Free Trade Agreement (NAFTA) countries, South/Central America, Australia and Oceania, and Africa.

Figure 6-5. Air Imports and Exports (Washington State)

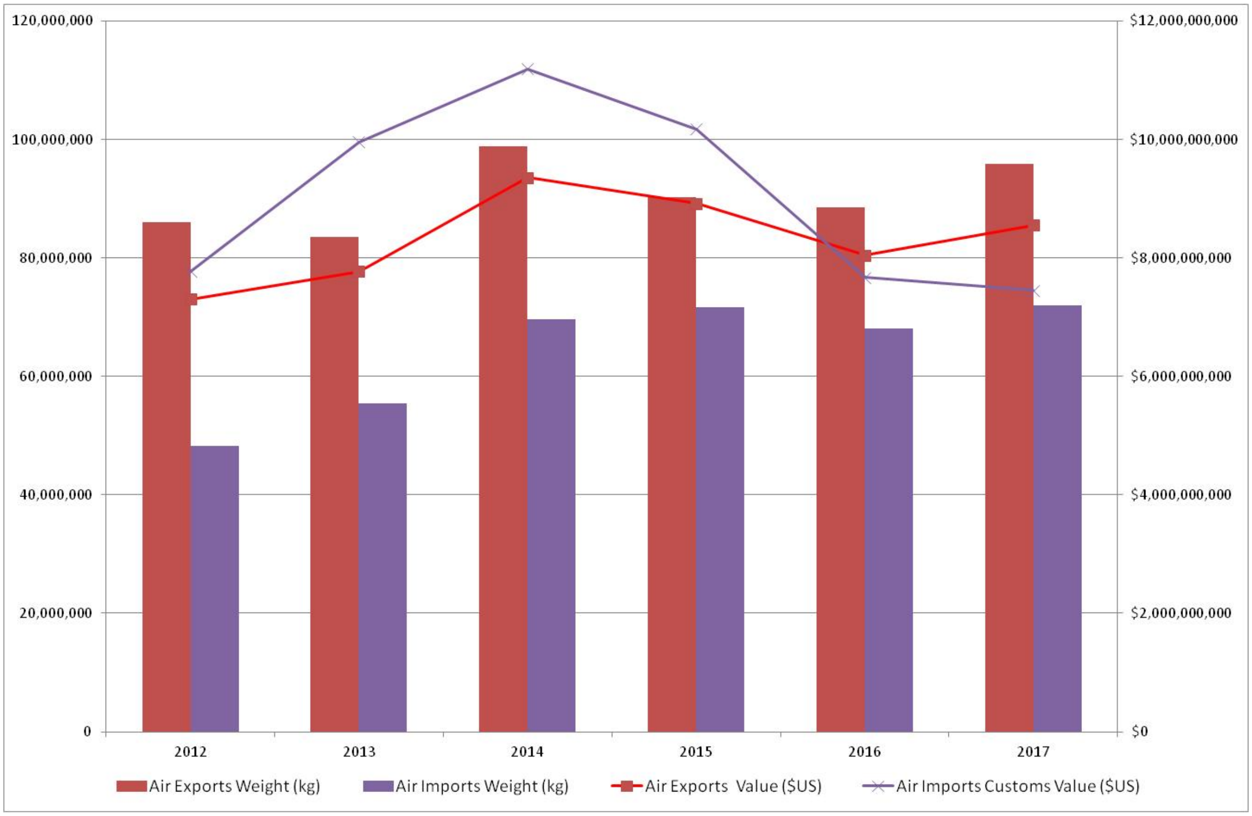
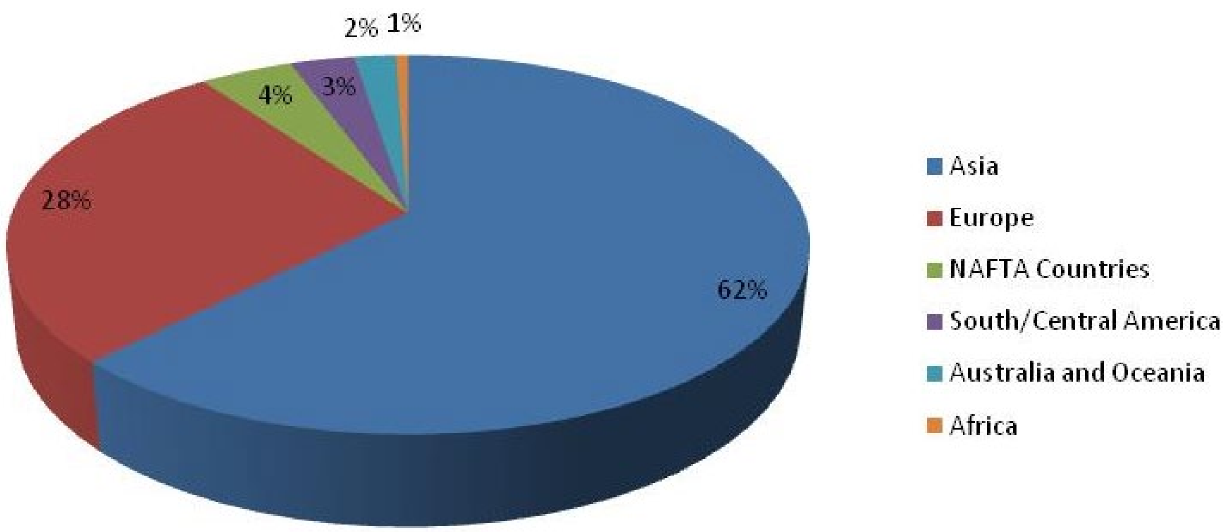


Figure 6-6. Air Exports and Imports by Region (Washington State)



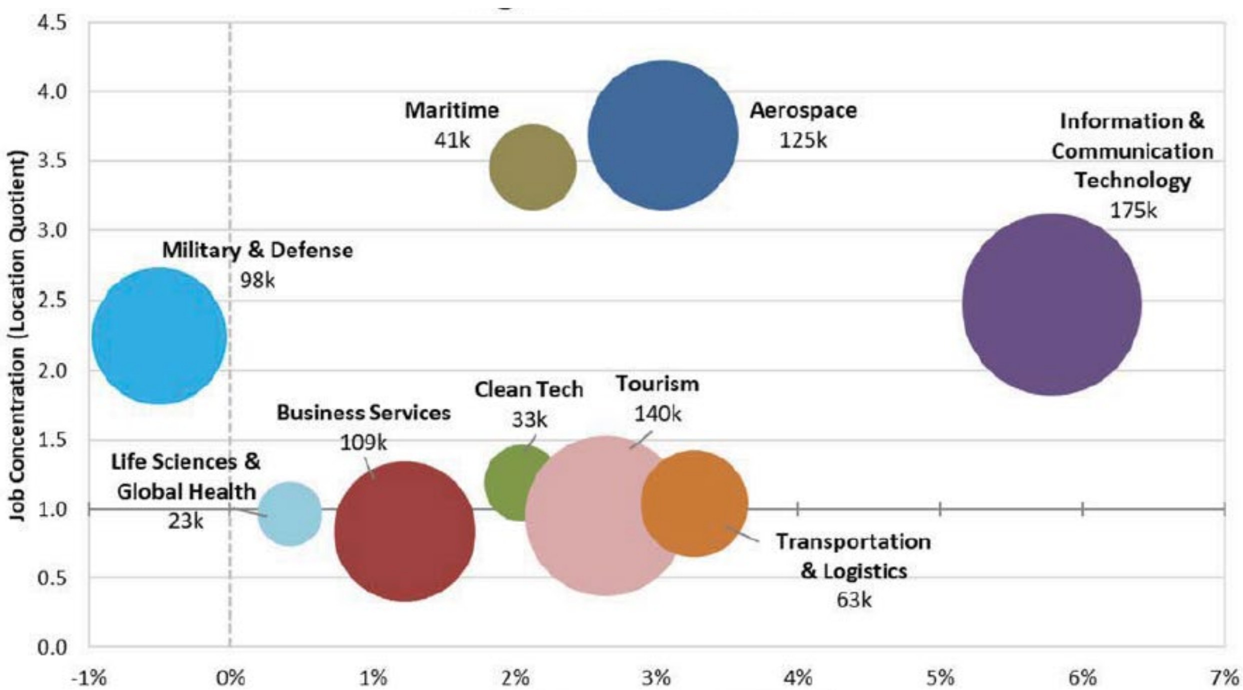
6.2.3.2 THE CENTRAL PUGET SOUND REGION ECONOMY

Chapter 3 of this report presents a detailed analysis of the central Puget Sound region socioeconomic trends. This section focuses on a general central Puget Sound region economic profile most related to air cargo.

According to the *Economic Analysis of the Central Puget Sound Region* (published by the Puget Sound Regional Council in September 2017), nine industrial clusters drive the regional export economy: Aerospace, Business Services, Military & Defense, Clean Technology, Information & Communication Technology, Life Sciences & Global Health, Maritime, Transportation & Logistics, and Tourism.

As shown in Figure 6-7, drawn from that PSRC report, Information & Communication Technology accounts for the largest source of regional employment, followed by Aerospace, Tourism, and Military & Defense.

Figure 6-7. Key Regional Export Industry Job Growth (2010–2015)



Source: EMSI, PSRC, DOD

Of the key industry clusters driving the regional economy, all depend heavily on local access to a viable and global air cargo network to lower production costs, expand business sales, lower overall costs for shipping, and lead to longer term catalytic activity (increased regional production captured from elsewhere or new to the region).

6.2.3.3 WORLD AIR CARGO TRENDS

The Great Recession of 2008-2009, the worst economic contraction since the Great Depression, dragged down all modes of freight transport. World air cargo traffic dropped 13 percent over the two years ending in 2009. Traffic jumped 19.4 percent in 2010 and gained a further 0.8 percent in 2011 as global businesses replenished their inventories. The net result of these developments is a world air cargo traffic growth rate of only 2.6 percent for the span of years between 2003 and 2013.

Regional air cargo market shares have changed a lot during the past two decades. Airlines based in Asia, Europe, and North America have accounted for more than 80 percent of the world's air cargo traffic for that entire span of years.

Airlines based in North America led all other world regions with a 35 percent share of the world's air cargo traffic in 1992. This changed during the 1990s and early 2000s as the share flown by airlines based in Asia, including those based in China, grew from 28 percent in 1992 to 39 percent in 2010, reflecting the rapid expansion of Asian export markets. Since 2000, however, carriers based in the Middle East have leveraged their geographic position at the crossroads between Africa, Asia, and Europe. Middle East carriers have quickly expanded their wide-body passenger and freighter fleets, allowing them to increase their share of world air cargo traffic from 4 percent in 2003 to 11 percent in 2013.

In 2015, most major regions experienced weakness in air freight demand, including Asia Pacific, where growth was just 2.3 percent in 2015 compared to 2014. For North American carriers, there was a small expansion of 0.1 percent in 2015 overall. These small gains in volumes over the year are explained by the surge in activity in Q1 2015 due to switching toward air cargo because of the U.S. West Coast seaport backlog and recalls in the United States for Japanese auto-parts.

According to the International Air Transport Association (IATA), global air freight grew by a solid 3.6 percent in 2016. The solid expansion in air freight in 2016 reflected strengthening in the upward trend for freight traffic during the second half of the year. This trend coincided with a steady and ongoing rise in the new export orders component of the global purchasing managers' index over the same period, pointing to healthy orders for global manufacturing exporters. The industry reported strong growth in areas such as cross-border e-commerce and pharmaceuticals, which is expected to continue to offer opportunities for air freight. International air freight rose by 11.0 percent YOY in December 2016, which was up from 7.2 percent in November 2016. Overall, international freight traffic grew by 3.6 percent in 2016.

A review of IATA statistics indicates that industry-wide air cargo grew by 9.0 percent YOY in 2017 as a whole, which was up from 3.6 percent YOY in 2016 and the strongest calendar-year of growth since 2010. Year 2017 was also the strongest year of global goods trade growth since 2011. Air cargo grew more than twice as fast as global trade volumes during the year as a whole—the widest margin of out-performance since 2010. This out-performance largely reflects an improved business environment for manufacturing businesses, which enjoyed buoyant demand for their exports, linked to the global restocking cycle and a long-awaited pickup in investment. Many factors are likely to contribute to the remainder of the out-performance, including recent strong increases in consumer confidence, along with the impact that growing sectors such as e-commerce and pharmaceuticals are having on air freight growth.

According to IATA, international air cargo grew by 9.9 percent year-on-year in 2017 as a whole, which was up from 3.6 percent in 2016. While global air freight growth has moderated in 2018 after unusually strong growth in 2017. For 2018, industry-wide freight volumes increased by 2.8 percent YOY in the three months ended October—a slowdown compared to the double-digit growth rates seen in mid-2017. In broad terms, annual freight ton kilometers (FTK) growth has continued to slow across the key international markets. Routes to/from North America continue to trend upwards, albeit modestly.

Based on data from the Association of Asian Pacific Airlines, Asian airlines saw international air cargo demand as measured in FTK increase by 5.6 percent YOY in October 2018, which was supported by increasing orders going into the year-end peak season. Offered freight capacity increased by 7.3 percent, resulting in a 1.1 percentage point decline in the average international freight load factor to 65.5 percent for the month.

Protectionism measures remain a downside risk to global trade, whose growth eased for the second consecutive quarter of 2018. Nevertheless, FTK demand is likely to continue to be supported by fast-growing areas such as e-commerce.

6.2.3.4 INDUSTRY FORECASTS OF AIR CARGO ACTIVITY

According to most industry analysts, worldwide air cargo is expected to rise between 3 percent and 5.5 percent per year over the next 20 years. This growth relates to an improving world economy and accelerating rates of international trade.

According to the Boeing Company World Air Cargo Forecast 2018-2037 over the next 20 years, world air cargo traffic will grow 4.2 percent per year. Air freight, including express traffic, will average 4.3 percent annual growth. Mail is projected to grow slower at 2 percent per year. Overall, world air cargo is projected by Boeing to more than double over the 20 years, expanding from 256 billion Revenue Ton Kilometers Miles (RTKs) to 584 RTKs in 2037.

Asia will continue to lead the world in average annual air cargo growth, with domestic China and intra–East Asia markets expanding 6.3 percent and 5.8 percent per year, respectively. Supported by faster-growing economies and growing middle classes, the East Asia–North America and Europe–East Asia markets will grow slightly faster than the world average growth rate. Middle East and Latin America markets connected to Europe and North America will grow at approximately the world average. In the more established and mature trade flows between North America and Europe, growth will be below the world average.

The East Asia–North America and East Asia-Europe markets will grow slightly faster than the world average growth rate. Low, baseline, and high annual growth of 3.7 percent, 4.3 percent, and 4.8 percent, respectively, are forecast by Boeing for world air freight traffic. Boeing predicts that air cargo markets linked to Asia, especially the Pacific Rim countries, will lead all other international markets in average annual growth between 2018 and 2037; but the mature markets of North America and intra-Europe will grow more slowly, both at 2.2 percent per year over the next 20 years.

Regionally, North American air traffic is projected by Boeing to average 2.3 percent growth over the next 20 years to the 2037 forecast period. Baseline growth in North America-to-Europe air trade is predicted by Boeing to average 2.3 percent per year, with the high end of the rage at 2.9 percent. Europe-to–North America baseline growth will average 2.7 percent per year with the high range projection at 3.5 percent.

The combined total market baseline growth for the next 20 years is projected to be 2.4 percent, compared with 1.9 percent average growth during the past 20 years.

East Asia–North America air cargo traffic flowing in both directions across the Pacific is forecast by Boeing to grow an average of 4.7 percent per year over the next 20 years. The flow from Asia to North America is forecast to grow at an average rate of 4.6 percent per year. The flow from North America to Asia is forecast to grow 4.8 percent per year over the next 20 years.

The total Latin America–North America market for air cargo services is forecast by Boeing to grow 4.1 percent per year between 2018 and 2037. North America-to-Africa flows are expected by Boeing to grow 6.1 percent per year through 2037, driven by continued United States and Canadian investment in African extractive industries. Africa-to–North America air trade are expected to grow at the nearly identical rate of 3.3 percent per year, as African light manufacturing develops export markets in North America.

Boeing predicts that the overall domestic air trade in China will grow at 5 percent per year over the next 20 years with growth most rapid in the first 10 years of the Boeing forecast period.

Airbus forecasts air cargo to grow 4 percent per year over the next 20 years. According to Airbus, Asia Pacific (including India and China) today represents 36 percent of the world freight traffic and will grow to 42 percent by 2032. Europe/CIS and North America combined accounted for 51 percent of the total traffic in 2012; by 2032 its share will be 45 percent. China is the largest driver of air cargo growth; today it represents 15 percent, and by 2032 it will be 22 percent of the global market. Due in part to the expanding middle class in emerging countries, traffic from mature to emerging markets is the second fastest growing segment of the industry. Airbus predicts that the North American domestic market will grow at 1.63 percent per year, while the United States-Asia market will grow at 4.93 percent per year. The North America-Europe market is project by Airbus to grow at 2.4 percent per year.

According to the Federal Aviation Administration Aerospace Forecast Fiscal Years 2017-2017, air cargo RTMs flown by all-cargo carriers comprised 77.6 percent of total RTMs in 2016, with passenger carriers flying the remainder. In 2016, all-cargo carriers carried 89.0 percent of domestic cargo RTMs.

Between 2016 and 2037, the Federal Aviation Administration predicts that domestic cargo RTMs will increase at an average annual rate of 1.3 percent. International cargo RTMs are forecast to increase an average of 3.8 percent a year based on projected growth in world GDP with the Pacific region having the fastest growth, followed (in descending order) by the Other International, Atlantic, and Latin regions.

According to IATA, air cargo growth over the next five years will be positive. It is the emerging markets and regions—led by the Middle East and Africa—that are expected to deliver the fastest growth in air cargo volumes over the next five years. Strongest forecasted growth is foreseen on trade lanes between Asia and the Middle East, within the Middle East region, and between North America and South America. Growth in mature markets of the North Atlantic and within Europe is expected to be well below the global average. Domestic operations, especially in China and the United States, will also form a large portion of future traffic.

IATA predicts that air freight volumes and revenues will rise 4.5 percent and 8.6 percent, respectively, in 2018.

According to IATA, moderating influences on air cargo growth are increasing uncertainty, with three key factors weighing on global outlook:

- U.S. Federal Reserve looking to normalize monetary policy—while other major currencies are likely to ease further—paving the way for further tightening in U.S. bank credit conditions
- China's economy embarking on a multi-year rebalancing
- The decade-long commodity super cycle may begin to slow

6.2.3.5 THE IMPACT OF E-COMMERCE

Emerging trends are beginning to influence the makeup and structure of the world air cargo market, including the following:

- Increases in urban consumption by the growing consumer class – By 2025 there will be 1.8 billion more people in the consumer class, and global consumption is expected to surpass $30 trillion—an increase from $22 trillion today.
- Manufacturing moving away from traditional passenger hubs to areas such as Columbus, Birmingham, Manaus, Chongqing, Zhengzhou, Hanoi, etc., requiring the use of freighter aircraft.
- Change in buying behaviors – the growth of buying or selling online, that is, e-commerce.
- China is the world's largest e-commerce market, valued at approximately $1.1 trillion USD. Its annual growth rate has been 43 percent compared to a U.S. growth rate of 15 percent.

The popularity and growth of e-commerce is causing major structural changes to supply chain management and the physical movement of commodities and products between suppliers, manufacturers, distributors, warehouse operators and consumers. Most air forwarders and airlines interviewed as a part of this study have all mentioned that e-commerce has had a large impact on their operations. A notable example of the impact on the airline industry is the emergence of Amazon Air (formerly Prime Air), an all-cargo airline initiated in 2015 by Amazon.com to expand its e-commerce shipping capabilities. Based in Cincinnati/Northern Kentucky International Airport, Amazon Air utilizes Sea-Tac as one of its West Coast gateways.

The term cross-border e-commerce generally defines international online trade. It entails the sale or purchase of products via online shops across national borders. Buyers and sellers are not located in the same country and are often not ruled by the same jurisdiction, use different currencies, and speak different languages. Online trade within the EU, with its single market and common currency in many member states, is evenly referred to as cross-border e-commerce (e.g., selling from Germany to China).

Cross-border e-commerce can refer to online trade between a business (retailer or brand) and a consumer (B2C), between two businesses, often brands or wholesalers (B2B), or between two private persons (C2C) (e.g., via marketplace platforms such as Amazon or eBay). In many counties, the fastest growing e-commerce segment is cross-border purchases.

The growth of e-commerce is well documented. The National Retail Federation expects that online retail will grow 8 percent to 12 percent, up to three times higher than the growth rate of the wider industry. Forrester predicts that online sales will account for 17 percent of all U.S. retail sales by 2022, up from a projected 12.7 percent in 2017, according to Forrester's new Online Retail Forecast (2017–2022) as cited by Digital Commerce 360. The report also expects U.S. online sales to grow 13 percent YOY in 2017, which is five times faster than projected offline sales growth, and in line with the National Retail Federation's estimates. Amazon—No. 1 in the Internet Retailer 2017 Top 500— is expected to play a heavy role in that growth.

6.3 COMMERCIAL AIR CARGO FORECAST (CENTRAL PUGET SOUND REGION)

6.3.1 Introduction

The forecast of demand is a key element in both the short- and long-term development of air cargo facilities. Forecasts provide a basis for determining the type, size, and timing of airside and landside facilities development and consequently influence many phases of the airport planning process.

A 10-year forecast of air cargo tonnage in Washington state was performed in January 2018 as a part of the *Washington State Air Cargo Goods Movement Study* (Washington State Legislature JTC, December 21, 2018). The purpose of the report was to explore possibilities for accommodating the state's growing air cargo market at more airports in Washington state outside the three primary state air cargo airports described in Section 6.1.7.3.

The focus of this effort is to provide an estimate of commercial air cargo volumes and freighter activity in the central Puget Sound region over the long-term 33-year planning horizon. The forecast does not account for specific infrastructure or operational limitations at area airports. The base year for this forecast is 2017.

It should be noted that air cargo data collection, both at the industry and airport levels, is problematic. Historical air cargo data is limited, and activity by carrier and cargo type at some airports in the region is unavailable.

Table 6-12 presents a summary of the air cargo forecast for the central Puget Sound region.

Table 6-12. Air Cargo Forecast (metric tons) (Central Puget Sound Region)

	SEATTLE-TACOMA INTL		KING COUNTY INTL		TOTAL CENTRAL PUGET SOUND REGION	
	TONS OF CARGO	FREIGHTER OPS	TONS OF CARGO	FREIGHTER OPS	TONS OF CARGO	FREIGHTER OPS
Historical						
2017	425,856	14,310	113,718	4,892	539,574	19,202
Forecast*						
2022	504,521	17,732	145,136	6,244	649,657	23,976
2027	581,016	20,420	168,253	6,471	749,268	26,892
2037	745,336	26,196	217,484	7,249	962,820	33,445
2050	1,000,000	35,800	300,000	10,000	1,300,000	45,800

*Many of the factors influencing future aviation demand cannot necessarily nor readily be quantified. As a result, the forecast process should not be viewed as precise, particularly given the major structural changes that have occurred in the air cargo industry, the uncertain global economy, the security regulations imposed by ongoing terrorist threats and major natural disasters.. Actual future traffic levels addressed here may differ materially from the projections presented herein because of unforeseen or unrealized events.

6.3.2 Factors Affecting Industry Growth

The air cargo industry, like most industrial groups, depends on population growth, gains in the economy, and growth in international trade. The volume of freight shipped by air will also be sensitive to the shipping tariffs of other modes of transportation. In addition to the primary influence of economic activity, many other factors can influence the levels of world air cargo, particularly the express/integrators and small package carriers. These factors include changing inventory management techniques, deregulation and liberalization of trade, national development programs, and a never-ending stream of air-eligible commodities.

The dramatic growth of e-commerce in particular has created a fundamental supply chain upheaval. New consumer expectations require retailers, both brick and mortar and e-commerce platforms, to have the capacity to redirect shipments, rebalance inventories and respond to new demands almost instantaneously. A key component of emerging supply chain management techniques to manage these expectations is the inclusion of air cargo into internal company distribution systems.

At the local level, many of these same factors apply. However, extreme change in freight volumes at an airport more often results from the initiation new service or loss the loss air service than from overall industry growth or decline.

6.3.3 Inhibitors to Growth

Protectionism, trade friction, Brexit, and anti-globalization rhetoric are part of a genre of recent developments that pose a real risk to air cargo growth in the short term. A recent press release by FedEx Express reported declining international revenue as a result of unfavorable exchange rates and the negative effects of trade battles:

> "Slowing international macroeconomic conditions and weaker global trade growth trends continue, as seen in the YOY decline in our FedEx Express international revenue." —Alan B. Graf, Jr., Executive Vice President and Chief Financial Officer

According to a conversation with one Chinese airline in the last three months, the recent round of trade tariffs between China and the United States had a direct impact on the price of cherries in China, and this particular airline cancelled over 40 wide-body Washington state cherry charters in 2018.

Other factors that can slow growth include increased national air cargo security directives, fuel price volatility, global armed conflict. and cataclysmic natural and technological disasters.

6.3.4 Forecast of Air Cargo Tonnages

6.3.4.1 INTRODUCTION

As previously discussed, air cargo in the central Puget Sound region is generated by activity at Sea-Tac and KCIA. A small amount of general aviation air cargo activity also takes place at Paine Field in support of activity related to the Boeing aircraft assembly plant.

The development of an air cargo demand forecast involves both quantitative analysis and subjective judgment. In general, past air cargo activity data are examined in anticipation of identifying past trends that will give an indication of future activity levels.

Typically, the most reliable approach to estimating aviation demand is by using more than one analytical technique. Methodologies considered for forecasting generally include both a bottom-up and top down approach using regression analysis, time-series extrapolation, and market share analysis. Forecasts of air cargo activity prepared as part of existing or ongoing master plans at Sea-Tac, KCIA, and Paine Field were also reviewed and considered.

Many of the factors influencing future aviation demand cannot necessarily nor readily be quantified. As a result, the forecast process should not be viewed as precise, particularly given the major structural changes that have occurred in the air cargo industry since airline deregulation, trucking deregulation, the advent of Open Skies, and the war on terrorism. Actual future traffic levels addressed here may differ materially from the projections presented herein because of unforeseen or unrealized events.

6.3.4.2 SEATTLE-TACOMA INTERNATIONAL AIRPORT

Sea-Tac dominates the regional and the Pacific Northwest air cargo market with a mix of domestic and international belly cargo, domestic and international freighter cargo, as well as integrator/express cargo. In 2017 Sea-Tac accommodated 425,856 metric tons of enplaned and deplaned freight and mail. The annual air cargo tonnage increase rate from 2016 to 2017 was 16 percent.

Due to an increase in international wide-body aircraft passenger service, Sea-Tac has experienced significant increase in international air cargo volumes. In the five-year period from 2012 to 2017, total air cargo at Sea-Tac grew at 7.9 percent per year and international air cargo increased at 9 percent per year. The international air cargo market share was 32 percent for both years of 2016 and 2017.

The airport has also seen a profound change in its air cargo market composition with the relocation of ABX Air, ATI, and Atlas Airline operating for the integrator DHL from KCIA to Sea-Tac in mid-2016 and the introduction of service by Amazon Air to Sea-Tac. Cargo tonnages by the integrated/express airlines at Sea-Tac represented approximately 50 percent of the air cargo market in 2017, up from 42 percent in 2014 and 47 percent in 2016. In 2018 the integrator/express market share of total air cargo was 53.5 percent. The one-year integrator/express cargo growth rate from 2017 to 2018 was 8.1 percent.

The total 2017 to 2018 cargo increase rate of 1.5 percent was smaller than expected due to a decrease in international belly freight as well, adecrease in the number of cherry charters related to tariffs imposed by China and the grounding of the Nippon Cargo Airlines freighter fleet during the early and mid-part of 2018.

Forecast

Three projections of air cargo tonnages at Sea-Tac were prepared and are presented in Table 6-13. Also included in this table is the Seattle-Tacoma International Airport Sustainable Airport Master Plan (SAMP) air cargo forecast that was prepared in 2014.

The 2014 SAMP air cargo forecast represents the low end of the range of future air cargo tonnages at Sea-Tac, while the Boeing high world air cargo growth rate of 4.7 percent per year represents the high range. The SAMP compounded average annual growth rate (CAAGR) projection applied the 2014 SAMP air cargo projected compounded average annual growth rate of 1.6 percent to the 2018 cargo tonnage of 432,304 tons to generate a forecast of 587,768 tons of air cargo for 2037 and 725,000 tons by 2050. Due to the changing air cargo trends and market conditions since the SAMP forecast was produced, Sea-Tac is in the process of completing an updated air cargo forecast.

The preferred forecast considered the profound changes to the Sea-Tac market represented by the relocation of ABX Air and Atlas Airlines from KCIA to Sea-Tac and the increasing influence that e-commerce is having on the air cargo market as reported in the industry publications.

Going forward, it is assumed that the integrator/express market will maintain a 50 percent market share at Sea-Tac until the year 2050. It is predicted that the integrator/express market at Sea-Tac will grow at compounded annual average growth rate of 6 percent for years 2019 and 2022; for years 2023 and 2022 the rate of growth will be 5 percent per year; for years 2022 through 2029 a 3 percent annual rate of growth is assumed; and for years 2030 through 2050 a 2.5 percent annual rate of growth is assumed.

Over the 11-year period between 2007 and 2018, international air cargo at Sea-Tac has grown steadily from a 21 percent share of the Sea-Tac air cargo market to a 35 percent share, resulting in a CAAGR of 3.9 percent. It is assumed that the international air cargo market will grow at an average annual rate of 3 percent until 2029 at which time it will slow to 2.5 percent for the remainder of the forecast period.

It is assumed that air cargo other than integrator/express and international will grow at a steady rate of 2.0 percent per year.

Table 6-13. Air Cargo Projections (metric tons) (Seattle-Tacoma International Airport)

YEAR	HISTORICAL	SAMP FORECAST	(LOW) SAMP AAGR	(HIGH) BOEING WORLD FORECAST	PREFERRED FORECAST
2004	347,574	—	—	—	—
2005	338,663	—	—	—	—
2006	342,042	—	—	—	—
2007	319,095	—	—	—	—
2008	290,847	—	—	—	—
2009	270,216	—	—	—	—
2010	283,291	—	—	—	—
2011	279,893	—	—	—	—
2012	283,611	—	—	—	—
2013	292,709	—	—	—	—
2014	327,239	319,842	—	—	—
2015	332,646	326,081	—	—	—
2016	366,430	332,378	—	—	—
2017	425,856	338,726	—	—	—
2018	432,304	345,117	432,304	432,304	432,304
2019	—	351,544	439,351	452,622	451,567
2020	—	357,998	446,512	473,896	471,811
2021	—	364,251	453,790	496,169	490,492
2022	—	370,509	461,187	519,489	504,521
2023	—	376,764	468,704	543,905	518,957
2024	—	383,008	476,344	569,468	533,812
2025	—	389,231	484,109	596,233	549,098
2026	—	395,426	491,999	624,256	564,828
2027	—	401,585	500,019	653,596	581,016
2028	—	407,697	508,169	684,315	597,673
2029	—	413,755	516,453	716,478	614,816
2030	—	419,750	524,871	750,152	629,784
2031	—	425,400	533,426	785,409	645,119
2032	—	430,974	542,121	822,324	660,829
2033	—	436,464	550,958	860,973	676,923
2034	—	441,863	559,938	901,439	693,411
2035	—	—	569,065	943,806	710,302
2036	—	—	578,341	988,165	727,607
2037	—	—	587,768	1,034,609	745,336
2038	—	—	597,348	1,083,236	763,498
2039	—	—	607,085	1,134,148	782,106

Table 6-13. Air Cargo Projections (metric tons) (Seattle-Tacoma International Airport) (continued)

YEAR	HISTORICAL	SAMP FORECAST	(LOW) SAMP AAGR	(HIGH) BOEING WORLD FORECAST	PREFERRED FORECAST
2040	—	—	616,981	1,187,453	801,168
2041	—	—	627,038	1,243,263	820,698
2042	—	—	637,258	1,301,696	840,705
2043	—	—	647,646	1,362,876	861,203
2044	—	—	658,202	1,426,931	882,203
2045	—	—	668,931	1,493,997	903,717
2046	—	—	679,834	1,564,215	925,758
2047	—	—	690,916	1,637,733	948,340
2048	—	—	702,178	1,714,706	971,474
2049	—	—	713,623	1,795,297	995,175
2050	—	—	725,255	1,879,676	1,019,458

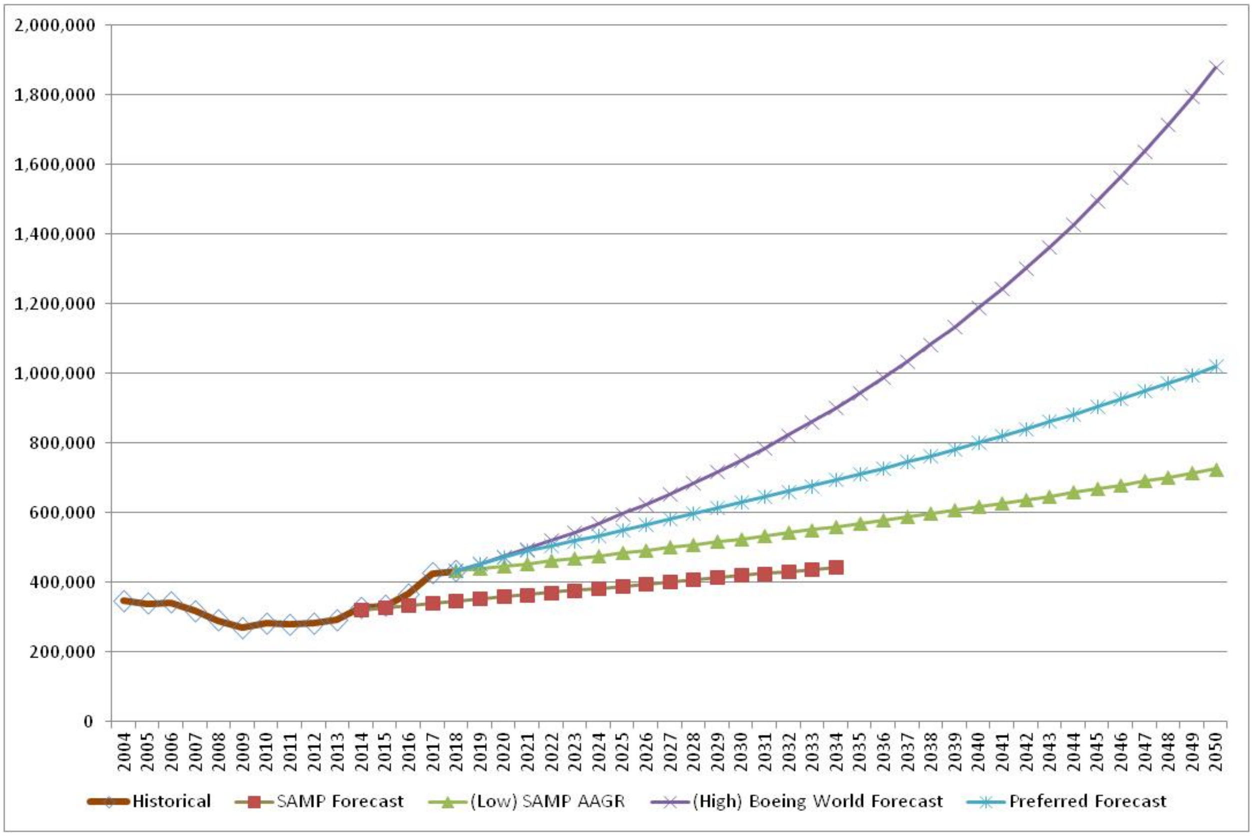
*2018 air cargo tonnage is based on actual year to 2018 data

Freighters represented 56 percent of the Sea-Tac air cargo market in 2013 with year-to-year fluctuation before growing to 60 percent of the market by 2016 and 62 percent in 2017. The freighter market share has increased at Sea-Tac due the new presence of DHL and Amazon Air to the Sea-Tac market and has reached 66 percent of the cargo tonnage in 2018.

The forecast will assume a 65 percent freighter market share going forward, with additional freighter capacity being added by the upsizing of aircraft gauge.

Figure 6-8 presents a comparison of Sea-Tac air cargo projections going out to the year 2050.

Figure 6-8. Air Cargo Projections (Seattle-Tacoma International Airport)



6.3.4.3 KING COUNTY INTERNATIONAL AIRPORT

As reported previously, KCIA is a mixed-use general aviation, commercial service and industrial airport located just south of the SODO District in Seattle.

Due to its inner-city location and access to I-5, the airport is attractive to domestic express air cargo operators. Air cargo at KCIA is generated almost exclusively by the integrator all-cargo carriers. The dominant air cargo carrier at KCIA is UPS with an almost 100 percent market share in 2017 since ABX Airlines (flying for DHL Express and Amazon Air) relocated their operation to Sea-Tac Airport in June 2016.

KCIA does not collect air cargo data directly from the airlines. All air cargo data used in this analysis is from the U.S. DOT Bureau of Transportation Statistics T-100 Market and Segment (All-carriers) Report. The unit of measurement is metric tons. Due to the lack of a consistent data reporting mechanism, historical air cargo volumes reported in the KCIA Draft Airport Master Plan Update and the data used in this report do not always match.

From year 2013 to 2014 YOY air cargo growth at KCIA was 7.6 percent. From year 2014 to 2015 YOY air cargo at KCIA increased 15 percent. In 2016 ABX Air, ATI, and Atlas Airlines (flying for DHL Express and Amazon Air) relocated from KCIA to Sea-Tac, resulting in YOY air cargo tonnages decreasing by 9.4 percent.

UPS is now the sole air cargo airline located at KCIA. From 2016 to 2017 air cargo tonnages declined at BFI by just 0.6 percent. The U.S. DOT Bureau of Transportation Statistics data for the first six months of 2018 indicates a 6.7 percent increase in air cargo tonnages over the first six months of 2017.

Forecast of Air Cargo

A working paper produced by Mead & Hunt in May 2016 (Draft Working Paper One) as a part of the ongoing KCIA Airport Master Plan Update process prepared a 20-year forecast of air cargo for the years 2015-2035. The air cargo forecast was calculated using the past 10-year net increase versus decrease of total enplaned plus deplaned volumes, generating an average annual increase of 1,769 metric tons, that equates to 1.3 percent annual growth. This methodology resulted in a 2026 projection of 141,508 metric tons.

Table 6-14 presents three projections for air cargo at KCIA. The projections are the draft Master Plan Update forecast, a projection utilizing the Master Plan Update average annual growth rate of 1.3 percent, the Boeing high world air cargo CAAGR of 4.7 percent, and a preferred projection.

The Master Plan projection was based on a 1.3 percent average annual growth rate applied to 2015 KCIA air cargo tonnages that reflected the cargo tonnages generated by ABX Air (DHL) for that year. The Master Plan CAAGR projection utilized the Master Plan Update projected KCIA growth rate of 1.3 percent applied to the more recent 2017 KCIA air cargo tonnages.

The preferred air cargo forecast for KCIA is more aggressive, taking into consideration the increase in e-commerce activity and the growth in air cargo volumes for the first six months of 2018.

Going forward, it is predicted that the integrator/express market at KCIA will grow at a compounded annual average growth rate of 5 percent per year for years 2018 through 2022; for years 2023 through 2029, a growth rate of 3 percent per year is assumed, and for years 2030 through 2050 a 2.5 percent annual growth rate is assumed.

6.3.4.4 PAINE FIELD AIRPORT

Existing air cargo activity at Paine Field is generated by mix of specialized/modified wide-body freighters as a part of the Boeing's 787 airplane manufacturing and assembly program. Typical air cargo market dynamics and operating parameters are not relevant to cargo activity at Paine Field because there are no commercial air cargo flights available for use by the general public. For all intents and purposes, air cargo activity at Paine Field related to the Boeing Company should be considered general aviation activity and will not be included in this air cargo forecast.

As of March 2019, limited commercial passenger activity was initiated at Paine Field by Alaska Airlines. The number of proposed commercial flights from Paine Field is anticipated to be 24 departures and arrivals each day using small narrow-body aircraft utilizing two gates. Due to the aggressive arrival and departure schedule, small aircraft capacity, limited gate and terminal facilities and small cities being served, little or no belly cargo is anticipated to be generated at Paine Field in the foreseeable future.

Table 6-14. Air Cargo Projections (King County International Airport)

	KCIA 2016 MASTER PLAN	MASTER PLAN 1.3% CAAGR	BOEING WORLD FORCAST (HIGH)	PREFERRED
Historical				
2017	—	113,718	113,718	113,718
Forecast				
2018	127,247	115,196	119,063	119,404
2019	129,029	116,694	124,659	125,374
2020	130,812	118,211	130,518	131,643
2021	132,595	119,748	136,652	138,225
2022	134,377	121,304	143,075	145,136
2023	136,160	122,881	149,799	149,490
2024	137,942	124,479	156,840	153,975
2025	139,725	126,097	164,211	158,594
2026	141,508	127,736	171,929	163,352
2027	—	129,397	180,010	168,253
2028	—	131,079	188,470	173,300
2029	—	132,783	197,328	178,499
2030	—	134,509	206,603	182,962
2031	—	136,258	216,313	187,536
2032	—	138,029	226,480	192,224
2033	—	139,824	237,124	197,030
2034	—	141,641	248,269	201,955
2035	—	143,483	259,938	207,004
3036	—	145,348	272,155	212,179
3037	—	147,237	284,946	217,484
2038	—	149,151	298,339	222,921
2039	—	151,090	312,361	228,494
2040	—	153,055	327,042	234,206
2041	—	155,044	342,412	240,062
2042	—	157,060	358,506	246,063
2043	—	159,102	375,356	252,215
2044	—	161,170	392,997	258,520
2045	—	163,265	411,468	264,983
2046	—	165,388	430,807	271,608
2047	—	167,538	451,055	278,398
2048	—	169,716	472,255	285,358
2049	—	171,922	494,451	292,492
2050	—	174,157	517,690	299,804

Source: 1 King County International Airport/Boeing Field Master Plan Update May 2016; 2 KPA; 3 Boeing World Air Cargo Forecast 2018-2013; 4 KPA

6.3.5 Forecast of Freighter Aircraft Operations

There are two options for air cargo transport—dedicated freighters and passenger aircraft lower holds, also referred to as passenger belly capacity—and each offers unique advantages. Freighters are particularly well suited for transporting high-value goods because they provide highly controlled transport, direct routing, reliability, and unique capacity considerations.

With the introduction of a new generation of wide-body passenger airplanes with larger lower-hold capacity, more airlines are combining cargo transportation with passenger operation to capitalize on additional revenue opportunities. However, while lower-hold capacity in wide-body airplanes serving long-haul missions has increased by nearly 6 percent in the last five years, several parameters can limit the cargo operations in passenger aircraft: the reduced height of the lower deck can limit volumes and different security standards and regulations may restrict commodities that can be shipped in passenger airplane lower holds. In addition, range restrictions on fully loaded passenger aircraft and limited passenger service to major cargo airports make freighter operations essential.

Integrator/express carriers dominate at Sea-Tac and KCIA and operate substantial freighter fleets, flying more than half of the wide-body freighters in the world and generating 43 percent of air cargo industry revenues in 2017. Because of a unique business model tailored to the needs of their customers by using unique schedules, specialized airplanes, and a door-to-door transportation network, carriers that operate only lower hold cannot offer the same level of service.

For these structural reasons, freighters are forecast by Boeing to carry more than half of the world's air cargo for the next 20 years.

6.3.5.1 TYPES OF FREIGHTERS

Narrow- or standard-body freighters are those with less than 45 tons of carrying capacity. Fuselage cross-sections are those of single-aisle airplanes. Medium wide-body freighters have capacities of 40 to 80 tons.

Table 6-15. World Freighter Fleet Size Categories

STANDARD/NARROW-BODY (<45 TONS)	MEDIUM WIDE-BODY (40-80 TONS)	LARGE WIDE-BODY (80 TONS)
707	767 series	747 series
727 series	787	777 series
737 series	A300 series	A350
757	A310 series	AN-124
A320 series	A330 series	Il-96T
BAe 146	DC-10 series	MD-11
DC-8 series	Il-76 TD series	—
DC-9 series	—	—
MD-880 SF	—	—
Tu-204	—	—

Source: Boeing

These are “twin-aisle” airplanes. Large freighters are those with 80 tons of capacity or more.

North America is the second-largest market for freighter deliveries, with needs driven mainly by the integrator/express carriers domiciled in the United States. According to Boeing, these airlines will require many medium wide-body freighters—supporting a balance of moving cargo with relatively low-density volumes and providing daily flights—to connect all network nodes.

6.3.5.2 FREIGHTER AIRCRAFT OPERATIONS FORECAST (SEATTLE-TACOMA INTERNATIONAL AIRPORT)

In 2017, there were 14,310 freighter aircraft operations at Sea-Tac. Wide-body and standard/narrow-body freighters comprised almost 80 percent of freighter takeoffs and landings. Turboprop air taxi feeder aircraft represented 21 percent of the total. The average payload per freighter operation was 18.466 metric tons (41,372 lbs.). The peak month was December with 10.7 percent of annual operations.

In 2018, there were 15,736 freighter aircraft operations with the percentage of air taxi feeder aircraft decreasing to 18.5 percent of the total freighter takeoffs and landings. FedEx and ATI (flying for the integrators DHL and Amazon Air) represented almost 50 percent of the transport (Part 121 non-air taxi feeder) freighter operations at Sea-Tac.

The average payload per freighter aircraft operation was 18.109 metric tons (39,923 lbs.). It is assumed that the payload per freighter aircraft operation decreased somewhat in 2018 due to the smaller cherry season and the corresponding reduction in the use of large wide-body aircraft at Sea-Tac associated with this market.

In the future, it is assumed that Sea-Tac fleet freighter mix will be dominated by medium wide-body freighters (40 to 80-ton payload capacity) used by DHL, Amazon, and FedEx, with the continued use of larger wide-body aircraft for the cherry charter season, outsized international cargo shipments and peak holiday season charters. The air cargo freighter operations forecast for Sea-Tac was projected using the 2017 freighter payload per operation as a constant and is presented in Table 6-16.

Table 6-16. Forecast of Air Cargo Freighter Operations (Seattle-Tacoma International Airport)

	FREIGHTER CARGO	FREIGHTER AIRCRAFT OPERATIONS
Historical		
2017	264,254	14,310
Forecast		
2018*	284,957	15,736
2019	298,034	15,871
2020	311,396	16,582
2021	323,725	17,239
2022	332,984	17,732
2023	342,511	18,239
2024	352,316	18,761
2025	362,405	19,299
2026	372,787	19,852
2027	383,470	20,420
2028	394,464	21,006
2029	405,778	21,608
2030	415,658	22,135
2031	425,778	22,673
2032	436,147	23,226
2033	446,769	23,791
2034	457,651	24,371
2035	468,800	24,964
2036	480,221	25,573
2037	491,922	26,196
2038	503,909	26,834
2039	516,190	27,488
2040	528,771	28,158
2041	541,661	28,844
2042	554,866	29,548
2043	568,394	30,268
2044	582,254	31,006
2045	596,453	31,762
2046	611,001	32,537
2047	625,904	33,331
2048	641,173	34,144
2049	656,816	34,977
2050	672,842	35,830

* Actual 2018 freighter operations

6.3.5.3 FREIGHTER AIRCRAFT OPERATIONS FORECAST (KING COUNTY INTERNATIONAL AIRPORT)

Freighter aircraft types used on a regular basis at KCIA include the A300-600, B767-200/300ER, MD11, MD/DC-10 and B757-200. According to the U.S. DOT Bureau of Transportation Statistics T-100 Segment data there were 2,446 all-cargo freighter aircraft landings at KCIA in 2017 for a total of 4,892 total freighter operations. Based upon the number of all-cargo freighter aircraft landings and tons of air cargo moved in 2017 the average payload per was 23.25 metric tons (51,257 pounds) per freighter operation.

UPS is the primary air cargo operator at KCIA. As of March 2019, UPS Airlines has an active fleet of 249 aircraft. The primary workhorses of the UPS domestic aircraft fleet are the standard-body (single aisle) Boeing 757-200 (75 aircraft) and the medium wide-body Boeing 767-300 (59 aircraft) and Airbus A300-600 (52 aircraft). Reportedly, UPS has nine B767 freighters on order.

Over 94 percent of the freighter landings at KCIA in 2017 were by B767 aircraft (57.6 percent) and by B757 aircraft (36.7 percent). It is anticipated that in the future the B767 (maximum payload of 132,200 lbs.) will replace more of the B757 (maximum payload of 86,900 lbs.) operations, resulting in an incrementally higher payload per freighter aircraft operation. Table 6-17 presents the forecast of freighter aircraft operations.

Table 6-17. Forecast of Air Cargo Freighter Operations (King County International Airport)

	FREIGHTER CARGO	FREIGHTER OPERATIONS
Historical		
2017	113,718	4,892
Forecast		
2018	119,404	5,137
2019	125,374	5,393
2020	131,643	5,663
2021	138,225	5,946
2022	145,136	6,244
2023	149,490	5,750
2024	153,975	5,922
2025	158,594	6,100
2026	163,352	6,283
2027	168,253	6,471
2028	173,300	6,189
2029	178,499	6,375
2030	182,962	6,534
2031	187,536	6,698
2032	192,224	6,865
2033	197,030	6,568
2034	201,955	6,732
2035	207,004	6,900
2036	212,179	7,073
2037	217,484	7,249
2038	222,921	7,431
2039	228,494	7,616
2040	234,206	7,807
2041	240,062	8,002
2042	246,063	8,202
2043	252,215	8,407
2044	258,520	8,617
2045	264,983	8,833
2046	271,608	9,054
2047	278,398	9,280
2048	285,358	9,512
2049	292,492	9,750
2050	299,804	9,993

6.3.6 Forecast Summary

Table 6-18 presents the preferred air cargo forecast for the central Puget Sound region and is illustrated in Figure 6-9. The 20-year 2017–2050 average annual growth rate for the central Puget Sound region air cargo is 2.75 percent. As to be expected, Sea-Tac will continue to dominate the central Puget Sound region air cargo market for the duration of the forecast.

Table 6-19 shows the forecast for air cargo freighter operations in the central Puget Sound region.

As presented in Table 6-19, air cargo freighter aircraft operations are projected to increase almost 75 percent in 20 years from 19,200 in 2017 to approximately 33,445 by 2037 and to approximately 46,000 by 2050—a 140 percent increase. The fleet mix will be dominated by medium wide-body freighters operated primarily by the express integrator airlines.

6.3.6.1 JTC WASHINGTON STATE AIR CARGO GOODS MOVEMENT FORECAST

A 10-year forecast of air cargo in Washington state was performed in January 2018 as a part of the *Washington State Air Cargo Goods Movement Study* (Washington State Legislature JTC, December 21, 2018) (JTC Study).

The JTC Study used a 10-year CAAGR of 3.52 percent for the forecast years 2017 through 2026. The current forecast anticipates a slightly lower 3.34 percent 10-year CAAGR. The reason for new the lower growth rate relates primarily to protectionism, trade friction, and anti-globalization rhetoric that has begun to influence global trade and international air cargo volumes.

As stated in the JTC Study, it is expected that the Seattle market will continue to dominate the Washington state air cargo market for the duration of the forecast, with Sea-Tac maintaining the largest share.

Table 6-18. Commercial Air Cargo Tonnage Forecast

	SEA-TAC	KCIA	TOTAL CENTRAL PUGET SOUND REGION AIR CARGO TONNAGE
Historical			
2017	425,856	113,718	539,574
Forecast			
2018	432,304*	119,404	551,708
2019	451,567	125,374	576,941
2020	471,811	131,643	603,454
2021	490,492	138,225	628,717
2022	504,521	145,136	649,657
2023	518,957	149,490	668,447
2024	533,812	153,975	687,787
2025	549,098	158,594	707,692
2026	564,828	163,352	728,180
2027	581,016	168,253	749,268
2028	597,673	173,300	770,974
2029	614,816	178,499	793,315
2030	629,784	182,962	812,746
2031	645,119	187,536	832,655
2032	660,829	192,224	853,053
2033	676,923	197,030	873,953
2034	693,411	201,955	895,366
2035	710,302	207,004	917,307
2036	727,607	212,179	939,787
2037	745,336	217,484	962,820
2038	763,498	222,921	986,419
2039	782,106	228,494	1,010,600
2040	801,168	234,206	1,035,375
2041	820,698	240,062	1,060,759
2042	840,705	246,063	1,086,769
2043	861,203	252,215	1,113,418
2044	882,203	258,520	1,140,723
2045	903,717	264,983	1,168,700
2046	925,758	271,608	1,197,366
2047	948,340	278,398	1,226,737
2048	971,474	285,358	1,256,832
2049	995,175	292,492	1,287,667
2050	1,019,458	299,804	1,319,262

* Actual Sea-Tac air cargo tonnages for 2018

Figure 6-9. Air Cargo Tonnage Forecast

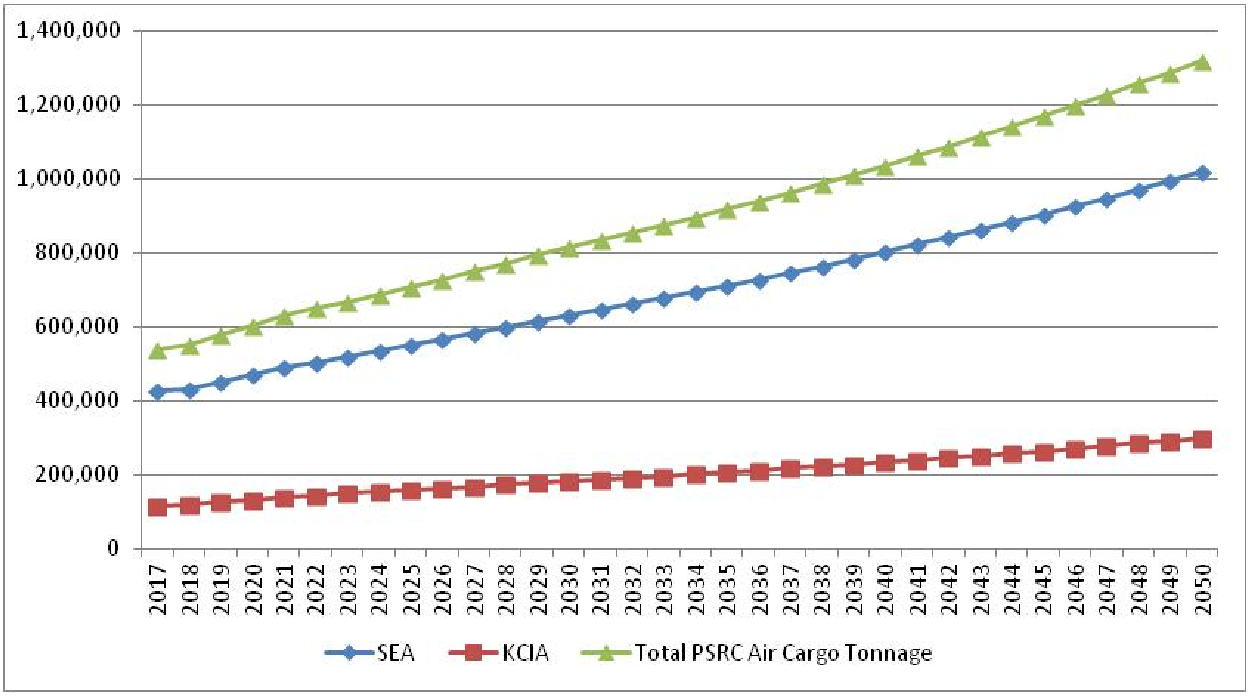


Table 6-19. Forecast of Air Cargo Freighter Aircraft Operations

	SEA-TAC AIRCRAFT FREIGHTER OPERATIONS	KCIA FREIGHTER AIRCRAFT OPERATIONS	TOTAL CENTRAL PUGET SOUND REGION FREIGHTER AIRCRAFT OPERATIONS
Historical			
2017	14,310	4,892	19,202
Forecast			
2018	15,736*	5,137	20,873
2019	15,871	5,393	21,264
2020	16,582	5,663	22,245
2021	17,239	5,946	23,185
2022	17,732	6,244	23,976
2023	18,239	5,750	23,989
2024	18,761	5,922	24,684
2025	19,299	6,100	25,398
2026	19,852	6,283	26,134
2027	20,420	6,471	26,892
2028	21,006	6,189	27,195
2029	21,608	6,375	27,983
2030	22,135	6,534	28,669
2031	22,673	6,698	29,371
2032	23,226	6,865	30,091
2033	23,791	6,568	30,359
2034	24,371	6,732	31,103
2035	24,964	6,900	31,865
2036	25,573	7,073	32,645
2037	26,196	7,249	33,445
2038	26,834	7,431	34,265
2039	27,488	7,616	35,105
2040	28,158	7,807	35,965
2041	28,844	8,002	36,846
2042	29,548	8,202	37,750
2043	30,268	8,407	38,675
2044	31,006	8,617	39,623
2045	31,762	8,833	40,595
2046	32,537	9,054	41,590
2047	33,331	9,280	42,610
2048	34,144	9,512	43,656
2049	34,977	9,750	44,726
2050	35,830	9,993	45,824

* Actual Sea-Tac air cargo freighter aircraft operations for 2018

REGIONAL AVIATION BASELINE STUDY:
WORKING PAPER 1

Chapter 7
Multimodal Connections and Access

June 11, 2019

Prepared for

Prepared by

In association with

Contents

7. Multimodal Connections 7-1
7.2 INTRODUCTION 7-1
7.3 MULTIMODAL LANDSIDE ACCESS – EXISTING CONDITIONS 7-1
7.3.1 Future High Capacity Transit 7-7
7.3.2 Rental Cars 7-7
7.3.3 Shuttle Services 7-7
7.3.4 Parking 7-7
7.3.5 Transportation Network Companies 7-8
7.4 MULTIMODAL LANDSIDE ACCESS 7-8
7.4.1 Arlington Municipal Airport 7-9
7.4.2 Auburn Municipal Airport 7-10
7.4.3 Bremerton National Airport 7-11
7.4.4 Harvey Field 7-12
7.4.5 King County International Airport 7-13
7.4.6 Paine Field 7-15
7.4.7 Renton Municipal Airport 7-17
7.4.8 Seattle-Tacoma International Airport 7-18
7.4.9 Tacoma Narrows Airport 7-21
7.5 DRIVE-TIME COVERAGE 7-22
7.5.1 Approach 7-22
7.5.2 Results 7-24
7.6 REGIONAL TRANSPORTATION PLANS AND FUTURE PROJECTS 7-34
7.6.1 Puget Sound Regional Council Regional Transportation Plan 7-34
7.6.2 City of Seattle Freight Master Plan 7-36
7.6.3 Move Seattle Plan and Levy 7-37
7.6.4 Sound Transit 7-38
7.6.5 Local Transit Plans 7-39
7.6.6 WSDOT State Route 509 and State Route 518 Projects 7-41
7.7 I-405 EXPRESS TOLL LANES / SR 167 HOT LANES 7-43
7.8 FUTURE TRENDS IN MULTIMODAL TRANSPORTATION 7-44
7.9 CONCLUSION 7-45

Tables

Table 7-1. Multimodal Landside Access at Regional Airports 7-2
Table 7-2. Airports Meeting Criteria for Drive Time Analyses 7-23
Table 7-3. People and Jobs in the Buffer Area (Total and Percentages) 7-25

Figures

Figure 7-1. Interstate Access 7-4
Figure 7-2. Interstate and State Route Access 7-5
Figure 7-3. High Capacity Transit Access 7-6
Figure 7-4. Ground Access at Arlington Municipal Airport 7-9
Figure 7-5. Ground Access at Auburn Municipal Airport 7-10
Figure 7-8. Ground Access at Bremerton National Airport 7-11
Figure 7-9. Ground Access at Harvey Field 7-12
Figure 7-6. Ground Access at King County International Airport 7-13
Figure 7-7. Drive-Time Analysis – King County International Airport 7-14
Figure 7-10. Ground Access at Paine Field 7-15
Figure 7-11. Drive-Time Analysis – Paine Field 7-16
Figure 7-12. Ground Access at Renton Municipal Airport 7-17
Figure 7-13. Ground Access at Seattle-Tacoma International Airport 7-18
Figure 7-14. Drive-Time Analysis – Seattle-Tacoma International Airport 7-20
Figure 7-15. Ground Access at Tacoma Narrows Airport 7-21
Figure 7-16. Population and Employment within 60 minutes of an Airport with Commercial Passenger Service 7-27
Figure 7-17. Population and Employment within 30 Minutes of an Airport with Jet Fuel Service 7-28
Figure 7-18. Population and Employment within 30 Minutes of an Airport with a Precision Instrument Approach 7-29
Figure 7-19. Population and Employment within 30 Minutes of an Airport Capable of Supporting Business Aircraft (5,000-foot runway length, AWOS/ASOS, and approach with vertical guidance) 7-30
Figure 7-20. Population and Employment within 30 Minutes of an Airport with De-icing Capabilities 7-31
Figure 7-21. Population and Employment within 60 Minutes of an Airport with International Large Freighter Service 7-32
Figure 7-22. Population and Employment within 60 Minutes of an Airport with Domestic and International Wide-body Belly Cargo Service 7-33
Figure 7-23. Current and Future Per-Capita Delay with and without 2040 Plan 7-35
Figure 7-24. SR 509 Project Map 7-42
Figure 7-25. SR 518 Corridor Planning Study Map 7-43

Acronyms

BRT .... Bus Rapid Transit
GIS .... Geographic Information Systems
KCIA .... King County International Airport
POF .... Passenger Only Ferry
SPB .... Sea Plane Base
TNC .... Transportation Network Companies
HOV .... High-Occupancy Vehicle
NPIAS .... National Plan of Integrated Airport System
PSRC .... Puget Sound Regional Council
SODO .... South of Downtown

7. Multimodal Connections

7.2 INTRODUCTION

Good roadway and transit connections to the interstate highway system, state highways, and public transportation are essential to a thriving airport system. In the central Puget Sound region, a strong network of highways, buses, light rail, bicycle and pedestrian connections help connect airports to passengers, employees, businesses, and freight services in the four-county region and beyond.

The purpose of this chapter is to provide an overview of multimodal landside access to the region's airports. It notes where configurations are deficient and provides an overview of planned improvements, both those that are directly airport related as well as broader regional transportation trends and plans likely to affect future multimodal access.

In the first section of this chapter, landside access is analyzed through metrics established in the project development phase and evaluated in the context of individual airport master plans, regional plans, and future projects that may impact how users travel to and from regional airports. A matrix is used to identify airports and evaluate current connectivity. It is accompanied by maps that illustrate locations of nearby connections to highways and public transportation.

Airport master plans at the nine busiest and largest airports within the central Puget Sound region are evaluated in the second section. The strengths and deficiencies of these airports in connecting regional users to aviation are noted.

The third section of the chapter assesses drive-time access to various types of airports throughout the region. Residential and employee access to various aviation services are assessed.

The final sections discuss the future plans and trends that might affect multimodal access to the airports. Potential ground access improvements that may impact regional airports are identified using published documents and planned projects. Finally, relevant emerging trends in transportation are evaluated for their potential impact on multimodal connectivity.

7.3 MULTIMODAL LANDSIDE ACCESS – EXISTING CONDITIONS

To analyze current ground access at regional airports, a matrix with distance from highways and public transportation was created. Due to the importance of convenient ground access for passengers, employees and others wishing to access airport services, the following criteria are used to determine whether an airport is meeting the key metrics:

- **Interstate** – within 5 miles of Interstates 5, 90, or 405
- **United States and State Routes** – within 2 miles of a U.S. or state route
- **High Capacity Transit** (bus rapid transit or rail) – within 0.5 mile of the airport terminal
- **Local Public Transportation** (bus) – within 0.5 mile of the airport terminal

Table 7-1 displays how well airports meet access metrics, with planned major capital improvement projects included. Additional information related to rental cars, shuttles and parking, where available, is also discussed following the matrix, outlining their impacts on ground access as well as their primary user groups.

Table 7-1. Multimodal Landside Access at Regional Airports

CATEGORY	CITY	INTERSTATE	STATE ROUTE ACCESS	HIGH CAPACITY TRANSIT	LOCAL SERVICE
Commercial Airports					
Paine Field	Everett	✓	✓	✓	✓
King County International	Seattle	✓	✓	♦	✓*
Seattle-Tacoma International Airport	Seattle	✓	✓	✓	✓
General Aviation Airports					
Arlington Municipal	Arlington	✓	✓		
Auburn Municipal	Auburn	✓	✓	♦	✓
Bandera State	Bandera	✓	✓#		
Bremerton National	Bremerton		✓		
Darrington Municipal	Darrington		✓		✓
Swanson Field	Eatonville		✓		
Ranger Creek State	Greenwater		✓		
Kenmore Air Harbor Sea Plane Base (SPB) S60	Kenmore	✓	✓	♦	✓
Norman Grier Field	Kent		✓		
First Air Field	Monroe		✓		✓
Port of Poulsbo SPB	Poulsbo		✓		✓
Pierce County	Puyallup		✓		✓
Renton Municipal	Renton	✓	✓	✓	✓*
Will Rogers-Wiley Post Memorial SPB	Renton	✓	✓	✓	✓
Kenmore Air Harbor SPB W55	Seattle	✓	✓	✓	✓
Seattle Seaplanes SPB	Seattle	✓	✓	♦	✓
Apex Airpark	Silverdale		✓		
Skykomish State	Skykomish		✓		
Harvey Field	Snohomish		✓		✓
Shady Acres	Spanaway				
American Lake SPB	Tacoma	✓	✓#		✓
Tacoma Narrows	Tacoma		✓		
Vashon Municipal	Vashon				

Source: Google Maps
Notes:
# indicates the airport does not have U.S. or state route access but meets the interstate access metric.
* indicates measurement taken from Boeing facilities rather than airport terminal.
♦ indicates planned high capacity transit in the future.

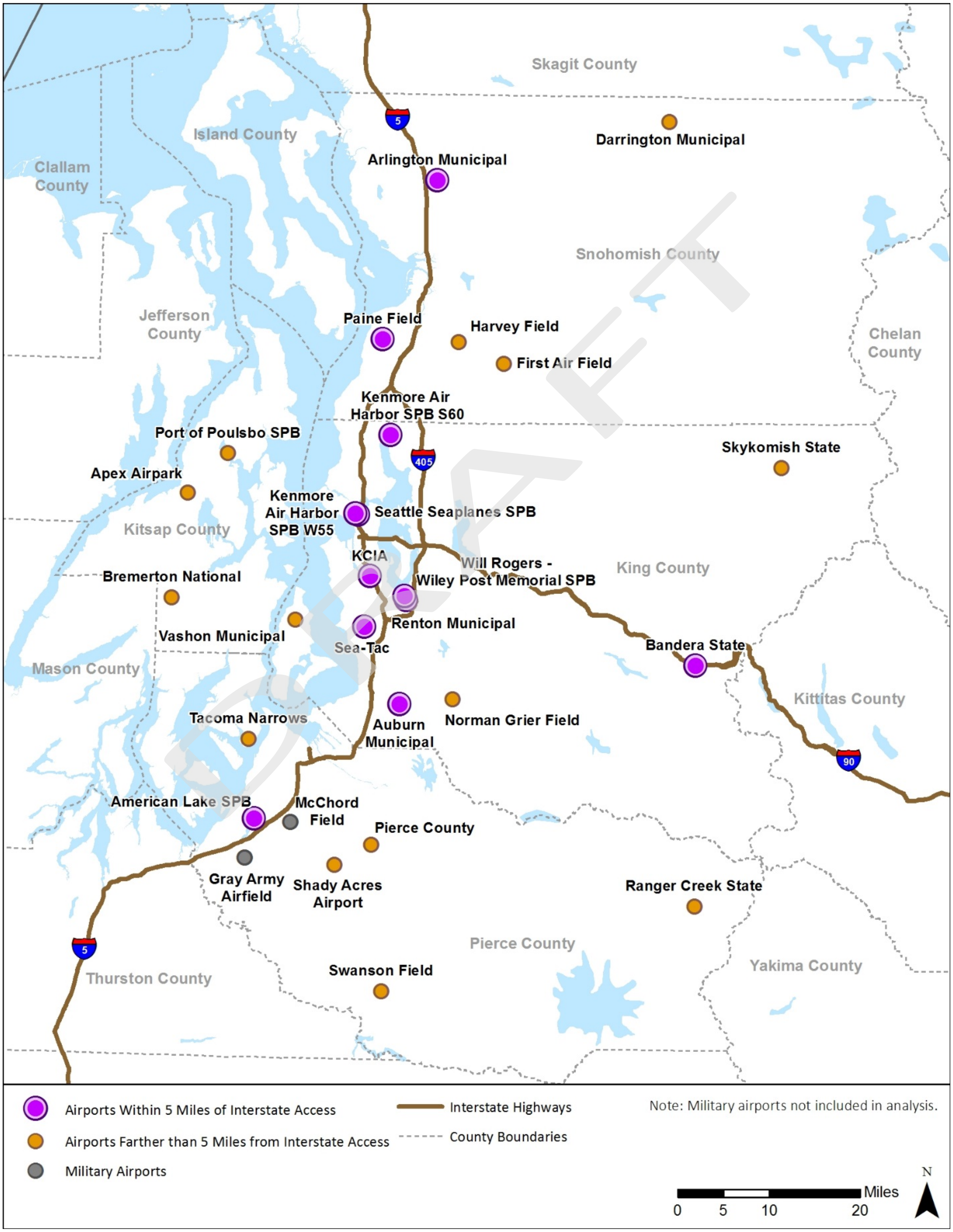
The different types of access have varying levels of importance to the central Puget Sound region airports based on the types of uses occurring at those airports. Interstate access is particularly important at airports with cargo operations while high capacity transit may be important for airports with commercial service and large employers. Future planning efforts related to aviation activity needs to consider multimodal ground access.

Identifying airports located in proximity to interstates and state routes offers an opportunity to explore potential shifts in responsibilities between airports where overloading may be occurring or there are gaps in service. In many instances, public transportation could be expanded to meet airports if activity dictates the need for service.

In summary, 24 out of the 26 system airports are within 2 miles of a U.S. or state route, indicating most airports are easily accessible by automobile for regional trips. Of the system airports, however, only 12 airports are within 5 miles of an interstate—an important connection to the rest of the state for recreational, business, and freight operations. The relatively limited number of airports within close proximity to an interstate places additional emphasis on those that are for current and future charter, commercial, and cargo operations. Figure 7-1, Figure 7-2, and Figure 7-3 illustrate interstate; U.S. and state routes; and transit access at airports in the region.

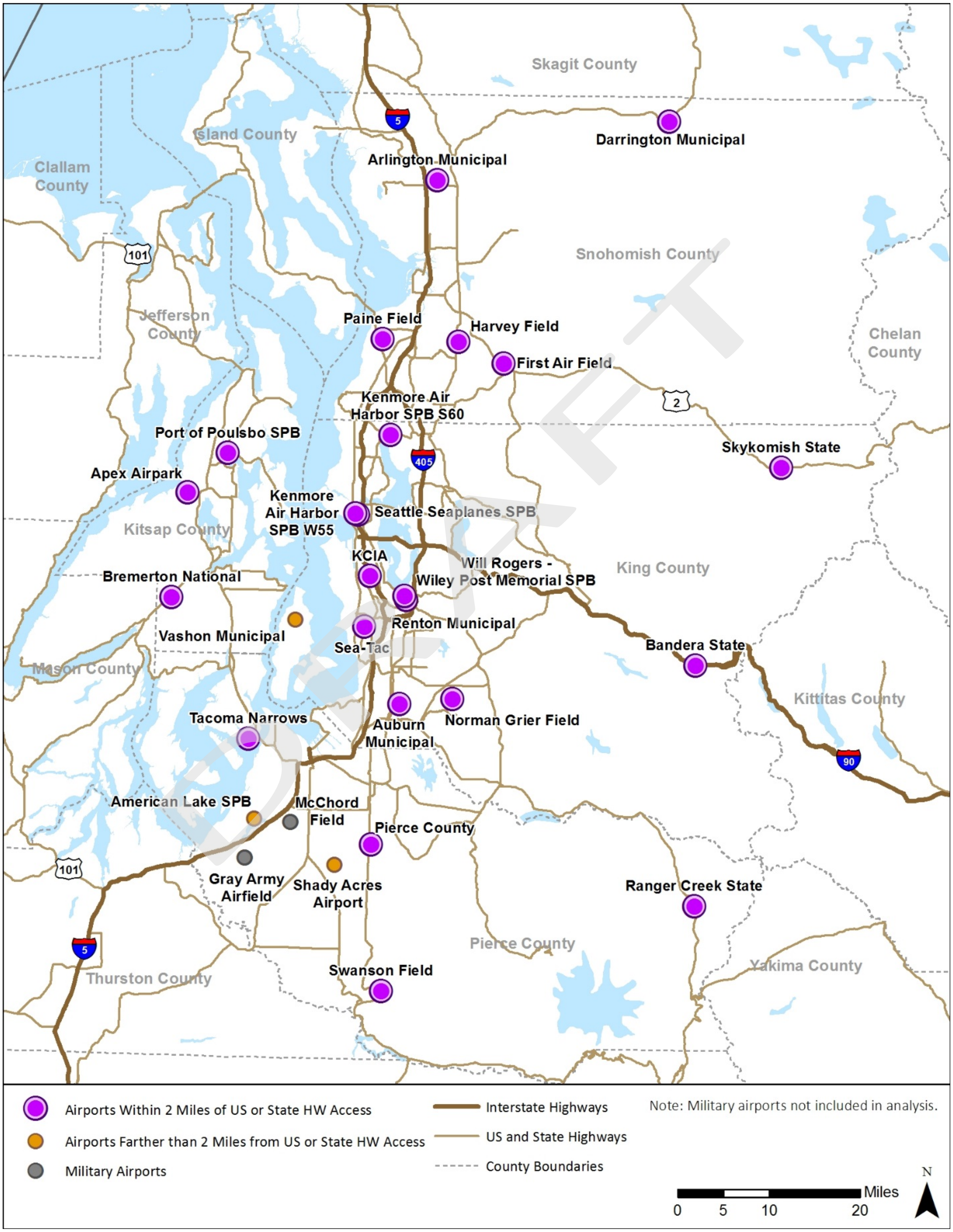
Aside from interstate, state route, and transit access, some study area airports provide other forms of access based on the types and frequency of uses. For instance, airports with heavy business use tend to offer rental cars and area hotels near Seattle-Tacoma International Airport (Sea-Tac), which offer shuttle services for businesses and recreational users staying near the airport.

Figure 7-1. Interstate Access



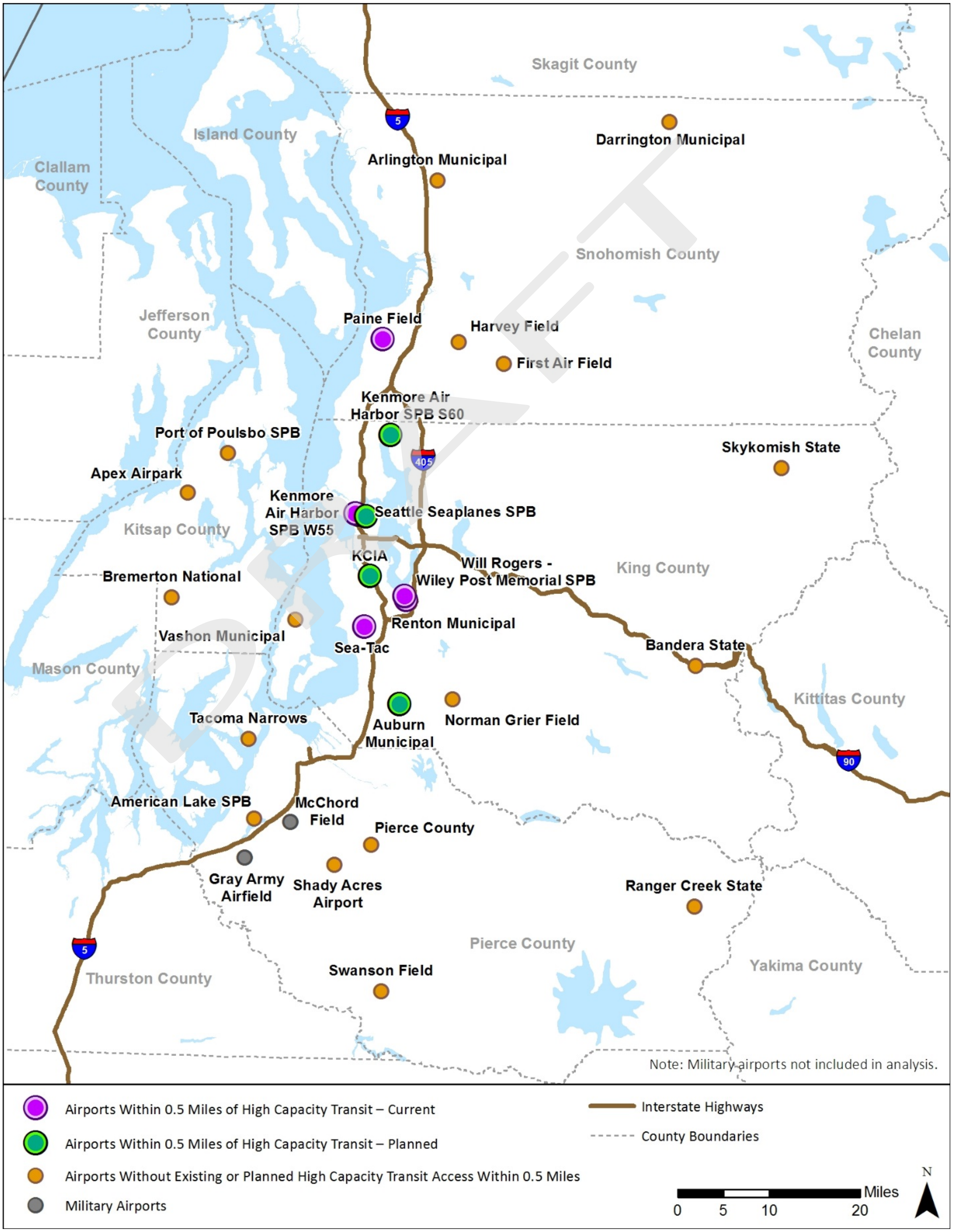
Source: CDM Smith and Puget Sound Regional Council

Figure 7-2. Interstate and State Route Access



Source: CDM Smith and PSRC

Figure 7-3. High Capacity Transit Access



Source: CDM Smith and PSRC

7.3.1 Future High Capacity Transit

New high capacity transit access to regional airports is planned, with King County International Airport (KCIA), Paine Field, Auburn Municipal, Seattle Seaplanes Sea Plane Base (SPB), and Kenmore Air Harbor SPB S60 slated to gain access on Link light rail or King County Metro's RapidRide. Sound Transit is planning to expand the Link light rail to Everett from its current terminus at the University of Washington. This extension would add a stop at Paine Field, providing access for the new commercial terminal as well as Boeing facilities. An infill stop near KCIA is also planned that would provide Link access on the South Boeing access road.

King County Metro is also planning to expand its high capacity transit service, RapidRide. Kenmore Air Harbor SPB S60 at the north end of Lake Washington, and Seattle Seaplanes SPB on the south end of Lake Union are both located near planned RapidRide expansions. Auburn Municipal in the southern part of King County is also expected to receive upgraded service, changing from a local transit line to a new RapidRide line. Finally, KCIA is expected to get RapidRide service at the south end of the airport on the South Boeing access road.

7.3.2 Rental Cars

Rental car companies are present at four airports: Sea-Tac, Paine Field, KCIA, and Tacoma Narrows. Three of these four airports have commercial service with the fourth, Tacoma Narrows, located near the second-largest city in the region. Companies providing the service at these airports do so strategically to capture business and recreational aviation users that may opt for personal transportation.

7.3.3 Shuttle Services

Shuttle service is also available at Sea-Tac and Paine Field to and from select hotels. A special ground service option is offered from Kenmore Air Harbor SPB at Lake Union to Sea-Tac to connect passengers flying to and from remote areas.

7.3.4 Parking

In surveys sent out to all airports in the region, 4 out of 19 respondents indicated that vehicle parking was insufficient for their needs:

- Paine Field noted that there are 1,170 parking spots at the airport now dedicated to commercial service, which began in March 2019. Previously, this space had been allocated to parking and uses related to general aviation.
- Renton Municipal, co-located with Will Rogers-Wiley Post Memorial SPB, also noted a strain on parking, especially for tenants located near the Boeing production facilities where there is limited area to expand.

- Harvey Field (in Snohomish County) indicated that an overflow gravel lot was often used when the 105-space parking lot is full. Considerations for additional parking may be made in future master plans while also considering the context of the future regional transportation system.

7.3.5 Transportation Network Companies

One area that has already significantly impacted multimodal connections, especially at commercial airports, is the advent of Transportation Network Companies (TNC) such as Uber and Lyft. Uber and Lyft utilize mobile applications and individuals with personal vehicles to complete requested trips, adding another option to available ride services. The availability, affordability, and popularity of these services have set the industry up for success into the future. Uber has begun piloting self-driving vehicles to eventually augment humans in their fleet of drivers, another innovation that will eventually change the way users connect, including traveling to and from airports. However, the required curb space to accommodate TNC drop-offs and pick-ups has been problematic for many airports and may require additional consideration and facilities.

7.4 MULTIMODAL LANDSIDE ACCESS

Nine airports with master plans were evaluated for adequacy of landside access:

- Arlington Municipal
- Auburn Municipal
- KCIA
- Bremerton National
- Harvey Field
- Paine Field
- Renton Municipal
- Sea-Tac
- Tacoma Narrows Airport

The latest airport master plans, as well as airport manager survey responses and results of drive-time analyses conducted for this study were analyzed with a focus on important connections, identified deficiencies, planned improvements, and overall adequacy of access within the context of use and demand at each airport. All commercial airports (Sea-Tac, KCIA, and Paine Field) were included in the 60-minute drive-time access analysis and associated maps have been included for these airports.

7.4.1 Arlington Municipal Airport

Arlington Municipal Airport's master plan was first created in 2002 with subsequent updates in 2008 and 2012. The airport is located within proximity to I-5 and several state routes providing quick and easy access. Interstate 5 runs to the west of the airfield, providing access to Seattle to the south and Bellingham to the north. State Route 531 runs south of the airport, leading to two connections via Airport Boulevard and 59th Avenue NE (Figure 7-4).

Figure 7-4. Ground Access at Arlington Municipal Airport

Source: Google Earth, Landsat / Copernicus

7.4.2 Auburn Municipal Airport

Auburn Municipal Airport, in southern King County, is located within two miles of State Routes 18 and 167 and within five miles of Interstate 5 (I-5). Transit access is available through King County Metro via Route 180, which makes stops less than one-tenth mile away from the current terminal parking lot (Figure 7-5). The airport is in a heavily urbanized area with limited room for expansion, which affects potential development and limits the use of the airport to its current role.

Figure 7-5. Ground Access at Auburn Municipal Airport

Source: Google Earth, Landsat / Copernicus

The airport is primarily used for recreation and flight instruction on a daily basis, with intermittent use for medical and law enforcement operations. According to the latest airport master plan, there are about 75 designated parking spaces on the property, with users often parking personal vehicles near hangars, if room is available. Airport management noted that the current amount of parking is sufficient for current operations.

The 2015 Master Plan outlines three development alternatives that would reconfigure areas of the airfield, two of which that would add significant amounts of parking. Future development will likely emphasize the expansion of parking areas.

Based on the frequency and types of use at the airport, current landside access should remain sufficient if the airport continues with similar use. As noted in the master plan, future development at the airfield may aim to expand parking which in turn could allow for new activities at Auburn Municipal Airport.

7.4.3 Bremerton National Airport

Bremerton National Airport is in Kitsap County, on the west side of the Puget Sound. Air access is important to this part of the region due to the increased time required for land access to other regional airports, particularly across the Sound. Landside access at Bremerton National relies heavily on State Route 3 that runs to the west boundary of the airport. State Route 3 connects the airport to Bremerton as well as to the larger cities of Tacoma and Olympia. Ferry service is also provided from Bremerton to Seattle, connecting the area to the center of the region and cutting significant time from driving alternative routes (Figure 7-8.)

Figure 7-6. Ground Access at Bremerton National Airport

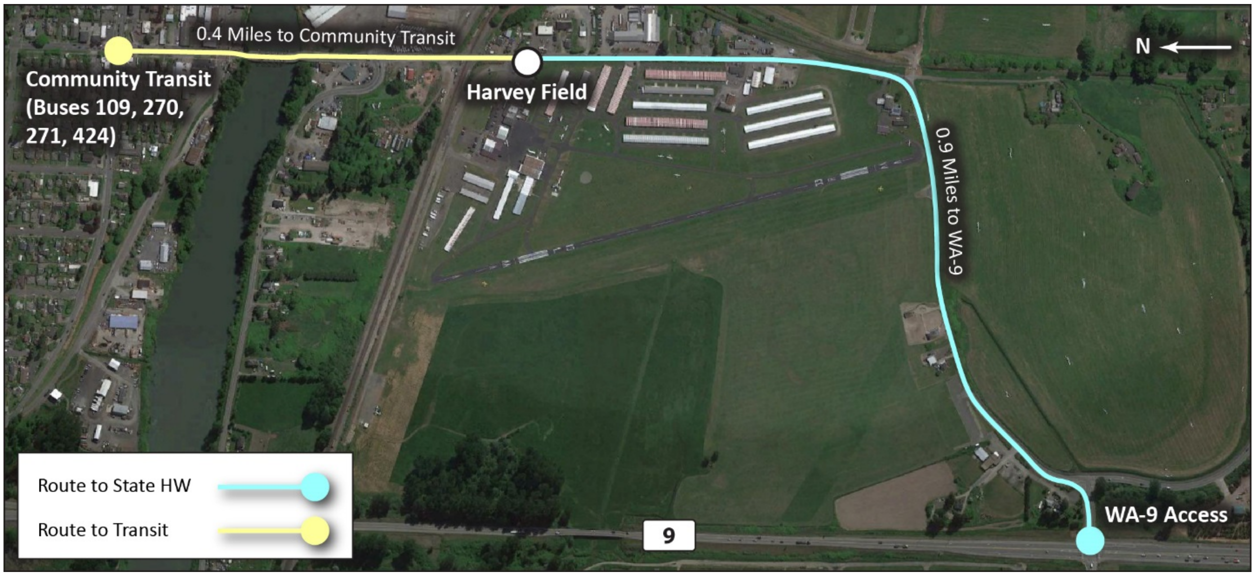
Source: Google Earth, Landsat / Copernicus

Due to its location within the region, the airport sees daily use for local air cargo operations, as well as recreational flights and flight instruction. The 2015 Master Plan outlines the road access provided to the airport and the available parking; 132 spots for tenants and customers, and an additional 23 spots for a restaurant on the airfield. The master plan notes that development on the west side of the airfield is at capacity due to stormwater constraints and available land. Potential development of the east side of the airport would require improvements to surface access such as roads and parking in order to appropriately serve the growth.

7.4.4 Harvey Field

Harvey Field is a privately owned, public use airport in Snohomish County that serves general aviation uses. The airport is located about one mile from State Route 9, a north-south highway connecting communities in the eastern portion of the central Puget Sound region (Figure 7-9). The Snohomish River runs to the north and east of the airport and separates the facility from the city of Snohomish. Bus access is provided from Community Transit via four different routes with connections to Everett, Monroe, Lake Stevens, and Lynnwood.

Figure 7-7. Ground Access at Harvey Field



Source: Google Earth, Landsat / Copernicus

The airfield is used daily for recreation, flight instruction, and skydiving. Landside access, as noted in the 2018 Master Plan, is currently constrained by the traffic on Airport Way, which is operating at a low level of service. Additionally, survey responses indicated that current parking is insufficient for current demand. The airport currently has a 105-space paved parking lot with a 95-space gravel lot frequently used for overflow parking on weekends and during special events.

7.4.5 King County International Airport

King County International Airport (KCIA) is in a heavily urbanized area with multiple points of access by different modes. Roadway, transit, and freight access are all key areas that the airport is in the process of evaluating through their master plan update.

KCIA is an important airport in the central Puget Sound region, serving as a primary airport according to the National Plan of Integrated Airport System. The airport experiences daily operations for commercial service, air cargo, business, military, medical, and more, which demonstrates the importance of landside connectivity. Boeing also maintains an aircraft delivery facility at the airport, which requires strong landside connections for employee access as well as freight movement.

While in the process of updating the airport master plan, the airport owner has posted a draft technical working paper on the airport's website that evaluates current landside access at KCIA as well as what may be needed to ensure its success in the future. Parking is projected to remain sufficient through the study's 20-year planning period, with space for 207 vehicles near the terminal building that adequately serves tenants, airport staff, and passengers.

Roadway access is provided on the east, northwest, and west sides of the airfield, via State Route 99 and I-5. The airport is well-supported with road infrastructure, with the entire airport surrounded by arterial streets, with additional classification as Major Truck Streets by the City of Seattle. These roadways not only offer access to passengers and employees but also to trucks that move freight throughout the region and state (Figure 7-6).

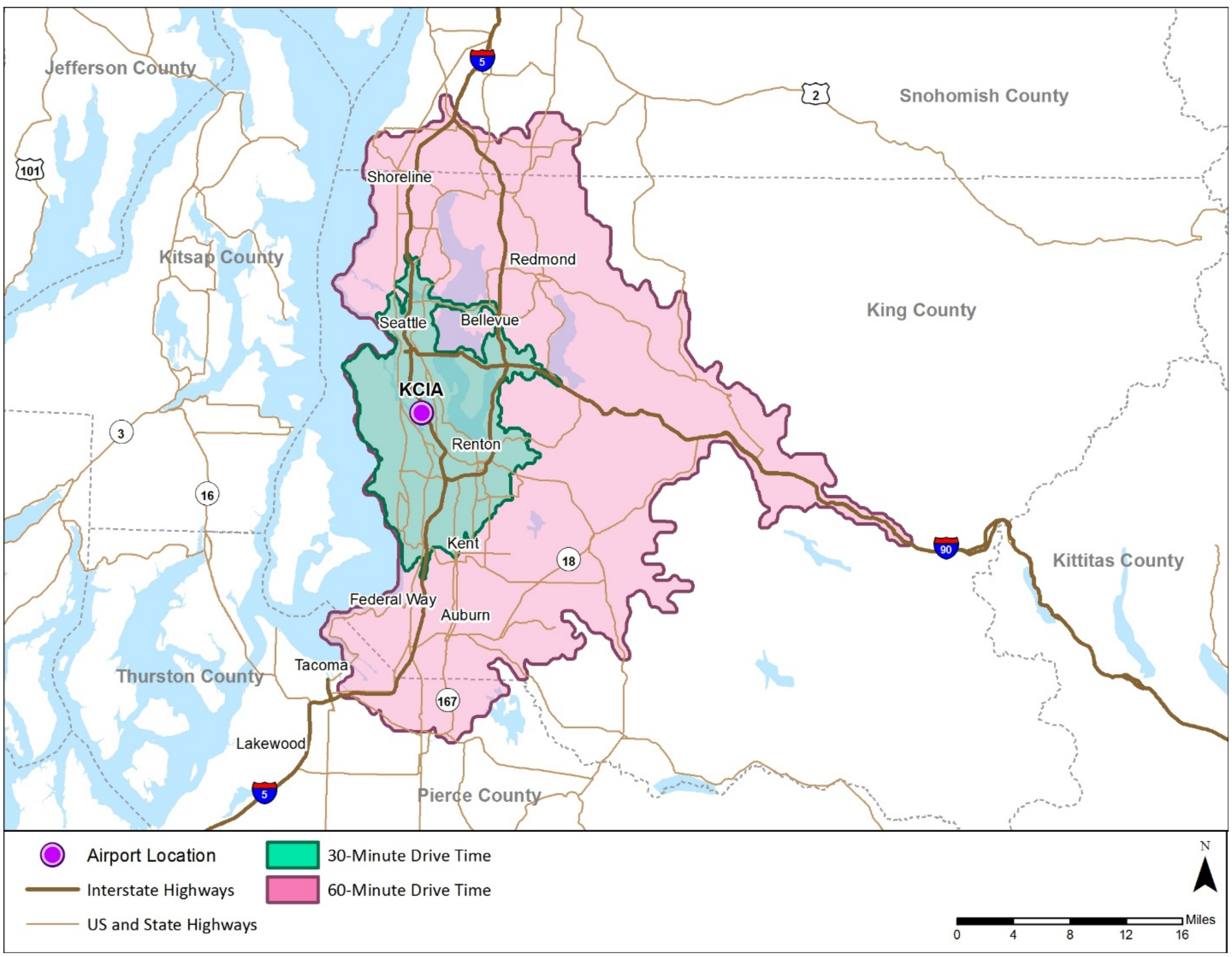
Figure 7-8. Ground Access at King County International Airport

Source: Google Earth, Landsat / Copernicus

Transit is an especially important link at KCIA due to the high number of employees at Boeing facilities as well as the location of the airport near the urban core where there is more congestion on roadways. The airport is also supported by several King County Metro bus routes; however, these are located just over one mile away to the north of the terminal building. Bus routes running on the west side of the airport also serve several airport related businesses including the major Boeing facilities located along East Marginal Way South. A new transit link is proposed that would provide connections to the Link and Sounder rail options via the South Boeing access road with shuttles to the Boeing facilities located around the airport.

A drive-time analysis was conducted for airports as further described in Section 7.5 of this chapter. The drive-time analysis maps for existing conditions are shown in this section for commercial airports. As illustrated in Figure 7-7, area congestion limits 60-minute drive-time coverage to the airport, and excludes Tacoma and Everett, in particular. However, as illustrated later in this section, both Sea-Tac and Paine Field provide similar services and coverage to these areas. Improvement of employee access to Boeing facilities via transit should help all areas of ground access by improving the number of transportation options open to the different users of airport facilities.

Figure 7-9. Drive-Time Analysis – King County International Airport



Source: CDM Smith analysis of 2019 HERE data and Google Maps data

7.4.6 Paine Field

Paine Field is the home of production for select Boeing wide-body jets. It employs about 30,000 workers and their commuting needs, affecting the local transportation system as well as the overall layout of the airport's facilities. The airport last updated its master plan in 2002 and focused heavily on nearby roadway routes. Access to I-5 is less than three miles away and access to SR 526, a major east-west connector, is at the north end of the airport (Figure 7-10). Since that update, Community Transit's Swift Green Line bus rapid transit service began in March 2019 between Canyon Park/Bothell and Paine Field, providing frequent service less than one-half mile from the terminal.

Figure 7-10. Ground Access at Paine Field

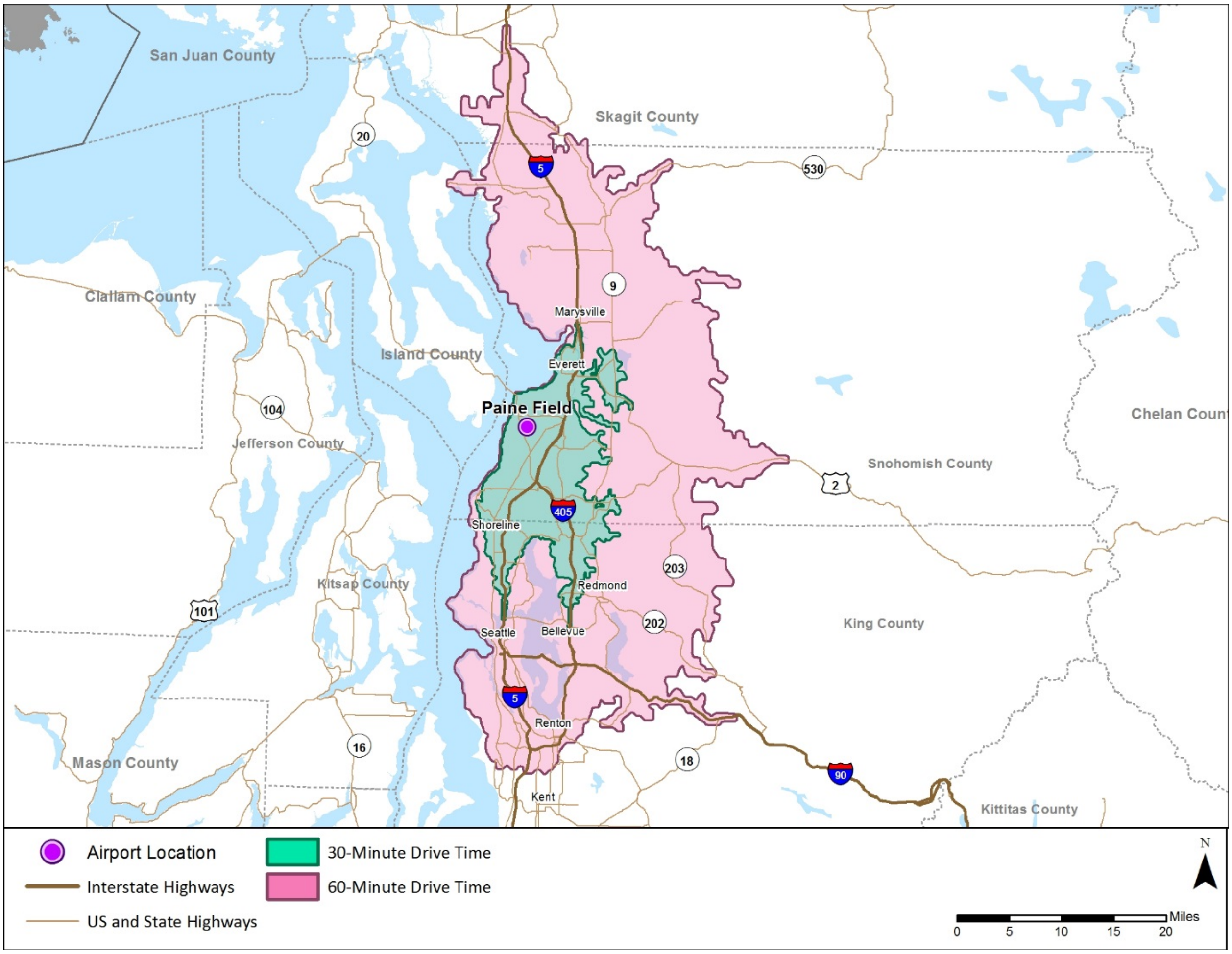
Source: Google Earth, Landsat / Copernicus

Daily operations at Paine Field include flights related to business, air cargo, medical, and recreation, as well 24 commercial service departures and arrivals each day provided by Alaska and United. The new service connects Snohomish County to destinations such as Denver, Las Vegas, Phoenix, and Los Angeles.

The addition of commercial airline service has altered landside access needs at the airport, with about 1,200 parking spaces now dedicated for commercial service users. Parking may prove to be inadequate moving forward depending on the success of commercial service and airport-based businesses. Parking for the Boeing facilities is privately held by Boeing and not included in these figures.

Ride-share services and the new Swift Green Line bus rapid transit (BRT) service add additional options for passengers and employees to reach the airport. Figure 7-11 provides an assessment of 30- and 60-minute drive-times to and from the airport showing coverage reaches the Snohomish County border to the north, sufficiently far east to cover major populated areas, and south into Seattle and Bellevue. Link light rail is also planned to stop at Paine Field when it is extended to the city of Everett. The new connection will provide an additional HCT link, aside from Swift BRT, to commercial service and important Boeing facilities.

Figure 7-11. Drive-Time Analysis – Paine Field



Source: CDM Smith analysis of 2019 HERE data and Google Maps data

7.4.7 Renton Municipal Airport

Renton Municipal Airport is located at the southern end of Lake Washington and is adjacent to the Will Rogers-Wiley Post Memorial Seaplane Base. The airport is located 1.5 miles from I-405, which provides access to the rest of the central Puget Sound region (Figure 7-12.)

Figure 7-12. Ground Access at Renton Municipal Airport

Source: Google Earth, Landsat / Copernicus

Immediate ground access at the airport is provided at three entrances, to the west, the south, and southeast. Transit access is provided by King County Metro via routes 106 and 107 at stops located about a half mile to the south and southwest of the airport tower as well as the RapidRide F Line about two-tenths of a mile from the southeast entrance.

Renton Municipal is used on a daily basis for corporate and business flights as well as flight instruction and recreation. Due to these uses and the location of the airport in a constrained urban area, parking access is limited and identified as in both the master plan and airport management survey response.

The Renton Municipal Airport Master Plan was last updated in 2009 and highlights the airport's desire to eliminate ground access at the southeast corner of the airport via Logan Avenue. Because this entrance provides access to Boeing and other airport facilities on the east side of the airport, eliminating it would help control access and security, while also allowing more room for potential parking. As of 2019, this entrance appears to still be in use.

The master plan also mentions that the airport is monitoring future seaplane passenger activity which could further strain an already limited amount of parking. As different areas of the airport are redeveloped, access and parking needs will need to be evaluated to determine the appropriate action.

7.4.8 Seattle-Tacoma International Airport

Sea-Tac is an international hub located in King County serving the four-county central Puget Sound region. In 2018, the airport handled nearly 50 million passengers. In terms of air cargo, the airport moved nearly 430,000 metric tons of cargo in 2017. The airport's importance as a passenger and freight hub requires a large number of employees to ensure smooth operations. Direct employment at the airport is estimated at just over 87,000 with a range of jobs requiring different responsibilities and schedules.[1]

The airport has passenger ground access via State Route 99 on the east side and State Route 518 to the north, which also connects to I-5 farther to the east. State Route 509 runs on the west side of the airfield and provides an alternate route around the airport (Figure 7-13).

Figure 7-13. Ground Access at Seattle-Tacoma International Airport

Source: Google Earth, Landsat / Copernicus

As of March 2019, the terminal parking garage currently provides parking for about 13,000 vehicles with approximately 11,000 spaces allocated for public parking. There are also many off-airport parking vendors providing over 14,000 additional spaces for airport related parking. Current parking levels are adequate and should remain efficient through 2034 according to the airport master plan.

Aside from personal vehicles, rental cars and ride-sharing companies are other popular means of access. The airport developed a ride-share pick-up area in the garage alongside taxi and limousine services to help reduce ride-share congestion on the terminal frontage. The 2015 Master Plan identifies curbside access as an important area for improvement. Forecasted demand will leave roadways and curbsides congested with these areas requiring major expansion in the future.

[1] https://www.portseattle.org/news/increased-business-and-vacation-connections-drive-2018-volume-airport

The Link light rail station is located just west of International Boulevard. A pedestrian bridge connects the Link station to the passenger terminal. According to the Q4 2018 Link Service Delivery Performance Report, average weekday boardings at the Airport Link station were around 5,800 for CY 2018. Growth was 7.8 percent over Q4 2017, reflecting increasing use of Link and growth of airport usage. Future expansion of the Link network will increase passenger and employee rail transit access opportunities.

Bus service to the airport is provided by Sound Transit and King County Metro, with Sound Transit Routes 560 and 574 arriving on the Lower Drive while all King County Metro pick-up and drop-off areas, including direct access to RapidRide A lines, are on State Route 99/International Boulevard, with a direct pedestrian connection to the light rail station. Additional services at the airport include several "airporter" scheduled links including to Whidbey Island, cities along I-5 north, and cities east to Yakima.

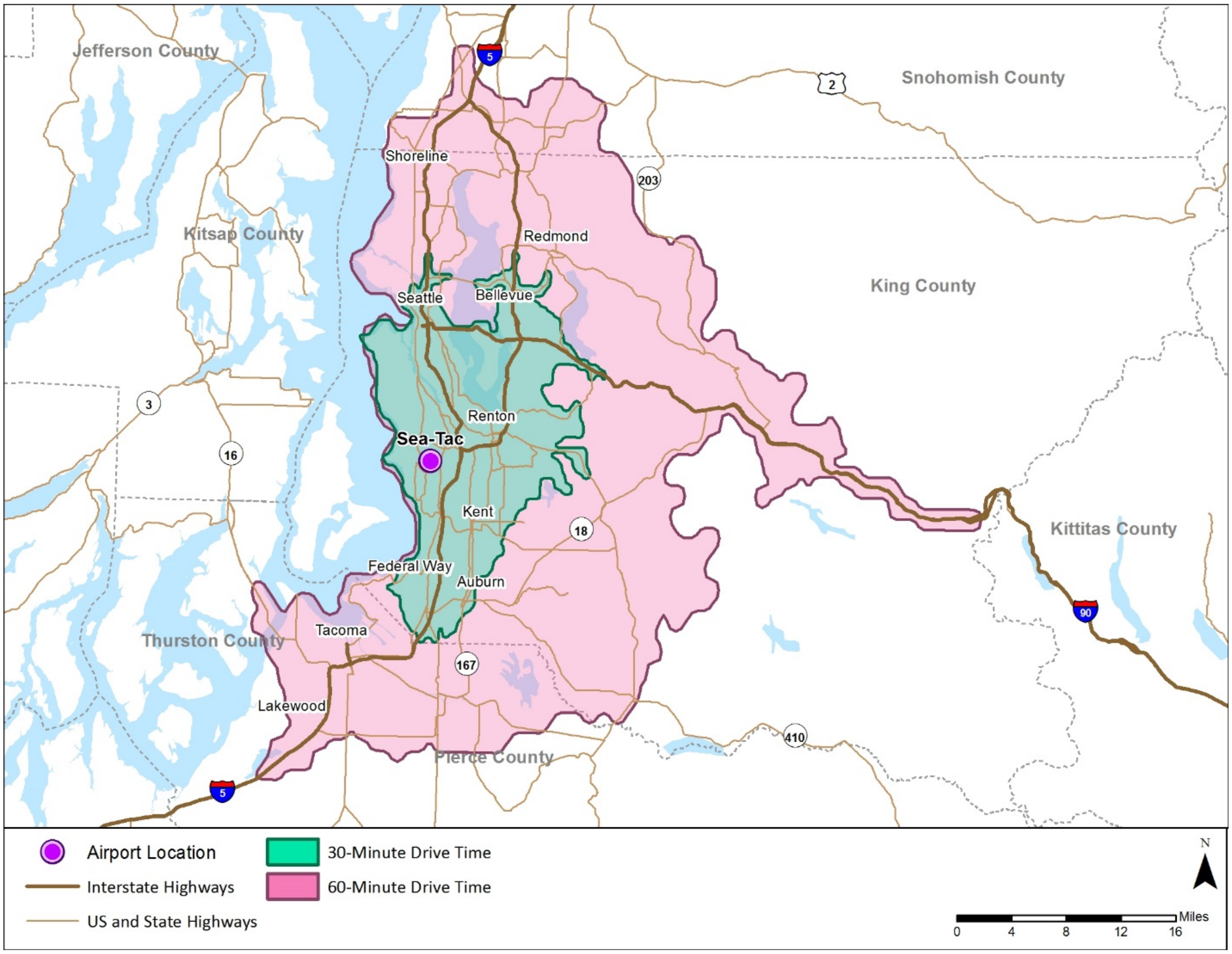
ST Express Routes 560 and 574 had about 1,800 and 2,300 average weekday boardings, respectively, for their entire lengths in 2018 and a less than 1 percent growth rate over 2017 for Q4. According to the King County Metro 2018 system evaluation report covering 2017 performance, the RapidRide A line had 10,200 average weekday boardings in the fall for the entire route—an increase of 5.2 percent over 2016 levels.

Air cargo tenants currently occupy about 60 acres of the airport, with many different providers conducting operations at the airport. FedEx, UPS, and U.S. Postal Service are all popular multimodal cargo operators with leases at the airport. Traditional passenger carriers also maintain cargo operations at the airport with Delta, Southwest, and Lufthansa as examples of airlines leasing space in hangars around the airport. Additionally, there are contractors such as Worldwide Flight Services and Swissport that conduct cargo operations for airlines such as American Airlines, Hawaiian Airlines, and All Nippon Airways.

According to the Washington State Air Cargo Movement Study, improvements could be made to increase the efficiency and volume of cargo that moves through the airport, indicating that by 2021 congestion could severely inhibit cargo processing and movement in and around Sea-Tac. Cargo is competing with passenger growth for space on the airport as well as in the transportation network. That study identified access as restricted. However, the study concluded that, with future improvements planned for the roadway network around the airport, overall congestion on roadways will not be a major disadvantage in the competitive landscape when compared to access at other airports on the west coast.

Overall, the airport is well connected to the central Puget Sound region with current roadway and public transportation access, however there are existing issues that will pose challenges moving forward. Significant peak congestion on nearby roadways delays passenger and cargo movements that use the nearby state routes and interstate. Figure 7-14 demonstrates 30- and 60-minute peak-hour travel times which fail to reach significant portions of the region, especially Everett and Snohomish and Kitsap Counties. Additionally, the airport is constrained on all sides, which may require innovative planning for landside access depending on airside development opportunities.

Figure 7-14. Drive-Time Analysis – Seattle-Tacoma International Airport



Source: CDM Smith analysis of 2019 HERE data and Google Maps data

7.4.9 Tacoma Narrows Airport

Tacoma Narrows is located west of Tacoma, just across the Tacoma Narrows Bridge. Primary access to the airport is by automobile from State Route 16. The closest transit access is nearly 3 miles away (Figure 7-15.)

Figure 7-15. Ground Access at Tacoma Narrows Airport

Source: Google Earth, Landsat / Copernicus

The airport is used daily for corporate and business flights as well as flight instruction and recreational flying. The master plan lists the airport as having 70 parking spaces, primarily used by airport business tenants such as the Fixed Based Operator (FBO) and restaurant. Employees such as air traffic controllers and airport staff also use this lot. There are an additional 19 spaces south of the main parking area that serves the FBO and other hangars. Airport management indicated that parking is sufficient at current usage levels.

7.5 DRIVE-TIME COVERAGE

For an airport system to serve its population and regional economy, it must be reasonably accessible via ground transportation. The metrics developed for this Regional Aviation Baseline Study, further described in Chapter 8, include several indicators which rely on the regional proportion of population or employment within specific drive-times of airport groupings. The groupings are based on airport characteristics such as those with scheduled passenger service or those with jet fuel. Table 7-2 illustrates the metrics and airports that meet them.

Applying information derived from geographic information systems (GIS) based network analysis, big data travel-time sources, and cross analysis with the central Puget Sound region population and employment estimates and forecasts, the coverages for the specific study metrics were developed. The approach to developing the drive-time market areas is described in detail in the following section.

7.5.1 Approach

To assess accessibility, the study employed GIS. ESRI's industry standard ArcMap software suite includes the Network Analyst toolset, which can be used to construct drive-time market areas for points on a map. Network Analyst uses all highways and roads, including interstate, federal, and state highways as well as all arterial and feeder roads, and takes into account travel factors such as time of day, direction (toward or away from the point), and average speeds.

A drive-time market area of an airport, as produced by Network Analyst, is a geographic polygon covering the area that is accessible from the airport within a designated time frame. For the purposes of this study, geographic coverage was analyzed using 30-minute or 60-minute drive-times, depending on the performance metric. Being within a 30-minute drive is acceptably fast access for general aviation airports and services, while passengers are more likely to drive farther for commercial services, so 60 minutes is used in those instances. Draft drive-times produced by Network Analyst were only the initial step in developing an accurate set of market areas for each airport. For several airports, the Network Analyst approach produced areas that were too large given local knowledge. Additional polygons at 15- to 50-minute distances were developed using this approach.

A secondary methodology using HERE maps provided additional detail on airports where traffic congestion is highest. HERE maps allow web developers to access real-time traffic information and are used by mainline companies to develop drive-time information presented in many map applications for smart devices. HERE information was used to develop 30-minute and 60-minute isochrones (a series of geocoordinates centered around the airport) during peak times and off-peak times. Due to the additional cost of this approach, only four key airports were analyzed: Sea-Tac, KCIA, Renton Municipal, and Paine Field. Travel-time calculations from Google Maps and HERE maps during the peak times were then used to verify the HERE maps-based isochrones.

Table 7-2. Airports Meeting Criteria for Drive Time Analyses

ASSOCIATED CITY	AIRPORT NAME	AIRPORT THAT PROVIDES COMMERCIAL PASSENGER SERVICE (FIGURE 7-16)	AIRPORT WITH JET FUEL (FIGURE 7-17)	AIRPORT WITH A PRECISION INSTRUMENT APPROACH (FIGURE 7-18)	A BUSINESS AIRCRAFT CAPABLE AIRPORT (5,000-FOOT RUNWAY, AWOS/ASOS, APPROACH WITH VERTICAL GUIDANCE) (FIGURE 7-19)	AIRPORT WITH DE-ICING CAPABILITIES (FIGURE 7-20)	AIRPORT WITH INTERNATIONAL LARGE FREIGHTER SERVICE (FIGURE 7-21)	AIRPORT WITH DOMESTIC AND INTERNATIONAL WIDE-BODY BELLY CARGO SERVICE (FIGURE 7-22)
Arlington	Arlington Municipal		✓		✓			
Auburn	Auburn Municipal		✓					
Bremerton	Bremerton		✓	✓	✓			
Everett	Paine Field	✓	✓	✓	✓	✓		
Kenmore	Kenmore Air Harbor SPB S60		✓					
Renton	Renton Municipal		✓					
Renton	Will Rogers-Wiley Post Memorial SPB		✓					
Seattle	Kenmore Air Harbor SPB W55		✓					
Seattle	King County International	✓	✓		✓	✓		
Seattle	Seattle-Tacoma International	✓	✓	✓	✓	✓	✓	✓
Snohomish	Harvey Field		✓			✓		
Tacoma	Tacoma Narrows		✓	✓	✓			

Source: CDM Smith and WSP Consultant Team Analysis
Note: Airports in the central Puget Sound region system not listed in the table do not meet any of the performance metrics

Staff with local knowledge then compared the information available from Network Analyst, HERE maps, and spot-checked Google maps drive-times to determine the polygons for each airport. For airports analyzed using the HERE data (Sea-Tac, KCIA, Renton, and Paine Field), the HERE travel-time results were more reasonable than the Network Analyst approach and those travel times were selected for use in the analysis.

For the remaining airports, polygons were selected from the different levels of Network Analyst. For instance, for airports in less congested locations such as Bremerton, the 30-minute Network Analyst shapes appeared realistic for actual 30-minute drive-times. For airports in more congested areas, such as Arlington Municipal, the 20-minute Network Analyst shapes were more realistic for actual 30-minute drive-times. For airports in and close to Seattle, such as the Kenmore Air Harbor SPBs, the 15-minute Network Analyst shapes appeared most realistic for actual 30-minute drive-times. Finally, for Auburn Municipal, the 20-minute Network Analyst access times appeared to be accurate for actual 30-minute drive-times to and from the east, but owing to frequent congestion on SR 18 and I-5, the 15-minute Network Analyst access times appeared to be accurate for actual drive-times to and from the west.

7.5.2 Results

The study's final set of drive-time market areas includes a combination of drive-times provided by the methodologies employed. These drive-time areas allow for an analysis of factors such as availability of jet fuel within 30 minutes or commercial airline service within 60 minutes, among others. By combining the drive-times of all airports that meet certain metrics, it was possible to estimate the percentage of regional population and employment that is within these areas. Population and employment were analyzed by PSRC staff for base year and future year regional economic conditions.

To ensure against double counting, airport drive-times were not analyzed individually, but as full sets that were combined into one polygon. For example, the 30-minute drive-times of all airports with a precision instrument approach were combined into an individual polygon and the population within the combined polygon determined. The analysis measured both current estimated population and employment coverage (for base year 2017) and forecasted population and employment for 2050. The same drive-time polygons were used for both 2017 and 2050 analyses.

Table 7-3 shows the results of this analysis, with the former showing the total number of regional residents and jobs located within the drive-time coverages and the latter showing this as a percentage of the total people and jobs within the PSRC coverage area. Percentages are expressed as a percentage of the total jobs and persons within King, Kitsap, Pierce, and Snohomish Counties.

Note that future coverage is based on current drive-time evaluation results, but as congestion increases in the region, the coverages will shrink in the future. The differences will likely be significant but depend on numerous assumptions about projects, growth in traffic and travel behavior that could not be accounted for in this effort.

Table 7-3. People and Jobs in the Buffer Area (Total and Percentages)

MEASURE	2017				2050			
	PEOPLE	PERCENTAGE	JOBS	PERCENTAGE	PEOPLE	PERCENTAGE	JOBS	PERCENTAGE
60 minutes to an airport with commercial passenger service	3,332,000	82%	1,997,000	91%	4,843,000	83%	3,055,000	91%
30 minutes to an airport with jet fuel	3,481,000	86%	2,070,000	95%	5,047,000	87%	3,176,000	95%
30 minutes to an airport with a precision instrument approach	2,686,000	66%	1,704,000	78%	3,993,000	69%	2,651,000	79%
30 minutes of a business aircraft capable airport (5,000-foot runway, Automated Weather Observing System and Automated Surface Observing System, approach with vertical guidance)	2,907,000	71%	1,821,000	83%	4,335,000	74%	2,838,000	85%
30 minutes to an airport with de-icing capabilities	1,967,000	48%	1,403,000	64%	2,962,000	51%	2,136,000	64%
60 minutes to an airport with international large freighter service	2,754,000	68%	1,772,000	91%	3,964,000	68%	2,656,000	79%
60 minutes to an airport with domestic and international wide-body belly cargo service	2,754,000	68%	1,772,000	95%	3,964,000	68%	2,656,000	79%

Source: CDM Smith and PSRC Analysis

Overall, airports within the region performed quite well based on these metrics. In 2017, all metrics except one were accessible to at least 60 percent of regional population and nearly 80 percent of regional jobs. In both cases, airports with de-icing capabilities was the metric with the lowest coverage.

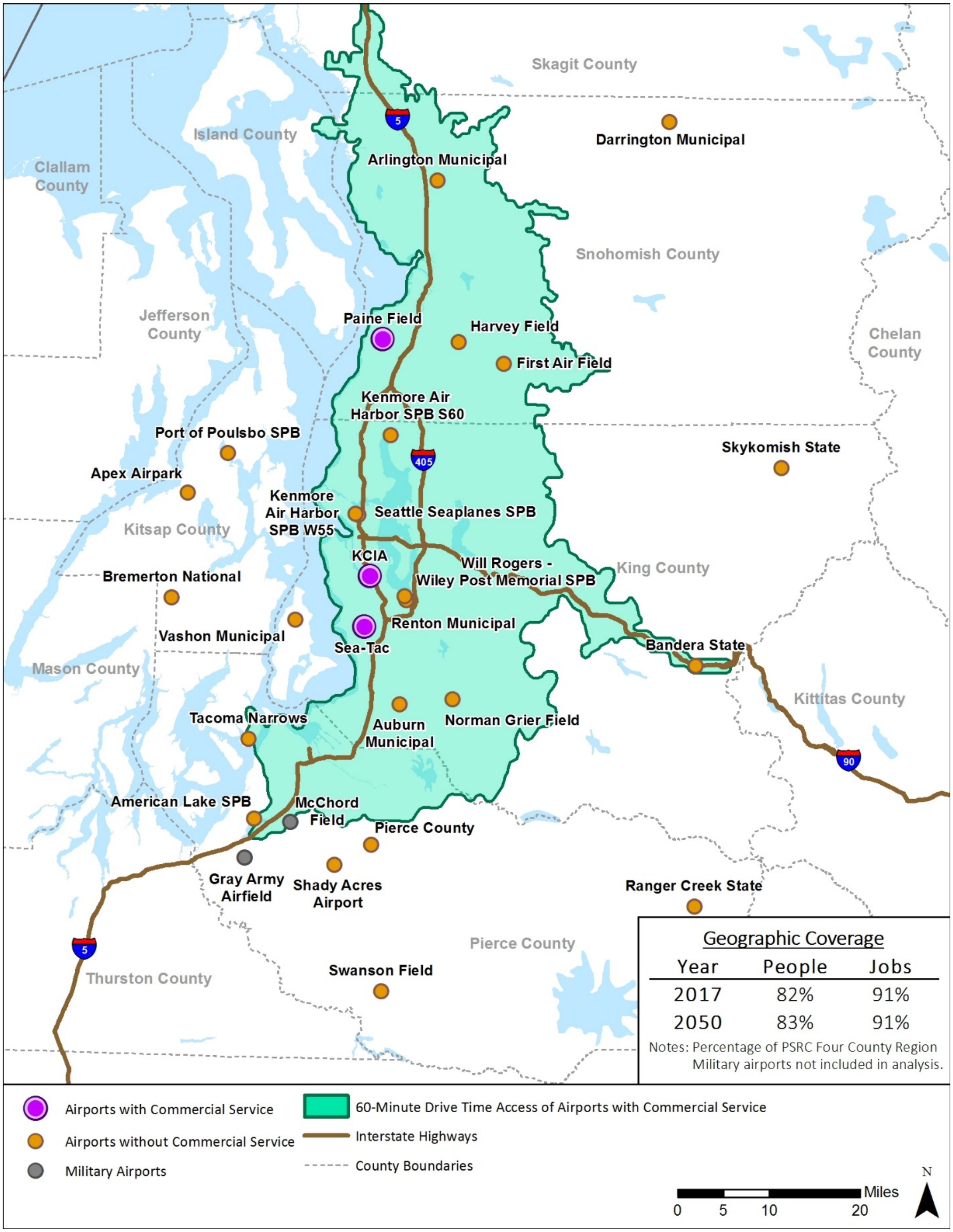
The metrics that would likely be most in demand for both business and personal travelers—commercial passenger service and jet fuel—performed best among all metrics. For current coverage, 82 percent of people and 91 percent of all jobs fall within a 60-minute drive of an airport with commercial passenger service, while 86 percent of people and 95 percent of jobs fall within 30 minutes of an airport with jet fuel.

Forecasted future coverage largely mirrors current coverage. Nearly all metrics are expected to maintain current coverage or show a slight improvement, a reflection of forecasted population and employment increases in parts of the central Puget Sound region near these airports. The only metrics that experienced a decrease were those related to jobs in the 60-minute drive-time areas of airports with international large freighter service or domestic and international wide-body belly cargo service. Because Sea-Tac is the only airport meeting these metrics, these decreases reflect a forecasted decrease in jobs located within 60-minute of its market area in 2050.

Note that future coverage is based on current drive-time evaluation results, but as congestion increases in the region, the coverages will shrink in the future. The differences will likely be significant but depend on numerous assumptions about transportation projects, growth in traffic and travel behavior that could not be accounted for in this effort.

Figure 7-16 through Figure 7-22 illustrate the geographic coverage of each metric. The highlighted drive-time coverage areas, shown in green, are the combined areas of all airports meeting each metric. Airports that meet metrics are shown with green icons. Drive-time maps for individual airports are provided in Appendix B to this working paper.

Figure 7-16. Population and Employment within 60 minutes of an Airport with Commercial Passenger Service



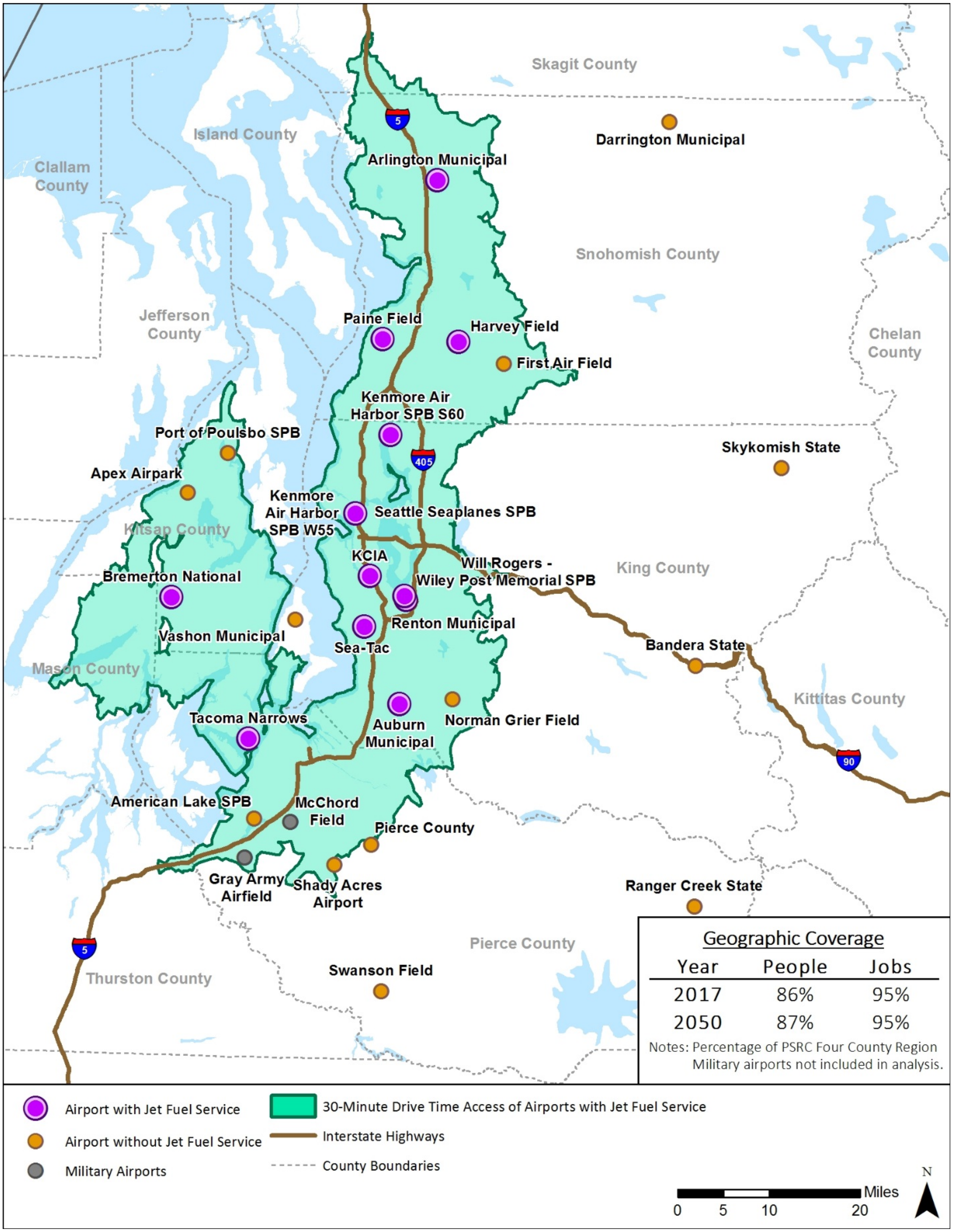
Geographic Coverage

Year	People	Jobs
2017	82%	91%
2050	83%	91%

Notes: Percentage of PSRC Four County Region
Military airports not included in analysis.

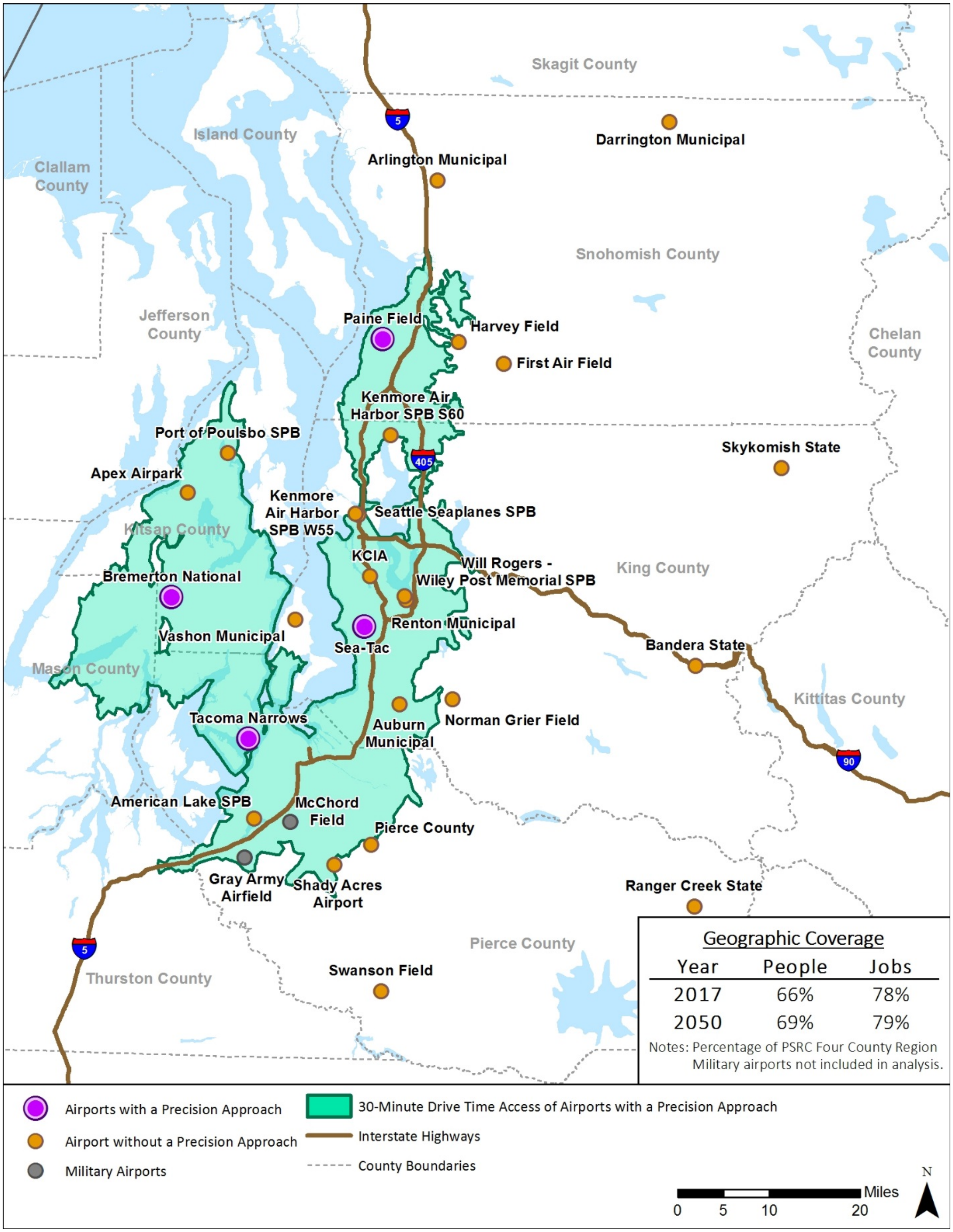
Source: CDM Smith analysis of ESRI ArcMap Network Analyst, HERE data, and Google Maps data

Figure 7-17. Population and Employment within 30 Minutes of an Airport with Jet Fuel Service



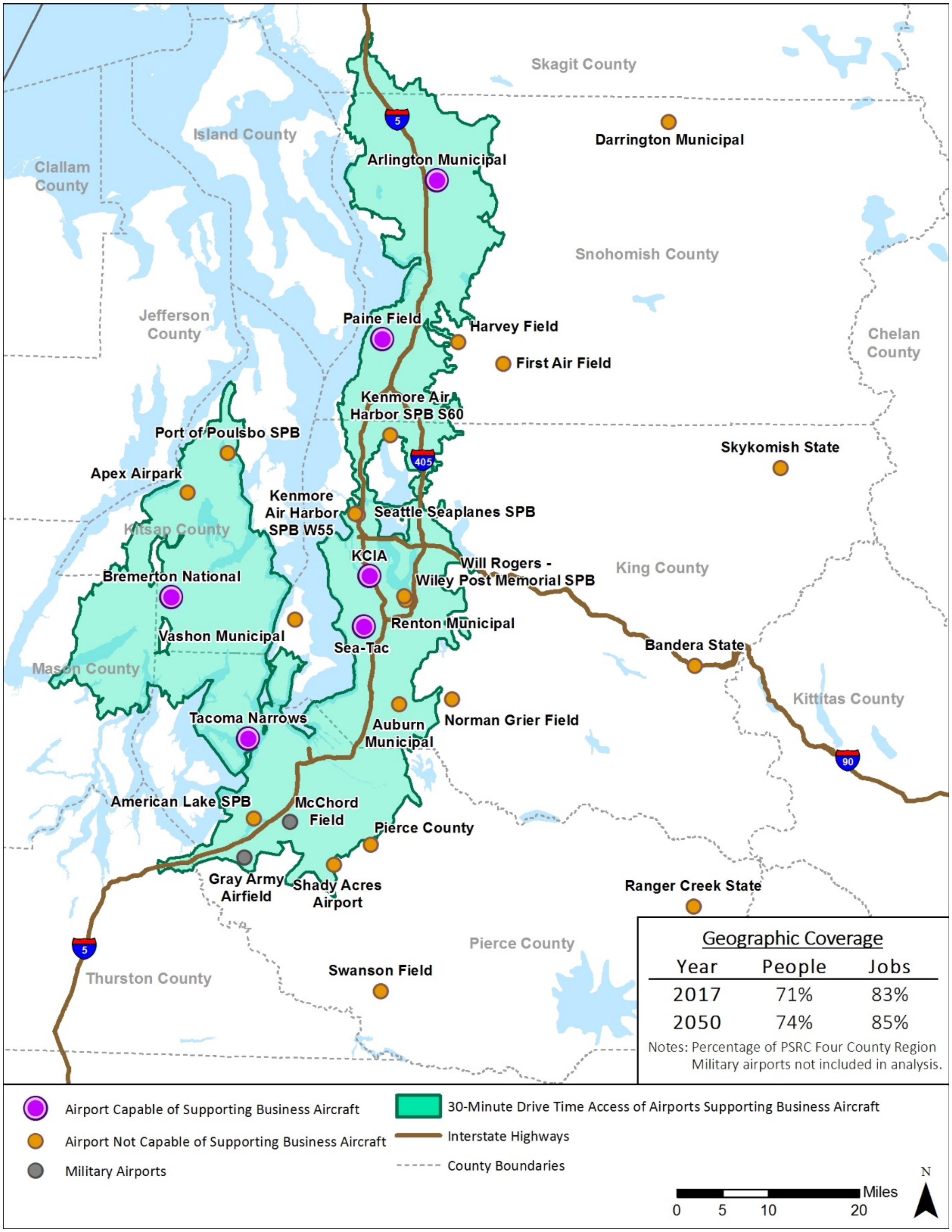
Source: CDM Smith analysis of ESRI ArcMap Network Analyst, HERE data, and Google Maps data

Figure 7-18. Population and Employment within 30 Minutes of an Airport with a Precision Instrument Approach



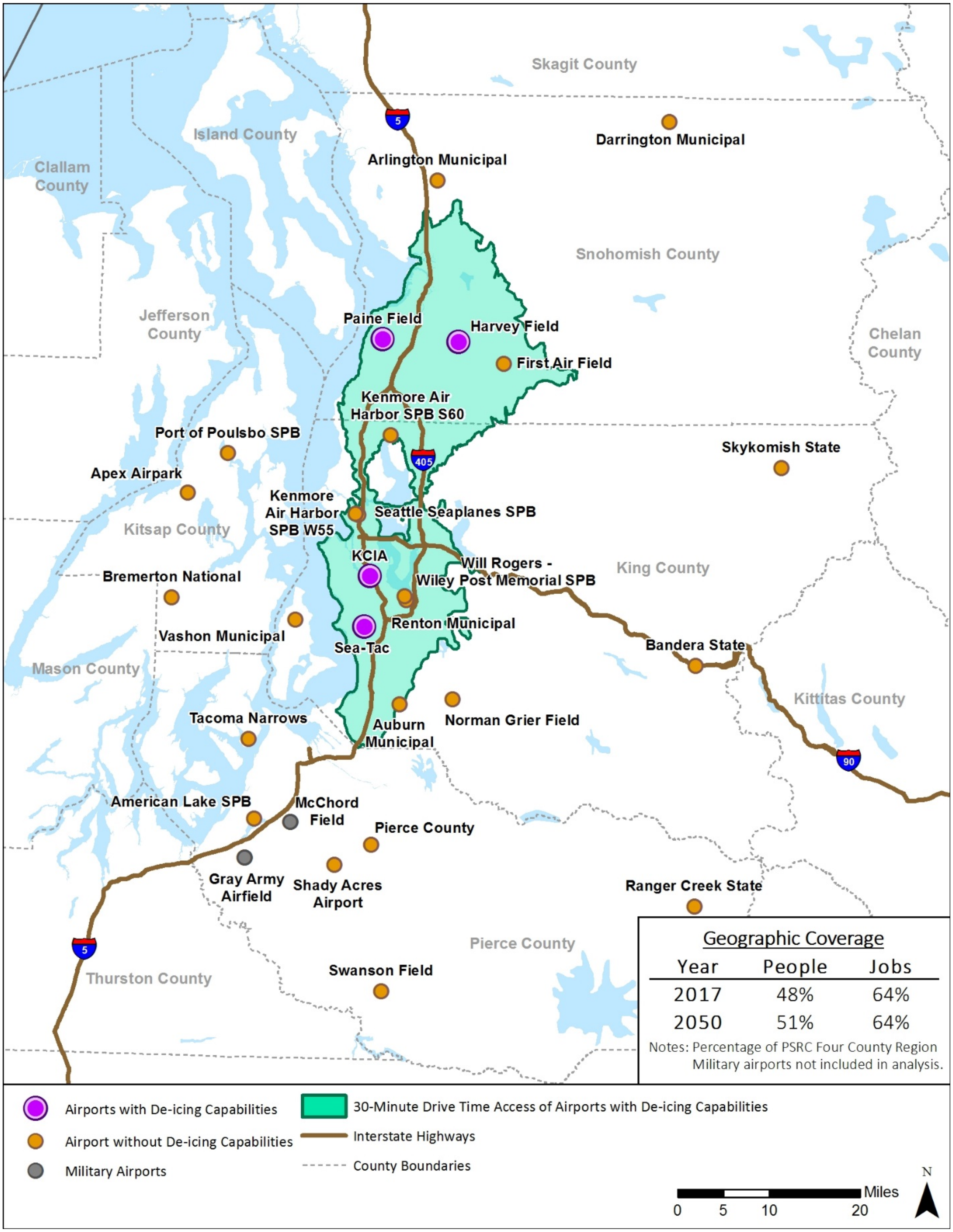
Source: CDM Smith analysis of ESRI ArcMap Network Analyst, HERE data, and Google Maps data

Figure 7-19. Population and Employment within 30 Minutes of an Airport Capable of Supporting Business Aircraft (5,000-foot runway length, AWOS/ASOS, and approach with vertical guidance)



Source: CDM Smith analysis of ESRI ArcMap Network Analyst, HERE data, and Google Maps data

Figure 7-20. Population and Employment within 30 Minutes of an Airport with De-icing Capabilities



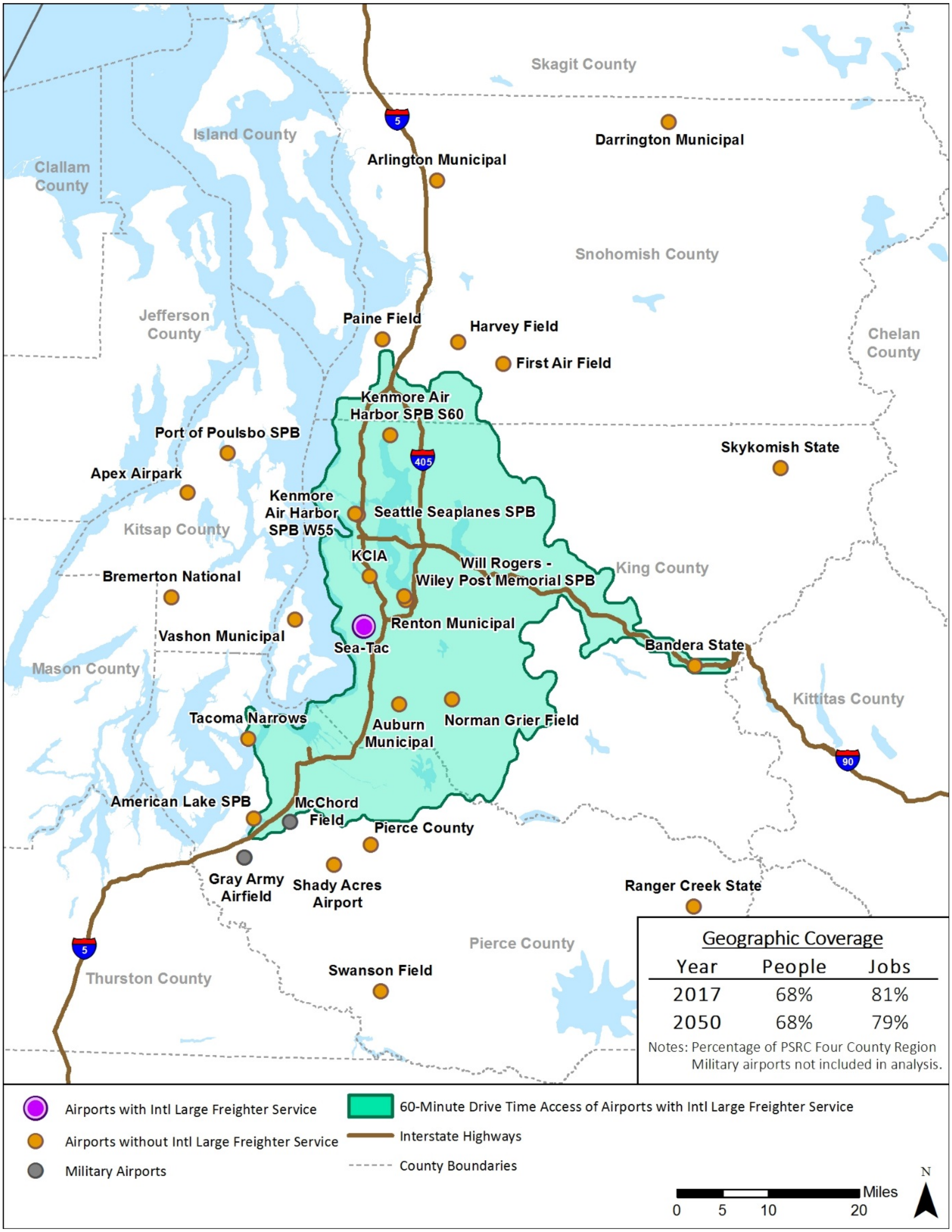
Geographic Coverage

Year	People	Jobs
2017	48%	64%
2050	51%	64%

Notes: Percentage of PSRC Four County Region
Military airports not included in analysis.

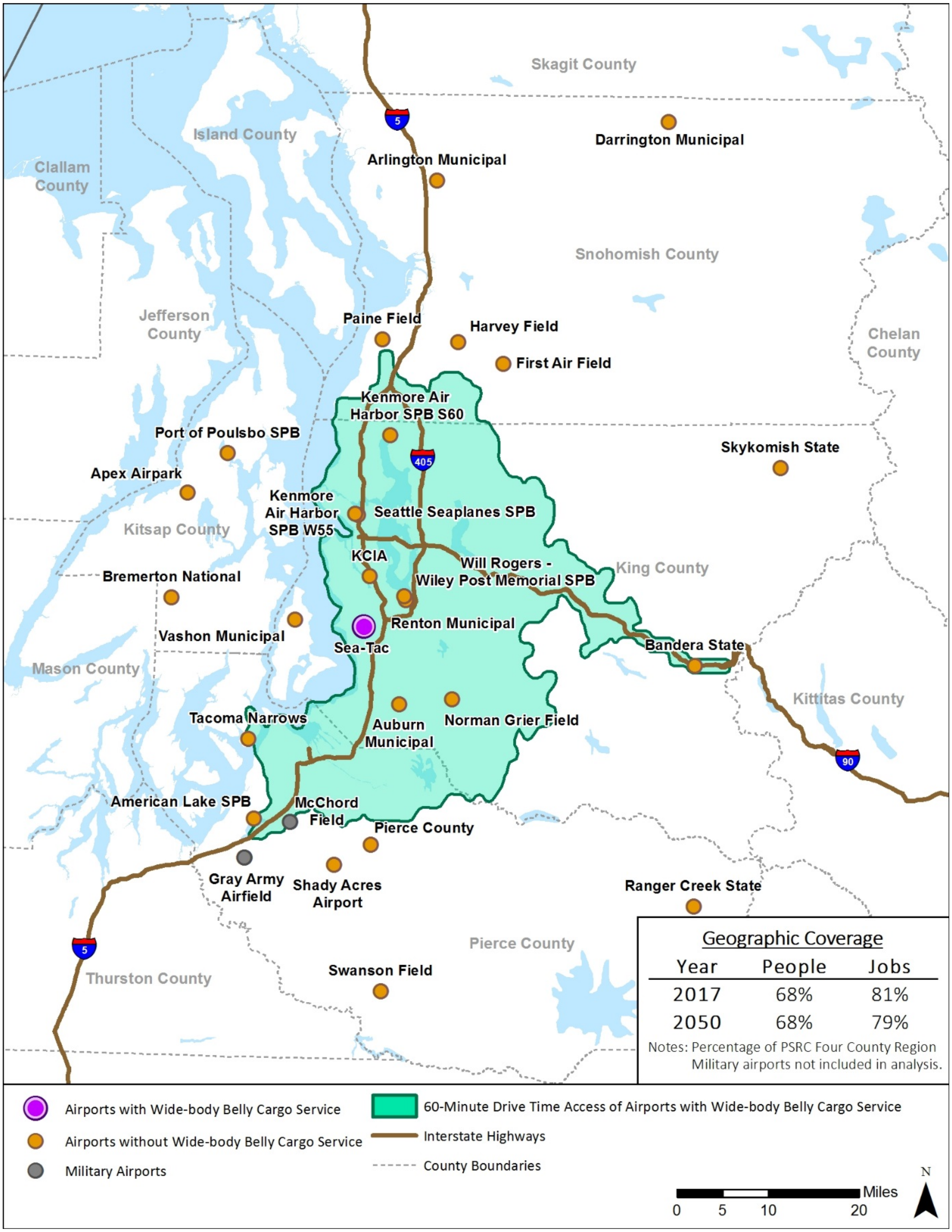
Source: CDM Smith analysis of ESRI ArcMap Network Analyst, HERE data, and Google Maps data

Figure 7-21. Population and Employment within 60 Minutes of an Airport with International Large Freighter Service



Source: CDM Smith analysis of ESRI ArcMap Network Analyst, HERE data, and Google Maps data

Figure 7-22. Population and Employment within 60 Minutes of an Airport with Domestic and International Wide-body Belly Cargo Service



Source: CDM Smith analysis of ESRI ArcMap Network Analyst, HERE data, and Google Maps data

7.6 REGIONAL TRANSPORTATION PLANS AND FUTURE PROJECTS

With the rapid growth of the central Puget Sound region, multimodal landside transportation access to the region's airports will continue to be affected by regional changes as well as planned improvement projects. The purpose of this section is to provide an overview of the key regional projects which may affect airport access.

7.6.1 Puget Sound Regional Council Regional Transportation Plan

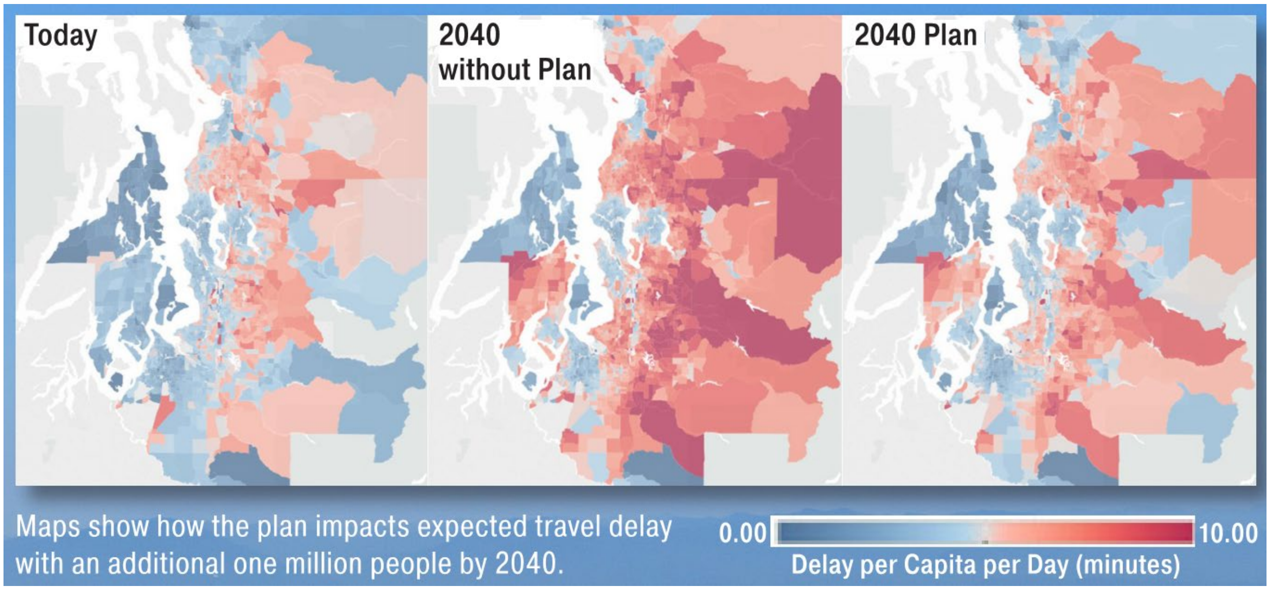
The Puget Sound Regional Council adopted a Regional Transportation Plan in 2018, which includes many important aspects of the regional transportation network that also affects ground access at nearby airports. The plan is focused on improving transportation within the context of the rapid growth the area has seen and is projected to experience. The plan outlines projected investments by county, as well as by project type, illustrating projects related to highways, transit, and local roadways. Areas of the plan that will impact the region's airports include a focus on reducing congestion along the I-5 corridor, improving efficiency of freight movements by coordinating planning efforts, as well as utilizing technology to improve the safe movement of people and goods throughout the area.

7.6.1.1 Traffic Growth

Appendix K of the 2018 PSRC Regional Transportation Plan analyzes system performance through congestion measurements. The plan uses a 2014 model base year and projects out to 2040. Overall, with the 2040 Plan, the region is expected to see 16.6 million more vehicles miles per day by 2040—an increase of 21 percent from the base year. Hours of delay are also projected to dramatically increase, with 233,000 hours added daily to the region by 2040—an increase of 51 percent. The increase in hours of delay relates directly to the levels of congestion that could occur while the increase in vehicle miles results from the expected growth in the region and that people could drive farther or more often by 2040. Truck trips— an important measure for cargo growth and an additional factor in congestion—are projected to grow by 35.7 percent, adding about 95,000 trips daily to regional highways.

Figure 7-23 shows the impact of growth on per-capita delay and the impact of the regional 2040 transportation plan to lessen this impact.

Figure 7-23. Current and Future Per-Capita Delay with and without 2040 Plan



Source: Puget Sound Regional Council, The Regional Transportation Plan - 2018

7.6.1.2 Highways

Connecting Washington is a funding package approved by the Washington State Legislature that will help address highway projects. Investments in the regional highway system help connectivity for aviation users, employees at businesses in the aviation sector, and cargo that is transported through these airports. Projects that will be addressed through the funding include:

- I-5 improvements near Joint Base Lewis-McChord, a major constraint to travel to and from the south
- Extension of State Route 509 near Sea-Tac (see Section 7.6.6.1)
- Lane additions on I-405 near Renton which will help access at Renton Municipal Airport and may improve drive-times to Sea-Tac from the eastside (see Section 7.7)

Aside from *Connecting Washington*, the region is also aiming to improve high-occupancy vehicle lane efficiency, add new technology to roadways to speed up commutes, and plan for the long-term future of I-5. Planning for the regional roadway system will help the airport system remain accessible to all of its users.

7.6.1.3 Freight Mobility

Air cargo is a valuable component of the region's economy and is distributed via highway, rail, and maritime connections. Continuing safe and efficient airport connections to the area's interstates and state routes will help air cargo distribution to its final destination as well as make connections to rail and maritime facilities.

Cargo movement as an industry is incredibly important to the central Puget Sound region and is recognized nationally, with the Northwest Seaport Alliance ranking as the fourth largest container port by volume. The PSRC Regional Transportation Plan outlines several future projects that will impact cargo movement:

- South Lander Street grade separation for roadway and BNSF railway in Seattle
- Canyon Road Freight Corridor Improvements that plan to connect Frederickson to the Port of Tacoma
- 41st Street Rucker Avenue Freight Corridor in Everett to better accommodate over-dimensional freight traffic

Most of the air cargo in the region is moved through Sea-Tac, with KCIA hosting operations for UPS and several other smaller carriers. Additionally, the facilities at Renton Municipal Airport, Paine Field, and KCIA play a key role in the assembly and delivery of Boeing aircraft. All three airports include direct rail access for the shipment of Boeing parts and materials.

According to the Puget Sound Regional Council analysis, regional air cargo volumes reached 539,600 tons in 2017 and is expected to rise to 1.32 million tons by 2050—an increase of over 145 percent. On an annual basis, this represents an increase of 2.7 percent. The rate of growth is expected to be higher at KCIA at nearly 3.0 percent, while Sea-Tac is expected to grow just under 2.7 percent. Sea-Tac handled about 79 percent of the regional total in 2017, and that share is expected to dip slightly to 77 percent by 2050.

7.6.1.4 Resiliency Appendix

Resiliency is a key component of a transportation network and is addressed in an appendix to PSRC's Regional Transportation Plan. The region's resiliency can be affected by major natural disasters such as potential earthquakes, flooding, volcanic activity, and wildfires, as well as by other disruptors such as infrastructure failures and climate change. As it relates to aviation, resiliency can take the form of ensuring that plans are in place for emergency operations at certain airports or creating structures and infrastructure that can withstand the different forces that could affect the central Puget Sound region. The appendix touches on the need for the region's transportation network to be kept functioning to the best ability prior to, during, and after major disasters. By preparing for natural disasters and planning for a resilient transportation system, the central Puget Sound region can address issues related to ground transportation serving airports and the aviation community in the event of a disaster.

7.6.2 City of Seattle Freight Master Plan

The Seattle Department of Transportation published the City of Seattle's Freight Master Plan in 2016. Developed as a portion of a four-part modal master plan series, the freight master plan will help Seattle plan for more growth over the next 20 years. As economic activity increases in the region, freight demand will also increase, meaning more trucks, planes, and ships will be using Seattle's transportation network.

The plan identified key investments to improve freight mobility into the future, including the following concepts that will improve the transportation network:

- Intelligent Transportation Systems along major truck streets and other important corridors to improve north-south freight movements
- Freight-only pilot projects with dedicated lanes for cargo on certain streets
- Reconstruction of roadways to improve traffic flow

The plan notes that KCIA, the only airport of significant size in Seattle, is the 29th ranking national airport for cargo. It is a major location for economic activity generating 5,100 direct and 16,000 indirect jobs with 150 companies located at the airport, including Boeing. The plan identifies East Marginal Way South and Airport Way South, which border KCIA, as major truck streets and Over-Legal routes. Improvements planned near the airport include upgrading East Marginal Way South to heavy haul standards and separating out pedestrian and bicycle facilities to improve safety as well as improving curb radius at 16th Avenue South and East Marginal Way South.

The City of Seattle Freight Master Plan notes that employment in high freight-generating sectors of wholesale and retail trade are expected to grow faster than other industries at 64 percent during the period from 2014 to 2035, or about 2 percent annually. The plan also notes national and international trade forecasts project total freight tonnage from, to, and within the Seattle region to grow 2.2 percent per year through 2040.

7.6.3 Move Seattle Plan and Levy

In 2015, the City of Seattle adopted the Move Seattle Plan and Levy designed to invest approximately $930 million over 10 years (2015-2024) funded through the voter approved levy. In the plan, the City of Seattle organized actions around core values, integrate the cities modal plans, and prioritize projects.

The plan cites three projects near KCIA, which are summarized below along with current status:

- East Marginal Way Corridor Improvements – The East Marginal Way project would reconstruct a core freight route to heavy haul vehicle standards and offers safety and operational improvements for all users. It is intended to serve South of Downtown (SODO) neighborhood's freight terminals and the center of the Duwamish industrial district, invest in major maintenance needs, and incorporate separate bicycle and pedestrian facilities while maintaining freight efficiency. After community outreach in 2017, the city announced recommended concepts for the corridor but the project needs significant grant funds to move into the construction phase.
- Lander Street Grade Separation/Railroad Crossing – The Lander Street project constructs grade separation (overpasses or underpasses) on a major Port of Seattle freight route that crosses a railroad mainline. The project is intended to reduce truck delay, congestion, and emissions due to extended periods of idling, and drive economic development at port terminals and throughout the Duwamish industrial area. The 2018 plan update notes construction began in 2018 on the Lander Street Overpass Project. The City of Seattle anticipates the new Lander Street Overpass will open to traffic in 2020.

- 1st Ave/1st Ave South Corridor - The 1st Ave/1st Ave S project is intended to improve operating efficiency and safety for all modes. It would: add extensive intelligent transportation systems including traffic cameras, vehicle detection, and traffic responsive signals; improve pavement conditions and reduce long-term maintenance needs; improve freight flow on a key Port of Seattle and Duwamish industrial district route; upgrade existing sidewalks, and; add pedestrian crossings. Originally this project was slated to be after 2024, however parts of the corridor are being addressed, including:
  - Pedestrian and bicycle improvements completed 2018 – 1st Ave South Bridge
  - Vision zero safety corridor – in planning, to be completed by 2024
  - Bridge improvements - 1st Ave S Viaduct/Argo Bridge slated for 2023

7.6.4 Sound Transit

7.6.4.1 Link Light Rail Expansion

Sound Transit 3 is a transit system plan and ballot initiative that passed in November 2016 and will increase transit options into different parts of the central Puget Sound region. Link light rail, a successful Sound Transit project, will be expanded to new communities in multiple directions:

- To the north, Everett will eventually be added to the network with new stations slated to open in 2036. Everett is an important connection due to the presence of Paine Field, with Boeing production jobs and now commercial air service via a new terminal. The line will terminate at Everett Station in downtown Everett.
- Link light rail will be extended south to Tacoma and Federal Way, which will both be getting new transit stations estimated for completion by 2030. On the existing line, a stop is anticipated to be added in 2031 at the South Boeing access road that will add a connection to the major job and cargo center at KCIA.
- To the east, service extensions are planned into downtown Bellevue, the new Spring District, and Microsoft by 2022, and connections to Redmond in 2024, and Issaquah in 2041.

Rail service will eventually provide closer transit options for many users and employees of the region's airports through connections both on rail and BRT. However, the only direct new connections will be the addition of a rail station on the south side of KCIA and the planned future Everett line which will have a station at Paine Field.

7.6.4.2 Bus Rapid Transit

I-405 Corridor

ST3 will expand BRT to many cities in the eastern portion of the region via I-405. The new BRT service will have stations at Tukwila International Boulevard and the South Renton Transit Center. Tukwila International Boulevard Station is on the Link light rail and the Rapid Ride A Line, with direct access to Sea-Tac. The new South Renton Transit Center will provide a direct transfer connection to the existing RapidRide F Line serving Renton Municipal Airport. Communities on the east side of Lake Washington—such as Bellevue, Kirkland, and Bothell—will now benefit from a better transit connection to Renton Municipal, the nearest general aviation facility and home to a Boeing manufacturing facility. Scheduled to be completed in 2024, the project includes 10 total BRT stations—three of which add parking.

SR 522 / NE 145th Street Corridor

BRT service on the SR 522 / NE 145th Street corridor will connect Link light rail service from the 145th Street Link station to NE 195th Street by I-405. The east-west route will provide upgraded service to Lake Forest Park, Kenmore, and Bothell and connections to north-south light rail and BRT around Lake Washington as well as to communities to the north. Kenmore Air Harbor Lake Washington Seaplane Base will gain nearby access to the Kenmore stop on this BRT route. This project is scheduled to be completed in 2024 and will add 8 miles of service to the region's BRT network.

7.6.5 Local Transit Plans

7.6.5.1 King County Metro

King County Metro issued its long-range plan, Metro Connects, in 2016. It focuses on increased service and choice for all riders in the system. To accomplish these improvements, King County Metro is making a concerted effort to expand service on many routes to encompass all day transportation needs instead of traditional peak-hour mobility. RapidRide is being expanded to 26 routes and other local routes are increasing headways allowing for show-and-go service. With these improvements, daily ridership is projected to increase from 446,000 in 2015 to 1,026,000 in 2040.

Sea-Tac and Renton Municipal already benefit from existing RapidRide lines close by. Other airports that will benefit from RapidRide expansion include Kenmore SPB at South Lake Union, Seattle Seaplanes Base, and Auburn Municipal Airport.

7.6.5.2 Pierce Transit

Pierce Transit's Destination 2040 Long Range Plan was adopted in 2016. Destination 2040 outlines planning for transit-oriented development and BRT as important areas that the agency will focus on into the future.

In 2014, Pierce Transit had 34,500 daily boardings with projected growth to 49,900 in 2040. This growth will be possible through improvements to the core service routes in the Pierce Transit system, which follow core tenets of frequent and consistent service. Pierce Transit is planning to add a BRT line serving Tacoma and south toward Spanaway, which will bring high frequency enhanced service with better connections to future Link Light Rail to Sea-Tac, but will not aid any new airport coverages.

7.6.5.3 Community Transit

Community Transit, which serves Snohomish County, issued a Six Year Transit Development Plan that looked at planning efforts from 2017 to 2022. As of 2015, daily ridership in the system was estimated to be just under 34,000 passengers. The transit development plan aims to help grow ridership and expand service to more areas of Snohomish County.

The plan forecasts sales tax revenue and anticipates necessary fleet and employment adjustments to match demand. Much of the future service will incorporate enhancements and additions to the Swift BRT service. The Swift Green Line, which began service in March 2019, runs directly next to Paine Field in Everett. Other planning steps include preparation for the Swift Orange Line, which will focus on access in the southern portion of the county. While the new Orange Line will improve connectivity for everyday transit riders, the route does not connect to any other airports in the PSRC system.

7.6.5.4 Kitsap Transit

Kitsap Transit, serving the western portion of the central Puget Sound Region, issued a 2016-2036 Long Range Transportation Plan. The plan focuses on improvements to the fixed route bus network and ferry service. Kitsap Transit lists the State Route 3 corridor as a potential area for future service, where downtown Bremerton would be connected to the Puget Sound Industrial Center when developed.

Due to Kitsap County’s location within the region, connections by ferry are an interesting area of improvement considering the potential for improved links to major population centers on the east side of the Puget Sound. Kitsap Transit is exploring operation of a Passenger Only Ferry service as a cross-sound option that could provide 30-minute connections to downtown Seattle. With a connection to Seattle, access from Kitsap County to commercial service at Sea-Tac, Paine Field, and KCIA could be significantly improved. The agency currently operates two ferry routes within Kitsap County from Bremerton, with service to Port Orchard and the Annapolis Dock.

7.6.5.5 Everett Transit

Everett Transit operates within the city of Everett and augments Community Transit bus service. Service is provided through local routes with lower frequency. One route maintains 15- to 20-minute headways during peak service hours. Major ridership areas include Everett Station and College Station, transit centers that serve the northern portion of the city. Service to Paine Field and KCIA is included on Route #8 with stops at the Seaway Transit Center and Everett Station. Additionally, Route #70 provides east-west service from the Seaway Transit Center to Mulkiteo Ferry Terminal with a stop at Boeing Facilities.

7.6.6 WSDOT State Route 509 and State Route 518 Projects

7.6.6.1 SR 509

State Route 509, passing along the western edge of Sea-Tac, is slated to be extended to the south of the airport where it will connect with I-5. The project has been partially funded by the 2015 Connecting Washington Revenue Package, and progress is being made as part of WSDOT's Puget Sound Gateway Program. The following WSDOT's project descriptions are keyed to Figure 7-24, which depicts planned improvements for SR 509.

The Port of Seattle has identified a corridor, the "South Access" corridor, to potentially provide direct access to the terminal area from the south. This corridor would provide an improved limited-access connection along 28th Avenue S to the future extension of SR 509. As it currently stands, some environmental work has taken place on the project, but additional land acquisition and funding is needed for the South Access corridor project to get underway. Together, the State Route 509 extension and the "South Access" corridor will link up to provide improved access from the south to Sea-Tac. The following specifically outlines the potential route of the "South Access" corridor:[1]

1. **Lake to Sound Trail Final Segment –** The Puget Sound Gateway Program will help to fund a portion of the Lake to Sound Trail, a 16-mile non-motorized trail extending from Lake Washington to the Puget Sound shoreline. WSDOT is working in close coordination with the City of Seattle and King County to finish the final segment of the trail. The SR 509 alignment will cross over the trail near South 200th St. and South 189th St.
2. **Southern Access to Sea-Tac Airport –** The SR 509 project design accommodates the Port of Seattle's concept for a South Airport Expressway from SR 509 to Sea-Tac International Airport. Trips to the airport from the south will have a new access point to the airport, relieving the north access route. By creating this new southern access point, communities south of Sea-Tac would have improved access. An interim South Access will be provided from 28th/24th Avenue South.
3. **Early Work in Sea-Tac –** The City of Seattle recently completed a project, with funding support from WSDOT, to build a new road between South 200th and South 208th streets to connect 28th Avenue South to 24th Avenue South. The project completes the gap in the 28th/24th Avenue South corridor and provides an alternative to SR 99 in the area. As part of the project, a new bridge and tunnel were constructed that accommodates the future SR 509 corridor and the South Airport Expressway.
4. **Tolling SR 509** – All lanes on the new portion of SR 509 will be tolled using one electronic toll point likely located west of I-5 but before turn-offs to 28th/24th Avenue South / South Airport Expressway. Toll collection will be all electronic with no tollbooths. Toll rates will be set by time of day with higher rates during peak periods. Toll rates for the new portion of SR 509 have not been determined. A toll authorization bill must be passed by the Legislature before tolling begins. $85 million from tolls will be used to construct the SR 509 Completion project. The Washington State Transportation Commission would then oversee the rate-setting process. The rate-setting process will begin closer to when the project is completed.
5. **Working with Sound Transit** – WSDOT is working closely with Sound Transit as both agencies work to build new major infrastructure projects in the area. Coordination is underway to work through shared property needs in the area. Both teams are also in close coordination at key locations where the projects interact with each other, including the SR 99 crossing, the South 216th St. Bridge, retaining walls near Mansion Hill Neighborhood, and the southbound off ramp to SR 516.

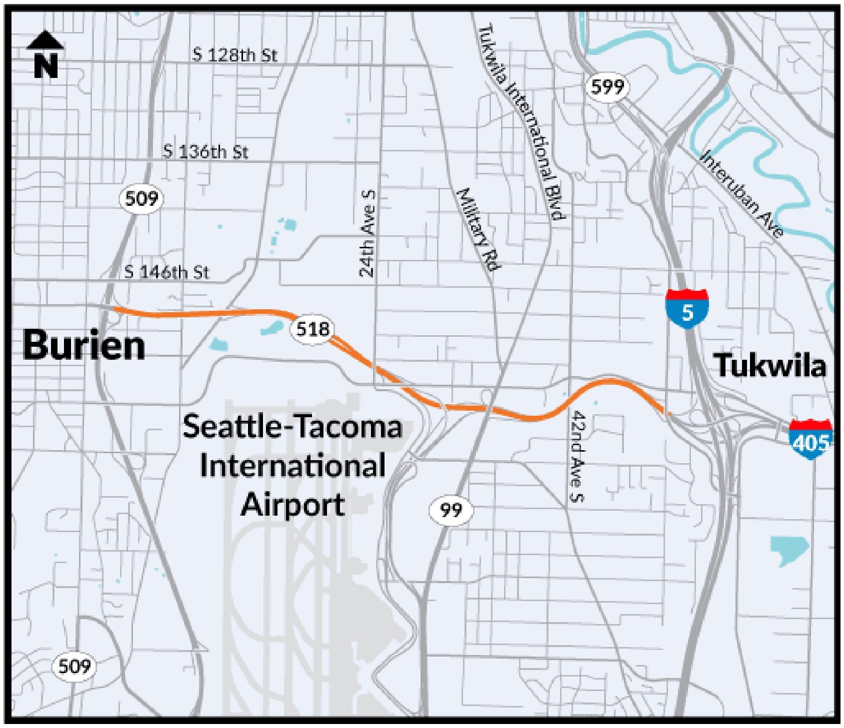
Figure 7-24. SR 509 Project Map

Source: WSDOT Puget Sound Gateway Program

7.6.6.2 SR 518

State Route 518 connects State Route 509 and I-5 by the north end of Sea-Tac. Due to its proximity to the airport, the road plays a major part in the success of its passenger and cargo operations. A corridor planning study led by WSDOT is underway to determine priorities for future highway work or transit service adjustments which will likely include improving the State Route 518 interchanges with International Boulevard, S. 154th Street, and Des Moines Memorial Drive. Figure 7-25 provides a map of the corridor planning study area. The study is expected to be completed in summer 2019.

Figure 7-25. SR 518 Corridor Planning Study Map



Source: WSDOT - SR 518 - SR 509 to I-5 - Corridor Planning Study - Study map

7.7 I-405 EXPRESS TOLL LANES / SR 167 HOT LANES

WSDOT has had high-occupancy toll lanes on SR 167 since 2008 with a single lane in each direction. Current authorization and funding from the state legislature will allow the extension of these lanes to the King/Pierce County line. Funding from the Connecting Washington project will allow extension of the Express Toll Lanes on I-405 from midtown Bellevue to SR 167 in Renton. The project will add a lane in each direction and convert the existing high-occupancy vehicle (HOV) lane in each direction to Express Toll Lanes, resulting in a two-lane Express Toll Lane system from Kirkland, through Bellevue, to Renton. These projects can help improve access to Renton Municipal, KCIA, and Sea-Tac by providing congestion relieve for those willing to pay the tolls.

7.8 FUTURE TRENDS IN MULTIMODAL TRANSPORTATION

Cars, trucks, and public transportation are the main ground connections that link communities to their airports, and this will continue into the future. How and who operates these vehicles is likely to change in the near future, and will impact the cost, time, and methods of travel to and from airports.

Sea-Tac, like many large airports in the United States, has a cellphone lot where people can wait before picking up passengers. It is located directly across from the S. 170th Street exit of the Airport Expressway and provides 200 parking spaces and free WiFi. Drivers awaiting the arrival of airline passengers may park free for up to 20 minutes in the Cellphone Waiting Lot. Once passengers have deplaned and collected their luggage they can then easily be picked up outside of Baggage Claim. The Cellphone Waiting Lot not only provides a convenient place to await arriving flights, but also helps keep traffic on the airport drives moving smoothly. Drivers must stay with their vehicles. There is no parking or waiting allowed on the airport roadway shoulders.

Shared mobility is a growing trend that includes multiple modes such as cars, bikes, and scooters that may affect users and employees at airports in the region. Car-sharing, particularly at general aviation airports, may have the opportunity to replace crew cars provided by the FBO or airport management. As more companies enter the industry, such as Car 2 Go, ZipCar, and Enterprise, car-share services could provide more robust service and handle greater demand than a traditional crew car fleet may be able to serve. Uber and Lyft would be primary competitors to car-share services, requiring car-share to enhance potential advantages such as convenience and cost. Shared mobility also stretches to bikes and scooters, offering an alternative mode for access to local towns or transit connections from airports. The ideal market for this service would include leisure visitors and airport employees, especially at airports without transit access or without rental vehicles or car-share as an easy option.

Autonomous vehicles are still in development but offer a glimpse of a potential future where cars are utilized differently, allowing for a reimagination of transport by personal car. Autonomous vehicles could circle airports predictably, reduce the number of vehicle trips in and out of the airport, and speed up traffic flow. Airports dedicate significant space for vehicle parking and curb drop-off and pick-up at busier commercial airports. If parking demand lessens, the need for curb space for pick-up and drop-off increases. These areas could potentially be redesigned to allow for additional airport property to be used airside. Consideration of these trends in future planning efforts will help the region stay ahead of new opportunities in mobility.

7.9 CONCLUSION

The central Puget Sound region offers multiple modes of connection, allowing passenger cars, trucks, buses, and passenger and freight rail to connect with different airports in the study area. In evaluating landside access at nine of the airports in the region, the following conclusions were drawn:

- Arlington Municipal Airport provides adequate access at current levels with potential room for growth.
- Auburn Municipal Airport provides adequate access at current levels with potential room for growth.
- Bremerton National Airport provides adequate access at current levels with potential room for growth.
- Harvey Field provides inadequate parking facilities and constrained by local roadways.
- KCIA provides adequate access at current levels but provides limited transit access to passenger terminal and is constrained by land and location in a congested area.
- Paine Field provides adequate access; however, this may change based on the addition of commercial service.
- Renton Municipal Airport provides inadequate parking facilities and is constrained by land and location in a congested area.
- Sea-Tac provides adequate parking and transit access but is constrained by local roadways for movement of passengers and freight.
- Tacoma Narrows Airport provides adequate access at current levels with potential room for growth.

The four largest airports in the region by operations are Sea-Tac, KCIA, Renton Municipal, and Paine Field. All of these airports are seeing some strain in access and are limited in available space for improvements due to their locations in dense areas of the region. As aviation grows in the region, landside access at these airports will need to be analyzed in more detail in order to ensure they can accommodate the new growth.

The drive-time analysis of regional airports also provided an opportunity to evaluate the entire region's proximity and access to certain airport qualities by percentage of the population and employment within 30- or 60-minute drives. The region performs well overall, with many important airport features such as commercial passenger service, access to jet fuel, and a 5,000-foot runway all covering over 70 percent of the population and over 80 percent of employment in 2017 and 2050.

The region is already planning for the future of connectivity, with Sound Transit 3 projects and new road expansions slated for construction over the next 20 years. New technology may alter the way multimodal connections are made in the region, as TNCs and autonomous vehicles change the parking and circulation needs at area airports. Finally, trends in air cargo movements indicate that ground access needs will also be changing, with more demand for delivery and materials on the horizon.

Regional Aviation Baseline Study: Working Paper 1

Chapter 8
Goals, Objectives, and Metrics

June 12, 2019

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Contents

8. Goals, Objectives, and Metrics 8-1
8.1 INTRODUCTION 8-1
8.2 RELEVANT PUGET SOUND REGIONAL COUNCIL POLICIES AND STRATEGIES 8-1
8.3 WASHINGTON AVIATION SYSTEM PLAN (WASP) GOALS AND OBJECTIVES........ 8-4
8.4 REGIONAL AVIATION BASELINE STUDY GOAL AREAS AND OBJECTIVES........ 8-5

Tables

Table 8-1. Washington Aviation System Plan Goals and Objectives 8-4
Table 8-2. Regional Aviation Baseline Study Goal Areas and Objectives 8-6

8. Goals, Objectives, and Metrics

8.1 INTRODUCTION

For the purposes of evaluating the system, it is essential to develop a set of metrics that will serve as a framework and standard of measurement to evaluate the baseline, utilization, efficiency and identify benchmarks for future needs and demand. To create efficiency and coordination with the airports, the metrics were developed early in the process and were one of the components in outlining questions for the airport managers.

The metrics were developed to support evaluation of study goals and objectives. Study goals and objectives were derived based on a careful review of, and in accordance with, existing goals, objectives and policies at state and regional levels as described below.

8.2 RELEVANT PUGET SOUND REGIONAL COUNCIL POLICIES AND STRATEGIES

In 2009, the Puget Sound Regional Council Board adopted VISION 2040, a regional plan for managing growth, which is currently being updated (VISION 2050).[1] The plan goals and policies are intended to support a high quality of life in the region and include the following:

- Protect and restore the natural environment and reduce greenhouse gas emissions.
- Plan for growth in cities and urban centers, while reducing sprawl.
- Improve the balance of jobs and housing across the counties.
- Create more vibrant and resilient urban centers.
- Support health, well-being and active living.
- Provide affordable housing choices to meet the needs of all residents.
- Improve mobility for people and goods.
- Maintain and operate the transportation system safely and efficiently.
- Encourage a strong, diverse economy.
- Provide services like solid waste, energy, and water systems to support the region's growth.[2]

[1] VISION 2040: People, prosperity, planet, Puget Sound Regional Council, December 2009, p. iv. Accessed at https://www.psrc.org/vision-2040-documents

[2] VISION 2050 Scoping Report, Puget Sound Regional Council, June 2018, p. 8. Accessed at https://www.psrc.org/sites/default/files/vision2050_scopingreport.pdf

In addition, VISION 2040 calls for strategically locating major capital facilities so that they provide benefits where needed and do not disproportionately burden one area or population. Specifically, related to aviation, VISION 2040 states the following:

> MPP-DP-51: Protect the continued operation of general aviation airports from encroachment by incompatible uses and development on adjacent lands.[3]

Further, VISION 2040 includes the following action related to aviation system planning:

> The PSRC will regularly assess the regional airport system and, as needed, update the Regional Airport System Plan, Strategic Plan for Aviation, Regional Airport Ground Access Plan, and Regional Air Cargo Strategy, in cooperation with member jurisdictions, airport sponsors, state agencies, and the Federal Aviation Administration.[4]

The Regional Transportation Plan states that planning for the future airport system is guided by the following policies:[5]

- The region should maximize aviation capacity within the existing regional airport system before constructing new airports.
- The state will play a lead role in addressing aviation capacity needs and place a priority on funding and planning the state's air transportation system.
- When additional capacity is forecast to be needed, and no feasible airport capacity is available within the region, the state will take the lead role in addressing the capacity needed, including by funding a site selection study for the placement of new airport(s) if no sponsor is available.

The Regional Economic Strategy, Amazing Place: Growing Jobs and Opportunity in the Central Puget Sound Region,[6] is a blueprint for achieving economic prosperity in all parts of the region. It has three goals, one of which is relevant to this study:

- **Compete Globally**. Nurturing the regional competitive edge requires continual business support, a talented and nimble workforce, and expansion of assets for ongoing innovation and global connection. Strategies that support industrial lands, military installations, maritime sites, trade and logistics

3 VISION 2040, Puget Sound Regional Council, December 2009, p. 61.
4 Ibid, p. 87.
5 Regional Transportation Plan – 2018, Puget Sound Regional Council, May 2018, p. 54-55. Accessed at https://www.psrc.org/sites/default/files/rtp-may2018.pdf
6 Amazing Place: Growing Jobs and Opportunity in the Central Puget Sound Region, Puget Sound Regional Council, September 2017, p. 21. Accessed at https://www.psrc.org/sites/default/files/amazingplacestrategy.pdf

infrastructure, and freight mobility rely upon coordinated investment in the region's transportation network.

This regional economic goal has a number of strategies,[7] of which the following are relevant for aviation:

- **Sustain and grow commercial air travel connections domestically and globally** – Aviation powerhouse Sea-Tac and emerging airfields around the region bring global destinations closer to home.
- **Build up and sustain ports and other infrastructure to support trade, logistics, and freight mobility** – Internationally significant port facilities, robust distribution infrastructure, and proximity to Pacific Rim countries make the region one of the world's great transshipment and export locations.
- **Support and promote international trade** – Strong trade relationships put local products in global markets and make the region a top choice for international collaboration and investment.
- **Preserve, protect, and support industrial lands, military installations, and maritime sites** – Industrial lands and maritime sites are diverse, specialized, and closely aligned with the needs of regional industry employers, with room to grow. Military installations are at the forefront of national defense, with missions and expertise leveraged by private sector partners.

7 Amazing Place: Growing Jobs and Opportunity in the Central Puget Sound Region, Puget Sound Regional Council, September 2017, p. 21. Accessed at https://www.psrc.org/sites/default/files/amazingplacestrategy.pdf

8.3 WASHINGTON AVIATION SYSTEM PLAN (WASP) GOALS AND OBJECTIVES

The Washington Aviation System Plan[8] (WASP) developed goals, objectives, and performance measures for the state aviation system. Table 8-1 lists the WASP goals and objectives.

Table 8-1. Washington Aviation System Plan Goals and Objectives

WASP GOAL	WASP OBJECTIVES
Aeronautical and Airport Safety	▪ Attain/maintain Washington Department of Transportation performance objectives and standards. ▪ Maintain safe/clear approaches. ▪ Attain/maintain applicable FAA/Sate design standards/metrics.
Economic Development and Vitality	▪ Support transport of goods and passengers by air, including increasing service opportunities. ▪ Collaborate with airport sponsors and other agencies to maintain and support high, stable levels of community economic growth and development. ▪ Increase airport tenant revenue growth, including promoting on-airport aerospace manufacturing jobs.
Education, Outreach and Community Engagement	▪ Promote aviation education to enhance safety and community support. ▪ Increase community knowledge of the aviation system to communicate airport benefit and contribution to local/ommunitie4s/economies. ▪ Promote aviation activities matched to community need.
Infrastructure Improvement, Preservation and Capacity	▪ Provide aeronautical access to airports during all weather conditions. ▪ Maintain airport facilities at established airport classification levels. ▪ Plan for new capabilities to meet emerging requirements, including NextGen technologies.
Aviation Innovation	▪ Support innovation in the aviation system. ▪ Support innovation in aeronautics.
Modal Mobility, Capacity, and Accessibility	▪ Provide adequate ground access to/from airports. ▪ Support road capacity access alternatives. ▪ Support and improve multimodal connections, including multiple transportation options for users.
Stewardship	▪ Protect the investment in the aviation system, including implementing and maintaining current airport planning documentation. ▪ Conduct requisite airport infrastructure preventive and corrective maintenance. ▪ Advocate local governments for land-use protection and height zoning.
Sustainability	▪ Reduce environmental impacts. ▪ Provide an aviation system that is sustainable. ▪ Implement airport financial sustainability measures.

[8] Washington State Department of Transportation, July 2017, Chapter 2. Accessed at https://www.wsdot.wa.gov/aviation/Planning/

8.4 REGIONAL AVIATION BASELINE STUDY GOAL AREAS AND OBJECTIVES

Since this study builds on the state airport system plan to evaluate the future regional aviation system needs, the Regional Aviation Baseline Study goals were proposed to be set within the system plan framework adopting those goals and, in some cases, objectives that are relevant to a regional assessment of aviation needs.

To do this, the outcomes for this study are as follows:

- Identify the roles of each airport and the aviation activities within the study area based on existing planning efforts.
- Provide a regional perspective on how aviation activities at airports in the study area interact with each other, the community and the broader economy.
- Obtain input from stakeholders about their needs and build a common understanding about aviation and airspace constraints.
- Identify future aviation needs within the central Puget Sound region and set the stage for future planning.

To achieve the intended outcomes, proposed study goal areas and objectives were developed drawing from the WASP study and other related regional goals and objectives described in previous sections of this chapter. Table 8-2 shows the goals and objectives. The proposed goals and objectives and metrics were reviewed by industry stakeholders at a Technical Workshop on June 11, 2019. Workshop participants expressed general support. There was discussion of the importance of workforce training and comment that it wasn't encompassed under the current education and outreach goal. Workforce training is addressed under economic development, in particular, the objective "Support meeting aviation needs to support economic growth now and in future."

In accordance with the scope of work, draft metrics for the study were developed collaboratively to assess the baseline system. The preliminary metrics were also reviewed during the June 11, 2019, Technical Workshop and are attached in Appendix A.

Some of these metrics have been compiled as part of this working paper. For example, 82 percent of the population within the study area is located within 60 minutes of drive time to an airport providing commercial service, 86 percent of population is located within 30 minutes of drive time to an airport with jet fuel, and 27 out of the 29 airports have acceptable access to either interstate or major expressway. These metrics influence the prospect of jobs and associated economic benefits. These findings reflect the good state of aviation within the central Puget Sound region today.

The next step in the process is to understand the inter-dependencies necessary to evaluate the complex aviation system. This will require creating benchmarks for analyzing the current and forecasted future performance. The creation of benchmarks will provide a powerful tool to understand the structure and dynamics, identify gaps and evaluate opportunities.

This step of the process must be carefully navigated, based on the body of research conducted thus far, because benchmarks and metrics are intertwined. The initial metrics will be reviewed for their effectiveness in measuring the system and will finalize the metrics and proposed benchmarks based on feedback from the study partners and the subject matter experts. Benchmarks will be developed, and the system will be evaluated as part of work to be presented in Working Paper 2.

Table 8-2. Regional Aviation Baseline Study Goal Areas and Objectives

STUDY GOAL AREA	STUDY OBJECTIVES
Economic Development and Vitality	▪ Identify aviation needs of growing population. ▪ Support meeting aviation needs to support economic growth now and in future. ▪ Support needs of aerospace industry for manufacturing and cargo that must be on, or in the immediate vicinity of, the airport. ▪ Quantify the economic impacts of each airport using Federal Aviation Administration guidance.
Education, Outreach and Community Engagement	▪ Understand community perceptions about regional aviation needs. ▪ Provide information that is credible and provides a consistent base for stakeholders and decision makers regarding the aviation system and constraints. ▪ Obtain feedback from the general public regarding aviation needs and scenarios to address them.
Infrastructure Improvement, Preservation and Capacity	▪ Develop a set of benchmarks that identify what each airport needs to fulfill its role. ▪ Determine the aviation demand and capacity at each airport based on airport master plans and other existing plans. ▪ Assess the existing and future regional aviation airspace configurations and constraints, taking into consideration Federal Aviation Administration NextGen airspace improvements.
Modal Mobility, Capacity, and Accessibility	▪ Provide adequate ground access to/from airports. ▪ Support road capacity and access improvement alternatives. ▪ Support and improve multimodal connections, including multiple transportation options for users. ▪ Support adequate vehicle parking at airports.
Stewardship	▪ Protect the continued operation of airports from encroachment by limiting incompatible uses and development on adjacent lands.

Regional Aviation Baseline Study:
Working Paper 1

Appendix A
Study Metrics

June 12, 2019

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STUDY GOAL AREA	STUDY OBJECTIVES	STUDY METRICS	DATA/SOURCE
Economic Development and Vitality	▪ Identify aviation needs of growing population.	▪ Percentage of population within 60 minutes of an airport that provides commercial passenger service ▪ Percentage of population within 30 minutes of an airport with jet fuel ▪ Percentage of population within 30 minutes of an airport with a precision instrument approach ▪ Percentage of population within 30 minutes of a business aircraft capable airport (5,000-foot runway, AWOS/ASOS, approach with vertical guidance) ▪ Qualitatively assess each airport for the following aviation sectors: Recreational/Tourism, Flight Training, Business, Charter, Air Cargo, Medical/Emergency, Firefighting, Law Enforcement, and Military	▪ Washington Aviation System Plan (WASP) report ▪ U.S. Census Bureau and local census data ▪ Regional/metropolitan planning organization traffic studies for GIS Travel time inputs ▪ Existing - Google maps analytical data analysis technique/Puget Sound Regional Council (PSRC) regional data ▪ Future – PSRC regional travel demand model results ▪ Federal Aviation Administration (FAA) NFDC database ▪ Airport manager's survey
	▪ Support meeting aviation needs to support economic growth now and in future.	▪ Percentage of employment within 60 minutes of a Major airport ▪ Percentage of employment within 30 minutes of an airport with jet fuel ▪ Percentage of employment within 30 minutes of an airport with de-icing capabilities ▪ Percentage of employment within 30 minutes of a business aircraft capable airport ▪ General aviation airports with expansion capability/capacity (runway/taxiway system, aircraft storage (ramp or hangars), terminal or other expansion/capacity option) ▪ Commercial service airports with expansion capability/capacity (runway/taxiway system, aircraft storage (ramp or hangars), terminals or other expansion/capacity option) ▪ Airports with air cargo with expansion capability/capacity (runway/taxiway system, aircraft storage (ramp or hangars), the terminal or other expansion/capacity option) ▪ Percentage of population and area within 60-minute drive time to an airport with international large freighter service ▪ Percentage of population and area within 60-minute drive time to an airport with domestic and international wide-body belly cargo service ▪ Number of airport air cargo access roads compliant WB62 (62' wheel base) design standards ▪ The ratio of air cargo warehouse space to annual tons of air cargo ▪ Develop quantitative and qualitative benchmarking for multi-airport systems – Identify and benchmark up to five multi-airport markets – Identify and benchmark the governance of the airports in multi-airport markets – Identify and benchmark the roles of the individual airports with in the market(s) – Compare multi-airport systems in the U.S. and discuss/benchmark roles – Domestic vs. International seats – Per capita departing seats (international and domestic) – Factors that influence market competitiveness (i.e., provisions of airline use and lease agreements	▪ (Feasible on and off airport growth potential) ▪ Master Plans, airport manager interviews ▪ GoogleEarth and U.S. Geological Survey ▪ FAA NFDC database ▪ Airport manager's survey ▪ Existing - Google maps analytical data analysis technique/PSRC regional data ▪ Future – PSRC regional travel demand model results ▪ U.S. Census Bureau Population Data ▪ OAG schedules data ▪ Sea-Tac Airline Use and Lease Agreement ▪ Official Statements from other multi-system airports ▪ Other regional airport system plans
	▪ Support needs of aerospace industry for manufacturing and cargo that must be on, or in the immediate vicinity of, the airport.	▪ Airports that can accommodate Airplane Design Group (ADG) III or larger for flight testing ▪ Airports with acceptable access to an interstate highway or major expressway ▪ Airports with incompatible land uses within 1 mile of the runway ends ▪ Airports that have 24/7 customs and/or foreign trade zone availability ▪ Airports with existing adequate facilities for Airport Industrial) operations ▪ Aerospace airports (defined as airports that directly support aerospace assembly plants (i.e. Boeing) with expansion capability/capacity for ramp storage)	▪ Runway length/FAA data ▪ PSRC GIS database ▪ Airport Master Plans ▪ FAA's Airport Obstruction Chart ▪ FAA's Instrument Approach Plates, FAA NFDC website, AirNav ▪ DHS website ▪ Industry interviews
	▪ Quantify the economic impacts of each airport using Federal Aviation Administration guidance.	▪ Overall economic impact of the airports in the region	▪ 2018 Economic Impact Study/Washington State Department of Transportation (WSDOT)

STUDY GOAL AREA	STUDY OBJECTIVES	STUDY METRICS	DATA/SOURCE
Education, Outreach and Community Engagement	▪ Clearly communicate the scope and findings of the study to diverse audiences ▪ Provide transparency and create confidence in the study findings as a consistent foundation about aviation system and constraints for stakeholders and decision makers. ▪ Obtain feedback from stakeholders and the larger public regarding aviation needs and scenarios to address them.	▪ The education objectives will seek information and input to the study, but specific metrics will not be developed.	▪ Survey questions/Surveys
Infrastructure Improvement, Preservation and Capacity	▪ Develop a set of benchmarks that identify what each airport needs to fulfill its role.	▪ WASP role or other use such as passenger service, cargo, aerospace, corporate, recreational ▪ Benchmarks: runway length, parallel taxiway, ramp space	▪ Runway length, parallel taxiway, ramp space ▪ FAA data, Airport Master Plans ▪ FAA FACT studies (Sea-Tac Airport only)
	▪ Determine the aviation demand and capacity at each airport based on airport master plans and other existing plans.	▪ Number of airports that can support the current and future demand and those that cannot, including their limitations ▪ Operational capacity of each General Aviation airport, measured in annual service volume (ASV) ▪ Hangar capacity ▪ Demand for hangar space through hangar demand/capacity ratio and hangar waiting lists ▪ Apron capacity ▪ Apron demand (airport manager) ▪ Auto parking capacity ▪ Auto parking demand (airport manager) ▪ Seaplane base anchorages/moorings capacity ▪ Seaplane base dock space	▪ Forecasts/PSRC Study ▪ Capacity/Master Plans ▪ AC 150/5060-5 Airport Capacity and Delay (Change 1 and 2) ▪ Airport manager survey
	▪ Assess the existing and future regional aviation airspace configurations and constraints, taking into consideration Federal Aviation Administration NextGen airspace improvements.	▪ General organization of airspace ▪ Number of existing airspace chokepoints ▪ Number of future airspace chokepoints	▪ Airspace Analysis/PSRC Study ▪ FAA Western-Pacific Region studies?

STUDY GOAL AREA	STUDY OBJECTIVES	STUDY METRICS	DATA/SOURCE

Modal Mobility, Capacity, and Accessibility	▪ Provide adequate ground access to/from airports.	– Airports with more than 2 lane connector roadways
		– Airports with good accessibility to an interstate highway or major expressway (within 5 miles of an interstate and 2 miles of a highway or state route)
		– Airports with direct access to limited access highway
		– Congestion metrics
		  – 30-minute vehicle access during peak to General Aviation airports
		  – 60 minute vehicle access during peak to Commercial airports within PSRC region
		  – baseline regional congestion comparison to other regions
			▪ Airport access road lanes/Google Maps
			▪ Puget Sound Regional Council, WSDOT, and Federal Highway Administration traffic congestion studies and capacity reports
			▪ Google maps analytical data analysis technique
			▪ TTI or other national metropolitan area congestion measures

	▪ Support road capacity and access improvement alternatives.	▪ Airports with roadways that are overcapacity ▪ Airports with planned access improvements	▪ Roadway capacity/WSDOT Transportation Plan ▪ Access improvements/WSDOT Transportation Plan ▪ Ground freight capacity/airport master plans, port plans, WSDOT freight plan
	▪ Support and improve multimodal connections, including multiple transportation options for users.	▪ Airports with current or future high-capacity transit access ▪ Airports with bus/transit/ferry access ▪ Passengers per mode of ground transportation to/from the airport ▪ Employee per mode of ground transportation to/from the airport ▪ Number of trips from Transportation Network Companies (Uber/Lyft/taxi) ▪ Airports with bicycle and pedestrian access ▪ Airports with shuttle access to hotels or other areas	▪ Airport authority monitoring and reporting/master plans ▪ Rail locations/WSDOT Transportation Plan/PSRC Long Range Transportation Plan ▪ Bus locations/Transit agency online data/Sound Transit, Pierce Transit, King County Metro, Community Transit, Everett Transit ▪ Ferry locations/WSDOT Transportation Plan ▪ PSRC, CPSRTA, and municipal studies
	▪ Support adequate vehicle parking at airports.	▪ Airports meeting or exceeding current parking needs ▪ Airports meeting or exceeding future parking needs ▪ Airports with on-airport rental car services/parking needs	▪ Parking capacity/Master Plans
Stewardship	▪ Protect the continued operation of airports from encroachment by limiting incompatible uses and development on adjacent lands.	▪ Airports with incompatible land use within 1 mile for general aviation airport runways and within 2 miles for commercial service airport runways ▪ Airports with height restriction ordinances ▪ Airport with zoning around the airport for encroachment protection	▪ Land use maps/Master Plans, city or county data ▪ Height restriction ordinances/Master Plans. city or county data ▪ Zoning maps/Master Plans, city or county data

REGIONAL AVIATION BASELINE STUDY:
WORKING PAPER 1

Appendix B
Drive Times

June 12, 2019

Prepared for

Puget Sound Regional Council

Prepared by

wsp

In association with

CDM Smith

KPA KEISER PHILLIPS ASSOCIATES

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BridgeNet INTERNATIONAL

Table

Table B-1. Airports in the Study Area B-1

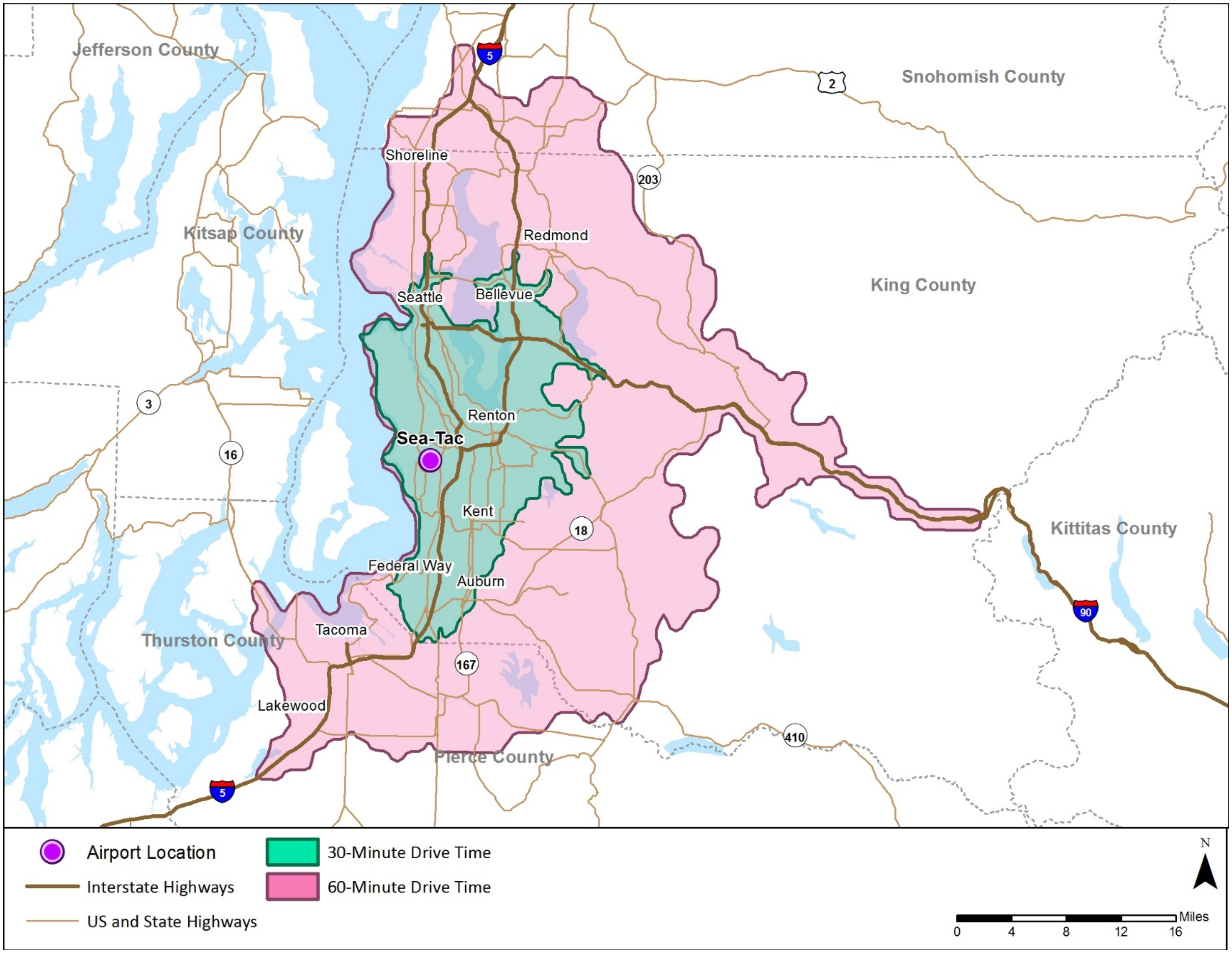
Figures

Figure B-1. Seattle-Tacoma International (Sea-Tac) B-2
Figure B-2. King County International (KCIA) B-3
Figure B-3. Paine Field B-4
Figure B-4. Renton Municipal B-5
Figure B-5. Auburn Municipal B-6
Figure B-6. Harvey Field B-7
Figure B-7. Kenmore Air Harbor Seaplane Base (S60) B-8
Figure B-8. Vashon Municipal B-9
Figure B-9. Bremerton National B-10
Figure B-10. Pierce County B-11
Figure B-11. Tacoma Narrows B-12
Figure B-12. Arlington Municipal B-13
Figure B-13. Bandera State B-14
Figure B-14. Skykomish State B-15
Figure B-15. Norman Grier Field B-16
Figure B-16. Kenmore Air Harbor Sea Plane Base (W55) B-17
Figure B-17. Seattle Seaplanes Seaplane Base B-18
Figure B-18. Will Rogers—Wiley Post Memorial Seaplane Base B-19
Figure B-19. Apex Airpark B-20
Figure B-20. Port of Poulsbo Seaplane Base B-21
Figure B-21. Ranger Creek State B-22
Figure B-22. Swanson Field B-23
Figure B-23. Shady Acres Airport B-24
Figure B-24. American Lake Seaplane Base B-25
Figure B-25. Darrington Municipal B-26
Figure B-26. First Air Field B-27

Table B-1. Airports in the Study Area

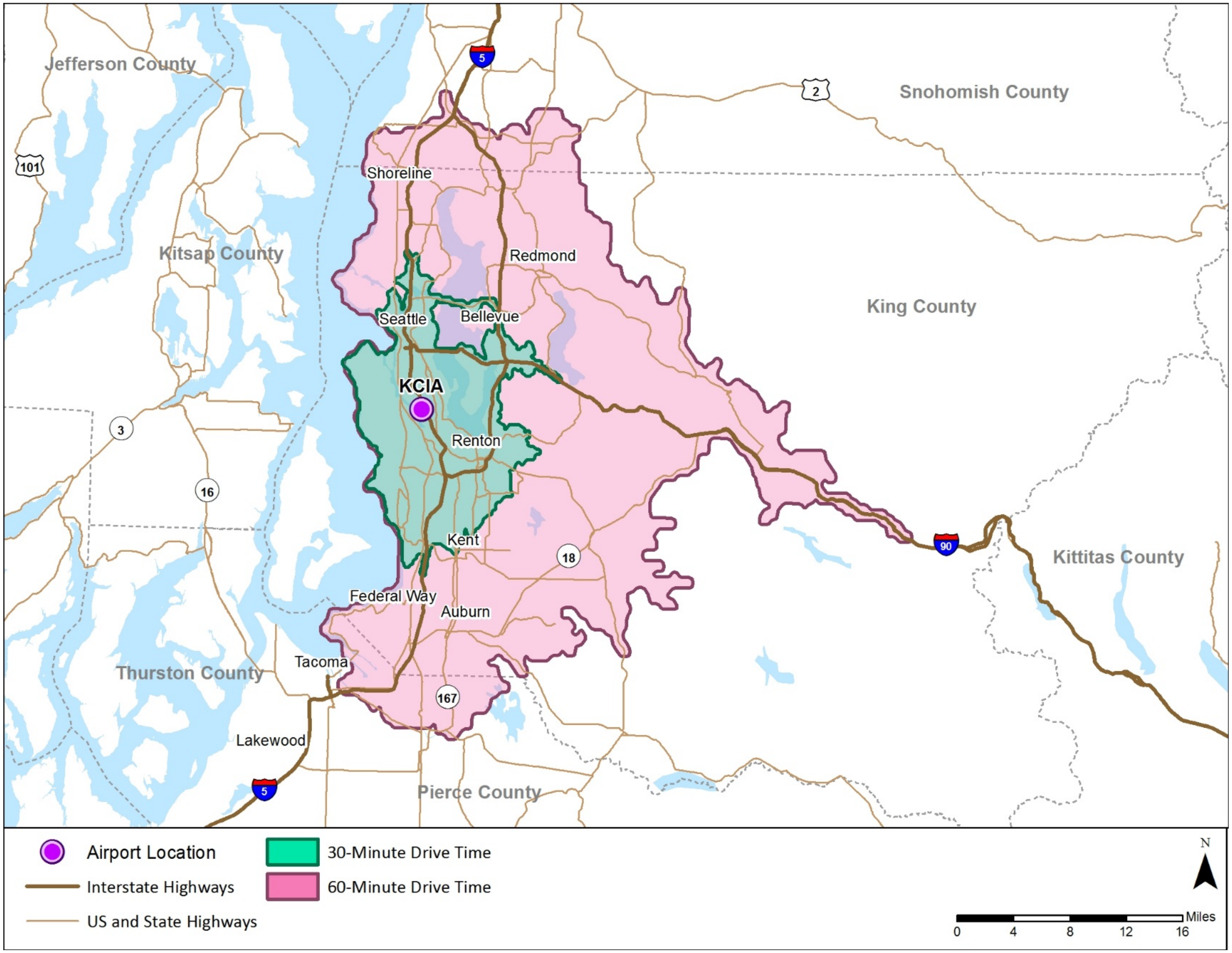
AIRPORT NAME (NAME USED IN WORKING PAPER)	CITY	COUNTY	DESIGNATION	CATEGORY
Seattle-Tacoma International (Sea-Tac)	Seattle	King	NPIAS	Commercial service - primary
King County International/Boeing Field (KCIA)	Seattle	King	NPIAS	Commercial service - primary
Paine Field/Snohomish County International (Paine Field)	Everett	Snohomish	NPIAS	New Commercial service 2019
Renton Municipal	Renton	King	NPIAS	Reliever
Auburn Municipal	Auburn	King	NPIAS	Reliever
Harvey Field	Snohomish	Snohomish	NPIAS	Reliever
Kenmore Air Harbor Sea Plane Base (SPB) S60	Kenmore	King	NPIAS	General Aviation
Vashon Municipal	Vashon	King	NPIAS	General Aviation
Bremerton National	Bremerton	Kitsap	NPIAS	General Aviation
Pierce County	Puyallup	Pierce	NPIAS	General Aviation
Tacoma Narrows	Tacoma	Pierce	NPIAS	General Aviation
Arlington Municipal	Arlington	Snohomish	NPIAS	General Aviation
Bandera State	Bandera	King	Non-NPIAS	General Aviation
Skykomish State	Skykomish	King	Non-NPIAS	General Aviation
Norman Grier Field	Kent	King	Non-NPIAS	General Aviation
Kenmore Air Harbor SPB W55	Seattle	King	Non-NPIAS	General Aviation
Seattle Seaplanes SPB	Seattle	King	Non-NPIAS	General Aviation
Will Rogers—Wiley Post Memorial SPB	Renton	King	Non-NPIAS	General Aviation
Apex Airpark	Silverdale	Kitsap	Non-NPIAS	General Aviation
Port of Poulsbo SPB	Poulsbo	Kitsap	Non-NPIAS	General Aviation
Ranger Creek State	Greenwater	Pierce	Non-NPIAS	General Aviation
Swanson Field	Eatonville	Pierce	Non-NPIAS	General Aviation
Shady Acres Airport	Spanaway	Pierce	Non-NPIAS	General Aviation
American Lake SPB	Tacoma	Pierce	Non-NPIAS	General Aviation
Darrington Municipal	Darrington	Snohomish	Non-NPIAS	General Aviation
First Air Field	Monroe	Snohomish	Non-NPIAS	General Aviation

Figure B-1. Seattle-Tacoma International (Sea-Tac)



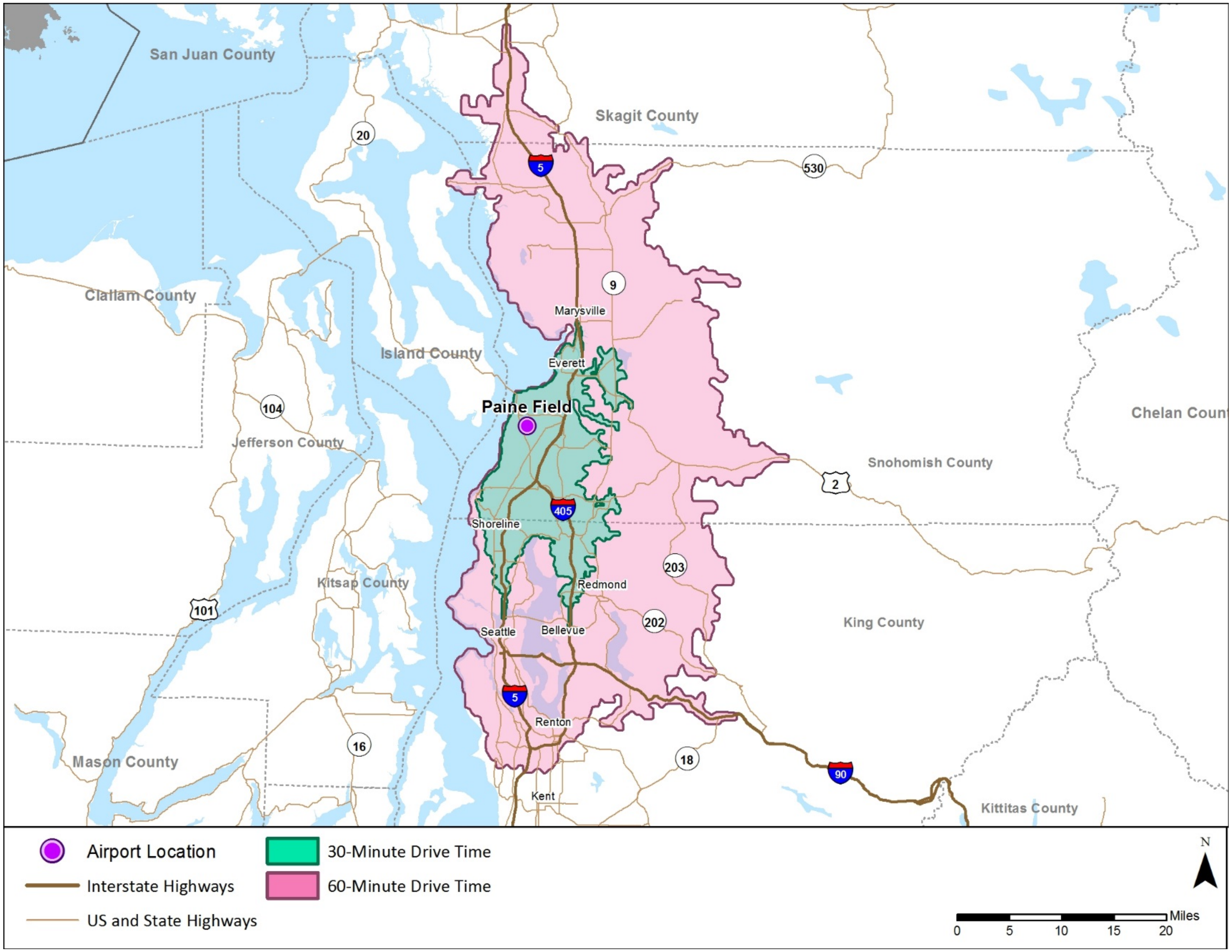
Source: CDM Smith analysis of 2019 HERE data and Google Maps data

Figure B-2. King County International (KCIA)



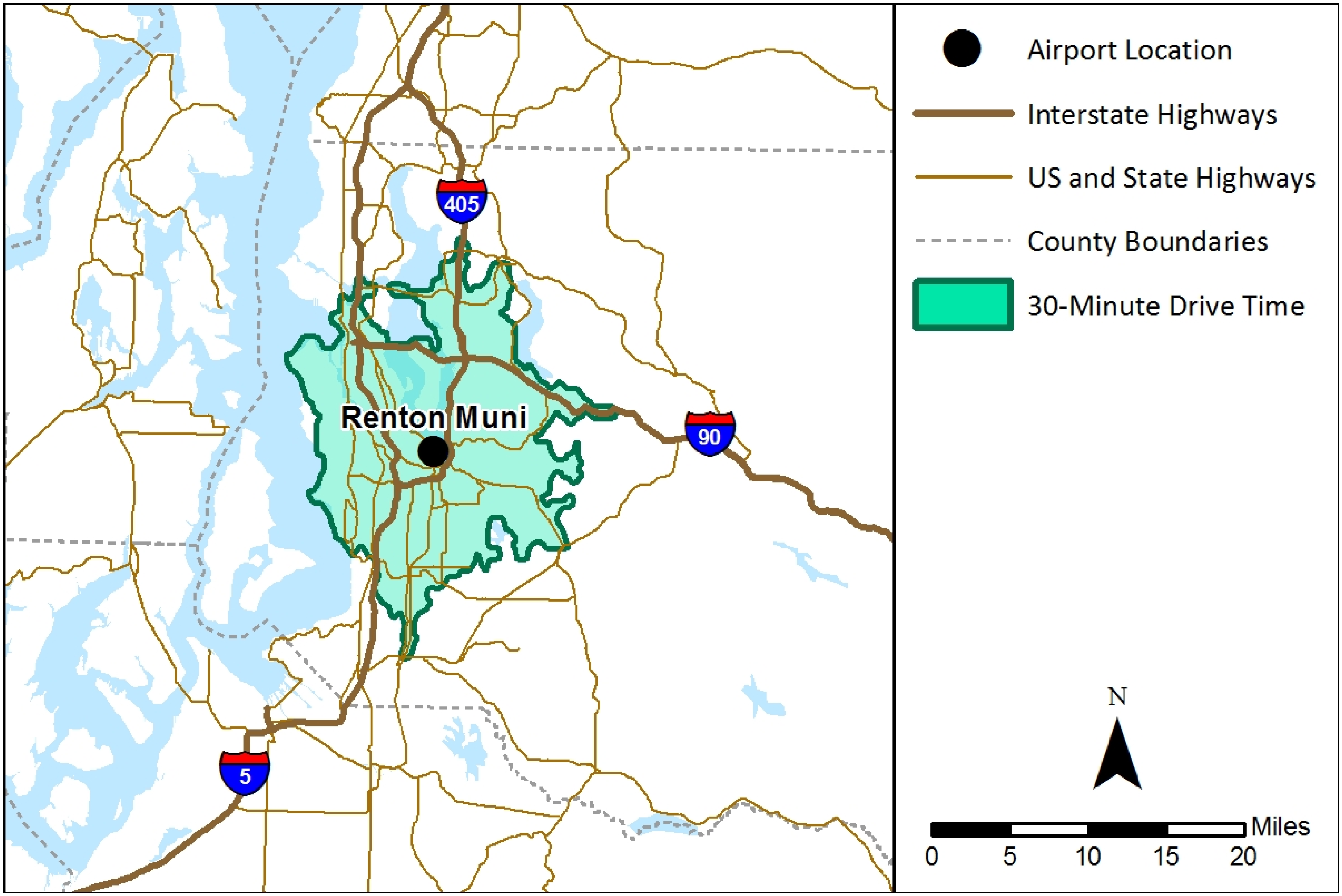
Source: CDM Smith analysis of 2019 HERE data and Google Maps data

Figure B-3. Paine Field



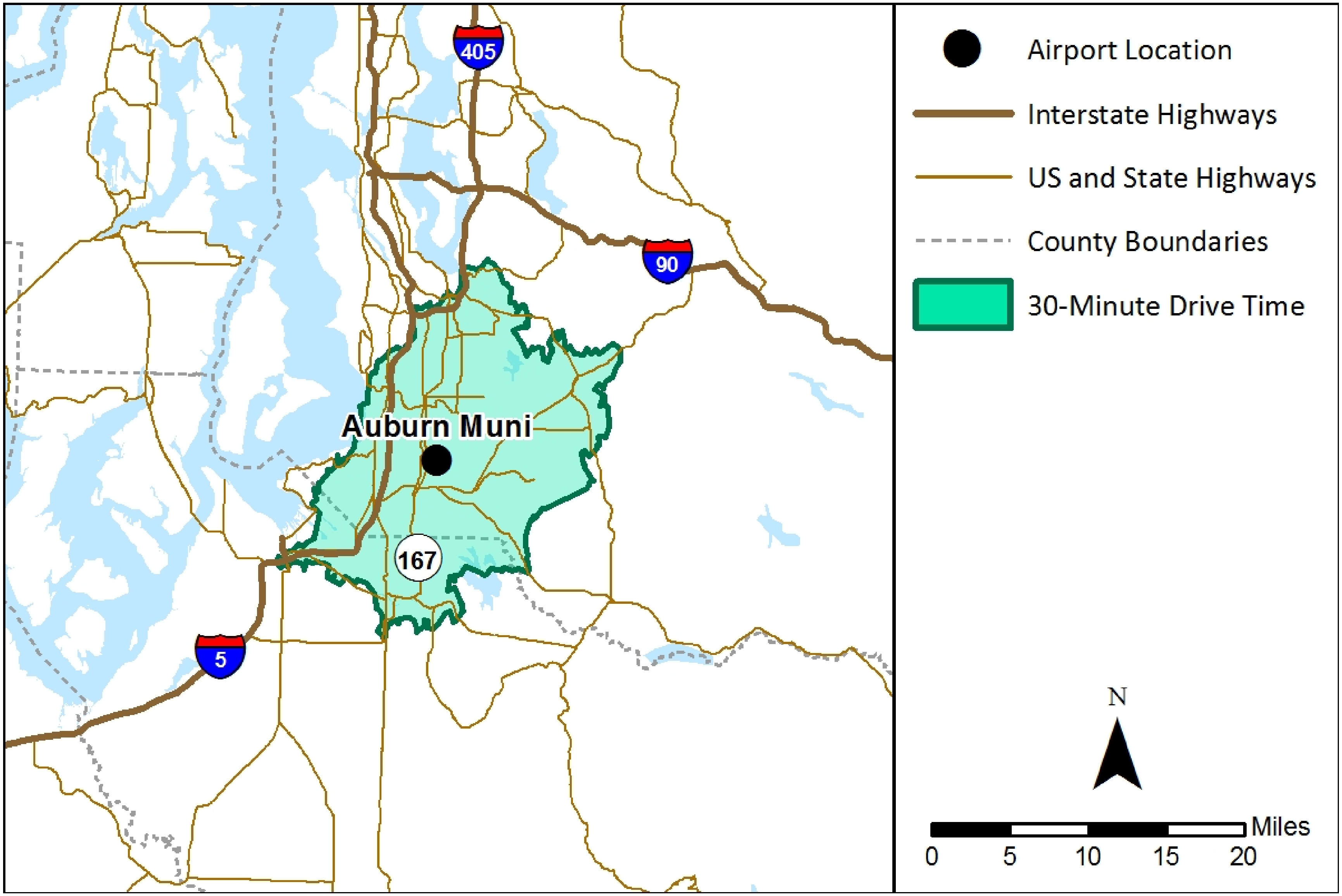
Source: CDM Smith analysis of 2019 HERE data and Google Maps data

Figure B-4. Renton Municipal



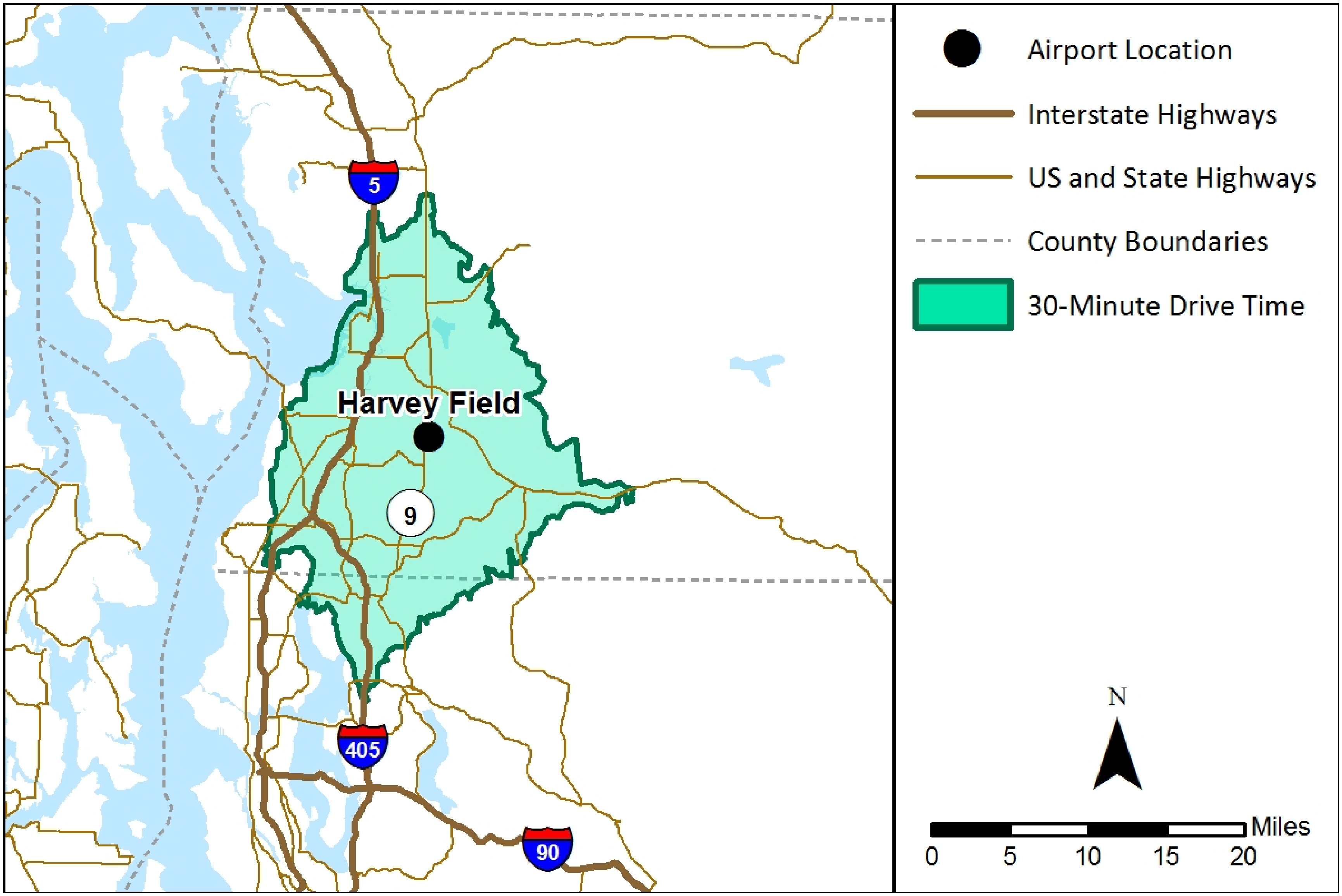
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-5. Auburn Municipal



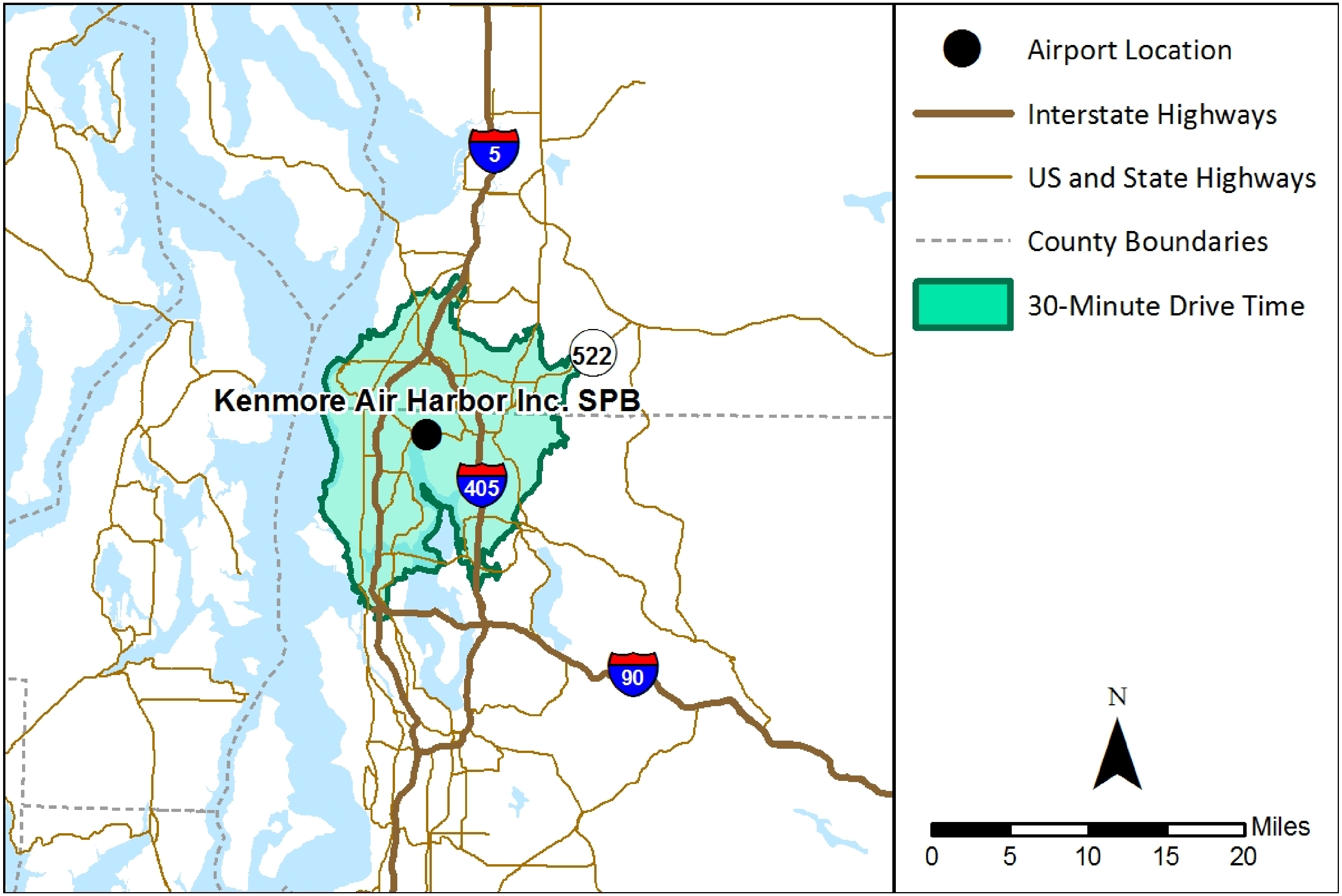
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-6. Harvey Field



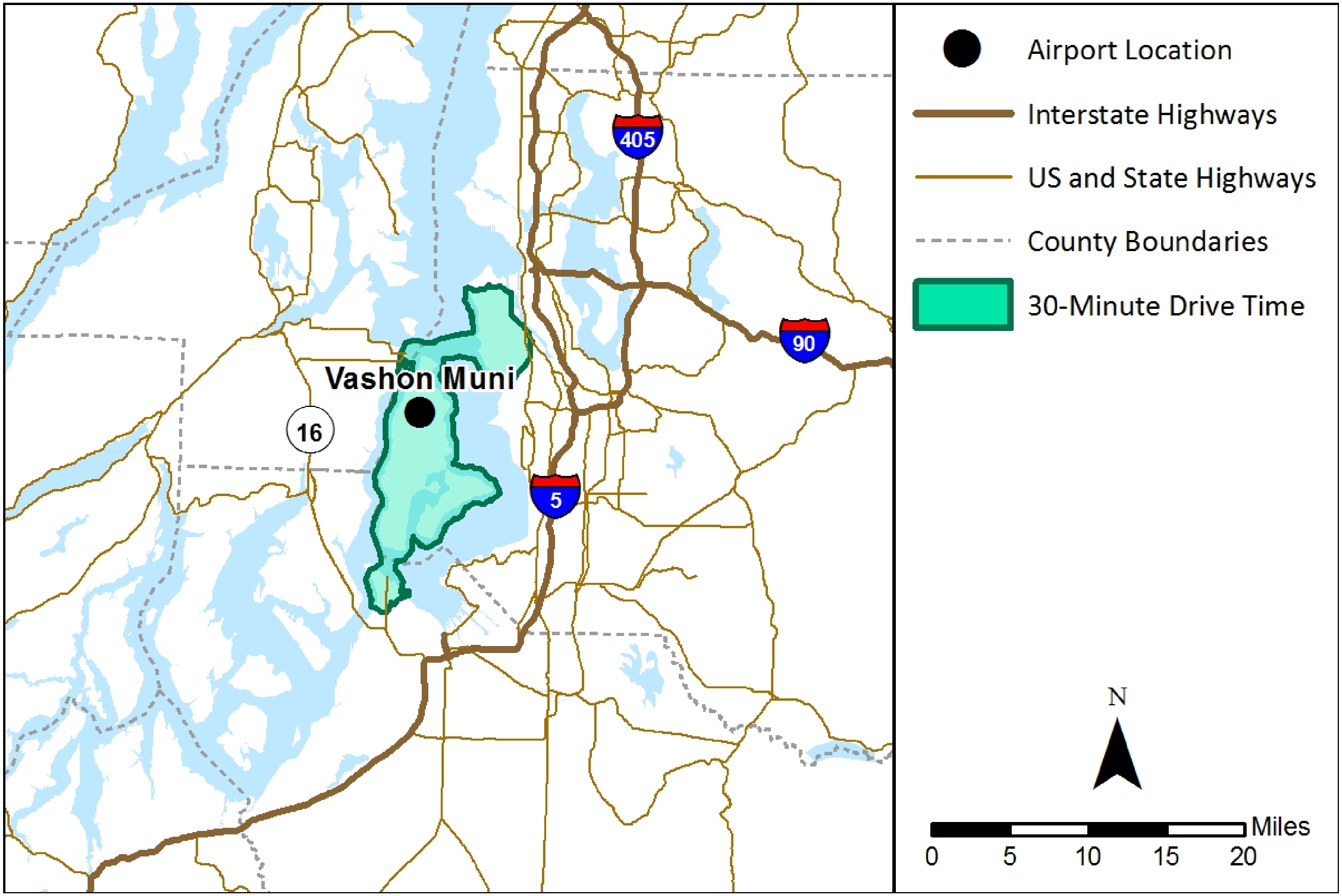
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-7. Kenmore Air Harbor Seaplane Base (S60)



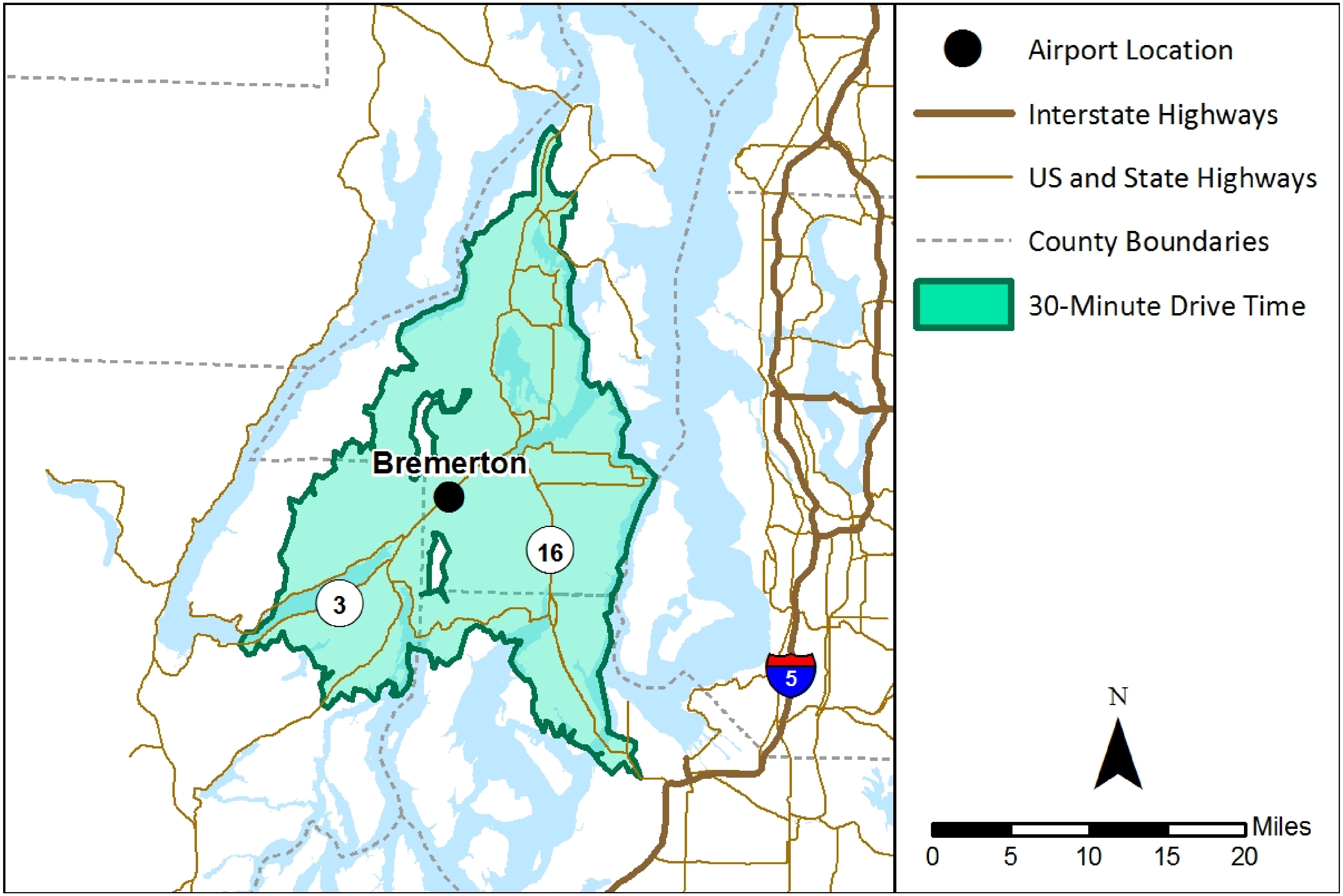
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-8. Vashon Municipal



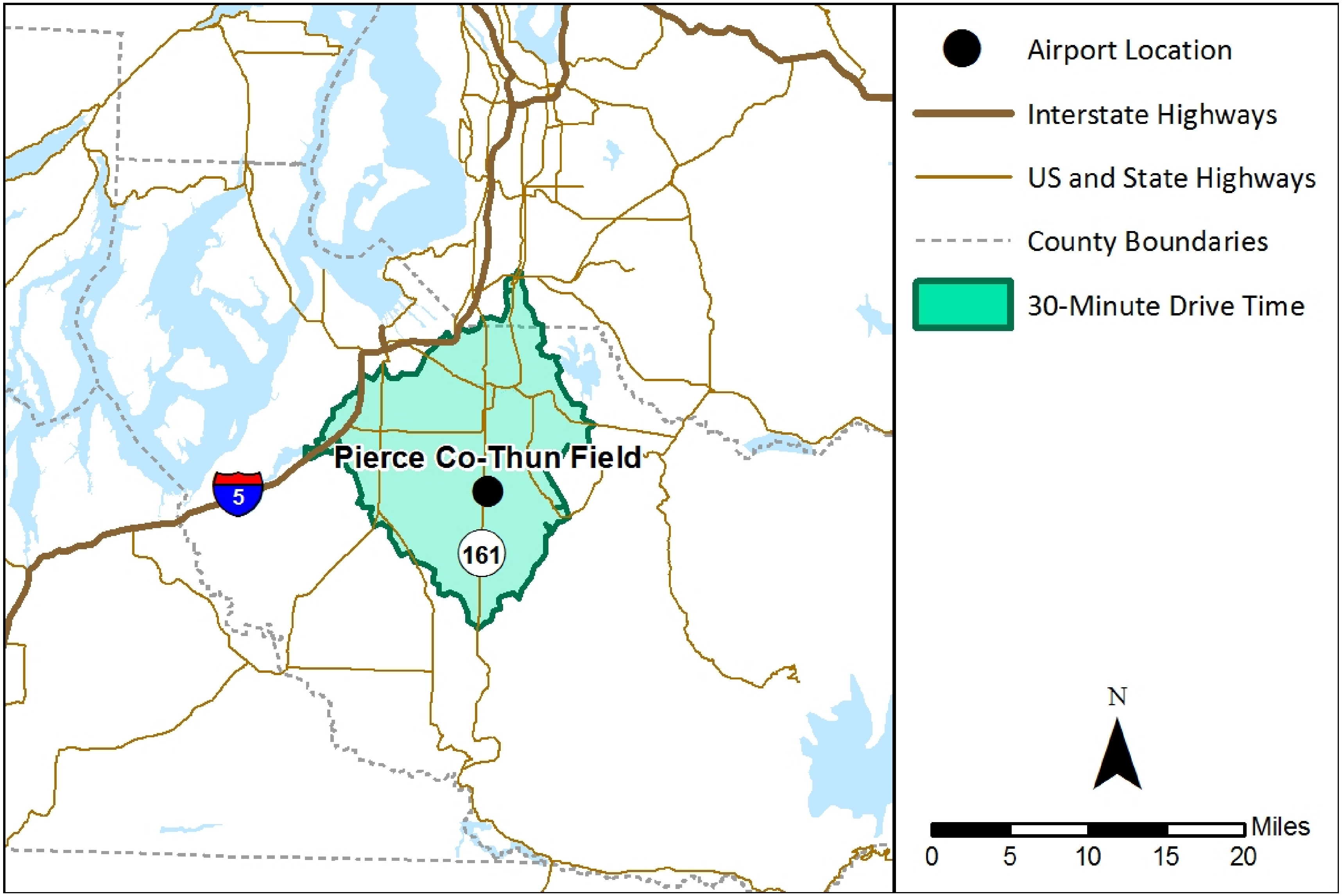
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-9. Bremerton National



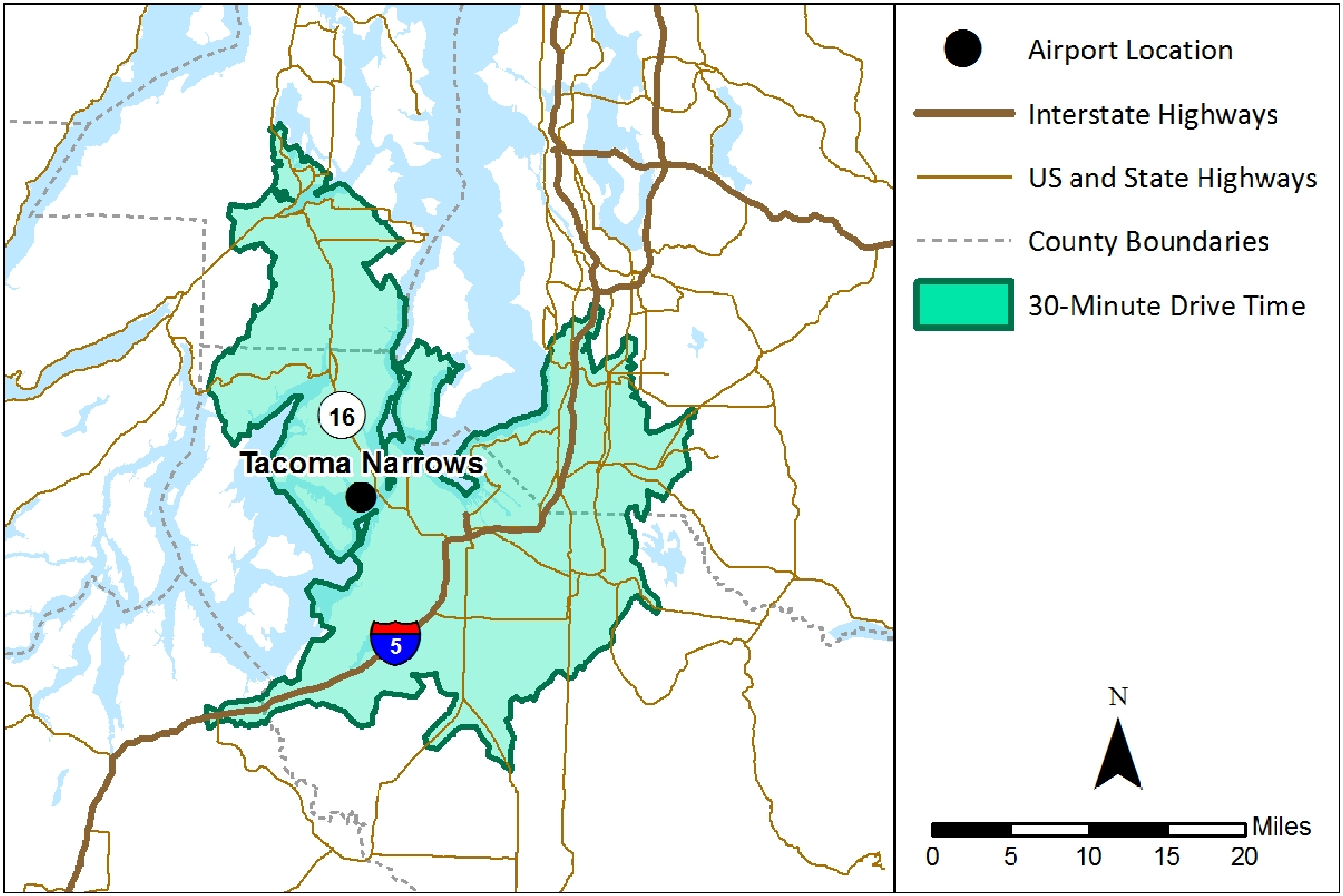
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-10. Pierce County



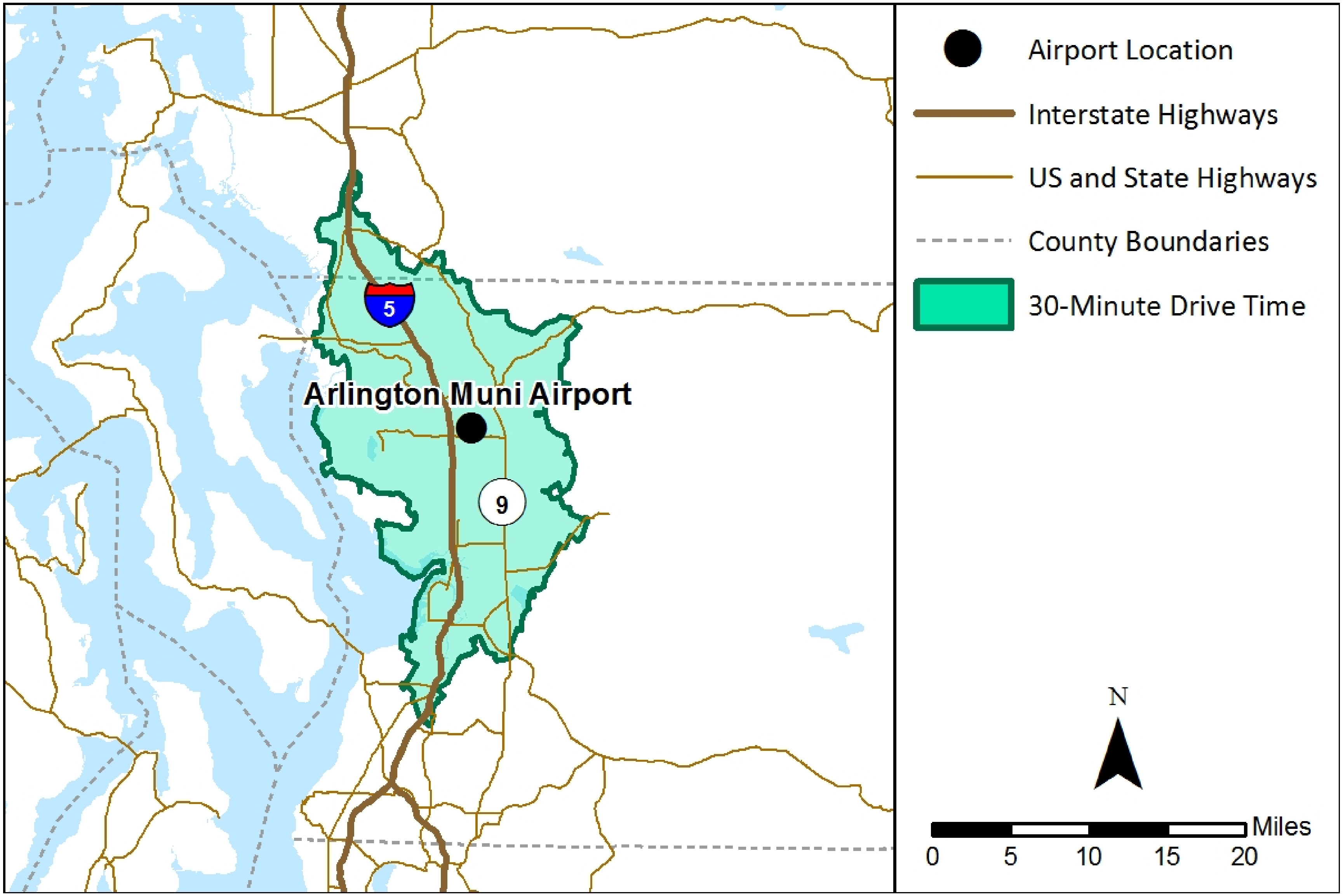
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-11. Tacoma Narrows



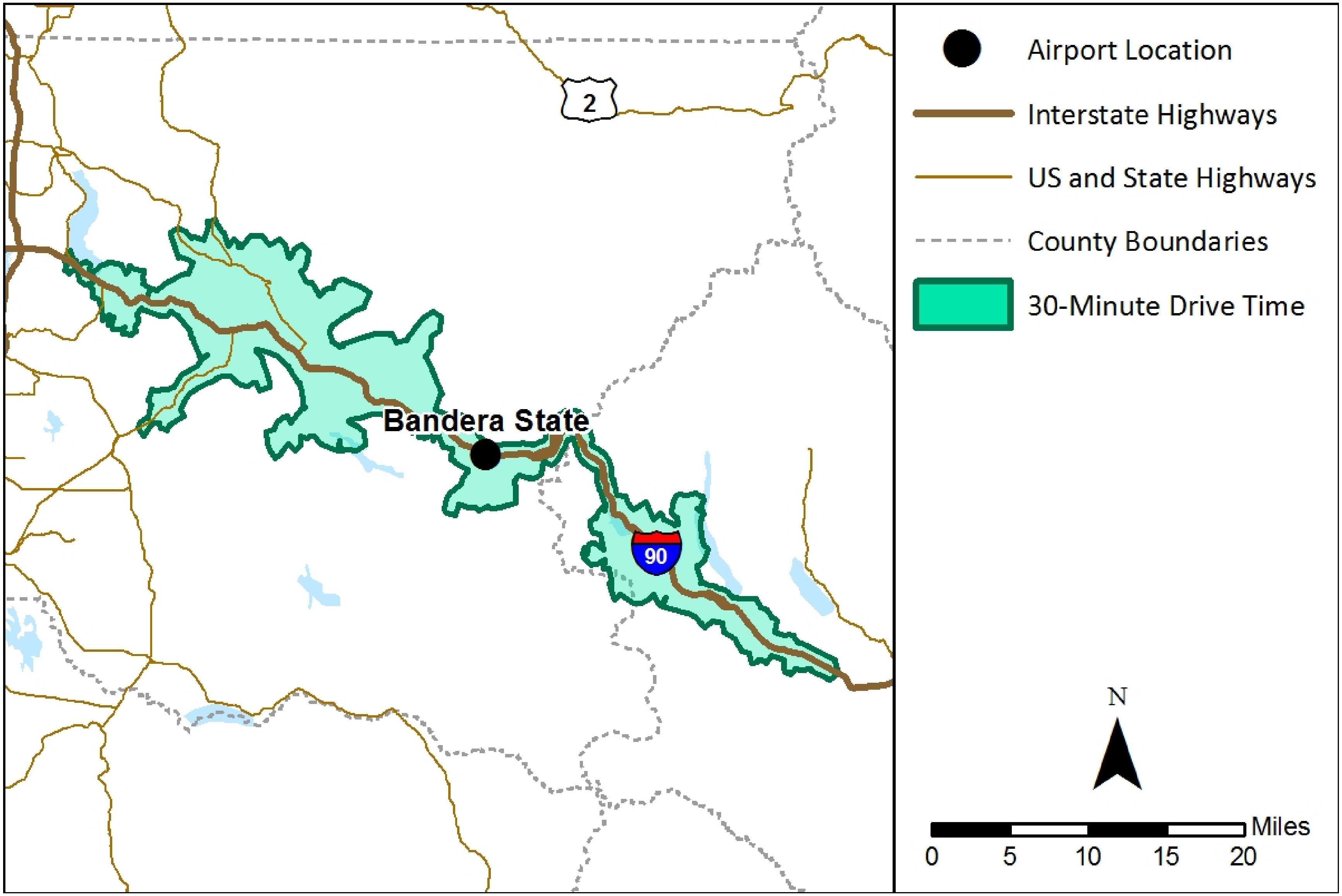
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-12. Arlington Municipal



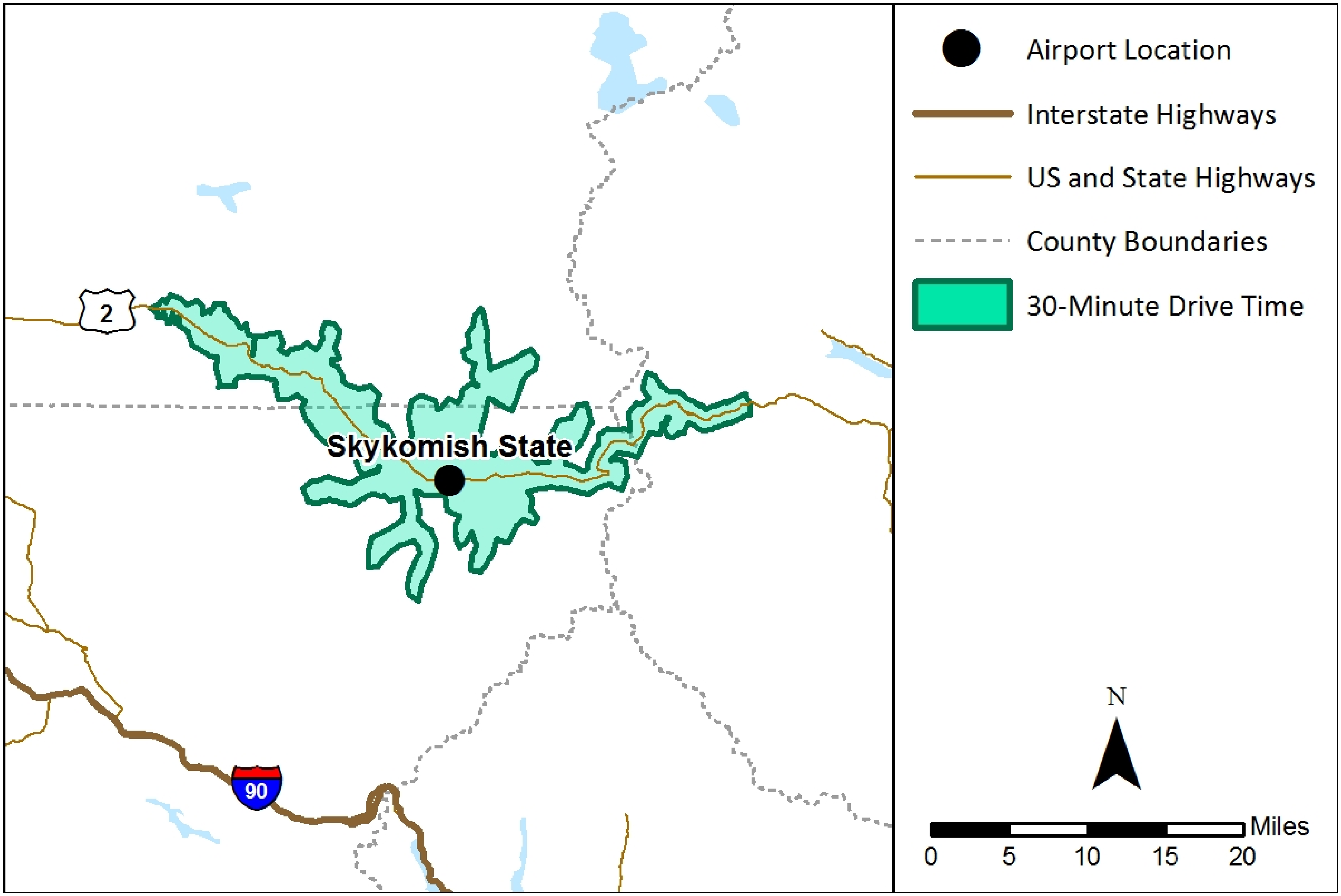
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-13. Bandera State



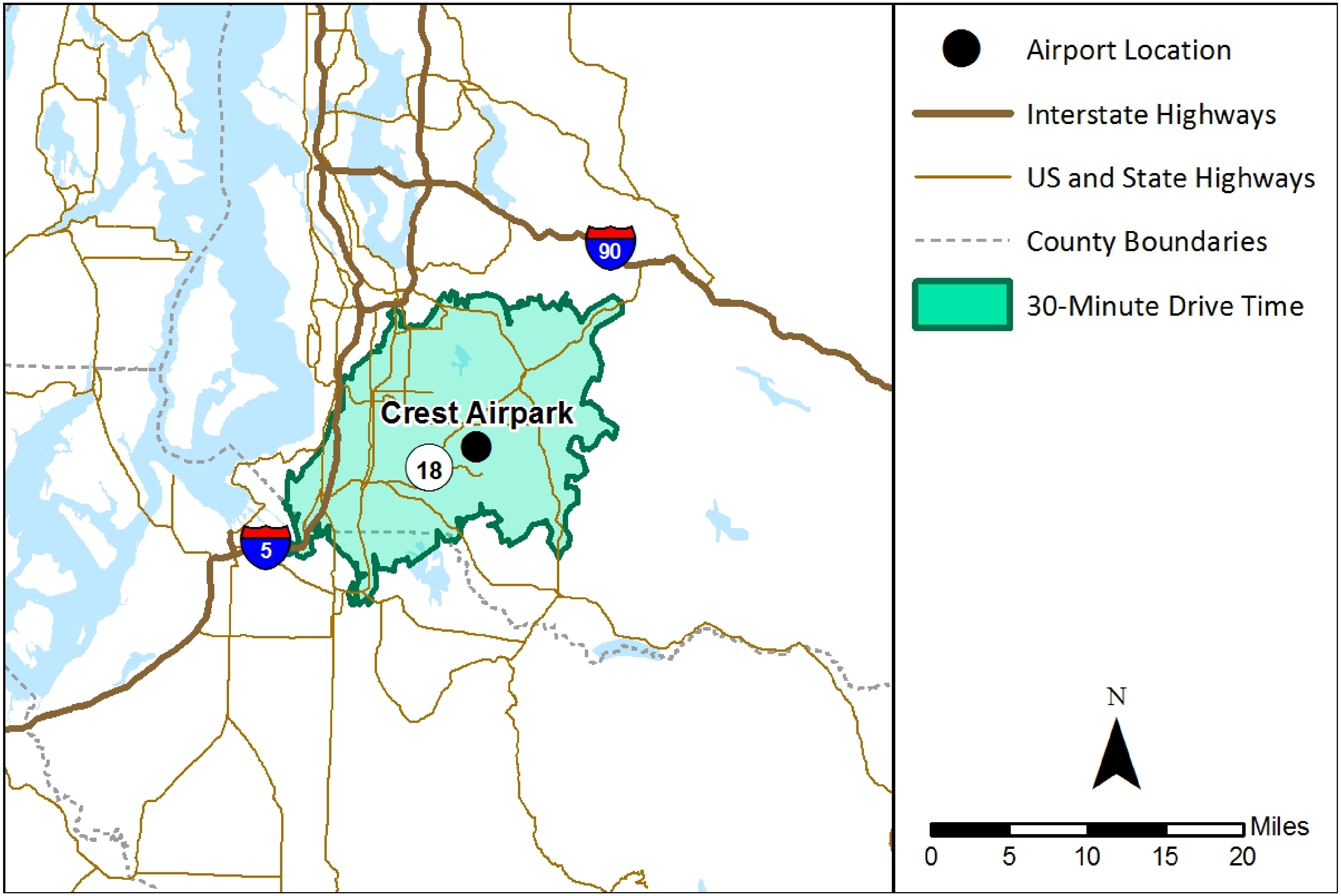
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-14. Skykomish State



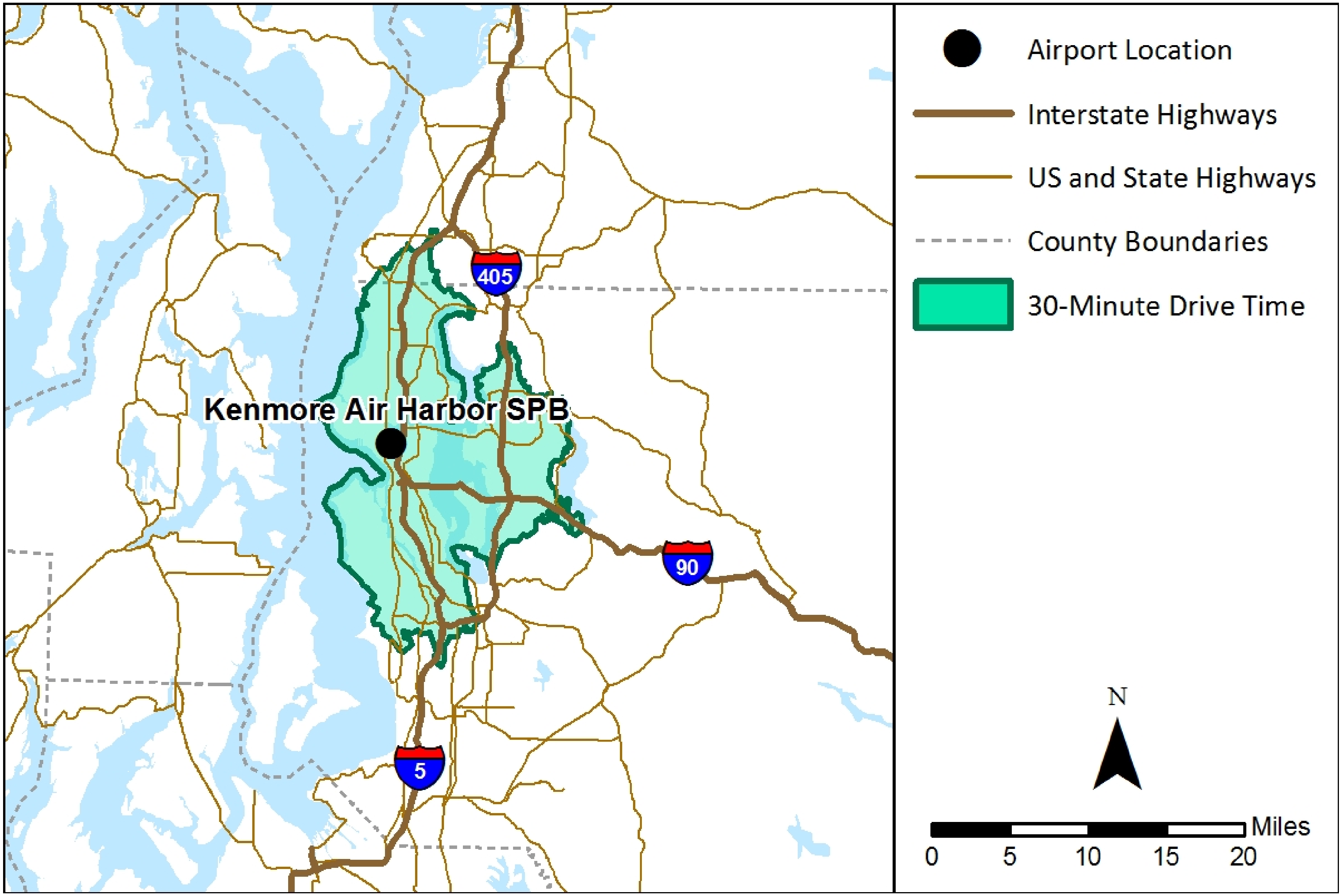
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-15. Norman Grier Field



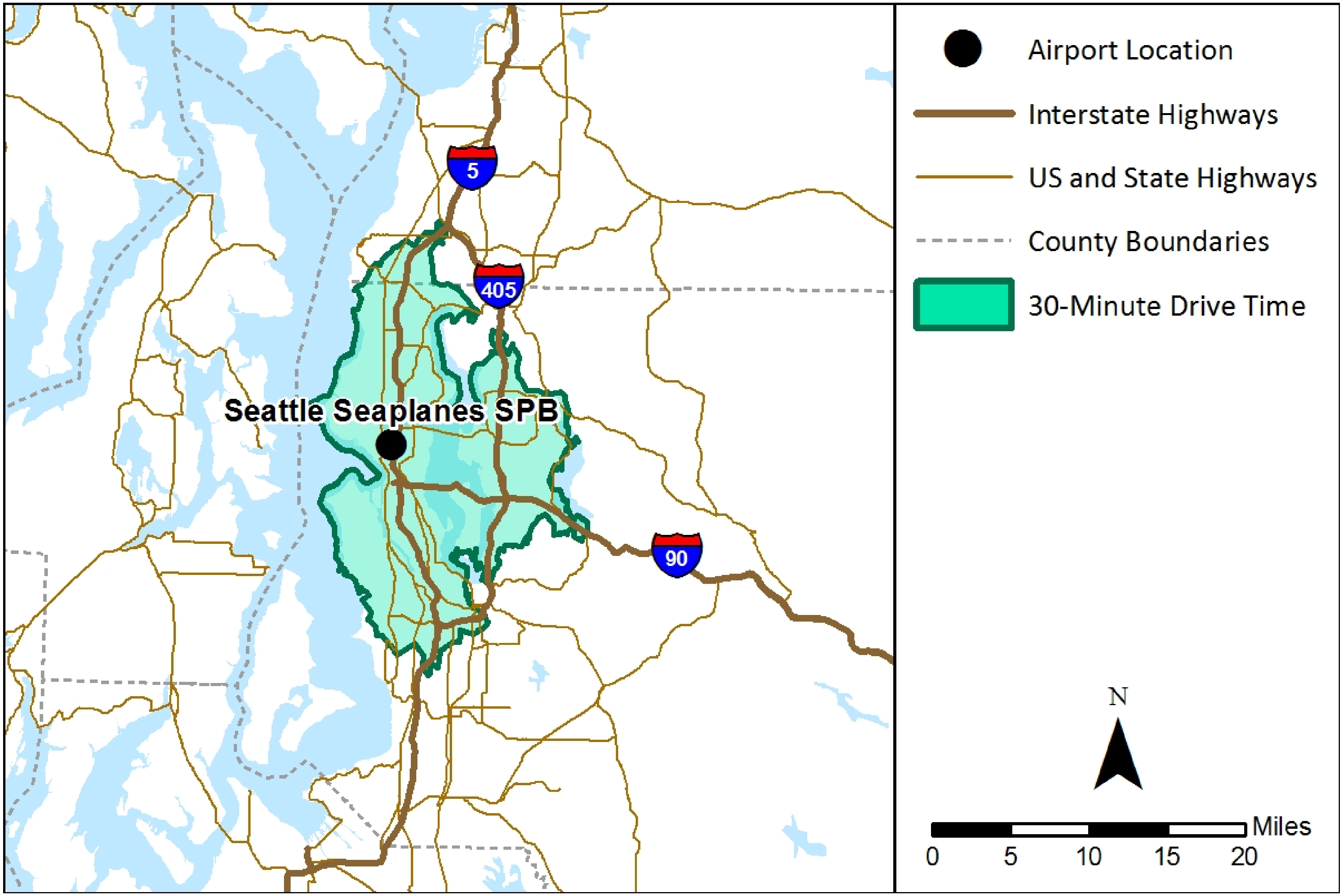
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-16. Kenmore Air Harbor Sea Plane Base (W55)



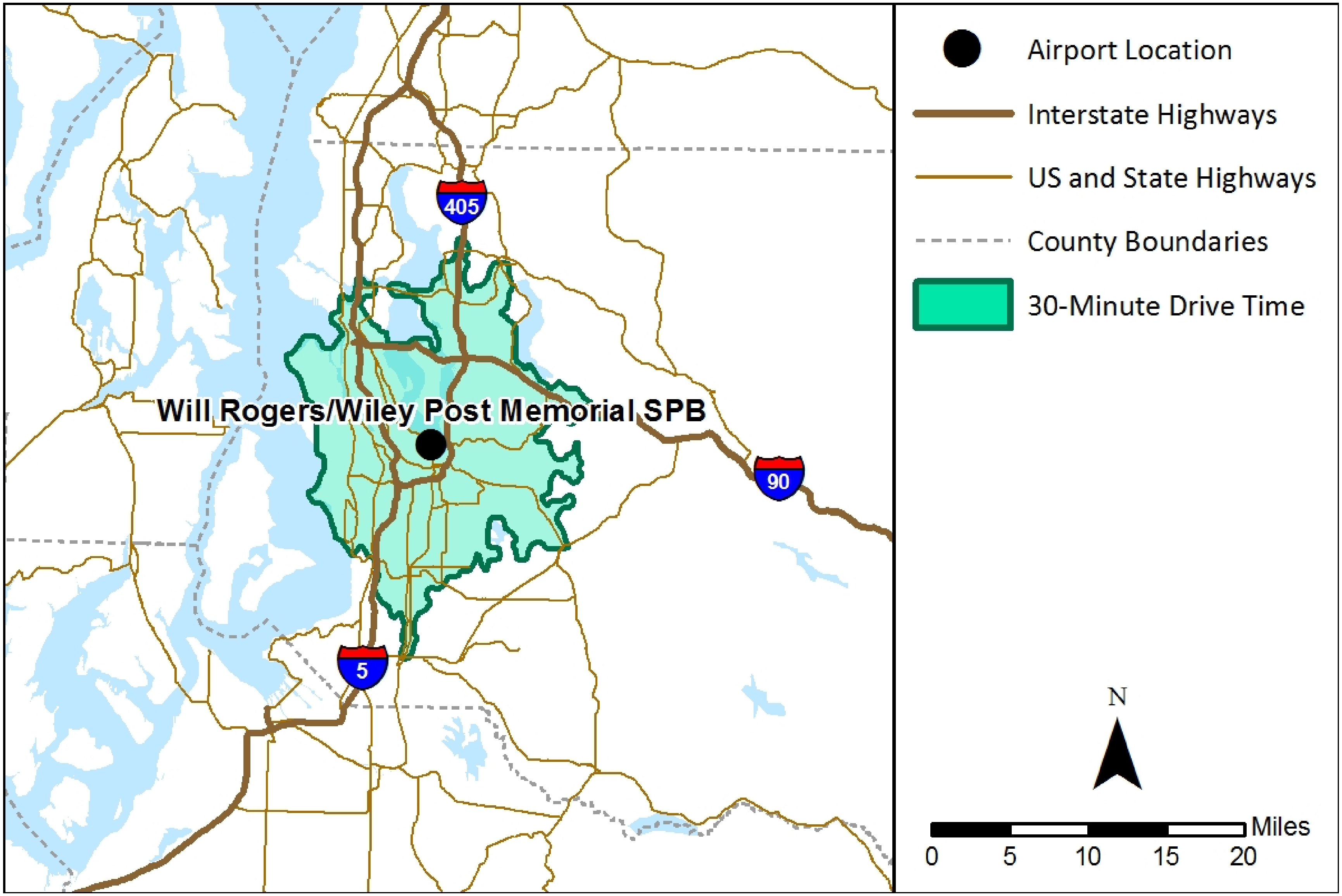
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-17. Seattle Seaplanes Seaplane Base



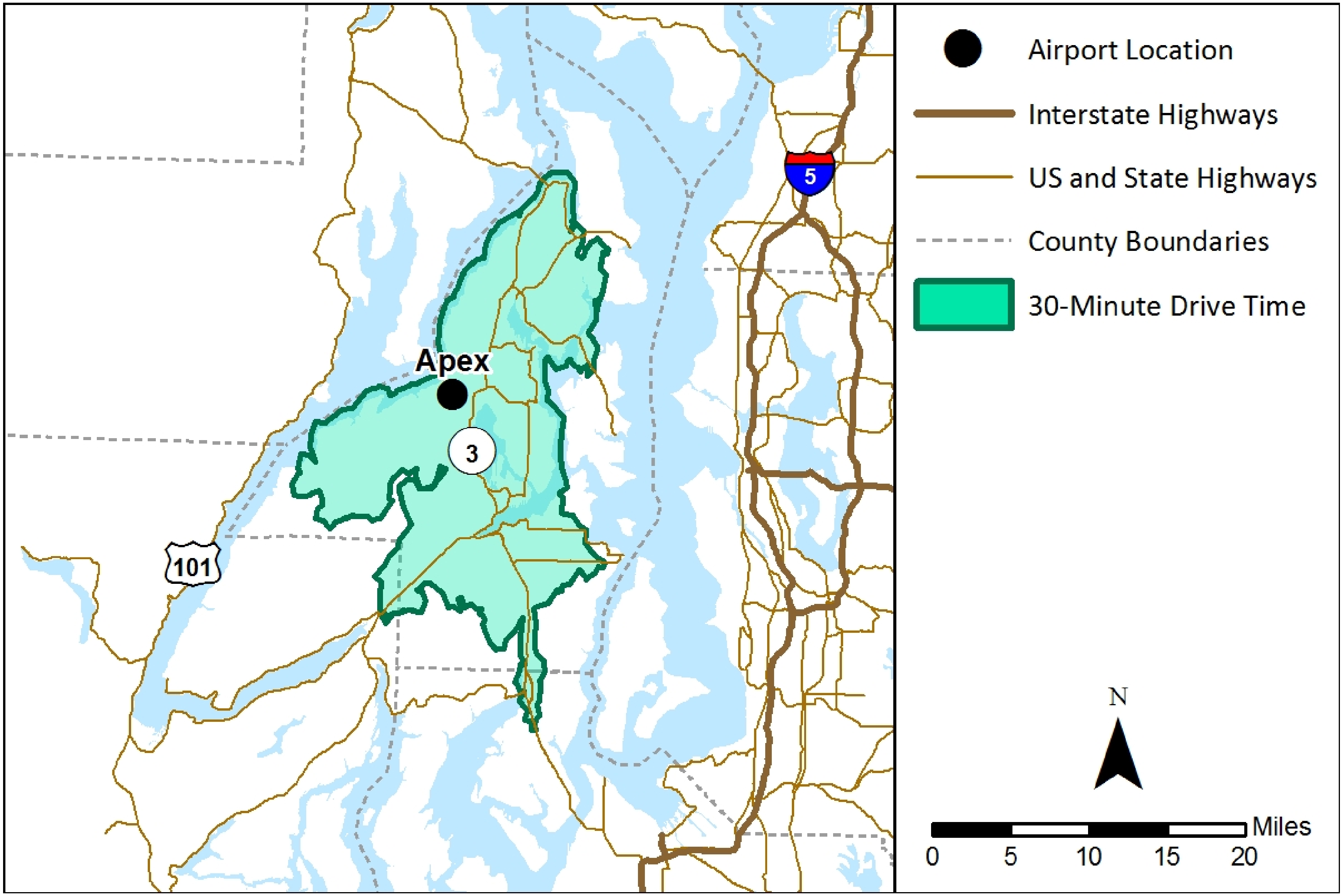
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-18. Will Rogers—Wiley Post Memorial Seaplane Base



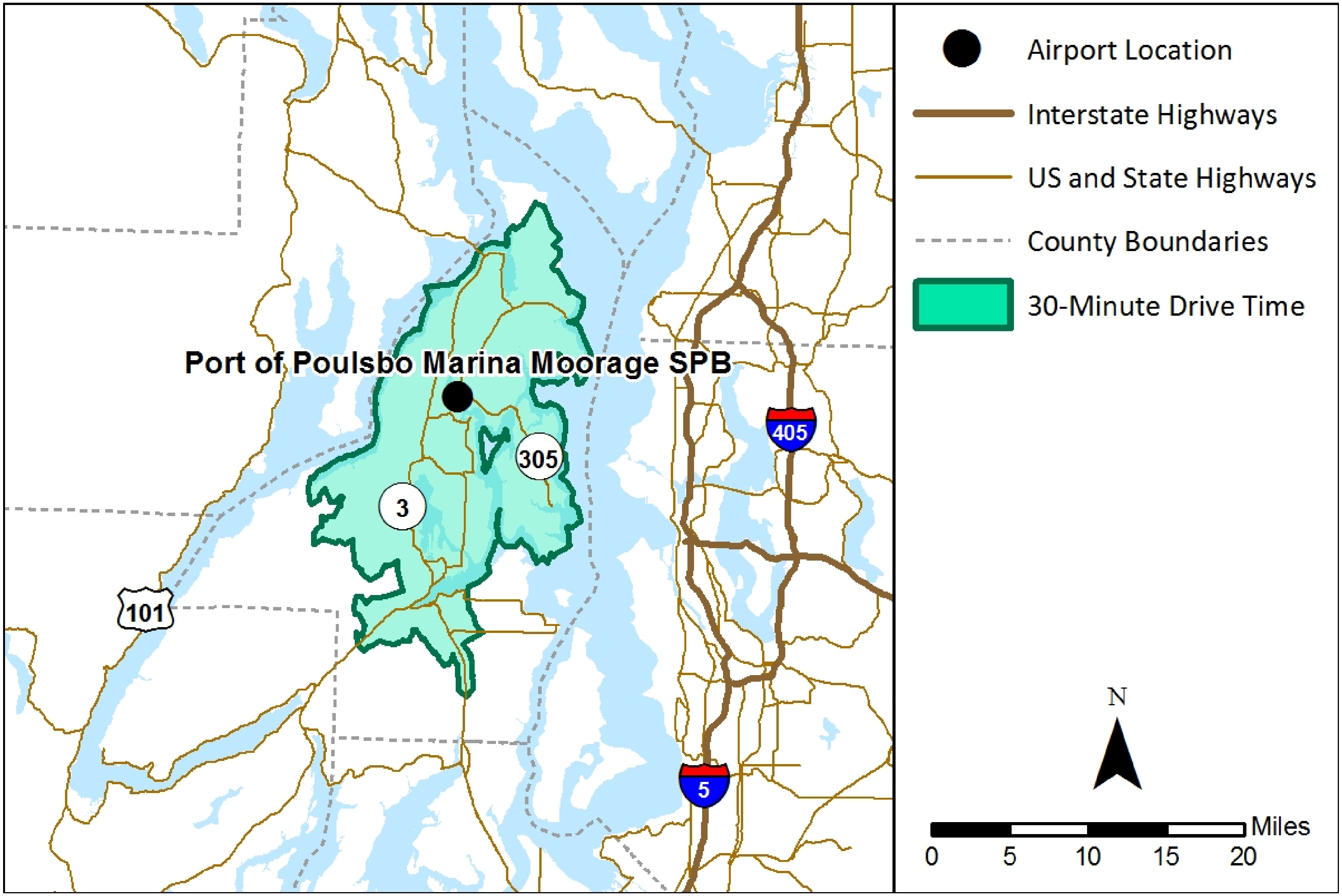
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-19. Apex Airpark



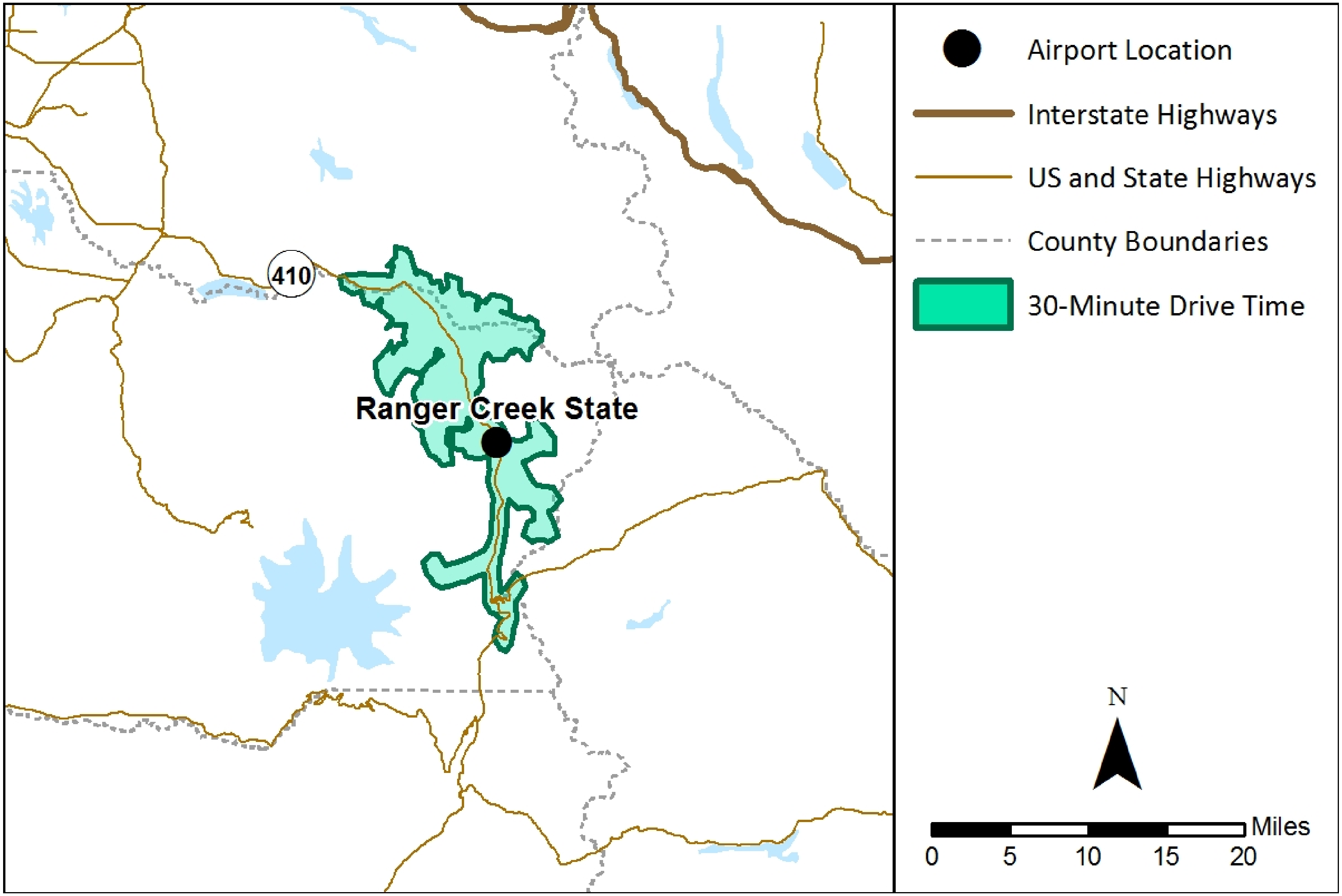
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-20. Port of Poulsbo Seaplane Base



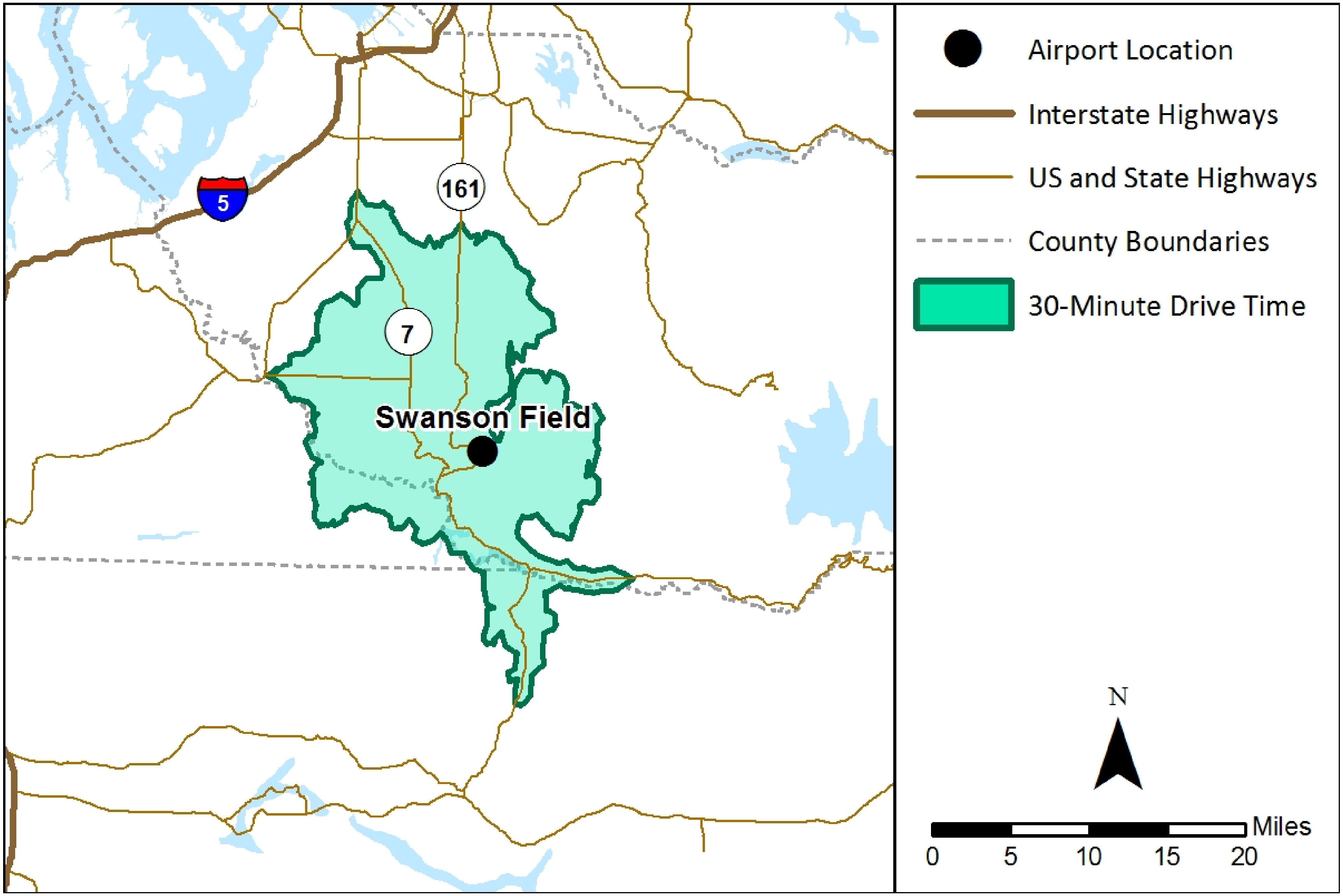
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-21. Ranger Creek State



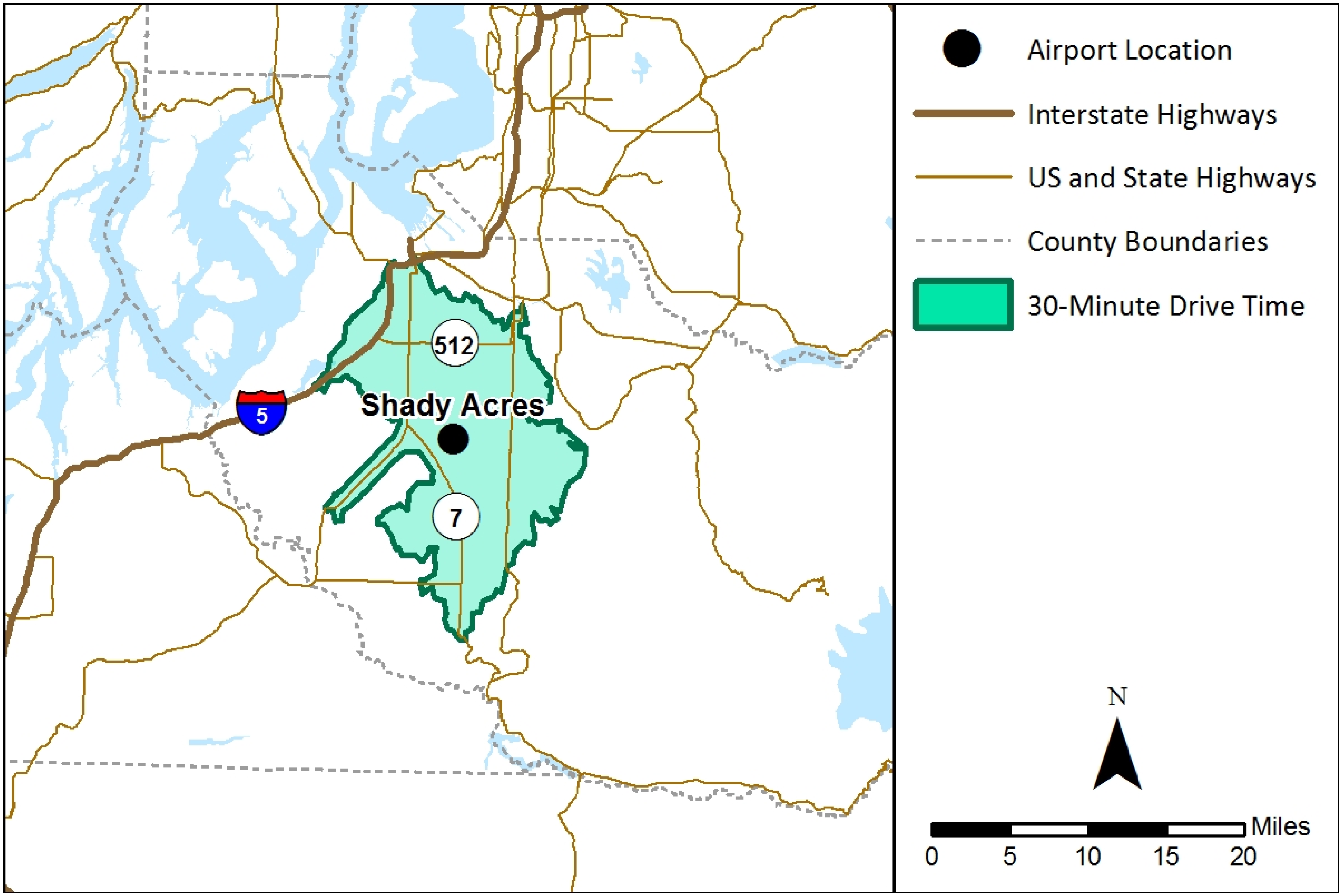
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-22. Swanson Field



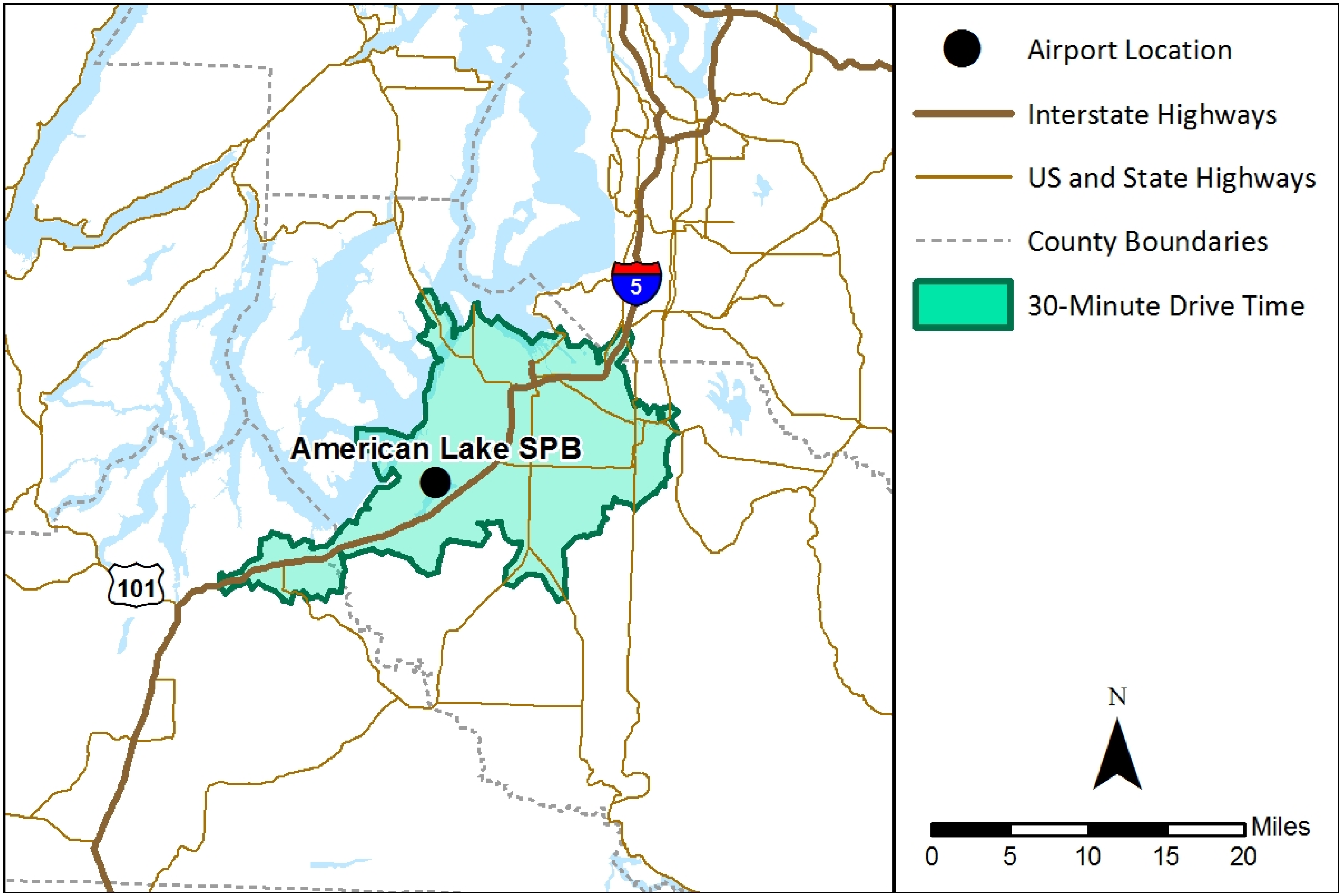
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-23. Shady Acres Airport



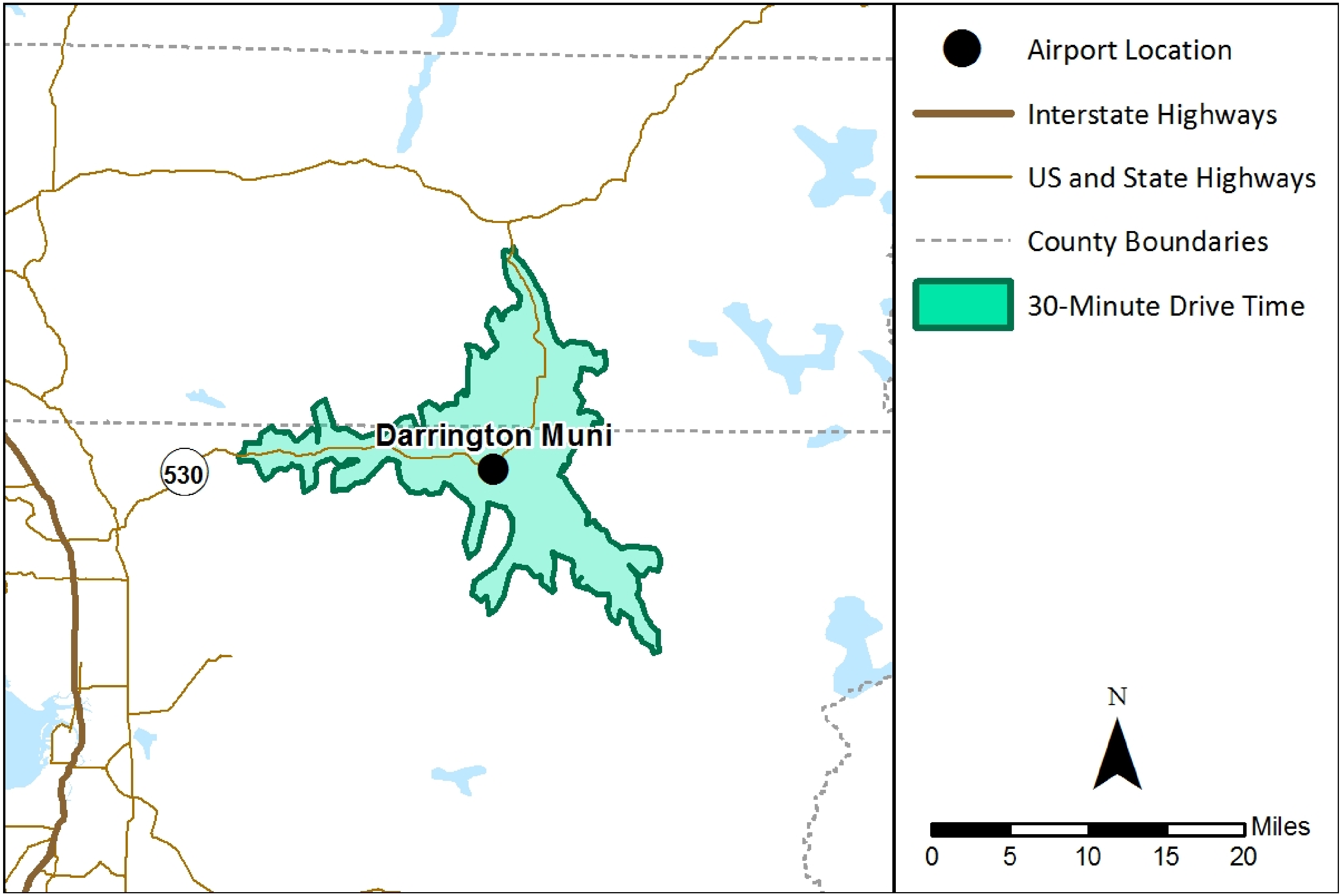
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-24. American Lake Seaplane Base



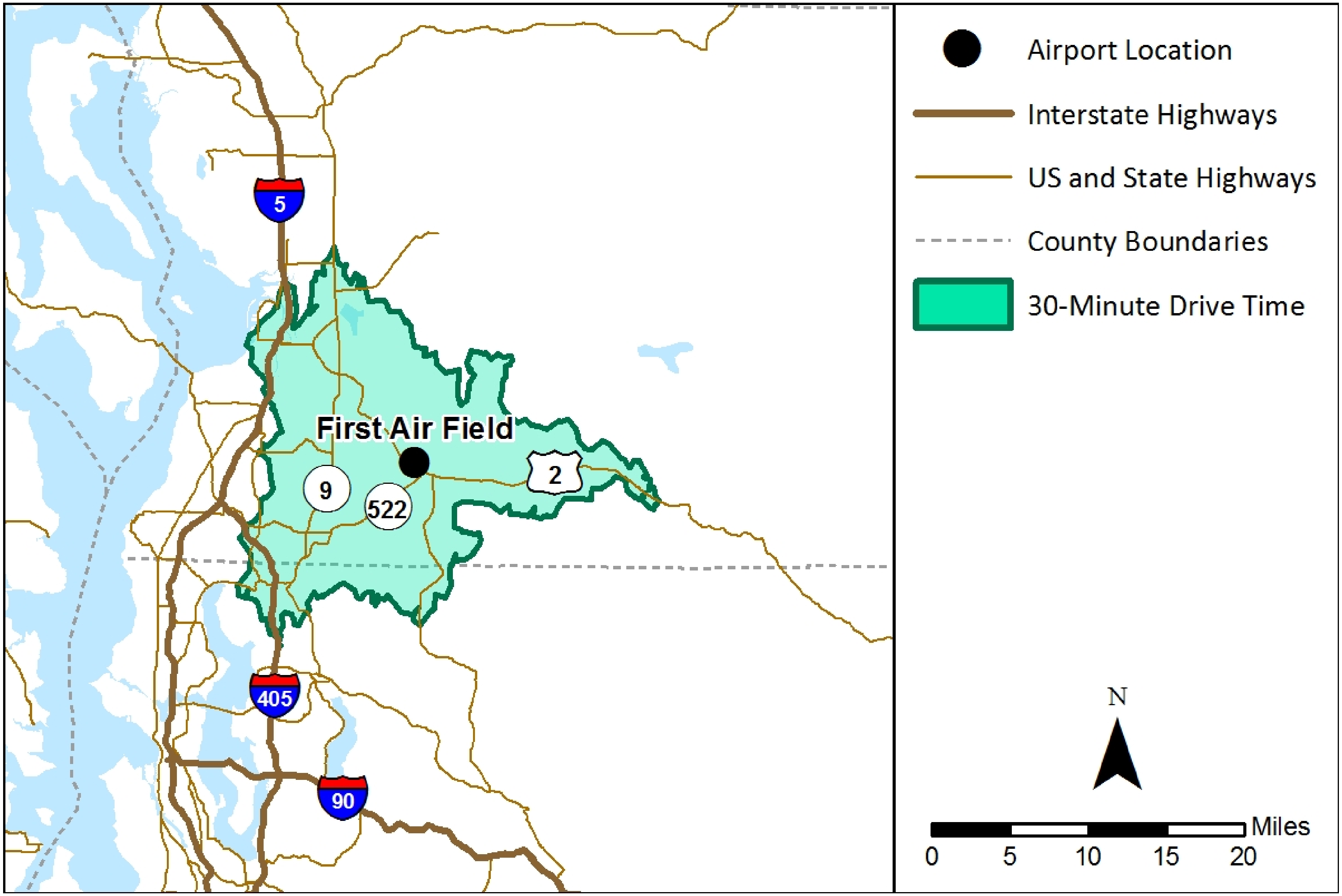
Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-25. Darrington Municipal



Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data

Figure B-26. First Air Field



Source: CDM Smith analysis of 2019 Network Analyst results and Google Maps data