Washington Aviation Economic Impact Study

Final Technical Report

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WSDOT

Prepared for

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NOTE

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Introduction

> *The Washington AEIS demonstrates that Washington's airports are not only a critical component of the state's multimodal transportation network, but that aviation is a fundamental element of the state's economic strength, diversity, and resiliency.*

The Washington State Department of Transportation Aviation Division (WSDOT Aviation) conducted the 2019 Aviation Economic Impact Study (AEIS) to measure the annual economic impact that Washington's 134 public-use airports and the entire aviation system provide to local communities, geographic regions, and to the state as a whole. Aviation has been a vital contributor to the state's economy for decades. In addition to transporting passengers and cargo, airports support emergency medical services, pilot training, agricultural spraying, wildland firefighting, and numerous other activities that enhance the state's economic vitality, mobility, access, and overall quality of life. Much of the state's multibillion-dollar aerospace industry relies on airports, and the facilities are critical resources in the development of leading-edge, innovative technologies that are likely to drive the future of aviation. The Washington AEIS provides a detailed look into how aviation and the airport system contribute to Washington state and provides a useful tool for airports and the WSDOT Aviation Division to communicate the value aviation brings to our world. The Washington AEIS underlines that Washington's aviation system is not only a critical component of the state's multimodal transportation network, but a fundamental element of the state's economic strength, diversity, and resiliency.

Study Components

The Washington AEIS is composed of multiple, interrelated analyses that evaluate the economic impacts of the system today and projected aviation landscape over the next 20 years. The study began in fall 2018 with a detailed data collection effort to gather the key inputs that drive individual airport's economic impacts as well as determine the overall state aviation economic impact. These inputs included on-airport activities such as employment, construction, and operating expenses, as well as money spent off-airport by out of state visitors who depart via scheduled commercial service or general aviation (GA) aircraft. These inputs were threaded through a nationally-recognized input/output (I/O) economic model (IMPLAN) to estimate how money generated at and by airports flows through local, regional, and statewide economies. Economic impacts were then calculated by individual airport, then modeled to quantify regional and total statewide impacts.

This evaluation reveals that Washington's aviation system annually supports 407,042 jobs, generates $26.8 billion in labor income, and provides business revenues (total economic impact) of $107.0 billion.

In addition to this core aspect of the study, the Washington AEIS took a more detailed look at several key Washington aviation activities, each of which provides essential services to the state's business community and/or are fundamental to the state's economic strength and diversity. Separate analyses quantified the statewide impacts of air cargo and aviation's contribution to the agricultural industry. Air cargo supports 38,117 jobs and generates $12.6 billion in business revenues. Industries that benefit from aerial application, plus the aerial application industry itself, contribute 31,190 jobs and $3.6 billion in annual business revenues to Washington's economy. Economic scenario forecasts projected the potential future economic impacts of these and four other activities including commercial passenger service, pilot training, business and corporate aviation, and aerospace manufacturing.

The Washington AEIS's forward-thinking approach is also evident in a series of whitepapers developed to assess how emerging aviation technologies may affect airports and the Washington aviation system. Electric aircraft, unmanned aerial systems (UAS or drones), and urban air mobility (UAM) options are already entering the market—potentially opening new opportunities for near-immediate delivery of goods and changing the way people move into, out of, and within the state. Sustainable aviation fuel (SAF) could reduce the environmental footprint of air travel and provide a new market for excess or waste organic materials. By considering the potential impacts of these innovations today, the WSDOT Aviation Division and airports will be better prepared to meet the demands of tomorrow.

> *By considering the potential impacts of emerging technologies including electric aircraft, UAS, UAM, and SAF, WSDOT Aviation and airports will be better prepared to meet the demands of tomorrow.*

Purpose, Benefits, and Study Tools

The analyses of the Washington AEIS are designed to help WSDOT Aviation, aviation system users, and airport owners/sponsors communicate the value of the system to policymakers, the general public, and other aviation stakeholders. There are many benefits of cultivating a positive and mutually respectful relationship between airports and their communities. Additional support for and investment into the state's aviation facilities not only increases their economic impacts, but also enhances the state's mobility, safety, security, and other quality of life benefits associated with aviation. Airport and aviation-specific economic activities also provide tax revenues directly back to city, county, and state jurisdictions. A community's support for its airport also pay dividends in terms of airport compatible land use zoning and enforcement. This is a key element in enhancing the safety of people and property in the sky and on the ground, as well as minimizing nuisance issues associated with aircraft operations.

> *The Washington AEIS is designed to help WSDOT Aviation, aviation system users, and airport owners/sponsors communicate the value of airports to policymakers, the public, and other aviation stakeholders.*

The Washington AEIS updated the Washington Aviation Calculator to provide insight into how an airport's economic impact may change with different activity types and/or frequency as well as investment in the facility. This online scenario forecast calculator stores baseline data and allows airports to modify inputs, such as the number and type of operations, annual capital improvement investments, and number of on-airport employees. Additionally, the study provided GIS data about Washington businesses with a high likelihood of using airports for services such as air cargo, transporting just-in-time manufacturing inputs, and supporting the aerospace industry. The data is now available via the WSDOT Aviation GeoPortal. Both of these tools are designed to provide airports with information that can be used to increase their economic impact for their communities and statewide.

As the final study component, the Washington AEIS developed a series of economic performance measures (PMs), performance indicators (PIs), and metrics. Building off the Economic Development and Prosperity goal of the 2017 *Washington Aviation System Plan* (*WASP*) and solutions of the 2015 *Airport Investment Study*, these recommendations work in concert to foster a diverse and vibrant aviation-and aerospace-related economy in Washington. A comparison of state and federal aviation funding levels was also conducted. This task highlights investing in aviation means investing in the Washington's workers and their families—every dollar spent on aviation is transformed into economic impacts that extend far beyond the fence. This presents more opportunities to grow Washington's economy as a result of investment in aviation.

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Changes Over the Study Timeframe including the Effects of COVID-19

The data used in this study is based on 2018 information obtained in 2018 and 2019. Since the start of the study, many notable changes took place within the aviation system including the highly-successful start of scheduled commercial passenger service at Snohomish County Airport (Paine Field) in Everett. Additionally, the world continues responding to COVID-19 as this study heads to publication. At the time of this writing (May 2020), U.S. enplanements are down 95 percent compared to the prior year for the months of March and April. Globally, the number of scheduled flights is down 70 percent compared to this same week in May of last year. The situation is even worse in the U.S., with scheduled flights down by 74.5 percent.[1] U.S. passenger airlines have idled nearly half the domestic fleet.[2] Looking more broadly, the International Monetary Fund projects a three percent contraction in world Gross Domestic Product (GDP) in 2020—far worse than witnessed during the previous economic downturn of 2008-2009. Closer to home, the Seattle-Tacoma International Airport (Sea-Tac or SEA) is reporting that the airport is now witnessing 2,500 enplanements per day compared to over 50,000 normally, with daily flights down by two-thirds.[3]

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[1] www.oag.com/coronavirus-airline-schedules-data (accessed May 5, 2020)
[2] Airports Consultant Council (April 23, 2020). COVID-19: Aviation Impacts and Recovery Scenarios.
[3] www.portseattle.org/news/updates-ports-covid-19-response (accessed May 5, 2020)

The situation surrounding COVID-19 is fluid and rapidly-evolving. This creates challenges in both dealing with the current situation and projecting recovery scenarios. The duration of the pandemic, government actions, and consumer responses will all be key questions that drive the severity; extent; and types of short-, mid-, and long-term impacts caused by the virus. The Airport Consultants Council (ACC) projects one scenario in which recovery is witnessed by the end of summer 2020 as global travel restrictions are lifted. Another scenario projects a geographically uneven recovery, with a return to pre-COVID-19 passenger traffic by mid- to late- 2022. Both Delta Air Lines and Boeing have projected a three-year recovery for the industry.

While the specifics still remain uncertain, it is recognized that various segments of the aviation industry will be affected differently. Commercial passenger service is clearly taking the brunt of the downtown, yet airlines are already working to modify their operations to maximize new opportunities in the air cargo segment. Alaska Airlines is now working to convert the passenger cabins of five Boeing 737-900 aircraft to carry air cargo.[4] Delta Air Lines is flying cargo-enabled passenger jets to 70 destinations.[5] These converted passenger jets and dedicated freighters are playing an important role in the global response to the virus, with one industry executive for Air Bridge Cargo noting, "Air cargo solutions have never been more important than they are now to global health services."[6] COVID-19 may also spur further advancements in UAS as consumers show increasing comfort with and preference for at-home deliveries for all types of durable and non-durable goods including groceries and pharmaceuticals.

Similarly, COVID-19 will impact different types of airports in various ways—although there is considerable disagreement on what those effects might look like. Large hubs, which have historically served the overwhelming majority of U.S. passenger traffic, may recover first. Small and nonhub airports, however, could eventually witness an uptick in activity as passengers choose smaller and less crowded facilities. Airlines are also predicted to consolidate hubs, and fleet mixes are already changing. Leisure travelers may choose destinations with warmer climates and access to outdoor recreational activities as opposed to urban centers. Recovery may be slower in heavy business markets.

In consideration of the magnitude of the negative effects on airports and airlines, as well as the considerable uncertainty regarding recovery scenarios, the Coronavirus Aid, Relief, and Economic Security Act (CARES Act or Act) was signed into law on March 27, 2020. This Act provides relief to airports in the form of $10 billion in funds for the economic relief of eligible airports affected by COVID-19. The Federal Aviation Administration (FAA) is using these new funds to increase the federal share of Airport Improvement Program (AIP) and supplemental discretionary grants already planned for fiscal year 2020 to 100 percent.[7] Additional funds will also be distributed by various formulas to all airports that are part of the National Plan of Integrated Airport System (NPIAS). Sea-Tac has already been

[4] blog.alaskaair.com/coronavirus/cargo-passenger-aircraft-conversion (access May 5, 2020)
[5] www.airport-technology.com/features/impacts-of-coronavirus-on-aviation/
[6] www.cnn.com/travel/article/boeing-747-covid-19/index.html
[7] www.faa.gov/airports/cares_act/

awarded $192 million in CARES Act grant funding to off-set the effects of the decrease in air travel and limit the spread of the virus.[8]

The Act also provides loan guarantees for air carriers and other eligible businesses, air carrier employee protections, small business relief, and federal excise tax relief for certain applicable air transportation taxes. More specifically, the Act provides loan guarantees in amounts up to $25 billion for passenger air carriers and association businesses, $4 billion for air cargo carriers, $17 billion for businesses critical to maintaining national security, in addition to $454 billion to a variety of other businesses.[9] The Boeing Company, one of Washington's most iconic businesses with more than 63,000 employees in the state, is eligible to receive these loan guarantees.

> *The federal government's commitment to air travel and aviation more broadly underscores it vital importance in national and state economies, as well as providing critical medical supplies to communities in need during this challenging and unprecedented time.*

The federal government's commitment to air travel and aviation more broadly underscores its vital importance in national and state economies, as well as providing critical medical supplies to communities in need during this challenging and unprecedented time. CARES Act funding will be used to support Washington businesses and keep Washington employees working. These funds will continue to flow through the economy in the form of supplier purchases and the re-spending of worker income, generating economic effects that extend far beyond an airport's fence. While the lasting impacts of COVID-19 are difficult to determine, it is clear that aviation will continue to be an important contributor to the state's economy and the transportation system as the nation addresses and recovers from the virus.

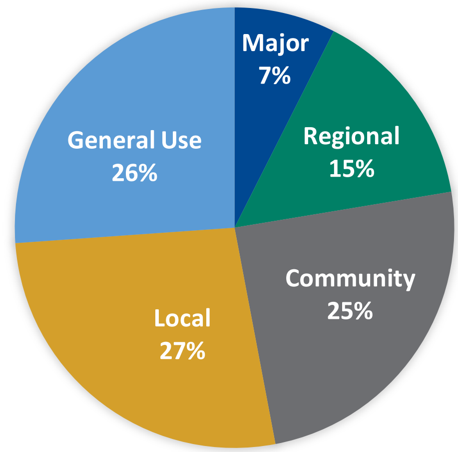
Study Airports and Regions

As shown in **Table 1**, the Washington AEIS includes 134 airports open for public use in Washington state.[10] One hundred and four airports are publicly-owned (78 percent) and 30 airports (22 percent) are privately-owned. Sixty-four airports (48 percent) are included in the FAA's NPIAS, while 70 are not (52 percent). Airports included in the NPIAS are eligible for federal funding through AIP, as well as state funding through the Airport Aid Grant Program and local matches. Non-NPIAS airports are only eligible for state and potentially local funding (depending on the local jurisdiction's ability to fund airports, either publicly or privately-owned).

[8] www.portseattle.org/news/updates-ports-covid-19-response
[9] www.natlawreview.com/article/coronavirus-aviation-industry-relief-legislation
[10] The economic impact of Seattle-Tacoma International Airport (SEA) was obtained from the "Sea-Tac International Airport Economic Impacts" study (Community Attributes, Inc., January 2018) conducted by the Port of Seattle. As such, while the total economic impact of Washington airports includes the economic impact of Sea-Tac, it was not independently calculated nor validated as part of Washington AEIS.

Additionally, Washington classifies airports at the state level in accordance with the methodology reported in the 2017 *WASP*. The *WASP* developed five state-level classifications based on community demand, the primary aviation activities that occur at the airport, and critical aircraft (indicating the most sophisticated or demanding aircraft that conducts a minimum of 500 operations annually).[11] **Figure 1** summarizes the percent of Washington airports per classification included in the Washington AEIS. Table 1 provides the Washington AEIS study airports by state classification and notes inclusion in the NPIAS and ownership type.

Figure 1. Percent of Study Airports by Classification



Source: WASP 2017

Table 1. Washington AEIS Study Airports

Associated City	Airport Name	FAA ID	NPIAS Inclusion	Ownership Type
	Major			
Bellingham	Bellingham International	BLI	NPIAS	Public
Everett[1]	Snohomish County (Paine Field)	PAE	NPIAS	Public
Moses Lake	Grant County International	MWH	NPIAS	Public
Pasco	Tri-Cities	PSC	NPIAS	Public
Seattle	Boeing Field/King County International	BFI	NPIAS	Public
Seattle[2]	Seattle-Tacoma International	SEA	NPIAS	Public
Spokane	Spokane International (Geiger Field)	GEG	NPIAS	Public
Walla Walla	Walla Walla Regional	ALW	NPIAS	Public
Wenatchee	Pangborn Memorial	EAT	NPIAS	Public
Yakima	Yakima Air Terminal (McAllister Field)	YKM	NPIAS	Public
	Regional			
Arlington	Arlington Municipal	AWO	NPIAS	Public
Bremerton	Bremerton National	PWT	NPIAS	Public
Burlington/ Mount Vernon	Skagit Regional	BVS	NPIAS	Public
Chehalis	Chehalis-Centralia	CLS	NPIAS	Public
Deer Park	Deer Park Municipal	DEW	NPIAS	Public
Ellensburg	Bowers Field	ELN	NPIAS	Public
Ephrata	Ephrata Municipal	EPH	NPIAS	Public

[11] Additional information about Washington's state classification system, see *WASP Chapter 6: Classifications and Airport Metrics* (2017) available online at wsdot.wa.gov/aviation/Planning/System.htm.

Associated City	Airport Name	FAA ID	NPIAS Inclusion	Ownership Type
Friday Harbor	Friday Harbor	FHR	NPIAS	Public
Hoquiam	Bowerman Field	HQM	NPIAS	Public
Olympia	Olympia Regional	OLM	NPIAS	Public
Port Angeles	William R Fairchild International	CLM	NPIAS	Public
Pullman/Moscow	Pullman/Moscow Regional	PUW	NPIAS	Public
Puyallup	Pierce County – Thun Field	PLU	NPIAS	Public
Renton	Renton Municipal	RNT	NPIAS	Public
Richland	Richland	RLD	NPIAS	Public
Shelton	Sanderson Field	SHN	NPIAS	Public
Snohomish	Harvey Field	S43	NPIAS	Private
Spokane	Felts Field	SFF	NPIAS	Public
Tacoma	Tacoma Narrows	TIW	NPIAS	Public
Vancouver	Pearson Field	VUO	NPIAS	Public
Community				
Anacortes	Anacortes	74S	NPIAS	Public
Auburn	Auburn Municipal	S50	NPIAS	Public
Brewster	Anderson Field	S97	NPIAS	Public
Camas	Grove Field	1W1	NPIAS	Public
Cashmere	Cashmere-Dryden	8S2	NPIAS	Public
Chelan	Lake Chelan	S10	NPIAS	Public
Colfax	Port Of Whitman Business Air Center	S94	NPIAS	Public
College Place	Martin Field	S95	Non-NPIAS	Private
Colville	Colville Municipal	63S	NPIAS	Public
Concrete	Mears Field	3W5	Non-NPIAS	Public
Davenport	Davenport Municipal	68S	NPIAS	Public
Eastsound	Orcas Island	ORS	NPIAS	Public
Elma	Elma Municipal	4W8	Non-NPIAS	Private
Kelso	Southwest Washington Regional	KLS	NPIAS	Public
Kent	Norman Grier Field (Crest Airpark)	S36	Non-NPIAS	Private
Lopez	Lopez Island	S31	NPIAS	Public
Lynden	Lynden Municipal Airport – Jansen Field	38W	Non-NPIAS	Public
Mead	Mead Flying Service	70S	Non-NPIAS	Private
Monroe	First Air Field	W16	Non-NPIAS	Private
Moses Lake	Moses Lake Municipal	W20	Non-NPIAS	Public
Oak Harbor	AJ Eisenberg	OKH	Non-NPIAS	Private
Okanogan	Okanogan Legion	S35	Non-NPIAS	Public
Oroville	Dorothy Scott	0S7	NPIAS	Public
Port Townsend	Jefferson County International	0S9	NPIAS	Public

Associated City	Airport Name	FAA ID	NPIAS Inclusion	Ownership Type
Prosser	Prosser	S40	NPIAS	Public
Sequim	Sequim Valley	W28	Non-NPIAS	Private
Silverdale	Apex Airpark	8W5	Non-NPIAS	Private
The Dalles	Columbia Gorge Regional/The Dalles Municipal	DLS	Non-NPIAS	Public
Toledo	South Lewis County (Ed Carlson Memorial Field)	TDO	NPIAS	Public
Tonasket	Tonasket Municipal	W01	Non-NPIAS	Public
Twisp	Twisp Municipal	2S0	Non-NPIAS	Public
Wilbur	Wilbur Municipal	2S8	NPIAS	Public
Woodland	Woodland State	W27	Non-NPIAS	Public
Local				
Chewelah	Chewelah Municipal	1S9	Non-NPIAS	Public
Cle Elum	De Vere Field	2W1	Non-NPIAS	Private
Cle Elum	Cle Elum Municipal	S93	NPIAS	Public
Darrington	Darrington Municipal	1S2	Non-NPIAS	Public
Eatonville	Swanson Field	2W3	Non-NPIAS	Public
Electric City	Grand Coulee Dam	3W7	NPIAS	Public
Forks	Forks Municipal	S18	Non-NPIAS	Public
Goldendale	Goldendale Municipal	S20	Non-NPIAS	Public
Greenwater	Ranger Creek State	21W	Non-NPIAS	Public
Ilwaco	Port Of Ilwaco	7W1	Non-NPIAS	Public
Ione	Ione Municipal	S23	NPIAS	Public
Langley	Whidbey Air Park	W10	NPIAS	Private
Lind	Lind Municipal	0S0	Non-NPIAS	Public
Mansfield	Mansfield	8W3	Non-NPIAS	Public
Mattawa	Desert Aire	M94	Non-NPIAS	Private
Morton	Strom Field	39P	Non-NPIAS	Public
Ocean Shores	Ocean Shores Municipal	W04	NPIAS	Public
Odessa	Odessa Municipal	43D	NPIAS	Public
Omak	Omak Municipal	OMK	NPIAS	Public
Othello	Othello Municipal	S70	NPIAS	Public
Packwood	Packwood	55S	NPIAS	Public
Quillayute	Quillayute	UIL	NPIAS	Public
Quincy	Quincy Municipal	80T	Non-NPIAS	Public
Republic	Ferry County	R49	Non-NPIAS	Public
Ritzville	Pru Field	33S	NPIAS	Public
Rosalia	Rosalia Municipal	72S	NPIAS	Public

Associated City	Airport Name	FAA ID	NPIAS Inclusion	Ownership Type
Sekiu	Sekiu	11S	Non-NPIAS	Public
South Bend/Raymond	Willapa Harbor	2S9	Non-NPIAS	Public
Stanwood	Camano Island Airfield	13W	Non-NPIAS	Private
Sunnyside	Sunnyside Municipal	1S5	NPIAS	Public
Tekoa	Willard Field	73S	Non-NPIAS	Public
Warden	Warden	2S4	Non-NPIAS	Public
Waterville	Waterville	2S5	Non-NPIAS	Public
Westport	Westport	14S	Non-NPIAS	Public
Wilson Creek	Wilson Creek	5W1	Non-NPIAS	Public
Winthrop	Methow Valley State	S52	NPIAS	Public
Anacortes	Skyline SPB	21H	Non-NPIAS	Private
General Use				
Anatone	Rogersburg State	D69	Non-NPIAS	Public
Bandera	Bandera State	4W0	Non-NPIAS	Public
Battle Ground	Goheen Field	W52	Non-NPIAS	Private
Battle Ground	Cedars North Airpark	W58	Non-NPIAS	Private
Bellingham	Floathaven Seaplane Base (SPB)	0W7	Non-NPIAS	Private
Clayton	Cross Winds	C72	Non-NPIAS	Private
Colfax	Lower Granite State	00W	Non-NPIAS	Public
Copalis	Copalis State	S16	Non-NPIAS	Public
Easton	Easton State	ESW	Non-NPIAS	Public
Friday Harbor	Friday Harbor SPB	W33	NPIAS	Public
Kahlotus	Lower Monumental State	W09	Non-NPIAS	Public
Kenmore	Kenmore Air Harbor Inc	S60	NPIAS	Private
Laurier	Avey Field	69S	Non-NPIAS	Private
Leavenworth	Lake Wenatchee State	27W	Non-NPIAS	Public
Lester	Lester State	15S	Non-NPIAS	Public
Mazama	Lost River	W12	Non-NPIAS	Private
Metaline Falls	Sullivan Lake State	09S	Non-NPIAS	Public
Olympia	Hoskins Field	44T	Non-NPIAS	Private
Point Roberts	Point Roberts Airpark	1RL	Non-NPIAS	Private
Poulsbo	Port of Poulsbo Marina SPB	83Q	Non-NPIAS	Public
Renton	Will Rogers Wiley Post Memorial SPB	W36	Non-NPIAS	Public
Rimrock	Tieton State	4S6	Non-NPIAS	Public
Roche Harbor	Roche Harbor SPB	W39	Non-NPIAS	Private
Rochester	R & K Skyranch	8W9	Non-NPIAS	Private
Rosario	Rosario SPB	W49	Non-NPIAS	Private
Seattle	Seattle Seaplanes SPB	0W0	Non-NPIAS	Private

Associated City	Airport Name	FAA ID	NPIAS Inclusion	Ownership Type
Seattle	Kenmore Air Harbor	W55	Non-NPIAS	Private
Skykomish	Skykomish State	S88	Non-NPIAS	Public
Starbuck	Little Goose Lock and Dam State	16W	Non-NPIAS	Public
Stehekin	Stehekin State	6S9	Non-NPIAS	Public
Tacoma	American Lake SPB	W37	Non-NPIAS	Public
Vancouver	Fly for Fun	W56	Non-NPIAS	Private
Vashon	Vashon Municipal	2S1	NPIAS	Public
Walla Walla	Page	9W2	Non-NPIAS	Private

Notes: (1) Snohomish County (Paine Field) began scheduled commercial passenger service in 2019 after the 2018 study year of the Washington AEIA. As such, was analyzed as a GA airport in the Washington AEIS. (2) Impacts of Sea-Tac obtained from the Sea-Tac International Airport Economic Impacts" study (Community Attributes, Inc., January 2018) conducted by the Port of Seattle. Sources: Washington AEIS 2020, WASP 2017, Sea-Tac International Airport Economic Impacts 2018

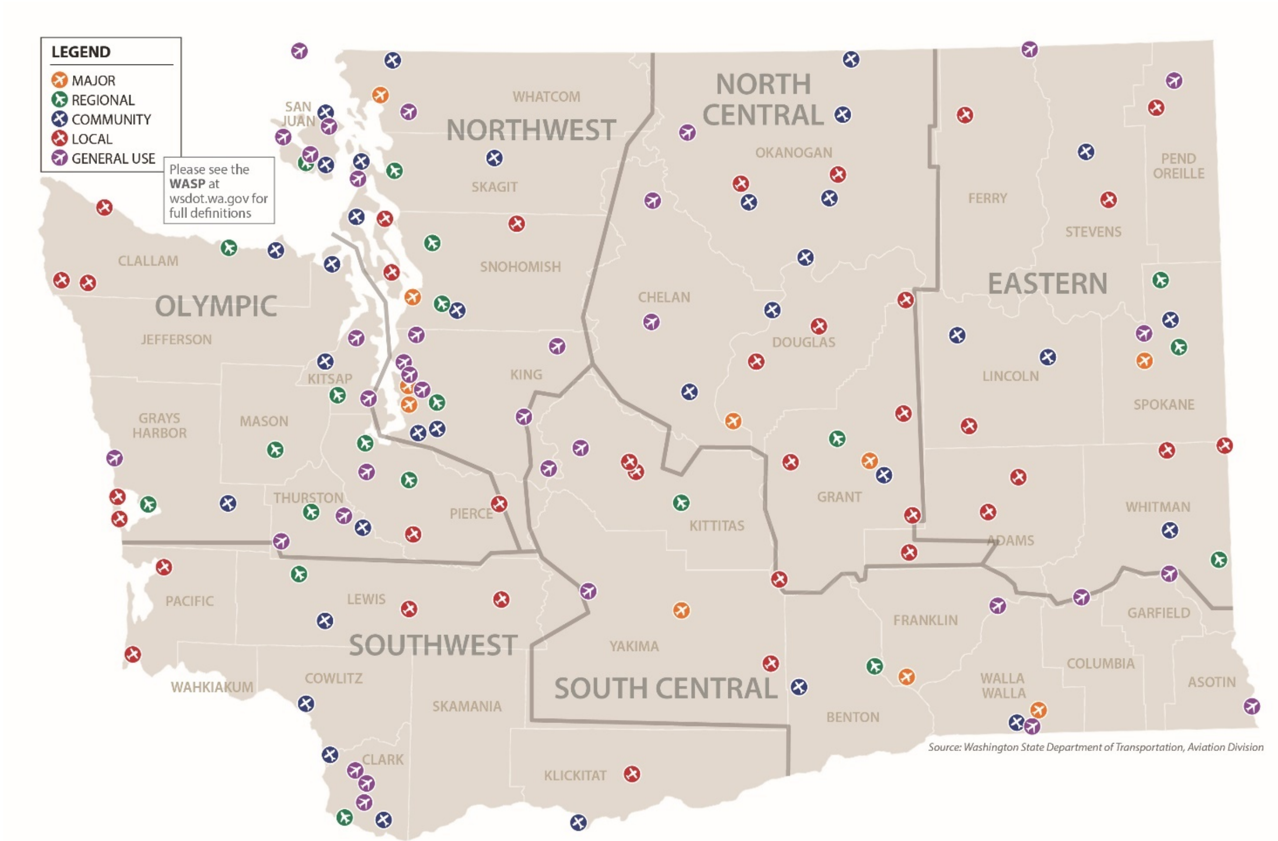
The Washington AEIS modeled the economic impacts of each airport based, in part, on the six transportation regions utilized by WSDOT Aviation for statewide transportation planning and development. Regional economies vary significantly across Washington. Productivity factors, cost of living, and salaries differ across the state, with differences apparent in industry mixes, wages, business revenues, and sales per employee. A regional approach allows for a reasonable way to incorporate local economic characteristics when modeling individual airports. While direct labor income, value added, and business revenues are based on regional economic characteristics, economic impacts were calculated using statewide multipliers. The counties that compose each WSDOT region are presented in **Table 2**. **Figure 2** presents the AEIS study airports by classification and WSDOT region.

Table 2. Counties in Each WSDOT Region

Region	Region Name	Counties
1	Eastern	Adams, Ferry, Lincoln, Pend Oreille, Spokane, Stevens, Whitman
2	North Central	Chelan, Douglas, Grant, Okanogan,
3	Northwest	Island, King, San Juan, Skagit, Snohomish, Whatcom
4	Olympic	Clallam, Grays Harbor, Jefferson, Kitsap, Mason, Pierce, Thurston
5	South Central	Asotin, Benton, Columbia, Franklin, Garfield, Kittitas, Walla Walla, Yakima
6	Southwest	Aahkiakum, Clark, Cowlitz, Klickitat, Lewis, Pacific, Skamania

Source: WSDOT 2018

Figure 2. Washington AEIS Study Airports by Region



Sources: WASP 2017, WSDOT 2018, Kimley-Horn 2020

Differences with 2012 AEIS

The Washington AEIS was previously conducted in 2012 and built upon the findings of the 2009 *WASP*. The 2012 Washington AEIS estimated that airports supported 248,000 jobs, $15.3 billion in wages, and $50.9 billion in total economic activity. The report further estimated that airports contributed more than $791 million in tax revenues. As shown in **Table 3**, the 2019 AEIS estimates significantly higher measures of economic activity and tax revenues as compared to the previous study.

Table 3. Economic Impacts by Measures, 2012 vs. 2019 AEIS*

Measure / Taxes	2012	2019	Percent Change
Jobs	248,000	407,042	64%
Wages	$15,300,000,000	$26,800,000,000	75%
Business revenues	$50,900,000,000	$107,000,000,000	110%
Tax revenues	$790,000,000	$913,304,020	16%

**Note: The 2012 AEIS did not calculate value added, nor are results available at the statewide level for value added impacts in 2019. Sources: WSDOT 2012, Kimley-Horn 2020, EBP US 2020, Community Attributes 2018*

In general, much of the data used in the 2012 analyses are unavailable for review and comparison.[12] As a result, a comprehensive analysis cannot be conducted to accurately identify the exact reasons for the increases witnessed at the statewide level or decreases experienced by some study airports. However, several key differences have been identified through the review and comparison:

- **Data sources.** The 2012 AEIS obtained data from "independent" sources at the state and federal level including the Washington Department of Revenue, WSDOT Aviation, and FAA. The study did not conduct individual airport or tenant surveys.
- **Capital improvements.** The 2012 AEIS did not evaluate the economic impacts of capital improvements as a component of on-airport activity.
- **Sea-Tac.** As noted previously, the 2019 AEIS obtained economic impacts for Sea-Tac from the *Sea-Tac International Airport Economic Impacts* study (January 2018) conducted by Community Attributes, Inc. It cannot be determined if the 2012 study incorporated the results of a Sea-Tac-specific economic impact study (as done in the 2019 AEIS), developed a different method for estimating impacts at Sea-Tac, or used the same method to estimate the economic impact of Sea-Tac as all other study airports.
- **Number of study airports**. The 2012 AEIS calculated the economic impacts of 135 airports.
- **Measures of economic impact**. The 2012 AEIS did not calculate "value added," which is a measure of the value contributed to a product or service provided by a firm or group of firms (such as on-airport businesses). This metric provided additional depth into profiling the economic impacts of Washington airports.

While a point-by-point comparison cannot be conducted, 2019 AEIS has been undertaken based on current industry best practices. WSDOT Aviation and the consultant team undertook multiple quality control processes to ensure data were as accurate as possible prior to modeling. Direct data were distributed to every airport for validation prior to economic modeling to afford another quality control opportunity. Detailed information about the 2019 AEIS economic impact approach, including modeling and data collection, is provided **Chapter 1. Economic Impact Approach**.

[12] The final 2019 study results were compared with 2012 to identify major discrepancies or changes over time as one element of the review and validation process. Additional details about the study's review and validation processes are presented in Section 2.4 below.

Chapter 1. Economic Impact Approach

WSDOT Aviation previously analyzed the economic contributions of its airport system in 2012. Since that time, the state has witnessed various changes affecting aviation demand and the aviation system. Between 2012 and 2018, the Washington state population rose from 6.7 million to 7.5 million (12 percent increase). The Gross Domestic Product (GDP) increased from $381.3 billion to $531.2 billion during that same timeframe (39 percent increase). Statewide aviation activity has increased, although growth has not been consistent across all airports. At the national scale, aviation fully recovered from the 2007 – 2009 economic downturn, and airlines and major manufacturers posted year-over-year profit growth.

Due to these and numerous other changes at the state and national levels, WSDOT Aviation conducted the Washington AEIS to thoroughly re-examine the impacts of aeronautical activity and the aviation services sector in local, regional, and statewide economies. This chapter outlines the methodology used to capture the economic impacts of on-airport activities and visitors who arrive in the state by air. The chapter is organized as follows:

- Overview
- Approach to data collection and calculation
- Economic modeling process
- Approval and validation methods
- Methodology to estimate data for non-responsive airports

The results of this analysis are presented in **Chapter 2. Economic Impacts of Washington Airports**. Subsequent analyses look at key aviation-related activities fundamental to Washington's economic diversity, resiliency, and strength to provide comprehensive analysis of aviation's impacts across the state. Air cargo, for example, relies on airports but generates economic impacts in industries such as manufacturing, consumer goods, and electronics. Washington's robust agriculture industry depends on aviation to ship perishable products to markets across the globe. Aerial spraying protects cropland value, enables crop production, and efficiently and cost-effectively increases crop yields. These and four other key Washington aviation activities are specifically discussed in **Chapter 3. Key Aviation Activities**.

Significant investment has been made in Washington's airports and these investments contribute to the economic vibrancy of the aviation system. **Chapter 4. State Aviation Investments** documents WSDOT's investment in analyses to support the system's development, including development of performance measures to monitor and evaluate the progress made over time. New performance measures were evaluated for WSDOT Aviation adoption. A comparison of Washington's level of aviation investment compared to other states was also conducted to identify how the state's investment compares,

> *The interrelated analyses of the Washington AEIS demonstrate that aviation propels regional and state economic prosperity and is a fundamental component of economic competitiveness in the 21st century.*

and the opportunities that can be created from aviation investment. **Chapter 5. Future Aviation Opportunities** looks to the aviation environment of tomorrow. This chapter highlights forecasted economic impacts based on state and national drivers, as well as emerging technologies that will likely shape the way people move into, out of, and within Washington. These forward-thinking analyses provide insight into strategies that WSDOT Aviation and airports can implement now to stay at the forefront of innovation, creativity, and economic growth. Together, the interrelated analyses of the Washington AEIS demonstrate that aviation propels regional and state economic prosperity and is a fundamental component of economic competitiveness in the 21st century.

1.1 Overview

As highlighted in Section 0, there are several noteworthy differences between the 2012 study and today. Furthermore, economies have changed, modeling tools have evolved, and there are new state-of-the-art analytical approaches. However, the basis of measurement (i.e., direct impacts and multiplier impacts) and the core measures of economic activity have remained constant over time, with the only changes being terminology and the additional of Value Added as a measure. **Table 1.1** summarizes the types and measures of economic impact employed by the 2019 Washington AEIS.

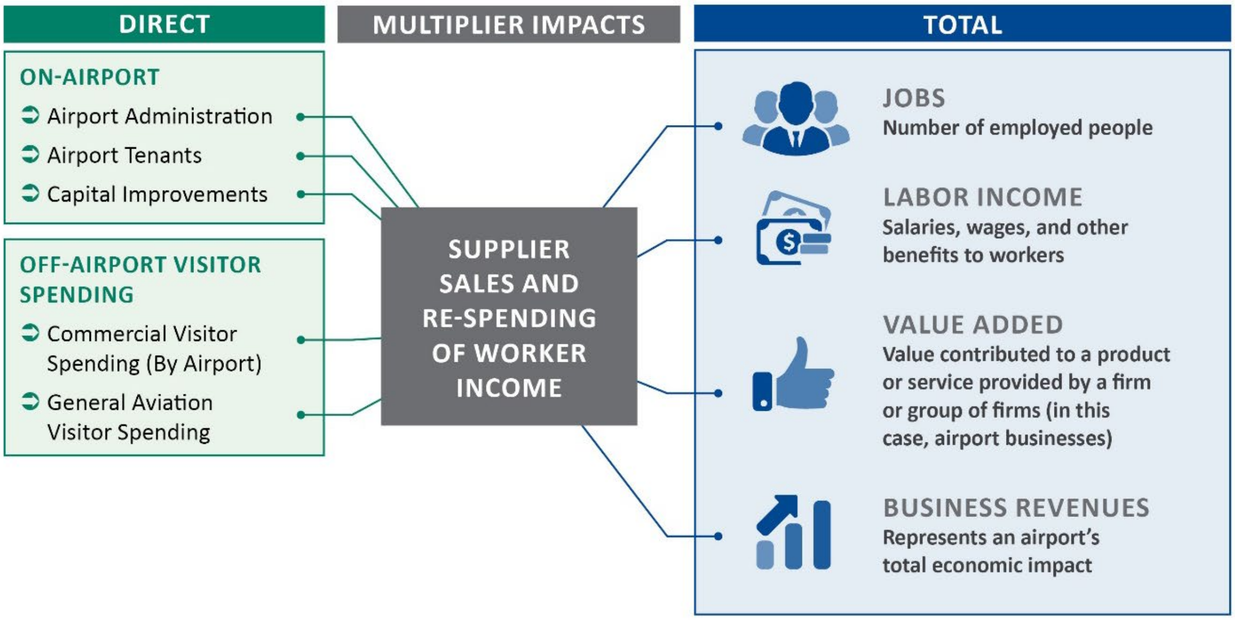
Table 1.1. AEIS Terminology Overview

Category	2019 Terminology
Types of Impacts	Direct
	Multiplier – Supplier sales – Income re-spending
	Total
Measure of Impacts	Jobs
	Labor Income
	Value Added
	Business Revenues

Source: EBP US 2020

Figure 1.1 illustrates the relationship between impacts types and measures. Detailed explanations and definitions of terms are provided in the section that follows.

Figure 1.1. Calculation of Total Impacts



Source: EBP US 2020

1.1.1.1 Types of Economic Impact

On-airport activities and off-airport visitor spending represent the direct effects of airport operations on the Washington economy. Direct effects generate additional multiplier impacts comprised of supplier sales and income re-spending. Total economic impacts represent the summation of direct effects, supplier sales, and the re-spending of worker income. **Table 1.2** defines these three terms or categories and presents the industry economic term for reference.

Table 1.2. Key Terms: Types of Economic Impact

Terminology	Definition	Economic Term
Direct	Initial effects resulting from economic activities occurring on airport property and spending by out of state or international visitors who arrive by air	Direct
Supplier Sales	Portions of direct revenues used to purchase goods and services from Washington businesses	Indirect
Income Re-spending	Income earned by workers from direct and supplier sales transactions that are then spent in the state (household spending)	Induced

Source: EBP US 2020

1.1.1.2 Measures of Economic Impact

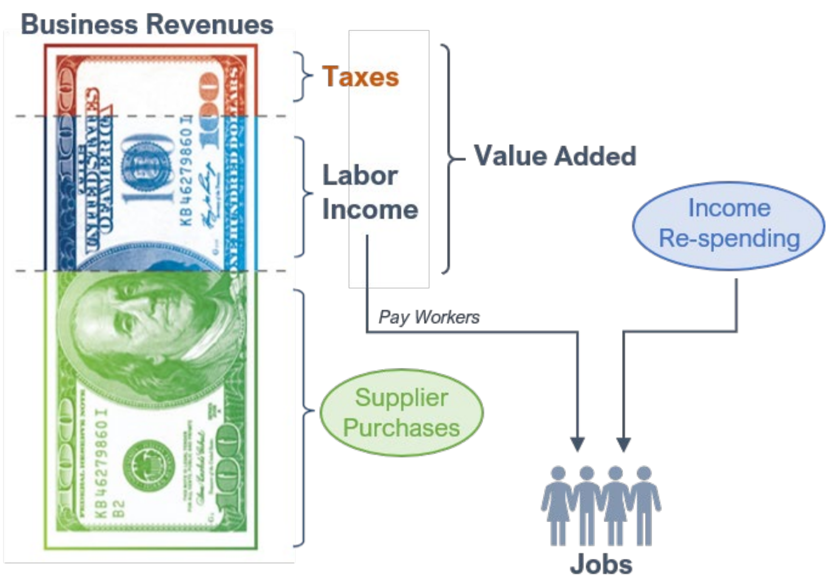
The direct, supplier, and income re-spending impacts are expressed using the following economic measures:

- **Jobs.** Total number of full- and part-time employees.
- **Labor Income**. Total employee compensation including wages and benefits. Labor income is part of value added.

- **Value Added.** Business revenues earned minus the costs of purchasing goods and services from other businesses. Direct value added measures the economic contribution of each aviation-related business establishment in Washington. Value added represents the industry's contribution to Washington's or State Product (GSP) and the U.S. GDP.
- **Business Revenues.** Represent industry sales or "output". Direct business revenues include expenditures needed to administer airports, sales of goods and services by airport tenants, budget expenditures by public sector agencies located on airports, capital expenditures, and visitor spending in Washington's hospitality-related sectors.

Figure 1.2 illustrates the relationships between these economic measures. Business revenues, value added, and labor income are subsets of one other and, as such, are not additive. Note that all dollar values have been rounded to thousands, and all monetary values are reported in 2018 dollars.

Figure 1.2. Relationship of Economic Impact Measures



Source: EBP US 2020

1.2 Approach to Data Collection and Calculation

A variety of primary and secondary data sources were collected to quantify the economic contribution of Washington's airports and the aviation system. As the primary means of data collection, a series of surveys were developed to gather airport-specific data for activities generating direct on-airport activities and some aspects of off-airport visitor spending. These surveys included:

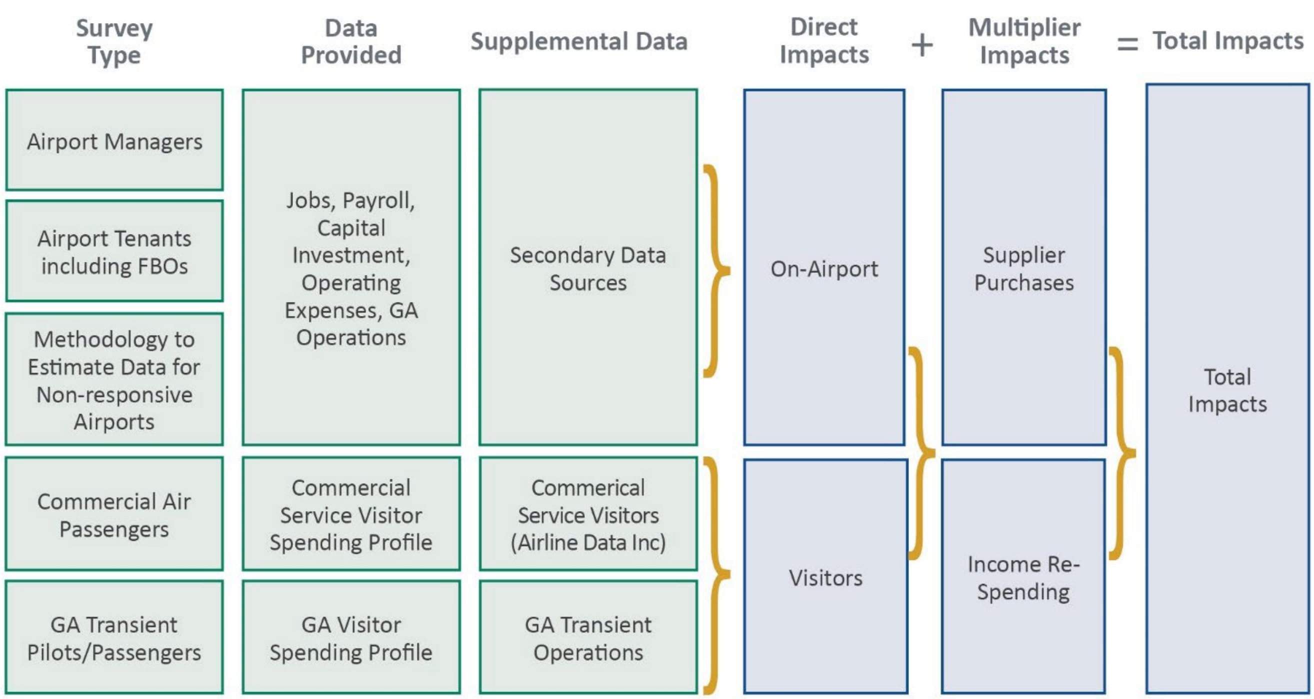
- Airport Manager Survey
- Airport Tenants/Fixed Base Operator (FBO) surveys[1]

[1] A separate survey was distributed to FBOs. The only difference between the FBO and Tenants surveys was that the FBO Survey requested information about airport operations. FBOs sometimes maintain records of activity levels for business purposes. Data

Secondary data sources were used to fill specific data gaps when information could not be obtained from airport managers and/or on-airport business tenants. These secondary sources included establishment-level geographic information system (GIS) databases such as ReferenceUSA and ESRI's Community Analyst Business Locator tool, as well as federal data sources such as the Bureau of Economic Analysis (BEA) and FAA. Additional secondary sources were used to develop spending profiles for visitors who departed via scheduled commercial service and GA. Additionally, the consultant team and WSDOT Aviation developed a Washington-specific methodology to estimate direct impacts for airports that did not submit data for use in the Washington AEIS.

Combining primary and secondary data sources is the foundation for estimating the direct economic impacts of each airport. These data were then integrated into the IMPLAN economic model to estimate the multiplier effects generated from supplier purchases and employee re-spending. **Figure 1.3** presents and overview of the data collection and economic modeling process of the Washington AEIS.

Figure 1.3. Overview of Economic Modeling Process



Source: Kimley-Horn 2020

The following section details the data collection and economic modeling approach for calculating the direct economic impacts of on-airport activities and visitor spending. **Section 1.3** explains the economic modeling process used to estimate the multiplier effects generated from supplier purchases and employee re-spending. **Section 1.4** describes the processes used to validate data inputs and the direct

received was compared to information provided by airport managers; however, no major discrepancies between the two sources arose and no operational data provided by FBOs was utilized in the study.

impacts generated by the economic model. An overview of methodology to estimate data for non-responsive airports is provided in **Section 1.5**.

1.2.1 On-airport Activities

As shown in Figure 1.3, direct on-airport impacts are generated by economic activity occurring on airport property, including airport administration, construction, and business tenants with employees working on airport property. Descriptions of each type of on-airport activity are provided below.

Airport Administration. Airport administration includes all staff required to operate an airport including the airport manager and employees responsible for business operations (working either on the airport premise or at an off-site airport sponsor/owner office), grounds care (landscaping, lawn care, and snow removal), routine building maintenance, contractors who receive 1099 tax forms from the airport, and other activities. The Airport Managers Survey specifically requested information regarding the number of full- and part-time employees working for the airport sponsor/owner on behalf of the airport, total payroll, and the airport's annual operating budget. In those cases where only jobs were provided, regional averages assembled by IMPLAN were used to estimate labor income and budget expenditures (equivalent to business revenues).

Construction. Capital expenditures reported by airport managers were averaged across the previous three years (2016-2018), with 2016 and 2017 expenditures adjusted to constant 2018 values. This process smooths out any uniquely high or low expenditures to develop a "representative" year for each airport. Additional expenditures were gathered through the Airport Tenant and fixed-base operator (FBO) surveys, in which tenants were asked if they had paid for capital improvements such as building out concession space or constructing a hangar. Construction data only accounted for capital expenditures, which were treated as direct business revenues received by construction companies. IMPLAN regional relationships between construction revenues and jobs, labor income, and value added were used to develop the full profile of direct impacts resulting from capital expenditures on construction for an average year.

Airport Tenants/FBOs. As part of the Airport Managers Survey, airports were asked to provide names, contact information, industry type, and estimated employees for all business tenants with employees working on airport property. These lists provided the basis for tenant outreach efforts. Tenants were asked to complete either the Tenant Survey or FBO Survey (as applicable). In general, response rates to the Tenant and FBO surveys were low. If employment data could not be obtained directly from each business, the AEIS obtained tenant employment estimates from airport managers or secondary data sources (i.e., ReferenceUSA or ESRI's Community Analyst tool), in that order of preference. Airport managers were asked to approve the total number of employees working on airport property during the data validation process as further described in **Section 1.4** below.

Two levels of data were obtained per business tenant:

- Employment (number of jobs) only; or
- Employment and labor income

Each tenant was assigned an industry classification based on their survey responses, description of business activity reported by the airport manager, web-based research, and/or coordination with WSDOT Aviation. The process of classifying each tenant by industry is an important step in attributing the correct levels of direct economic activity (i.e., jobs, labor income, value added, and business revenues) and estimating supplier sales and income re-spending.

Direct values for labor income and business revenues were calculated using IMPLAN if they were not reported by the tenant during the survey process. In instances when employment and labor income were both obtained, the IMPLAN model was adjusted to maintain the same ratio of business revenues to labor income as shown by regional industry averages.

1.2.1.1 On-airport Data Collection

Obtaining accurate and complete information about on-airport activities is a cornerstone of the AEIS process. Primary data collection efforts centered upon the Airport Managers Survey, with additional information obtained from on-airport tenants via the Tenant/FBO surveys. Each survey type is described in detail below.

> *Obtaining accurate and complete information about on-airport activities is a cornerstone of the AEIS process.*

Airport Managers Survey. The Washington AEIS conducted an intensive outreach effort to obtain the data necessary to accurately calculate the economic impact of the 133 airports included in the scope of the task.[2] This effort centered upon the Airport Managers Survey. This survey form was designed to collect information for each airport regarding on-airport business activities, as well as information specific to the airport's operations such as airport owner/sponsor employment, payroll, operating expenses, capital expenses, estimated aircraft operations, and other information. Data requested on the Airport Managers Survey were as follows:

- Airport administration contact information
- Employment (calendar year [CY] 2018)
  - Airport sponsor employment (full-time vs. part-time)
  - Number of individuals outsourced or on contract (full-time vs. part-time)
- Expenditures
  - Annual wages and benefits to all employees or average annual salary/wage per employee
  - Annual wages and benefits to contract employees
  - Airport capital improvements including federal, state, and local funding (2016 - 2018)
  - Operating expenses (2018)
  - Airport taxes by type (privately-owned airports only)

[2] The AEIS includes 134 airports. However, data collection was not required for Sea-Tac, as the AEIS integrated the results of the *2018 Sea-Tac International Airport Economic Impacts* study.

- Airport activities[3]
  - Estimated number of GA and commercial service operations (as applicable)
  - Percentage of 2018 transient (non-local) GA traffic
  - Average number of passengers (including pilots) for each 2018 transient GA operation
  - Volume and tonnage of international and domestic enplaned and deplaned air cargo
  - Available ground transportation options
  - Aviation-related activities including (but not limited to) recreational flying, agricultural spraying, corporate/business activities, aerial/wildland firefighting, search and rescue, medical flights, military and law enforcement activities
- Land use
  - Co-located business, office, or industrial parks
  - Agriculture-related land use
  - Other land designated for non-aeronautical use
- Qualitative information
  - Most important aviation-related activities occurring at the airport
  - Special attributes or services in the community
  - Proposed strategies to increase the economic impact of the airport
- Airport tenants and other business users
  - On-airport business tenants with employees working at that airport location, including contact information, industry type, and estimated on-airport employees and gross revenues (these tenants received an Airport Tenant Survey as described below)
  - Off-airport businesses that base an aircraft at the airport, including contact details and industry type[4]
  - Non-local businesses that rely on the airport to conduct business activities, including contact details and industry type

The Airport Managers Survey was distributed to all airport managers as reported in WSDOT Aviation's Airport Information System (AIS) as of October 2018. The survey was first disseminated via email by the consultant team with additional follow-up notifications sent by the WSDOT Aviation Communications Division. The survey was sent as a fillable PDF; managers also had the option of completing an online survey via SurveyMonkey or printing a hard copy and returning by mail or fax. A minimum of three

[3] This information was used, in part, to calculate GA visitor spending as described in Section 2.2.2.2.

[4] The Washington AEIS did develop and disseminate online surveys (via SurveyMonkey) to businesses with based aircraft and non-local businesses that rely Washington airports as obtained from airport managers. However, responses rates were insufficient to conduct a statistically-valid analysis of results.

Outreach was conducted to individual managers to fill data gaps, provide clarification on responses received, and confirm the total number of jobs identified for the airport prior to modeling the economic impacts.

follow-up phone calls were made to all managers to provide sufficient opportunity to submit a completed Airport Managers Survey. Outreach was also conducted to individual managers to fill data gaps, provide clarification on responses received, and confirm the total number of jobs identified for the airport prior to modeling. The on-airport data collection process continued through the initial aggregation of direct on-airport impacts in late summer 2019.

The AEIS obtained data for a total of 102 airports for a 75 percent response rate. **Table 1.3** summarizes the number of responses received per WSDOT airport classification and broken down by public/private ownership. The response rate for publicly-owned airports was significantly higher than privately-owned, public-use airports. The methodology to estimate key data inputs for non-responsive facilities in provided in Section 1.5.

Table 1.3. Data Collection Results by Classification and Ownership

WSDOT Classification	All Airports		Publicly-Owned, Public-Use Airports		Privately-Owned, Public-Use Airports	
	Total No.	Total No. Responsive	Total No.	Total No. Responsive	Total No.	Total No. Responsive
Major*	9	9	9	9	0	0
Regional	20	18	19	17	1	1
Community	33	25	25	23	8	2
Local	36	29	32	26	4	3
General Use	35	21	18	15	17	6
TOTAL	**133**	**102**	**103**	**90**	**30**	**12**

**Note: Sea-Tac has been removed from this analysis. Source: Kimley-Horn 2019*

The Washington AEIS identified 756 on-airport business tenants at Washington's airports (excluding Sea-Tac).

Tenants/FBO Surveys. All on-airport tenants with employees working on airport property identified by airport managers received a Tenants or FBO survey. These on-airport businesses often provide the greatest economic impact of an airport. Washington's airport tenants fall within a wide variety of market segments, including aviation- and aerospace-related repair, manufacturing, and sales; in-terminal concessionaires; ground transportation providers; and non-aviation-related manufacturing, fabrication, wholesale, storage, and retail establishments.[5] In total, the Washington AEIS identified 756 on-airport tenants at Washington's airports (excluding Sea-Tac).

Using the contact details provided by airport managers via the Airport Managers Survey, the consultant team emailed a Tenants Survey and associated transmittal letter to all tenants. If contact details were not provided, additional web research was conducted to obtain a valid email address, phone number, or

[5] The IMPLAN sectors used to categorize Washington's on-airport businesses are provided in Table 1.7.

both. Each tenant received a minimum of two emails and two phone calls from a member of the consultant team. The Tenants Survey requested the following information:

- Business/company information
- Type of business
- Employment (full- and part-time)
- Expenditures (CY2018)
  - Total annual payroll
  - Real estate taxes paid
  - On-airport capital expenditures (2014 – 2018)
- Additional economic benefits that the business provides to the local community
- FBOs only: Estimates of airport operations including percent transient and average number of people per operation

At a minimum, the AEIS needs the total number of employees and industry type to calculate the economic impact of each on-airport tenant. If these details could not be obtained directly from the tenant, tenant employment and industry types were obtained directly from airport managers in the Airport Managers Survey or subsequent follow-up efforts. The consultant team then reviewed ESRI's Community Analyst Business Locator report. These GIS-based reports provide the number of employees and gross revenues of individual businesses located within a defined geographic area. Reports were generated using a one-mile buffer zone around each Airport Reference Point (ARP) to serve as the likely geographic area that is considered "on-airport". If the tenant was not included in the ESRI's Community Analyst Business Locator report, an establishment-level economic research database (ResearchUSA) was consulted.[6]

Once the initial tenant data collection process was complete, the consultant team compiled a list of tenants by airport and submitted information via email to each airport manager for confirmation. This included confirmation of each tenant's company name, business type, and full- and part-time employee counts. Additionally, the correspondence included a comparison to the total number of employees (including airport administration and staff) reported by the previous 2012 AEIS. Adjustments were made based on all feedback received.

1.2.2 Off-airport Visitor Spending

Visitor spending is derived based on a subset of enplaned commercial service passengers and an estimate of the number of transient (i.e., out of state) operations and people per aircraft for GA. It is

[6] Additionally, the AEIS consultant team contacted the Washington Employment Security Division (ESD) to determine if the agency would be able to provide on-airport employment data for all airports within the scope of the AEIS. The ESD is responsible for maintaining employment records for all Washington businesses for tax purposes and to ensure businesses have adequate workers' compensation insurance coverage. This data was to be used to identify tenants at non-responsive airports, employment numbers for tenants identified by airport managers, and provide an additional level of quality control on the data provided directly by airports and their tenants. However, due to strict confidentially restrictions, the use of ESD data to identify or confirm on-airport employment was not feasible for the purposes of the AEIS.

important to note that visitor spending refers exclusively to out of state or international visitors, as these individuals bring new dollars into the Washington economy. Visitors traveling within the state simply circulate existing economic impacts to different areas within Washington—as one area loses impacts another gains it. The following sections outline the methodologies used to calculate commercial service and GA visitor spending.

1.2.2.1 Commercial Visitors

The AEIS determined that commercial service visitor spending was applicable to 13 airports in the scope of the study (excluding Sea-Tac). These airports include all Primary commercial service airports as defined in the FAA Report to Congress - *National Plan of Integrated Airport Systems (NPIAS) 2017-2023* (NPIAS Report) except SEA,[7] as well as Kenmore Air Harbor (W55) on Lake Union and Kenmore Air Harbor Inc. (S60) on Lake Washington. These airports provide scheduled commercial service to out of state or international destinations.

Enplanement data for all Primary commercial service airports was obtained from the FAA's Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports (based on the U.S. Department of Transportation's [DOT] Form 41 Schedule T-100). The AEIS then determined the percent of these passengers from out of state using origin and destination (O&D) data purchased from Airline Data, Inc. This database included all airports except Friday Harbor (FHR). In that case, the airport manager was contacted directly, who reported that 13 percent of all departures are destined for out of state or international airports. **Table 1.4** reports the number of 2018 commercial service visitors departing from each airport included in this analysis.

Table 1.4. Commercial Visitors Per Airport, 2018

Associated City	Airport Name	FAA ID	Number of Visitors
Bellingham	Bellingham International	BLI	95,979
Friday Harbor	Friday Harbor	FHR	1,568
Kenmore	Kenmore Air Harbor Inc	S60	1,342
Pasco	Tri-Cities	PSC	146,682
Pullman/Moscow	Pullman/Moscow Regional	PUW	27,297
Seattle	Boeing Field/King County International	BFI	5,549
Seattle	Kenmore Air Harbor	W55	6,974
Spokane	Spokane International	GEG	843,467
Walla Walla	Walla Walla Regional	ALW	20,214
Wenatchee	Pangborn Memorial	EAT	25,841
Yakima	Yakima Air Terminal (McAllister Field)	YKM	24,372
		Total	**1,199,285**

Source: Airline Data, Inc. 2018

[7] Sea-Tac was excluded from this analysis because economic impacts were obtained from the 2018 *Economic Impacts of Sea-Tac* study published by the Port of Seattle in 2018 (Community Attributes, Inc.)

Once the number of visitors was established, average spending by trip was estimated based on two existing studies. The 2018 *Sea-Tac International Airport Economic Impacts* study reported that commercial service visitors arriving through SEA spend an average of $876 per visit in Washington. This figure was used for Boeing Field/King County International Airport (BFI), Kenmore Air Harbor (W55), and Kenmore Air Harbor, Inc. (S60). Visitors traveling via these airports are assumed to exhibit similar spending patterns because they are all located in King County.

For all other commercial service airports, spending was extrapolated based expenditure data reported in *Washington State Travel Impacts and Visitor Volume (2000 – 2017p)* (Dean Runyan study).[8] This report provides detailed statewide travel impact estimates for Washington from 2000 to 2017, including some information regarding expenditures made by visitors arriving by air travel. Two key adjustments were made to air traveler expenditure data reported in the Dean Runyan study for use in the AEIS. First, the cost of purchasing an airline ticket was removed, as this purchase was likely made outside of Washington with no additional revenue coming into the state. Secondly, the Dean Runyan study reports expenditures separately for visitors arriving by air travel who stay in private homes versus hotels, motels, and short-term vacation rentals (e.g., AirBnBs). As shown in **Table 1.5**, the AEIS developed an average spend for all visitors arriving by air travel regardless of accommodation.

Table 1.5. Average Spending by Commercial Air Visitors

Category	Air- Spending per Trip ($)	Ratio	Product
Private home	$725	0.32	$235
Hotel, motel, short-stay rental	$938	0.68	$634
Combined average			$869
Air transportation (purchased outside of Washington)			($80)
Statewide commercial service visitor spending profile			**$789**

Source: Dean Runyan, Inc. 2018. Calculations by EBP US 2019

The Dean Runyan study documented 39.5 million visitors to Washington in 2017 who spend 113 million person-nights in the state (this excludes the "other" category, constituting day trippers, campers, and people going to their vacation homes). Approximately 32 percent of visitors stayed in private homes and 68 percent stayed in hotels, motels, or short-stay rentals. Spending per visitor arriving by air was $725 for visitors saying in private homes and $938 for visitors in hotels, motels, and short-stay rentals. Based on this 32/68 percent split between accommodation type, the average spending for visitors arriving by air was $869 across Washington regardless of commercial airport. Then the spending category of "Air Transportation" was subtracted, as the airline ticket was likely purchased out of state and does not contribute to the Washington economy. The process yielded an estimated statewide commercial service visitor spending profile of

> *The study calculated that visitors arriving to Washington by scheduled commercial service spend an average of $789 in the state.*

[8] Dean Runyan Associates (May 2019). *Washington State Travel Impacts & Visitor Volume, 2010-2018p*. Prepared for the Washington Tourism Alliance.

$789 per air visitor at all airports except those located in King County. This represents an average per-trip expenditure regardless of the number of nights a visitor spent in the state.

Because expenditures can vary significantly based on geographic location, this benchmark was tailored up or down to reflect local economic conditions of the county where each commercial service airport is located. Business revenues per capita by county were compared to the per capita statewide average ($113,258), then scaled to the $789 benchmark to estimate visitor spending by airport as follows:

(Output Per Capita County /Output Per Capita Washington) X $789

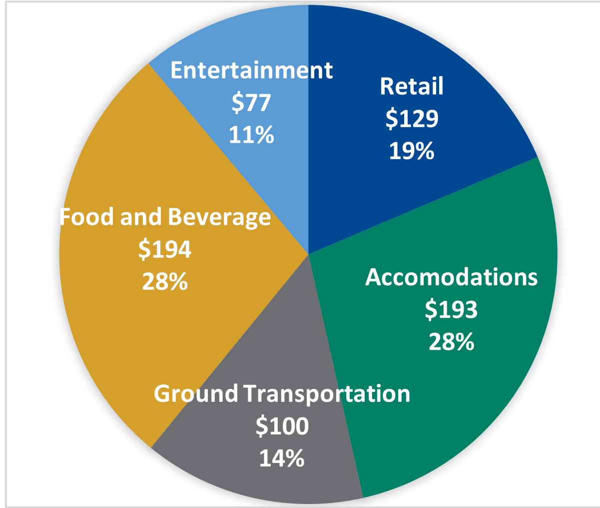
Visitor expenditures for commercial service visitors by airport are provided in **Table 1.6**.

Table 1.6. Visitor Spending by Commercial Airport Visitor

Associated City	Airport Name	FAA Identifier	County	Output Per Capita ($)	Visitor Spending ($) per Trip
Bellingham	Bellingham International	BLI	Whatcom	$118,787	$828
Friday Harbor	Friday Harbor	FHR	San Juan	$78,848	$549
Kenmore	Kenmore Air Harbor	S60	King*	NA	$876
Pasco	Tri-Cities	PSC	Franklin	$69,907	$487
Pullman/Moscow	Pullman/Moscow Regional	PUW	Whitman	$79,024	$551
Seattle	Boeing Field/King County International	BFI	King*	NA	$876
Seattle	Kenmore Air	W55	King*	NA	$876
Spokane	Spokane International	GEG	Spokane	$81,457	$567
Walla Walla	Walla Walla Regional	ALW	Walla Walla	$98,964	$689
Wenatchee	Pangborn Memorial	EAT	Douglas	$52,104	$363
Yakima	Yakima Air Terminal (McAllister Field)	YKM	Yakima	$69,928	$487
			State Average	$113,258	NA

**Note: All airports in King County are assumed to reflect the same commercial service visitor spending profile as identified for Sea-Tac. Sources: Dean Runyan, Inc. 2018, IMPLAN 2017, Community Attributes, Inc. 2017. Calculations by EBP US 2019*

Figure 1.4. Commercial Service Visitor Spending by Industry Sector ($Millions)



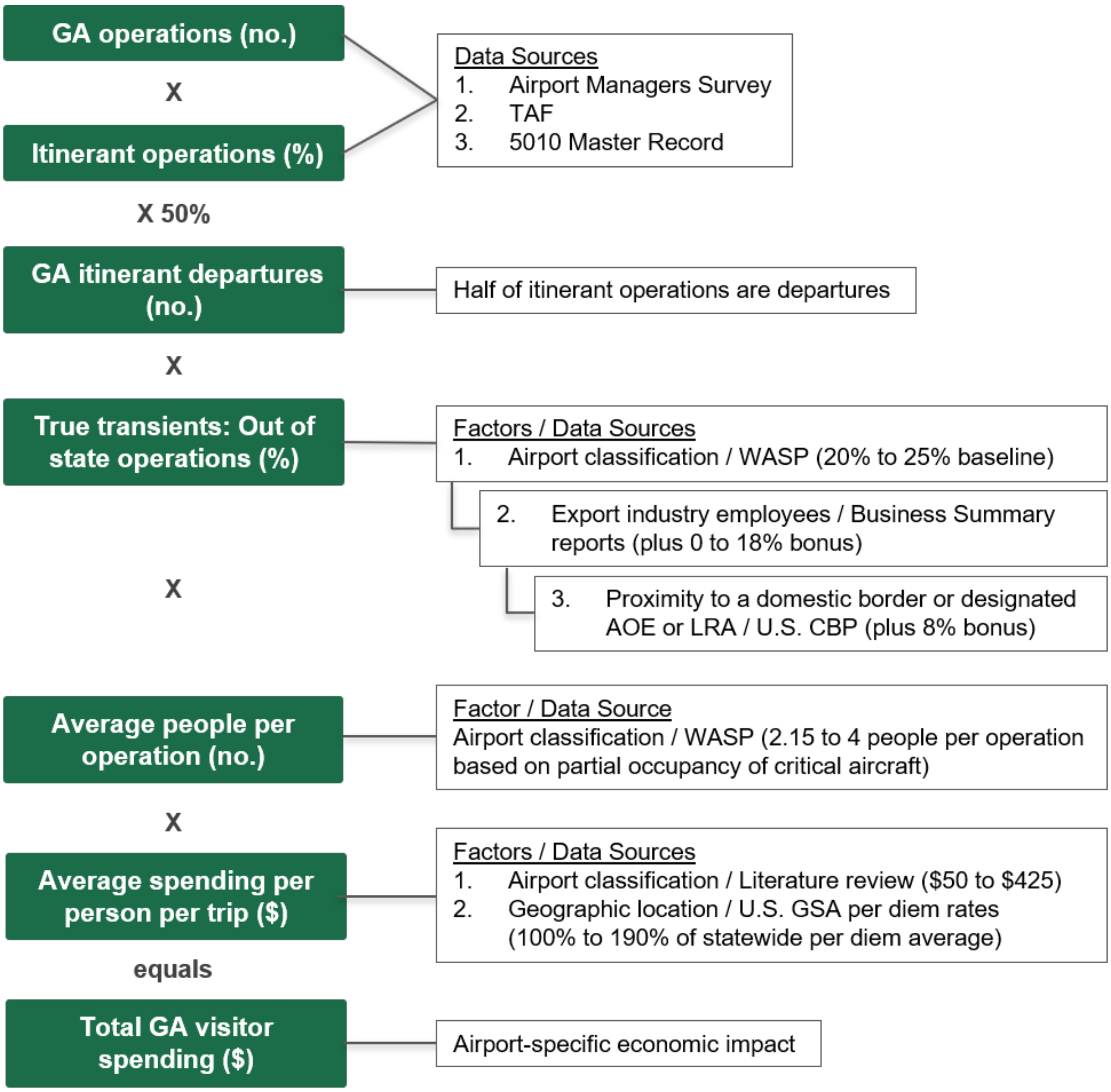
Sources: Dean Runyan, Inc. 2018, IMPLAN 2017, Community Attributes, Inc. 2017. Calculations by EBP US 2019

The IMPLAN model is used to estimate all measures of direct economic impact of visitor expenditures except business revenues (i.e., jobs, labor income, value added, and business revenues) and generate the associated multiplier effects. The model requires that commercial visitor expenditures be assigned to specific sectors such as accommodations, entertainment, food and beverage, and local ground transportation. Percentages of expenditures by each category were based on the Dean Runyan study. This process revealed that commercial air visitors spent more than an estimated $692 million in 2018 (adjusted from 2017 dollars used in Dean Runyan analysis to 2018 dollars) in Washington on accommodations, entertainment, food and beverage, local ground transportation, and retail. **Figure 1.4** shows the breakdown of spending for each industry sector that commercial visitor spending is associated with, by total spending (in millions) and percent of the overall spending.

1.2.2.2 GA Visitor Spending

In addition to visitors arriving via scheduled commercial service, out of state passengers and pilots also enter the state via GA operations (defined as all civilian aviation activity except scheduled air service). Estimating GA visitor spending is a multistep process summarized below and illustrated in **Figure 1.5**.

Figure 1.5. GA Visitor Spending Methodology



Source: Kimley-Horn 2019

1. **Total number of GA operations.** The Airport Managers Survey asked airport managers to provide the number of GA operations that occurred at their airports in 2018. If managers did not provide this information or a survey was not received, GA operations data were obtained from the FAA's Terminal Area Forecast (TAF) or 5010 Airport Master Record (in that order of preference). While the AEIS recognizes that operations data for non-towered airports represent only estimates of activity, managers were requested to provide an appropriate and reasonable number of annual GA operations based on their familiarity with their airport's 2018 activity levels.

2. **Percent of GA itinerant operations.** The Airport Managers Survey also requested airport managers to provide the percent of itinerant operations that occur at their facility. Itinerant operations are performed when an aircraft that is not based at the airport or operating in the local airport area lands or an aircraft that departs and leaves the local airport area. All itinerant aircraft operations are not necessarily from out of state and can include operations by locally based aircraft that depart to another airport outside the local area. Data on itinerant operations were obtained from the Airport Managers Survey, TAF, or 5010 Master Record (as available, in that order of preference). The number of itinerant operations for each airport was then halved to determine the number of itinerant departures per airport (as operations comprise both arrivals and departures). Only departing visitors are modeled because it is assumed that they have already spent money in the state.

3. **Percent of true transients.** Because the AEIS is specifically assessing out of state visitor expenditures, a Washington-specific methodology was developed to determine the percent of "true transient" operations at each study airport—that is for the purposes of this study, itinerant operations performed by out of state aircraft. As a standard industry practice, aviation economic impact studies generally estimate that out of state aircraft perform 30 to 50 percent of operations depending on the size or classification of the facility. For Washington, a tailored methodology was developed to determine the percent of true transient operations factoring in three primary drivers of out of state activity:

The percent of visitors relying on GA airports was estimated, in part, using a Washington-specific methodology based on state classification, the nearby presence of specific industries often reliant on air travel, and proximity to a state or international border.

- **WSDOT airport classification.** The classification of airports in Washington is tied to each airport's service area defined in terms of population, geographic size, or size of the aviation community. Factors used in the classification process include ARC, primary aviation activities supported, local populations, and runway surface types. Because Washington's classifications are tied to the ability to support larger aircraft with the ability to travel longer distances, this factor provides the foundation of the methodology to estimate percent of true transient operations. Airports received a baseline percentage defined by classification ranging from 20 to 25 percent. The following two factors provide "bonus" percentage points that are added to this baseline to calculate the total percent of true transient operations.
- **Export industry employees.** Export industries comprise the professional, technical, and scientific service and manufacturing business sectors. These industries have a particularly high propensity to use aviation services for business travel and air cargo and are a credible indicator of local economic activity. Accordingly, the number of employees working in export industries was established as a key indicator of out of state aviation activity.

Using ESRI's Community Analyst Business Summary reports, the AEIS obtained the number of export industry employees within a 10-mile radius of each ARP. These results were sorted from high to low, then split into six tiers along natural breaks in the data. Airports received an additional percent of true transient operations added to their classification baseline ranging from 18 points for airports in the highest tier (69,000 to 156,000 employees) to zero points for airports in the lowest tier (less than 500 employees).

- **Proximity to a domestic border or designated airport of entry (AOE) or landing rights airport (LRA).** Airports within 30 miles of a domestic border likely draw more aircraft from adjacent states and can also support a greater variety of out of state aircraft, since shorter travel times into Washington allow smaller aircraft to reach a particular facility. U.S. Customs and Border Protection (CBP) designates AOEs and LRAs for the lawful entry of international visitors. Airports within 30 miles of the domestic border or designated AOEs or LRAs received eight additional percentage points added to their baseline.

When aggregated, this methodology resulted in airports experiencing an estimated 20 percent true transient operations at General Use airports in Washington's interior with minimal surrounding economic activity to 51 percent at Major airports in urban areas with a significant number of nearby export industry employees. WSDOT Aviation determined this range is appropriate for Washington in consideration of the industry-accepted 30 to 50 percent threshold. The percent of true transients was multiplied by the number of itinerant departures to determine the number of out of state aircraft arriving in Washington via GA.

4. **Average people per operation.** Once out of state departures were established, the AEIS estimated the number of pilots, passengers, and other staff on each departure. Because WSDOT classifications reflect ARC and runway type, it was deemed appropriate to estimate the average number of seats on representative critical aircraft within each ARC. This average was then halved and then increased by 25 percent, as aircraft do not always operate at 100 percent occupancy. The AEIS estimated that aircraft arriving in Washington from out of state carry 2.15 to 4 individuals per true transient departure based on classification.

5. **Average spending per person per trip.** The AEIS estimated the average money spent by out of state visitors arriving in Washington based on an analysis of expenditure data used in other recent state aviation economic impact studies and state-specific data obtained from the U.S. General Service Administration (GSA) per diem rates. As the first step, a literature review of six recent or ongoing aviation economic impact studies was conducted to obtain GA visitor expenditure profiles used in other states. In all cases, these studies reported expenditure profiles by airport based on federal or state classifications or annual operations. The AEIS organized expenditures into five tiers to correspond with the five WSDOT classifications. The average of each tier serves as the baseline GA expenditure for Washington by classification.

   Building upon this baseline, the AEIS then used the U.S. GSA per diem rates for Washington to identify and account for regional cost variances. The U.S. GSA provides a standard statewide rate of $149 per day for lodging and some expenses. Higher rates are specified for Benton, Clallam, Clark, Cowlitz, Franklin, Grays Harbor, Jefferson, King, Pierce, Skamania, Snohomish, Spokane, and Thurston counties. Airports in these counties received a county-specific percent increase corresponding with U.S. GSA per diem rate differences. For example, the daily per diem rate in King County is $288—nearly twice the average statewide rate. Accordingly, GA visitor spending rates for GA visitors arriving in King County are 190 percent of the baseline GA expenditure for Washington.

6. **Total GA visitor spending.** As the final step in this process, the AEIS multiplied the number of arriving out of state visitors by airport-specific visitor expenditure profiles. The outcome of this process represents the GA visitor spending for each airport in the scope of the study.

1.3 Economic Modeling Process

Once direct impacts associated on-airport activities and visitor spending were established by airport, the IMPLAN Version 3 (2017) economic modeling system was used to estimate each airport's economic contribution to the statewide and its own regional economy. IMPLAN is the most widely used input/output (I/O) model in the U.S. The model utilizes data derived from the BEA, Bureau of Labor Statistics (BLS), U.S. Census Bureau, and U.S. Department of Commerce to reflect the current economic measures (e.g. jobs, labor income, value added, and business revenues) for over 536 industry classifications. These classifications generally correspond with the two- to five-digit groups in the North American Industry Classification System (NAICS). Additional details about the IMPLAN I/O model are provided in **Appendix A**.

An IMPLAN model was calibrated for each WSDOT region (as discussed in Section 0) and statewide. Washington regional economies vary in terms of industry mix, productivity of industries, and average labor income per job by industry. Therefore, the effects of business revenues in one region may differ from the effects of the same level of business revenues in another. Supplier sales and income re-spending "multiplier" effects were calculated for each region and the rest of Washington to produce both statewide and regional effects.

The multiplier effects of supplier sales and income re-spending vary by the combination of counties that constitute regions and the size and industry mixes of each regional economy. A larger region means that the marketplace for supplier sales and workers' re-spending is larger and more economically diverse. The opposite is true for a smaller region. For example, an aircraft repair company in a rural region that needs to buy a manufactured product may have to make the purchase in a neighboring urbanized county because the industry is not present at a sufficient scale in its home region. In this case, the dollars would not be counted in the regional multiplier. Similarly, the aircraft repair company's workers may shop for goods and services in that more urbanized county. However, if that aircraft repair company were in that more urbanized county in a larger region, then its purchases and sales would be part of the regional multiplier. For this reason, multiplier effects of supplier sales and income re-spending are larger when modeling impacts across the state of Washington as compared to those in a sub-state region. For the AEIS, impacts were determined at both statewide and regional levels. The difference is that the statewide multiplier counts supplier sales and income re-spending throughout Washington, while regional multipliers count only those effects that occur within the region where each airport is located.

1.3.1 Use of IMPLAN

The 2017 IMPLAN Package was purchased for Washington and each county in the state (most recent model available at the time of the analysis, with impacts adjusted to 2018 dollars). Models were calibrated for regions as well as statewide. IMPLAN was used in the following three ways, each of which is described in further detail below:

- Fill in data gaps to estimate direct impacts (as described in Section 1.2)
- Apply retail margining to isolate only the economic activity associated with the retail industry
- Derive multiplier impacts by estimating the additional economic activity associated with supplier purchases and employee re-spending

Fill Data Gaps to Estimate Direct Impacts. The IMPLAN package includes a database that provides jobs, labor income, value added, and business revenues by industry. Using the ratios between these measures, missing direct values were interpolated per industry per region. For example, these ratios were used to estimate labor income and business revenues for on-airport tenants that only provided employment totals. These IMPLAN ratios were also used to determine employment and labor income values based on visitor spending and construction expenditures. Regional values were used instead of statewide averages, as the regional values are more reflective of the local economies in which these airports operate and where visitors spend their money.

Retail Margining. While spending on retail reflects the value of the item sold, only a portion of the sale is actual revenue for the retail store. This portion, referred to as margin costs, reflects the "mark-up" value that retail stores add to the price of goods to cover their operating costs and profit. Only the mark-up produces revenue and economic activity for local retailers. Revenue generated by that mark-up supports employee payroll and operating costs of the business (e.g., rents, utilities, capital, and other business expenses)—not gross revenue collected by the retail business or industry. To isolate the revenues that accrue to retailers, the margin percentage was applied to the value of all retail goods sold. For example, if retail sales total $1 million, only $300,000 of these sales may be the mark-up earned by retail establishments, since it may have cost the stores $700,000 to purchase the items for sale from wholesalers or distributors. This approach was used to accurately reflect the economic impacts of retail spending. Margining was done when working with retail sales data to estimate jobs and payroll (such as for visitor spending). When jobs were provided for on-airport retail establishments, jobs represent direct effects after margining has occurred and additional margining was not required.

Estimate Multiplier Impacts. IMPLAN includes an I/O model that is widely used in economic impact analysis. I/O models trace the flows of money in an economy of varying sizes by the patterns of industry purchases and sales with other industries (for supplier sales effects) and household spending (used to calculate income re-spending effects), which help explain how revenues earned in direct transactions have additional impacts in an economy. For this study the WSDOT regions were selected as the regional economies; impacts were also calculated at the statewide level. At each geographic level, IMPLAN is used to trace the circulation of business revenues to calculate the extent to which supplier purchases and income re-spending support jobs and payroll for Washington residents and add gross state product to the state of Washington.

Multiplier effects begin with businesses on airports or those engaged directly with visitors that use part of their gross revenues to purchase goods and services from other businesses. For example, a restaurant may buy produce from farmers, dry goods from wholesalers, office equipment at stores or manufacturers, and utilize and pay for accounting services. To the extent that these purchases stay in Washington, they provide business revenues to other businesses in an airport's home region or to the rest of the state. These revenues are then used by businesses in the supply chain (in part) to hire workers and pay them wages and to purchase additional business supplies. Successive rounds of supplier sales occur until the dollars are spent outside of Washington. In instances when airport tenants or hospitality businesses initially purchase goods or services from outside the state, then the dollars are lost to Washington and are not part of the multiplier effects. Similarly, direct workers associated with on-airport businesses and visitor spending, or part of the supply chain of these direct businesses, use their wages to purchase goods and services (also known as household spending) in Washington. Worker income may be used to purchase a variety of consumer goods ranging from furniture to healthcare and groceries. These purchases continue to provide business revenues from income re-spending as long as the dollars used for the purchases stay in state.

1.3.1.1 Industry Sectoring

As noted previously, there are 536 industry sectors contained in IMPLAN. **Table 1.7** and **Table 1.8** documents the sectors used for the Washington AEIS associated with on-airport activities and visitor spending (respectively).

On-airport Activities. Modeling of on-airport impacts includes the sectors shown in Table 1.7. In some cases, generalized descriptions of certain business as provided by airport managers and/or tenants were not specific and therefore were assigned to an aggregated industry (e.g., retail, entertainment, aerospace manufacturing, etc.).

Table 1.7. Industries and Sectors Modeled for Washington's On-airport Economic Impacts

On-airport Activities: Industries and Sectors		
Aerospace	Federal government	Oil/gas drilling
Architectural & engineering services	Food & beverage	Other educational services
Auto repair & maintenance	Freight aviation	Photographic services
Aviation	Ground transportation	Real estate
Business & professional associations	Hospitals	Reliant services
Car rental	Hotels	Retail
Cattle ranching	Labor & civic organizations	Retail – Motor vehicle & parts dealers
Commercial rental & leasing	Legal services	Retail – Non-store retailers

On-airport Activities: Industries and Sectors		
Construction	Management consulting services	Security
Crop farming	Management of companies	Services to buildings
Crop spraying	Manufacturing	State & local government
Data processing	Marketing research	Transportation support services
Distribution	Miscellaneous manufacturing	Vehicle parts manufacturing
Electric power	Office administrative services	Wholesale trade
Entertainment	Offices of physicians	Wireless telecommunications
Environmental services		

Source: EBP US 2020

Visitor Spending. Table 1.8 displays the sectors used to categorize visitor spending for both commercial service and GA visitors. Visitor spending includes six primary sectors made up of 26 separate industries. Visitor spending is highly aggregated because a visitor cannot, for example, be realistically asked to divide food expenditures among different types of food and beverage establishments—let alone parse out spending of different types of retail or entertainment.

Table 1.8. Visitor Spending Categories Modeled for Washington's Visitor Spending Impacts

Visitor Spending Categories	Industry Sector
Accommodations	Hotels & motels, including casino hotels
	Other accommodations
Car rental (engaged off airport)	Automotive equipment rental & leasing
Entertainment	Performing arts companies
	Commercial sports except racing
	Racing & track operation
	Independent artists, writers, & performers
	Museums, historical sites, zoos, & parks
	Amusement parks & arcades
	Gambling industries (except casino hotels)
	Other amusement & recreation industries
	Fitness & recreational sports centers
	Bowling centers
Food & Beverage	Full-service restaurants
	Limited-service restaurants
	All other food & drinking places
Ground Transportation, other than car rental	Retail - Gasoline stores
	Transit & ground passenger transportation
	Transportation support activities
Retail	Retail - Electronics & appliance stores
	Retail - Food & beverage stores
	Retail - Health & personal care stores

Visitor Spending Categories	Industry Sector
	Retail - Clothing & clothing accessories stores
	Retail - Sporting goods, musical instruments, & books
	Retail - General merchandise stores
	Retail - Miscellaneous store retailers

Source: EBP US 2020

1.4 Approval and Validation Methods

Throughout the data collection and modeling processes of the Washington AEIS, WSDOT Aviation and the consultant team employed a number of validation and quality control processes to provide a high level of confidence in the study results. This entailed a multistep process in which all reasonable efforts were made to review and validate the inputs and outputs of each step of the AEIS process.

Throughout the data collection and modeling processes, WSDOT Aviation and the consultant team employed validation and quality control techniques to provide a high level of confidence in the study results.

1.4.1 Data Inputs

IMPLAN's ability to calculate and complete results for each Washington airport depended on reliable, validated data inputs. Data inputs were validated as follows:

- **Airport manager outreach.** Prior to compiling direct impacts associated with on-airport activities, all airport managers received an email requesting their approval of employee counts provided for airport administration and tenants. Emails contained all tenant details by business as received or obtained from secondary sources, including full- and part-time employees and business type. Managers were also asked to validate the number of "true transient" GA visitors estimated using the process described above.
- **Comparison with 2012 AEIS.** Data inputs were compared with the previous 2012 AEIS to identify major discrepancies in terms of on-airport employees, visitor spending, and operations. Note the 2012 AEIS did not calculate the economic impact of capital improvements. All efforts were made to explain, resolve, or otherwise address any significant discrepancies identified during this process.
- **Review of FAA and WSDOT grant histories.** FAA and WSDOT grant histories were compared with capital expenditures reported in the Airport Managers Survey. In cases where grants received from the FAA or WSDOT were higher than reported figures, the higher number was recorded in the AEIS.
- **ESRI's Community Analyst Business Locator reports**. The consultant team obtained a list of all businesses located within a one-mile radius of each Washington airport's ARP from ESRI's Community Analyst Business Locator tool. If an aviation- or aerospace-related businesses was identified but not listed in the original tenant list, additional follow-up was conducted to confirm the business' location as either on- or off-airport property. If the business was located on-airport property, the tenant list was modified, and employment details were obtained.

- **WSDOT Aviation review.** WSDOT Aviation reviewed and approved results for all Washington airports that were identified as not having tenants.

1.4.2 Direct Impacts

Direct impacts represent the assembled totals of on-airport activity and visitor spending expressed in terms of the four measures of this study (i.e., jobs, labor income, value added, and business revenues). Direct impacts were validated as follows:

- **WSDOT Aviation review.** The consultant team and WSDOT Aviation closely reviewed each airport's direct impacts. This process identified airports that appeared anomalous in terms of how they compared with peer airports (by classification and geographic region) or based on WSDOT Aviation's general familiarity with the activities occurring at system airports.
- **Comparison with 2012 study.** The 2019 AEIS compared each airport's direct impacts with those presented in the previous study (as available).
- **Outreach to Major and Regional airports.** In general, the airports that fall within Washington's two highest state classifications (i.e., Major and Regional) contribute the most significant economic impacts to their regions and statewide. As such, the 29 managers responsible for these airports were directly contacted to approve their direct impacts. The impacts of these airports could not be modeled until approval was received. As previously noted, economic impacts for Sea-Tac were obtained directly from their most recent economic impact study.

A detailed data audit was conducted of all airports identified during these processes to explain, address, or otherwise resolve all issues that arose. In total, 12 airports were identified with data inconsistencies. The direct impacts of these airports were re-modeled with revised data prior to calculating multiplier effects.

1.4.3 Multiplier and Total Economic Impacts

Direct impacts are modeled in IMPLAN to obtain the economic effects of supplier sales (i.e., indirect) and the re-spending of worker income (i.e., induced). As such, these types of economic impacts cannot be independently validated. Because total economic impact represents the sum of direct, indirect (supplier sales), and induced (re-spending of worker income) impacts, ensuring accurate direct economic impacts is the crux of the economic modeling process. Once total economic impacts were disseminated to airports in February 2020, managers were given the opportunity to ask questions regarding their results or the study methodology; however, impacts were not re-modeled unless a significant concern was discovered.[9]

[9] Kenmore Air Harbor and Kenmore Air Harbor, Inc. (S60 and W55) were re-modeled after total economic impact results had been disseminated based on a mis-categorization of visitor spending.

1.5 Methodology to Estimate Data for Non-responsive Airports

Section 1.2 (Approach to Data Collection and Calculation) describes the processes for obtaining data necessary to calculate the direct impacts associated with on-airport activity and visitor spending. These processes yielded results for 102 airports, or 75 percent of airports included in the scope of the task (see Table 1.3

Table 1.3). Because data could not be obtained for 31 airports in the state, including 13 publicly-owned airports and 18 privately-owned, public-use facilities, a methodology to estimate the minimum key data inputs for these non-responsive facilities was developed. At a minimum, data are needed for the following categories to estimate the economic impact for each airport:

- Direct on-airport jobs (representing airport owners/sponsors and business tenants with employees on airport property)
- Capital improvements (average of past three years, 2016 - 2018)
- Operating expenses
- Visitors (including those arriving from out of state via scheduled commercial service GA operations, as applicable)

To estimate these impact categories for the 31 non-responsive airports, several data points were analyzed to derive a recommended approach. The data points and recommendations for each category are summarized below.

1.5.1 Direct On-airport Jobs

On-airport employees represent both airport owners/sponsors and business tenants with employees working on airport property. Together, these employees are referred to as direct on-airport jobs. To estimate the total number of direct on-airport jobs, the AEIS independently assessed airport owner/sponsor employees and business tenants. The outputs of these processes were compared to the number of direct on-airport jobs reported in the 2012 AEIS to identify any major discrepancies and ensure job inputs generally align across study years. The methods to estimate airport owner/sponsor employees and business tenants are described below.[10]

1.5.1.1 Airport Owner/Sponsor Employees

As the first step in this process, ESRI's Community Analyst Business Locator reports were reviewed to potentially identify airport owner employees at private airports. These reports do not include government agencies; as such, airport owners/sponsor employees at publicly-owned airports are not available. These GIS-based reports provide the number of employees and gross revenues of individual businesses located within a defined geographic area. Reports were generated using a one-mile buffer

[10] Additionally, the AEIS consultant team contacted the Washington ESD to determine if the agency would be able to provide on-airport employment data for all airports within the scope of the AEIS. However, due to strict confidentially restrictions, the use of ESD data to identify or confirm on-airport employment was not feasible for the purposes of the AEIS. Additional information about ESD outreach efforts and data limitations is provided in the study methodology and approach section.

zone around each ARP to serve as the likely geographic area that is considered "on-airport". Airport owner/sponsor data were obtained for four private airports using Business Locator reports.

For all remaining airports, the number of full- and part-time airport owner/sponsor employees were estimated by calculating the average number of such employees reported by peer airports. Two different methods were employed based on the definition of peer airports:

- The first method defined peer airports in terms of WSDOT airport classifications. For each classification, the number of airport owner/sponsor employees reported by responsive airports was summed, then divided by the total number of responsive airports. The results of these calculations represent the average number of airport owner/sponsor employees per airport by classification.
- The second methodology defined peer airports in terms of WSDOT airport classification and ownership. Publicly- and privately-owned airports were assessed separately using the same process described above. The results of these calculations represent the average number of airport owner/sponsor employees per classification and ownership status.

After comparing the results of these two methodologies, the consultant/WSDOT team adopted the first methodology (in which all airports are analyzed together) for use in the AEIS. [11] Due to the low response rate of some classifications of privately-owned airports, it is not clear that the estimated data inputs are indicative of average economic activity across multiple airports. The adopted methodology provides a greater sample size and mitigates the potential effects of 'outlier' airports with unusually high or low activity levels. In accordance with the data requested in the Airport Managers Survey, direct airport and contract employees were estimated separately.

The calculated average number of airport owner/sponsor employees by classification are presented in **Table 1.9**. Note that all Major airports submitted Airport Managers Surveys, so data estimates were not developed for that classification.

Table 1.9. Proposed Data Inputs – Airport Owner/Sponsor Employees

WSDOT Classification	No. of Jobs				
	Full-time Direct	Part-time Direct	Full-time Contract	Part-time Contract	Total
Major	Not applicable (NA)				
Regional	4	2	0	1	7
Community	1	1	0	0	2
Local	0	0	0	1	1
General Use	0	0	0	0	0

Source: Kimley-Horn 2019

[11] This same assessment, in which all airports were analyzed together and then independently based on ownership, was also conducted to estimate capital improvements and operating expenses. The concerns noted here also apply to those categories of economic impact. As such, all airports were analyzed as a group to estimate direct on-airport jobs, capital improvements, and operating expenses.

1.5.1.2 Tenant Employees

Many of the non-responsive airports in Washington represent some of the smallest facilities in the state. General Use airports had the lowest Airport Manager Survey response rate, with just 60 percent of facilities submitting an Airport Managers Survey. However, the AEIS determined that 23 of the 31 non-responsive airports do not have any identifiable on-airport business tenants based on knowledge of the system and familiarity with the facilities and services offered. Business Locator reports were also reviewed to determine if any aviation-related businesses could be identified within one mile of the ARP. These 23 airports with zero tenants were approved by WSDOT Aviation after review of the data and further discussion. For the remaining eight non-responsive airports, tenant employee numbers were estimated as follows:

- Business Locator reports were reviewed to identify potential on-airport tenants based on geographic proximity to the ARP, type of business (i.e., aviation-related), and visual identification using Google Earth Pro. This data was used for six of the non-responsive airports.
- In two cases, on-airport tenants provided employment information even though an Airport Managers Survey was not received. It is assumed that these businesses learned of the AEIS through outreach efforts to the aviation community, including email distributions by 10 aviation- and aerospace-related organizations. These distributions requested that all on-airport business tenants in the state complete an Airport Tenants Survey or, at a minimum, provide the number of full- and part-time employees working on airport property.
- Friday Harbor's (FHR) website provides a list of on-airport tenants. Tenant data was then obtained from a Business Locator report as well ResearchUSA, a subscription-based industry research tool that provides detailed business data including industry type and number of employees.

1.5.1.3 2012 AEIS Direct Job Information

Based on the methodologies outlined above, the AEIS estimated the number of direct on-airport jobs with a high degree of confidence in nearly all cases. As the final step, the number of direct on-airport jobs estimated for each non-responsive airport was compared to the direct jobs reported in Appendix C of the 2012 AEIS. This process did not reveal any significant issues and provided additional credibility to the estimation methodology that was employed during this AEIS.

> *The study estimated the number of direct on-airport jobs at non-responsive airport with a high degree of confidence in nearly all cases.*

1.5.2 Capital Improvements

The AEIS requested three years of data (2016 – 2018) to calculate an average economic impact of airport capital improvements. Three years was used to provide a 'smoothing' of the impact associated with capital improvements since the spending amounts can vary significantly by year depending on projects and funding availability for airports.

The estimation process for non-responsive airports was two-fold. As the first step, WSDOT and FAA grant histories were reviewed to determine if any non-responsive airports received a capital improvement grant between 2016 and 2018. If yes, this figure was recorded as the capital expenditure during that study year. Grant histories were entered for the following non-responsive airports for the study year indicated:

- Jefferson County International (0S9) - $262,809 (2017)
- Rosalia Municipal (72S) - $742,997 (2017)
- Sand Canyon (1S9) - $86,787 (2016)
- Friday Harbor (FHR) - $235,000 (2017)

If no, it was assumed that the airport only received local funds (as it had already been determined that the airport received $0 state/federal dollars). Accordingly, an average local input was estimated using the data provided by responsive airports by classification. State/federal grants were first subtracted from the capital expenditure reported on each Airport Managers Survey. The remainder represented local contributions for capital improvements (i.e., all funds except state and federal grants). These figures were summed and then divided by the total number of responsive airports in that classification. The output (i.e., quotient) of this process was rounded to provide the estimated three-year average of local (and total) capital expenditure for non-responsive airports. **Table 1.10** provides the data inputs for capital improvements for each study year by classification.

Table 1.10. Proposed Data Inputs – Capital Improvements (2016 – 2018 and Three-year Average)

WSDOT Classification	Capital Improvement Study Year ($)			Three-year Average ($)
	2016	2017	2018	
Major	NA			
Regional	$376,000	$788,000	$316,000	$493,333
Community	$66,600	$390,600	$135,700	$197,633
Local	$179,900	$336,700	$252,000	$256,200
General Use	$2,100	$4,000	$15,000	$7,033

Source: Kimley-Horn 2019

1.5.3 Operating Expenses

The AEIS estimated 2018 operating expenses at non-responsive airports by averaging the data provided by responsive airports by classification. **Table 1.11** provides the data inputs for operating expenses at non-responsive airports.

Table 1.11. Proposed Data Inputs – Operating Expenses (2018)

WSDOT Classification	Operating Expenses ($)
Major	NA
Regional	$1,000,200
Community	$172,000
Local	$26,000
General Use	$15,500

Source: Kimley-Horn 2019

1.5.4 Visitor Spending

Visitor spending is derived based on a subset of enplaned commercial service passengers and an estimate of the number of transient (defined as out of state and/or international) operations and people per aircraft for GA. The AEIS determined that commercial service visitor spending was applicable to 13 airports in the scope of the study. All commercial service airports submitted Airport Managers Surveys except Friday Harbor (FHR); however, the FHR airport manager did provide an estimated percent of commercial service operations departing for out of state and/or international locations. For GA visitor spending, responsive and non-responsive airports are treated identically except for the data sources used for total operations and the percent identified as itinerant (see Section 1.2.2.2 above). GA operations and percent itinerant data were obtained from the TAF or 5010 Master Record, as available and in that order of preference.

1.5.5 Summary of Methodology for Non-responsive Airports

Table 1.12 summarizes the methodologies and sources used to estimate data for non-responsive airports in the four impact categories of the AEIS. Estimated direct on-airport jobs were compared to the 2012 AEIS to identify major discrepancies and ensure general alignment with the previous study. Because visitor spending can be estimated using third-party sources, no additional study is warranted to estimate this impact category.

Table 1.12. Summary of Non-responsive Airport Data Methodologies

Impact Category	Methodology Summary	Sources
Direct on-airport jobs: Airport owner/sponsor	Average of responsive airport data by classification.	– Airport Managers Survey – ESRI's Community Analyst Business Locator reports
Direct on-airport jobs: Tenant employees	NA. Tenant employment data were obtained directly from tenants or third-party sources.	– ESRI's Community Analyst Business Locator reports – WSDOT Aviation – Direct tenant involvement
Capital improvements (2016 – 2018)	WSDOT and FAA grant histories were reviewed to obtain grant data for all airports. Capital improvements reported on Airport Managers Surveys minus grant awards were averaged to provide local-only inputs for non-responsive airports by classification.	– WSDOT grant histories – FAA grant histories – Airport Managers Survey
Operating expenses	Average of responsive airport data by classification.	– Airport Managers Survey
Visitor spending: Commercial service visitors	For all commercial service airports except W55 and S60, enplanement data was obtained from the FAA's Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports. For all commercial service airports except FHR, commercial service visitor O&D data was purchased from Airline Data, Inc. SEA study used to	– FAA's Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports – Airline Data, Inc. – Sea-Tac International Airport Economic Impacts study – Dean Runyan study

Impact Category	Methodology Summary	Sources
	obtain expenditure data for BFI, S60, and W55 and served as the baseline for the development of visitor spending profiles for all other airports included in the analysis. The Dean Runyan study was used to tailor the statewide expenditure benchmark for all other airports. Expenditures tailored by county using business revenues output per capita.	– Airport manager discussion
Visitor spending: GA visitor spending	A Washington-specific method to estimate percent of out of state visitors based on airport-specific drivers of aviation activity. Pilots, passengers, and other staff per operation based on WSDOT airport classification using typical critical aircraft. GA visitor expenditure profiles developed by conducting a literature review of other recent aviation economic impact studies. Spending profiles were tailored to reflect county-specific economic conditions based on U.S. GSA per diem rates.	– Airport Managers Survey – TAF – 5010 Master Records – ESRI's Community Analyst Business Summary reports – *U.S. CBP Guide for Private Flyers* – U.S. GSA "FY 2019 Per Diem Rates for Washington" – WASP – Other states' recent aviation economic impact studies

Source: Kimley-Horn 2019

1.6 Summary

This chapter provides a detailed discussion into how the 2020 Washington AEIS calculated the economic impacts of Washington's 134 public-use airports. Impacts are categorized in terms of direct impacts, supplier sales, and income re-spending; impacts are expressed in terms of jobs, labor income, GDP, and business revenues. As this discussion has shown, economic impacts are generated not only by the activities that occur within the airport's boundary line. Commercial service and GA airports bring new money into the state by providing a gateway for out of state and international travelers. The money earned by on-airport workers and funds used to support on-airport activities such as construction are recirculated through the economy, generating additional impacts with each successive round of spending (i.e., re-spending of worker income and supplier sales, sometimes referred to as "multiplier effects"). In fact, this money continues to generate impacts until it is spent outside of Washington state. For this and other reasons, the process and outcomes of the 2020 Washington AEIS highlights that the state airport system is foundational to the economy. Investing in airports supports growth and stability in a diverse range of industry sectors well beyond those conventionally considered to be airport- or aerospace-related. The results of the methodology discussed here are presented in **Chapter 3: Economic Impacts of Washington Airports**.

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Chapter 2. Economic Impacts of Washington Airports

The Washington Aviation Economic Impact Study (AEIS) is designed to provide a comprehensive and robust evaluation of the economic impact of Washington's aviation industry. This chapter looks specifically at impacts associated with airports in their roles as centers for business activities and entry points for visitors who travel to Washington for recreational or business purposes.

STATEWIDE IMPACTS

- Jobs: **407,042**
- Labor Income: **$26.8 billion**
- Business Revenues: **$107.0 billion**

Airports serve as regional job centers and often influence the development and composition of surrounding economies. Additionally, airport capital improvements conducted by the airport administration or tenants create economic opportunities in the design, engineering, and construction industries. Airports also bring travelers to the state who spend money in hospitality industries and connect clients with local and regional businesses. The analysis of Washington airports' economic impacts associated with on-airport activities, including capital improvement investment, and visitor spending first looks at impacts at the statewide level, then provides a more granular analysis of impacts by WSDOT region. A regional approach highlights the significant impacts that airports have in their surrounding communities.

The difference between the statewide and regional analyses is in the extent of how money generated directly by airports continues to produce additional "multiplier" benefits. In statewide analyses presented in this chapter (see **Sections 2.2** and **2.4**), multiplier benefits account for supplier sales and income re-spending throughout Washington. However, in the regional analysis (see **Section 2.3**), these multiplier effects are confined to within the WSDOT region where the airport is located.[1] Regional analyses measure the impacts of all airports within a specific region but do not consider multiplier impacts that occur outside of that same region. All tables and references to "state" impacts include statewide multiplier effects, while tables and references to "regional" impacts include the geographically limited (and likely smaller) regional multiplier effects. As described in the **Introduction** of the Washington AEIS (see "Study Airports and Regions"), regional multipliers differ among the economies of the six regions. As a result, statewide impacts of airports can be added across the state, but regional impacts of airports can only be totaled within each region.

[1] For additional information about the WSDOT regions used in the Washington AEIS, see "Study Airports and Regions" in the Introduction (page vi) and Section 2.3 below.

In the final section, this chapter presents economic impacts by legislative district. The Washington State Department of Transportation Aviation Division (WSDOT Aviation) and airports are dependent on the support of local and state policymakers. State and local investment is critical in their work to ensure the aviation system remains safe, efficient, and supportive of Washington's transportation and mobility needs. Impacts by legislative district are an important tool for airports and WSDOT Aviation to demonstrate that airports' economic impacts nearly always exceed money invested. Further details about the economic contribution of airports versus state investments is available **Chapter 4. State Aviation Investments**.

> *Ongoing state and local investments are critical to ensure the aviation system remains safe, efficient, and supportive of Washington's transportation and mobility needs. The Washington AEIS provides a tool for airports and WSDOT Aviation to demonstrate that airports' economic impacts nearly always exceed money invested.*

The Washington AEIS provides a separate analysis of the off-airport impacts of air cargo and agriculture in **Chapter 3. Key Aviation Activities**. These activities are treated separately because a substantial portion of the impacts associated with both activities occur off-airport. Additionally, these impacts cannot be tied to specific airports. On-airport tenants relating to cargo movement and aerial applications are included in this chapter, but off-airport impacts are documented in **Chapter 3**. In addition to on-airport tenants, the agriculture analysis assesses how aerial applications support Washington's agriculture industry, and the air cargo analysis measures benefits to industries across Washington regions. Together, the economic impacts presented in Chapter 2 and Chapter 3 offer a comprehensive assessment of the economic contributions of Washington's airport system.

For additional details about the methodology used to calculate the economic impacts, see **Chapter 1. Economic Impact Approach**. Note that all dollar values have been rounded to the nearest thousand and all monetary values are reported in 2018 dollars throughout this report. **Appendix B** provides direct, multiplier, and total impacts by airport.

> *Together, the economic impacts presented in Chapter 2 and Chapter 3 show that the economic impact of aviation permeates the entirety of the Washington economy.*

2.1 Introduction to Impacts

This chapter of the Washington AEIS presents the contribution of Washington's airports to the state economy in 2018 through two main generators of economic activity:

- **On-airport Activity.** Airports function as regional job centers by providing services to airlines, airline passengers, and general aviation (GA) pilots and their aircraft, and other support and facilities services. Airports also support the economy through capital expenditures for construction drawn from federal, state, and local governments and by tenants such as those building out terminal concession areas or new private hangars.

- **Visitor Spending.** Airports serve as gateways for out of state tourists and business travelers. Visitors who arrive by scheduled commercial service or GA aircraft spend money on lodging, food, retail, entertainment, and local transportation and otherwise support Washington's hospitality industry.

As discussed in **Chapter 1. Economic Impact Approach**, this study describes the different levels of economic impacts in terms of direct impacts, supplier sales, and income re-spending. Supplier sales and income re-spending are also referred to as "multiplier effects". These key terms are summarized in **Table 2.1**; the table also presents the economic term for reference.

Table 2.1. Key Terms: Types of Economic Impact

Terminology	Definition	Economic Term
Direct	Initial effects resulting from economic activities occurring on airport property and spending by out of state or international visitors who arrive by air	Direct
Supplier Sales	Portions of direct revenues used to purchase goods and services from Washington businesses	Indirect
Income Re-spending	Income earned by workers from direct and supplier sales transactions that are then spent in the state (household spending)	Induced

Source: EBP US 2020

These three types of economic impact are expressed using the following economic measures (also referred to as categories):

- **Jobs.** Number of employed people
- **Labor Income.** Salaries, wages, and other benefits to workers
- **Value added.** Representing the industry's contribution to the Washington State Product (WSP) and the U.S. Gross Domestic Product (GDP), this measure equates to the value contributed to a product or service by a firm or group of firms (in this case, airport businesses)
- **Business revenues.** Represents total economic impacts

It is important to note that value added is not presented at the statewide level in this study. The economic impacts of Seattle-Tacoma International Airport (Sea-Tac or SEA) were obtained from the "Sea-Tac International Airport Economic Impacts" study completed in 2018 and incorporated into the results of the Washington AEIS.[2] Because the SEA study did not calculate value added, this measure can only be presented at the individual airport level.

Table 2.2 summarizes the economic contribution generated by Washington's airports by impact category. The Washington AEIS reveals that the state's 134 public-use airport annually generate over 407,000 jobs worth $26.8 billion in labor income, and $107.0 billion in business revenues.

[2] Community Attributes, Inc. (January 2018). "Sea-Tac International Airport Economic Impacts." Prepared for the Port of Seattle.

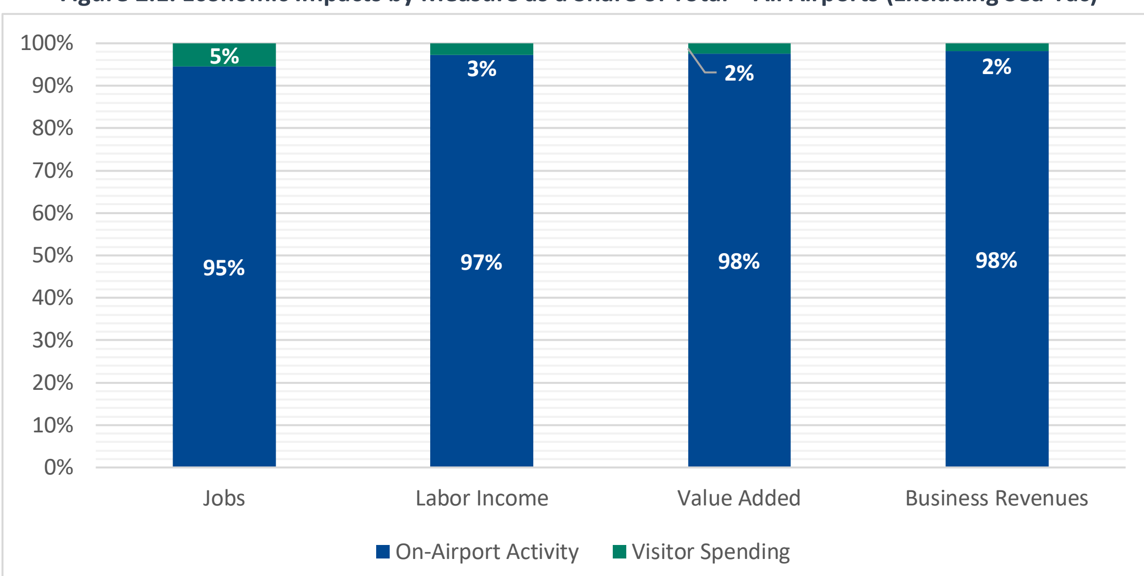
Table 2.2. Summary of Economic Impacts by Measure

Category	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Excluding Sea-Tac				
On-Airport Activity	241,656	$19,168,219,000	$38,283,086,000	$83,025,194,000
Visitor Spending	13,984	$533,182,000	$943,314,000	$1,536,971,000
Sub Total	255,640	$19,701,401,000	$39,226,400,000	$84,562,165,000
Including Sea-Tac				
On-Airport Activity	44,000	$2,760,300,000	N/A	$10,120,500,000
Visitor Spending	107,400	$4,339,300,000	N/A	$12,357,500,000
Sub Total	151,400	$7,099,600,000	N/A	$22,478,000,000
TOTAL	**407,040**	**$26,801,001,000**	**N/A**	**$107,040,165,000**

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

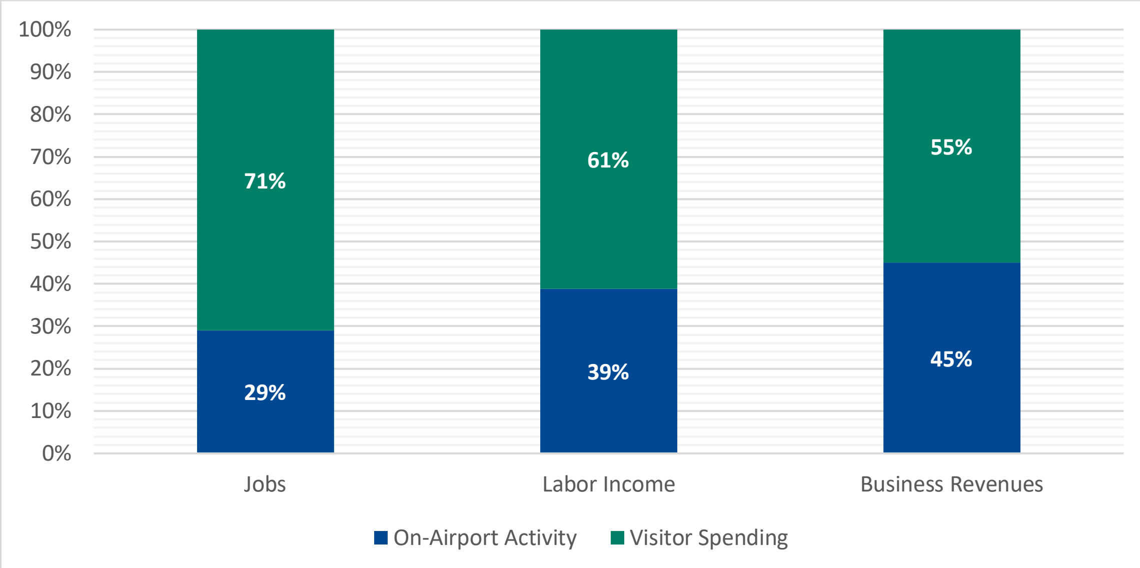
Figure 2.1 presents the total economic impact of all Washington airports except Sea-Tac in terms of on-airport activity and visitor spending. As shown, 95 to 97 percent of each measure of economic impact from all Washington airports excluding Sea-Tac are due to on-airport activities. **Figure 2.2** presents the same analysis for Sea-Tac. In comparison, this figure shows that only 29 to 45 percent of impacts at Sea-Tac are associated with on-airport activities. This demonstrates the importance of Sea-Tac to the state's tourism industry.

Figure 2.1. Economic Impacts by Measure as a Share of Total – All Airports (Excluding Sea-Tac)



Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Figure 2.2. Economic Impacts by Category as a Share of Total (Sea-Tac Only)



Note: This study did not calculate value added. Source: Community Attributes 2018

Airport administration, airport tenants, capital improvements, and visitor spending facilitated by airports provided by Washington's airports supports between 8 and 12 percent of the state economy, depending on the measure used (**Table 2.3**). The higher contribution to business revenues relative to the share of jobs and labor income is due in large part to Washington's robust aviation and aerospace manufacturing industries.

Table 2.3. Washington Airports Contribution to the State Economy

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Total Impacts (Airports)	407,040	$26,801,001,000	N/A	$107,040,165,000
Washington Economy	4,560,332	$325,562,300,000	N/A	$874,313,797,080
% of WA Economy	8.9%	8.2%	N/A	12.2%

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Washington's airports support between 8 and 12 percent of the state economy, including nearly nine percent of all jobs and eight percent of labor income. The significance of these contributions is in large part due to Washington's robust aviation and aerospace manufacturing industries.

2.2 Economic Impacts of On-airport Activities and Visitor Spending

This section provides greater detail regarding direct and multiplier effects from on-airport and visitor spending activities.[3] **Table 2.4** presents this detail for the sum of all airports excluding Sea-Tac. It is interesting to note that, of the nearly $84.6 billion in impacts to business revenues, approximately two-thirds were due to direct activities ($56.4 billion), with $15.4 billion (18 percent) in supplier sales and $12.8 billion (15 percent) in income re-spending. The high share of direct impacts to multiplier effects is attributable in large part to the strength of the state's aviation and aerospace manufacturing industry.

The data reveals that the majority of the total economic impact of Washington's airports (excluding Sea-Tac) is generated by direct on-airport employment and capital improvements, as well as non-local visitors who depend on air travel. To enhance airports' abilities to be economic engines for their communities, GA and commercial service airports should cultivate business-friendly on-airport environments to increase the number of business tenants located at their facilities. For example, airports can partner with local chambers of commerce or economic development organizations to identify and implement strategies to address local business needs and potentially attract new businesses based on the attributes of the airport and the community. Airport managers should also work with existing tenants to see if there are ways the airport can support additional on-airport economic activity. Airports can start by simply asking tenants if there is anything they can do to help expand their on-airport operations, which could bring additional employees to the property.

Table 2.4. Economic Impacts of On-airport and Visitor Spending – Total (Excluding Sea-Tac)

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Direct	88,973	$10,740,711,000	$24,111,467,000	$56,375,293,000
Supplier Sales	78,435	$5,011,601,000	$7,832,828,000	$15,402,431,000
Income Re-spending	88,232	$3,949,089,000	$7,282,105,000	$12,784,441,000
Total	**255,640**	**$19,701,401,000**	**$39,226,400,000**	**$84,562,165,000**

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table 2.5 presents this same information, this time incorporating impacts generated by Seattle-Tacoma International Airport (Sea-Tac). The difference in share of direct impacts across categories when Sea-Tac is added into the mix is particularly notable. For example, share of jobs from direct activities increases from 35 percent for all airports excluding Sea-Tac to 43 percent when Sea-Tac is included. This demonstrates the strength of on-airport and visitor expenditures at Sea-Tac and underscores the airport's importance to statewide tourism. Another notable result is the amount of business revenues, both direct and multiplier effects, generated by airports other than Sea-Tac. Nearly 80 percent of total business revenues are generated by airports other than Sea-Tac, including 83 percent of direct impacts, 78 percent of supplier sales, and 66 percent of income re-spending. This is further evidence of the

[3] On-airport activity and visitor spending are described in greater detail in Sections 2.2.1 and 2.2.2 respectively, along with detailed results from each source.

strength of the aviation and aerospace manufacturing across the state, much of which takes place largely at airports besides Sea-Tac.

Table 2.5. Economic Impacts of On-airport and Visitor Spending – Total (Including Sea-Tac)

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Direct	176,273	$14,391,511,000	N/A	$67,856,593,000
Supplier Sales	101,135	$6,263,101,000	N/A	$19,854,231,000
Income Re-spending	129,632	$6,146,389,000	N/A	$19,329,341,000
Total	**407,040**	**$26,801,001,000**	**N/A**	**$107,040,165,000**

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

In addition to the strategies noted above regarding on-airport tenant activity, commercial service airports are generally better positioned than GA facilities to increase their economic impacts associated with visitor spending. Airports can first identify industries typically reliant on air passenger service for non-local travel for activities such as marketing, sales, client relations, and other purposes. Business/corporate travel can occur at commercial service or GA facilities; however, businesses that fly via GA are less common than those that utilize scheduled commercial service offered by Primary airports. The Airport Cooperative Research Program (ACRP) provides a self-assessment guide to help airports consider the types of local industries that may have a high propensity to rely on air travel.[4] The ACRP self-assessment guide identifies these businesses as financial services; administrative and support services; professional, scientific, and technical services; and high-tech manufacturing. Additionally, airports should network with local tourism agencies, major tourist attractions, and convention centers that often attract non-local visitors traveling for business or leisure. These partnerships can be mutually beneficial, as airports can post signage and other marketing materials for local attractions in areas frequented by air travelers. In turn, these local attractions and agencies can recommend that travelers access the region through specific airports. The ACRP provides additional resources for airports striving to increase their economic impact in its online Aviation Toolkit available at https://crp.trb.org/acrp0331/aviation-toolkit/.

2.2.1 Economic Impacts of On-airport Activity

The previous section discussed the combined impacts of on-airport activity and visitor spending. This section addresses on-airport activity on its own. Airports are economic generators because of the jobs and income created by providing air travel and related services at both commercial and GA airports. As summarized below, there are three main categories of on-airport economic activity:

- **Airport administration.** Airport operations and management, which may include facility and grounds maintenance and other administrative needs.
- **On-airport tenants.** Airlines; fixed base operators (FBOs); maintenance, repair, and overhaul companies (MROs); avionics and other aircraft service companies; terminal concessions (e.g.

[4] ACRP (no date). "Identifying Airport-Reliant Businesses." Available online at https://crp.trb.org/wp-content/uploads/sites/7/2016/10/E2_Tool1-IdentifyingAirportReliantBusinesses.pdf (accessed June 2020).

restaurants and retailers) ; as well as on-airport warehouses/trucking, hotels, and other types of businesses that pay rent or fees to the airport and have establishments on airport property. Airport tenants may also include impacts of surface transportation providers (companies that move passengers to and from airports including taxis, Transportation Network Companies [TNCs, such as Uber and Lyft], private buses/vans, and public transportation), and air cargo (FedEx/UPS/other) that operate at a Washington airport.

- **Capital improvements.** Airport infrastructure improvements and tenant construction.

Recall that **Figure 2.1** indicated that on-airport visitor spending accounts for 95 to 98 percent of impacts at all airports excluding Sea-Tac. **Table 2.6** presents additional details associated with on-airport impacts from this group of airports. As the table shows, these airports supported 241,656 jobs, $19.2 billion in labor income, $38.3 billion in value added, and $83.0 billion in business revenues. Jobs impacts were generated relatively evenly between direct impacts, supplier sales, and income re-spending activities. In contrast, direct expenditures account for the majority of impacts expressed by the three other measures. This reflects the high salaries, value added, and business revenue associated with Washington's aerospace manufacturing industry.

> *The composition of impact types associated with on-airport activities reflects the high salaries, value added, and business revenues associated with Washington's aerospace manufacturing industry.*

Table 2.6. Economic Impacts of On-airport Activity (Excluding Sea-Tac)

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Direct	79,041	$10,424,935,000	$23,553,792,000	$55,489,979,000
Supplier Sales	76,512	$4,903,449,000	$7,645,695,000	$15,080,239,000
Income Re-spending	86,103	$3,839,835,000	$7,083,599,000	$12,454,976,000
Total	**241,656**	**$19,168,219,000**	**$38,283,086,000**	**$83,025,194,000**

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020. Calculations by EBP US 2020 using the 2017 IMPLAN model

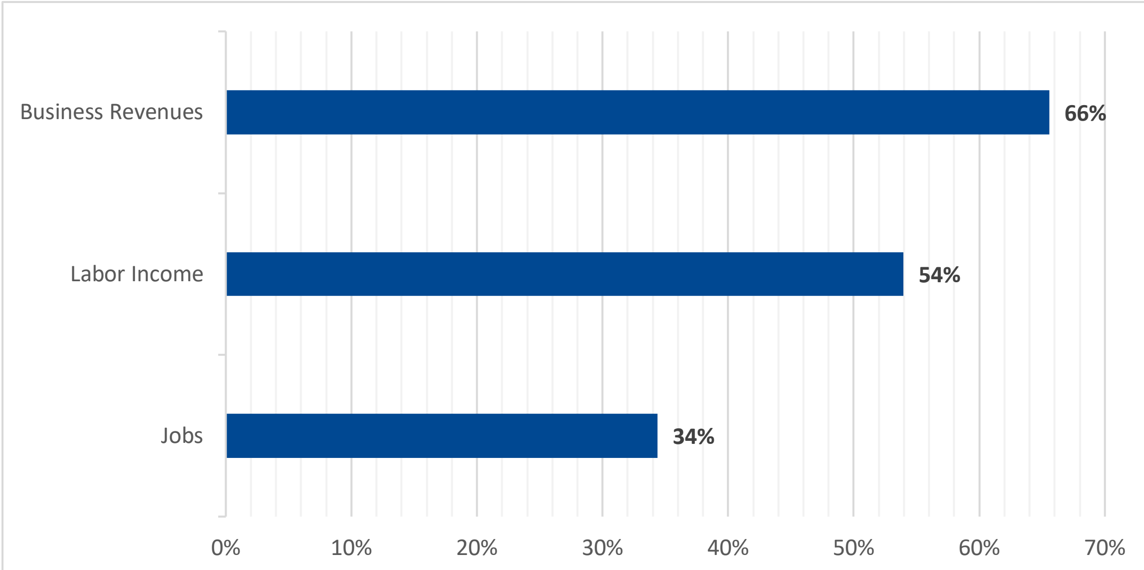
Table 2.7 presents details for on-airport impacts, and **Figure 2.3** illustrates direct impacts as a share of total impacts. Of note, approximately two-thirds of business revenues of $93.1 billion were from direct activity.

Table 2.7. Economic Impacts of On-Airport Activity – Total (Including Sea-Tac)

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Direct	98,141	$11,827,935,000	N/A	$61,064,779,000
Supplier Sales	85,312	$5,406,449,000	N/A	$17,081,339,000
Income Re-spending	102,203	$4,694,135,000	N/A	$14,999,576,000
Total	**285,656**	**$21,928,519,000**	**N/A**	**$93,145,694,000**

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Figure 2.3. Direct Economic Impacts as a Share of Total On-Airport Activity (Including Sea-Tac)



Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

2.2.2 Economic Impacts of Visitor Spending

Airports in Washington state function as gateways for out of state visitors who travel for personal and business reasons. These visitors use both commercial service and GA airports to arrive at their destinations and typically spend money in the following categories:

- Accommodations
- Food and beverage
- Local ground transportation
- Retail
- Entertainment

Spending by commercial service and GA visitors brought nearly $7.0 billion into Washington from international and domestic out of state locations. This spending supports local businesses, creates jobs, and provides income earned by employees that work in these hospitality-oriented businesses. Spending by visitors also generates multiplier effects as hospitality businesses purchase goods and services from Washington-based suppliers and as employees spend their income on household purchases.

Note visitor spending specifically refers to out of state or international visitors who bring new money into Washington. Washington residents traveling within the state, or transit passengers who arrive at a Washington airport but depart to another ultimate destination, are excluded from the analysis.

2.2.2.1 Commercial Service Airport Visitor Spending

As described in **Chapter 1 (Section 1.2.2.1)**, the Washington AEIS determined that commercial service visitor spending was applicable to 13 airports in the scope of the study (excluding Sea-Tac). These airports include all Primary commercial service airports as defined in the Federal Aviation Administration (FAA) *Report to Congress - National Plan of Integrated Airport Systems (NPIAS) 2019-2023* (NPIAS Report) except SEA, as well as Kenmore Air Harbor (W55) on Lake Union and Kenmore Air Harbor Inc. (S60) on Lake Washington. These airports were confirmed to provide scheduled commercial service to out of state or international destinations.

Commercial service visitor spending is a function of the total number of visitors to Washington times the amount of spending per trip. Overall, commercial service airport visitors to Washington spent approximately $6.6 billion off-airport, including $5.9 billion by visitors traveling through Sea-Tac and $700.0 million by visitors traveling through all other commercial service airports in the state. **Table 2.8** shows the number of visitors by airport, visitor spending by trip, and total commercial service spending identified by the Washington AEIS. This money was spent in a variety of hospitality industries as profiled in Chapter 1 (**Section 1.2.2.2**).

Table 2.8. Commercial Visitors and Spending by Airport Developed by the Washington AEIS, 2018

Associated City	Airport Name	FAA ID	Number of Visitors (no.)	Visitor Spending per Trip ($)	Total Commercial Service Spending ($)
Bellingham	Bellingham International	BLI	95,979	$828	$79,471,000
Friday Harbor	Friday Harbor	FHR	1,568	$549	$861,000
Kenmore	Kenmore Air Harbor Inc	S60	1,342	$876	$1,176,000
Pasco	Tri-Cities	PSC	146,682	$487	$71,434,000
Pullman/ Moscow	Pullman/Moscow Regional	PUW	27,297	$551	$15,041,000
Seattle	Boeing Field/King County International	BFI	5,549	$876	$4,861,000
Seattle	Kenmore Air Harbor	W55	6,974	$876	$6,109,000
Spokane	Spokane International	GEG	843,467	$567	$478,246,000
Walla Walla	Walla Walla Regional	ALW	20,214	$689	$13,927,000
Wenatchee	Pangborn Memorial	EAT	25,841	$363	$9,380,000
Yakima	Yakima Air Terminal (McAllister Field)	YKM	24,372	$487	$11,869,000
Total			**1,199,285**	**N/A**	**$692,375,000**

Notes: Totals represent total visitor spending and do not account for retail margining effects. The Sea-Tac Economic Impact Study reported $5,906,500,000 in off-airport spending (Community Attributes, Inc. 2018). Sources: Airline Data, Inc. 2018, Dean Runyan, Inc. 2018, IMPLAN 2017. Calculations by EBP US 2019

2.2.2.2 GA Visitor Spending

All airports in the scope of this study support GA, which is defined as all civil aviation except scheduled commercial service.[5] Like the commercial service analysis, the analysis of GA visitors only looks at out of state or international visitors known as "true transients" or "true visitors". This number represents a percent of itinerant departures, after visitors have spent money in the state. Based on the methodology presented in **Chapter 1 (Section 1.2.2.2)**, Washington's airports are estimated to support between 20 and 51 percent true transient operations. The Washington AEIS then estimated the number of persons per departure based on state classification and the average spending per person per trip based on industry averages tailored to Washington's regional economies.

As the final step in this process, the AEIS multiplied the number of arriving out of state visitors by airport-specific visitor expenditure profiles. The outcome of this process represents the GA visitor spending for each airport in the scope of the study. This analysis revealed that visitors relying on the state's GA airport services contributed more than $285 million.

2.2.2.3 Economic Impacts of Visitor Spending

Table 2.9 presents the direct impacts of visitor spending for passengers departing via scheduled commercial service and GA. **Figure 2.4** further illustrates this information, showing the share of direct impacts from scheduled commercial service and GA activities as a share of total direct impacts.

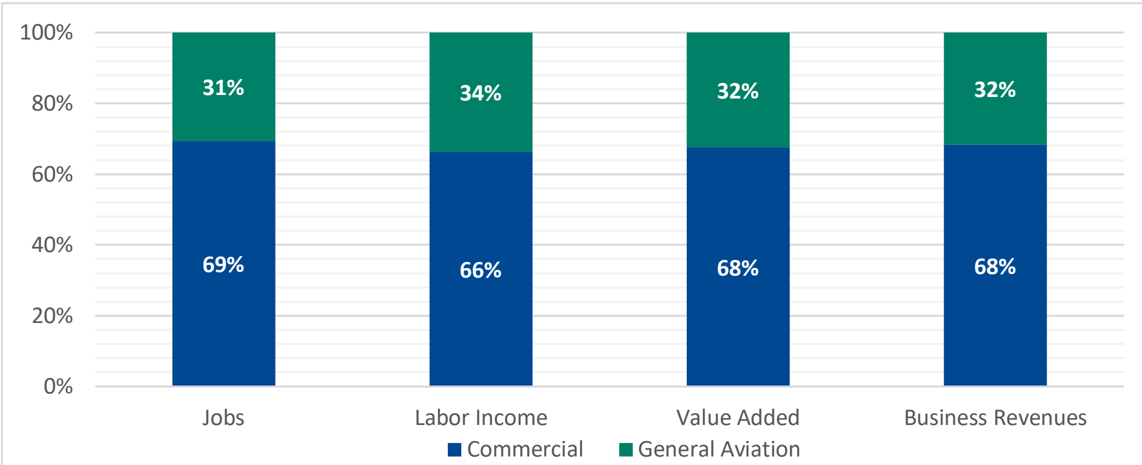
Table 2.9. Direct Impacts from Visitor Spending (Including Sea-Tac)

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Commercial Service	75,043	$2,455,304,000	N/A	$6,506,568,000
GA	3,089	$108,271,000	N/A	$285,243,000
Total	**78,132**	**$2,563,575,000**	**N/A**	**$6,971,811,000**

Notes: Numbers may not sum due to rounding. The direct impacts calculated by EBP US (all airports except Sea-Tac) accounted for retail margining effects. It is unclear if Sea-Tac's direct impact accounted for retail margining. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018., Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

[5] The Sea-Tac Economic Impact Study did not calculate the economic impact of GA activity at the airport; as a result, the GA visitor spending analysis only include 133 Washington system airports.

Figure 2.4. Direct Impacts from Visitor Spending - Share of Impacts from Commercial Airports vs. GA (Excluding Sea-Tac)



Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table 2.10 presents the combined visitor spending impacts from all airports except Sea-Tac. Recall from Figure 2.1 that these impacts make up a very small share of the combined impacts from on-airport and visitor spending impacts, ranging from two to five percent. Of 13,984 jobs created by visitor spending among this group of airports, the majority (71 percent) were direct, compared to labor income where $315.8 million (59 percent) was direct.

Table 2.10. Economic Impacts of Visitor Spending – Total (Excluding Sea-Tac)

Impact Type	Jobs	Labor Income	Value Added	Business Revenues
Direct	9,932	$315,776,000	$557,675,000	$885,314,000
Supplier Sales	1,923	$108,152,000	$187,133,000	$322,192,000
Income Re-spending	2,129	$109,254,000	$198,506,000	$329,465,000
Total	**13,984**	**$533,182,000**	**$943,314,000**	**$1,536,971,000**

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table 2.11 presents the economic impacts of visitor spending for all airports including Sea-Tac. In contrast to the economic impacts of visitor spending excluding Sea-Tac shown in Table 2.10, where multiplier impacts are relatively equally split between supplier sales and income re-spending, when Sea-Tac is added to the total, multiplier impacts are weighted in favor of impacts from income re-spending more or less two-thirds to one-third depending on the measure.

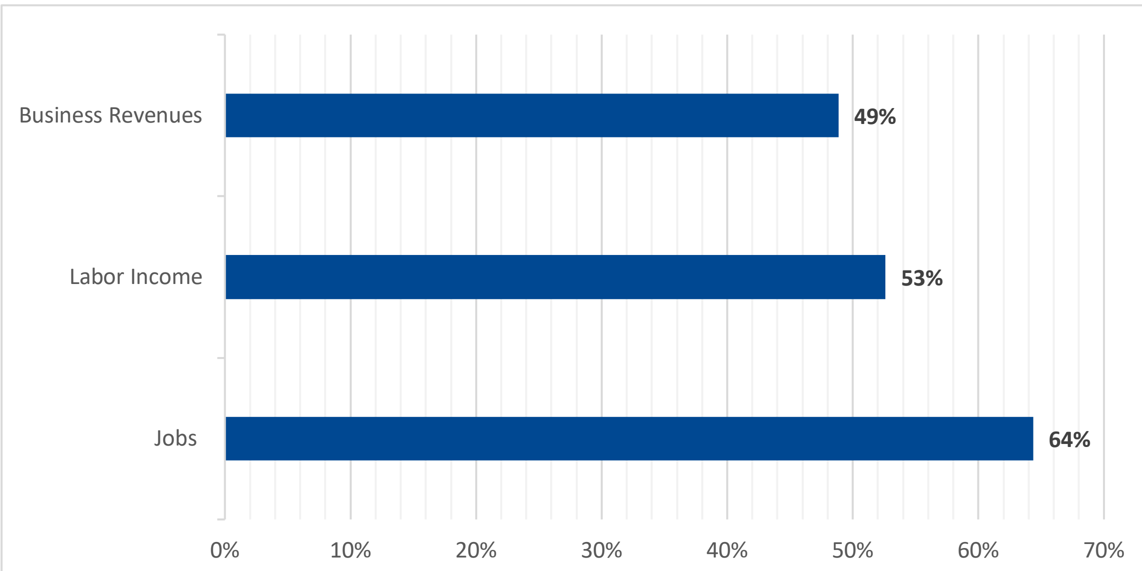
Table 2.11. Economic Impacts of Visitor Spending – Total (Including Sea-Tac)

Impact Type	Jobs	Labor Income	Value Added	Business Revenues
Direct	78,132	$2,563,576,000	N/A	$6,791,814,000
Supplier Sales	15,823	$856,652,000	N/A	$2,772,892,000
Income Re-spending	27,429	$1,452,254,000	N/A	$4,329,765,000
Total	**121,384**	**$4,872,482,000**	**N/A**	**$13,894,471,000**

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Figure 2.5 presents direct impacts as a share of total impacts for all airports including Sea-Tac. Direct impacts account for nearly two-thirds of jobs impacts, a little over half of labor income impacts, and about half of impacts to business revenues. Compared with the distribution associated with on-airport activities shown in Figure 2.4, which excluded the impacts of Sea-Tac, direct impacts to labor are a similar share of the total, but direct impacts to business revenues are much smaller (49 percent versus 66 percent), while the share of direct impacts to jobs is nearly twice as high as its share without Sea-Tac (64 percent versus 34 percent).

Figure 2.5. Direct Economic Impacts as a Share of Total Visitor Spending (Including Sea-Tac)



Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

2.2.3 Multiplier Effects – Impacts to Supplier Sales and Income Re-spending

This section provides additional detail regarding the multiplier impacts consisting of supplier sales and income re-spending for Washington airports excluding Sea-Tac. The multiplier effect reflecting impacts generated from supplier sales and income re-spending contributes between 33 and 65 percent of additional economic activity across all economic measures. This means that for every direct job created or direct dollar generated, the multiplier effect creates nearly an additional two jobs or an additional $0.50 within the Washington economy.

Table 2.12. Multiplier Effects as a Share of Total Economic Impacts (Excluding Sea-Tac)

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Direct	88,973	$10,740,711,000	$24,111,467,000	$56,375,293,000
Supplier Sales	78,435	$5,011,601,000	$7,832,828,000	$15,402,431,000
Income Re-spending	88,232	$3,949,089,000	$7,282,105,000	$12,784,441,000
Total Multiplier Effects	166,667	$8,960,690,000	$15,114,933,000	$28,186,872,000
Total	**255,640**	**$19,701,401,000**	**$39,226,400,000**	**$84,562,165,000**
Multiplier Effects				
Multiplier % of Total	65%	45%	39%	33%

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

For every direct job created or direct dollar generated, the multiplier effect creates nearly an additional two jobs or an additional $0.50 within Washington.

2.2.4 Economic Impacts to Industries

The economic impacts of airports are distributed throughout the state economy, depending on each industry's relative reliance on airports and aviation, as well as other industry characteristics such as whether they are labor intensive or capital intensive. This section highlights differences in how the multiplier effects of supplier sales and income re-spending are distributed to Washington industries.

Table 2.13 presents the top 10 industries by supplier sales (on the left) and income re-spending (on the right) impacts, as measured by jobs. From both multiplier sources, the top 10 industries encompass between 83 percent and 86 percent of impacts to all industries.

The list of industries on the left is ranked by supplier sales impacts and shows jobs generated in business-serving industries such as professional and scientific, business services, and management services. The list on the right is associated with income re-spending and shows job impacts generated in population-serving industries such as health care and social assistance, retail trade, and restaurants. While approximately half the industries appear on both lists (noted with *), their relative positions on each list reflect the extent to which they are business-serving versus population-serving.

Key transportation-related industries such as transportation equipment manufacturing, truck transportation, and wholesale trade, appear only on the list ranked by supplier sales. Likewise, industries of retail trade and arts, entertainment, and recreation appear only on the list ranked by income re-spending. The leading job generator from income re-spending is health care and social assistance as the sector accounts for a large share of household budgets and many hospital workers and social assistance providers are low-wage earners. Interestingly, however, this sector is not among the leaders in business revenue generated from income re-spending as dollars as well as jobs are also reported through finance and insurance companies (as will be seen in **Table 2.14**).

Table 2.13. Top Industries by Supplier Sales and Income Re-spending – Jobs Impacts (Excluding Sea-Tac)

Supplier Sales			Income Re-spending		
Industry Description	Jobs (no.)	% of Total	Industry Description	Jobs (no.)	% of Total
Professional & Scientific Services*	16,536	21%	Health Care & Social Assistance	16,167	18%
Business Services *	12,792	16%	Retail Trade	13,513	15%
Management Services	9,188	12%	Restaurants*	10,634	12%
Wholesale Trade	7,593	10%	Other Services	10,293	12%
Transportation Equipment Manufacturing	6,062	8%	Real Estate*	5,293	6%
Media & Information	3,478	4%	Finance & Insurance*	5,020	6%
Real Estate*	3,023	4%	Professional & Scientific Services*	4,832	5%
Finance & Insurance*	2,276	3%	Business Services *	4,074	5%
Restaurants*	2,146	3%	Arts, Entertainment & Recreation	3,379	4%
Truck Transportation	1,838	2%	Education Services	2,968	3%
All Other Industries	13,506	17%	All Other Industries	12,062	14%
Total – All Industries	**78,438**	**100%**	Total – All Industries	**88,235**	**100%**

*Notes: *Indicates sector ranks among the leading ten sectors in both Supplier Sales and Income Re-Spending. Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model*

Table 2.14 presents the same analysis for business revenues. As measured by business revenues, the top 10 industries for both supplier sales and income re-spending account for over 80 percent of their respective totals. As when measured by jobs, the list of industries on the left, which is ranked by supplier sales impacts, clearly favors business-serving industries while the list on the right, which is ranked by income re-spending, favors population-serving industries. When ranked this way by business revenues, the impact of the state's strong aviation and aerospace manufacturing industry is apparent, particularly by the strength of the transportation equipment manufacturing, management services, and professional and scientific industries.

Table 2.14. Top Industries by Supplier Sales and Income Re-spending – Business Revenues Impacts (Excluding Sea-Tac)

Supplier Sales			Income Re-spending		
Industry Description	Business Revenues ($)	% of Total	Industry Description	Business Revenues ($)	% of Total
Transportation Equipment Manufacturing	$3,205,544,000	21%	Real Estate*	$2,669,593,000	21%
Management Services	$1,975,438,000	13%	Retail Trade	$1,785,509,000	14%
Wholesale Trade	$1,709,104,000	11%	Restaurants	$1,285,906,000	10%
Professional & Scientific Services*	$1,696,259,000	11%	Other Services	$1,171,526,000	9%
Media & Information	$1,192,726,000	8%	Real Estate	$780,398,000	6%

Supplier Sales		
Industry Description	Business Revenues ($)	% of Total
Business Services*	$1,019,368,000	7%
Real Estate*	$814,921,000	5%
Finance & Insurance*	$478,428,000	3%
Utilities	$352,715,000	2%
Truck Transportation	$290,740,000	2%
All Other Industries	$2,667,193,000	17%
Total – All Industries	**$15,402,436,000**	**100%**

Income Re-spending		
Industry Description	Business Revenues ($)	% of Total
Finance & Insurance*	$730,478,000	6%
Professional & Scientific Services*	$592,873,000	5%
Business Services*	$570,698,000	4%
Arts, Entertainment & Recreation	$548,786,000	4%
Education Services	$330,409,000	3%
All Others	$2,318,274,000	18%
Total – All Industries	**$12,784,450,000**	**100%**

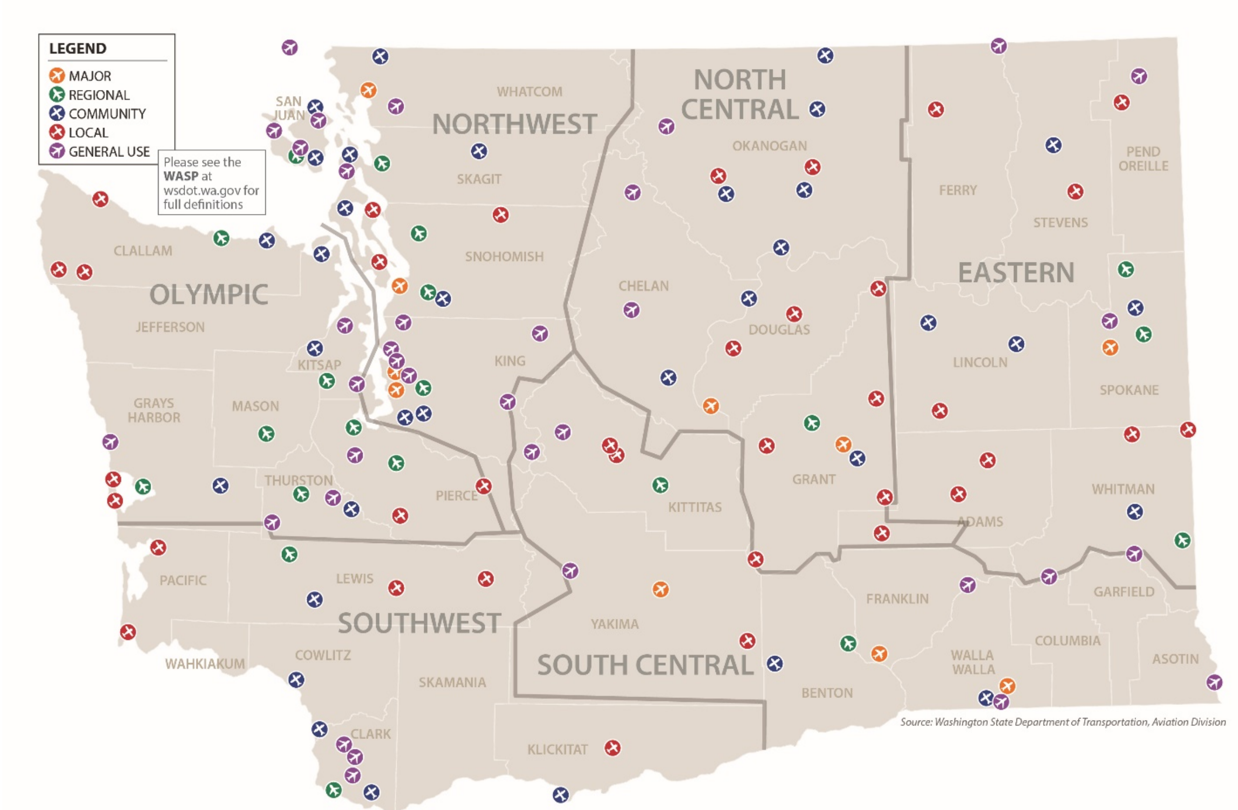
*Notes: *Indicates sector ranks among the leading ten sectors in both Supplier Sales and Income Re-Spending. Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model*

2.3 Impacts by Region

This section presents direct impacts by region to provide airport managers and area officials, residents, and stakeholders with a more localized profile of airports' economic impacts that recognizes the ways that local economies vary across Washington. Productivity factors, cost of living, and salaries differ in metropolitan districts, resort areas, and rural locations; across the eastern to western sections of the state; and from north to south. This means that across Washington there are different industry mixes, wage rates, business revenues, and sales per employee. A regional approach best reflects these local economic characteristics supported by each airport rather than using statewide averages. When direct impacts are estimated, regional economies are used to determine the relationships of jobs, labor income, value added and business revenue by business activity. For this reason, direct impacts are all estimated at regional levels. **Figure 2.7** and **Table 2.15** define the regional location of each airport in the Washington AEIS. Figure 2.7 illustrates the concentration of commercial and GA airports located in each region, while Table 2.15 lists the counties per region.

> *When direct impacts are estimated, regional economies are used to determine the relationships of jobs, labor income, value added, and business revenue by business activity. For this reason, direct impacts are all estimated at regional levels.*

Figure 2.6. Washington System Airports by Region



Source: WSDOT 2019

Table 2.15. Counties in Each WSDOT Region

Region	Region Name	Counties
1	Eastern	Adams, Ferry, Lincoln, Pend Oreille, Spokane, Stevens, Whitman
2	North Central	Chelan, Douglas, Grant, Okanogan,
3	Northwest	Island, King, San Juan, Skagit, Snohomish, Whatcom
4	Olympic	Clallam, Grays Harbor, Jefferson, Kitsap, Mason, Pierce, Thurston
5	South Central	Asotin, Benton, Columbia, Franklin, Garfield, Kittitas, Walla Walla, Yakima
6	Southwest	Aahkiakum, Clark, Cowlitz, Klickitat, Lewis, Pacific, Skamania

Source: WSDOT 2019

The majority of direct impacts from Washington airports takes place in the Northwest region (see **Table 2.16**). This region generated over 156,000 jobs, more than eight times as many as all other regions combined, largely due to Sea-Tac and Snohomish County Airport/Paine Field (PAE). The region also generates some $64 billion in business revenues—almost 18 times higher than the other regions combined. This is largely due to the state's robust aviation and aerospace manufacturing industry, which is concentrated in this region, and visitor spending impacts through Sea-Tac.

Table 2.16. Direct Impacts by Region (Including Sea-Tac)

Region	Region	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
1	Eastern	8,614	$364,382,000	$614,218,000	$1,041,303,000
2	North Central	2,297	$157,264,000	$295,799,000	$872,842,000
3	Northwest	156,096	$13,346,346,000	NA	$64,032,353,000
4	Olympic	3,722	$249,124,000	$399,995,000	$937,428,000
5	South Central	3,948	$206,922,000	$371,030,000	$775,987,000
6	Southwest	1,596	$67,473,000	$114,854,000	$196,680,000

Note: Numbers may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table 2.17 summarizes total impacts of airports by WSDOT region. The intent of this table is to show the overall importance of airports to the economies of the regions where they are situated. As described in the introduction to this chapter, Table 2.17 employs regional-specific multiplier analyses that separately account for the unique economies of each multi-county region. Spillovers effects of supplier sales or income re-spending—which occur when goods are purchased or worker income is re-spent at businesses located in a different region than the airport--are not represented in the table. This analysis presents the benefits accruing within each region from Washington airports. As a result, the total regional impacts presented here cannot be compared to the statewide impacts presented in Section 2.2 above.

Table 2.17. Total Regional Impacts by Region (Including Sea-Tac)

Region	Region	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
1	Eastern	12,632	$564,031,000	$963,534,000	$1,648,008,000
2	North Central	3,699	$218,502,000	$407,441,000	$1,074,620,000
3	Northwest	333,157	$24,063,515,000	N/A	$97,583,786,000
4	Olympic	6,319	$376,129,000	$621,600,000	$1,318,979,000
5	South Central	6,253	$318,313,000	$560,056,000	$1,106,824,000
6	Southwest	2,127	$91,084,000	$160,004,000	$270,961,000

Notes: Numbers may not sum due to rounding. Sea-Tac totals in the Northwest region represent statewide impacts calculated by Community Attributes, Inc. (2018), as that study did not calculate regional impacts. Additionally, the Sea-Tac Economic Impact Study did not report value added. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

2.4 Economic Impacts by Legislative District

Total statewide economic impacts organized by legislative district are presented in **Table 2.18.** Including statewide multipliers, Districts 21 and 33 combined account for about 75 percent of the jobs in the state, driven by Snohomish County/Paine Field (PAE) and Sea-Tac International Airport (SEA).

Table 2.18. Total Impacts by Legislative District

Legislative District	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
2	16	$1,101,000	$2,088,000	$4,379,000
3	463	$27,355,000	$45,514,000	$78,749,000
5	1	$27,000	$41,000	$67,000

Legislative District	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
6	11,566	$548,692,000	$936,830,000	$1,551,345,000
7	182	$8,805,000	$14,103,000	$25,573,000
8	682	$44,083,000	$65,619,000	$114,194,000
9	980	$49,683,000	$80,681,000	$141,893,000
10	443	$29,897,000	$49,192,000	$87,196,000
11	18,680	$1,285,590,000	$1,723,303,000	$3,039,820,000
12	1,441	$77,370,000	$125,936,000	$284,289,000
13	3,487	$247,321,000	$451,579,000	$1,068,439,000
14	255	$20,381,000	$37,012,000	$66,291,000
15	2,404	$163,153,000	$292,203,000	$596,244,000
16	3,763	$177,258,000	$313,485,000	$554,275,000
17	3	$70,000	$116,000	$193,000
18	23	$1,825,000	$3,278,000	$5,852,000
19	138	$9,632,000	$17,244,000	$30,714,000
20	1,715	$71,451,000	$120,785,000	$195,744,000
21	158,226	$13,039,481,000	$27,149,487,000	$59,915,295,000
22	524	$34,620,000	$56,740,000	$105,991,000
23	5	$437,000	$758,000	$1,543,000
24	423	$20,288,000	$34,220,000	$58,973,000
25	258	$15,135,000	$24,934,000	$46,133,000
26	685	$39,387,000	$73,592,000	$160,334,000
28	1	$5,000	$8,000	$13,000
31	1	$33,000	$51,000	$85,000
33	151,400	$7,099,500,000	N/A	$22,477900,000
35	5,545	$372,641,000	$601,647,000	$1,226,949,000
37	35,471	$2,946,367,000	$6,134,477,000	$13,641,059,000
39	2,658	$165,708,000	$359,810,000	$671,387,000
40	845	$56,161,000	$93,183,000	$164,385,000
42	2,947	$159,571,000	$271,563,000	$472,112,000
43	2	$60,000	$96,000	$162,000
44	566	$24,099,000	$44,635,000	$78,400,000
46	613	$30,787,000	$47,194,000	$78,008,000
47	338	$19,287,000	$31,755,000	$56,138,000
49	290	$13,640,000	$23,241,000	$39,941,000
Total	**407,042**	**$26,800,901,000**	**$39,226,400,000**	**$107,040,065,000**

Notes: Numbers may not sum due to rounding. Sea-Tac totals in District 33 not report value added. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Community Attributes, Inc. 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

2.5 Tax Revenue Analysis

In addition to contributing to the economy in terms of jobs, labor income, value added, and business revenues, Washington airports generate tax revenues for state and local governments. These tax revenues are realized from direct activity at commercial service and GA airports, first-round visitor spending, and purchases made from wages earned on-airport by airport and tenant employees. Multiple rounds of spending via supplier sales and income re-spending result in additional revenues to the tax base. This section of the Washington AEIS documents the tax rate information obtained as part of this study and reports collections for fiscal year (FY) 2018.

2.5.1 Washington State Taxes and Fees

Washington State taxes for on-airport activities include a hangar tax, aircraft excise tax, aviation fuel tax, and Washington Business and Operating (B&O) tax for FAA Part 145 Repair Stations. Washington off-airport taxes collected for the model focused on tourism-based spending including sales and use tax, hotel tax, and surface transportation taxes including transportation network companies (TNCs). Washington does not have a state income tax. The 2018 taxes and fees for on-airport and off-airport activity are presented in **Table 2.19**.

Table 2.19. Washington Aviation-related State Taxes and/or Fees

Tax or Fee Type	Activity	Rate / Fee	Notes
Hangar/Leasehold Tax	On-airport	12.84%	State tax
Passenger Facility Charge (PFC)	On-airport	$4.50 - $18	$4.50 per segment with a maximum of $18 per passenger. This is a federal tax, but airports use these fees to fund FAA-approved projects for security, safety, capacity, noise reduction, or increase air carrier competition.
Aviation Fuel Excise Tax	On-airport	$0.11	State tax
Aircraft Excise Tax	On-airport	$50 -$125	State fee. Planes over 41,000 pounds are exempt.
B&O - FAA Part 145 Repair Stations	On-airport	0.29%	State tax
Sales and Use Tax	Off-airport	6.50%	State tax includes prepared meals
Hotel Tax	Off-airport	6.50%	State tax. Counties and municipalities can have a local premium in addition to the 6.50%.
Rental Car Taxes	Off-airport	5.90%	State tax
TNC B&O	Off-airport	1.50%	State tax
TNC Public Utility Tax	Off-airport	1.93%	State tax

Source: Washington State Department of Revenue, "2018 Tax Reference Manual" and "Tax Rates." Online at https://dor.wa.gov/about/statistics-reports/tax-reference-manual

Table 2.20 presents state and local tax revenues collected on airports. State taxes include sales and use taxes that were estimated from on-airport purchases and the portion of wages earned by airport workers that were spent on taxable goods. State taxes also include B&O taxes on businesses operating on each airport. In addition, each municipality can have a "local premium" sales & use tax – on top of the state's 6.5 percent on airport purchases and worker spending. Note that taxes were not applied for exempt industry sales.

Table 2.20. On-Airport Tax Impacts, FY 2018 (Including Sea-Tac)

Airport Type	Local ($)	State ($)	Total On-airport ($)
Commercial	$12,693,630	$86,585,870	$99,279,500
GA	$35,454,600	$456,611,030	$492,065,630
Total	**$48,148,230**	**$543,196,900**	**$591,345,130**

Source: Washington State Department of Revenue 2019, Community Attributes 2018. Calculations by EBP US 2019

2.5.2 Visitor Spending Tax Impacts

The taxes and fees presented in Table 2.19 were applied to the commercial service and GA visitor spending estimates by airport developed as part of the Washington AEIS (see Section 2.2.2 above). Ground transportation taxes and fees were split between rental cars, taxis, and shuttles, and TNC fees were based on the Port of Seattle Commission's *Policy Directive on Ground Transportation Principles and Goals*; the appropriate rates were applied from Table 2.19. Additional tax revenues realized from visitor spending are generated from sales and use taxes on taxable categories, predominantly food, retail, restaurants, retail prepared food, taxis, ground shuttles, and restaurants. The results of the estimated tax impacts due to GA and commercial service visitor spending are presented in the following sections.

2.5.2.1 Commercial Service Visitor Spending

Commercial aviation enabled 1.2 million visitor trips to Washington in 2018, excluding Sea-Tac. **Table 2.21** presents off-airport tax revenues by WSDOT region generated from spending by commercial visitors using all commercial service airports excluding Sea-Tac. Of this total (i.e. all commercial service airports except Sea-Tac), the majority of visitor spending occurred in the Eastern Region (Region 1), producing 72 percent of the total statewide impact for commercial aviation visitor spending. As shown in **Table 2.22**, tax revenues were generated in a variety of spending categories, most notably Food and Beverage ($191.5 million), followed by Accommodations ($191.0 million).

Table 2.21. Commercial Service Visitor Spending Tax Impacts by Region, FY 2018 (Excluding Sea-Tac)

Region	Visitors (no.)	Visitor Spending ($Millions)	Tax Impacts ($Millions)
1 – Eastern	870,764	$493.3	$31.3
2 – North Central	25,841	$9.4	$0.6
3 – Northwest	103,096	$85.2	$5.4
5 – South Central	191,268	$97.2	$6.2
Total	**1,190,969**	**$685.1**	**$43.5**

Sources: Airline Data, Inc., Dean Runyan, Inc. 2018. Calculations by EBP US 2019

Table 2.22. Statewide Commercial Service Visitor Spending Tax Impacts by Spending Category, FY 2018 (Excluding Sea-Tac)

Spending Category	Visitor Spending ($Millions)	Tax Impact ($Millions)
Accommodation	$191.0	$12.4
Entertainment	$76.1	$4.9
Food and Beverage	$191.5	$12.4
Ground Transportation	$99.3	$5.4
Retail Food & Beverage*	$47.8	$3.1
Retail (except food & beverage)*	$79.4	$5.2
Total	**$685.1**	**$43.5**

Note: Taxes estimated based on unmargined retail spending (total retail cost to customers). Source: Airline Data, Inc. 2018, Dean Runyan, Inc. 2018. Calculations by EBP US 2019

The tax impacts of visitors arriving in Washington via Sea-Tac are presented in **Table 2.23**, along with the total tax impacts presented in Table 2.22. In total, visitors who depend on commercial service airports generated $234.1 million in tax impacts to the state in FY 2018.

Table 2.23. Commercial Service Visitor Spending Tax Impacts, FY 2018 (Including Sea-Tac)

Airports	Tax Impacts ($Millions
Sea-Tac	$190.6
All Other	$43.5
Total	**$234.1**

Sources: EBP US 2019, Washington State Department of Revenue 2019, Community Attributes 2018. Calculations by EBP US 2019

2.5.2.2 GA Visitor Spending

GA enabled almost a million visitors to travel to Washington in 2018. **Table 2.24** profiles the regional distribution of tax revenues from GA visitors.[6] The largest group of visitors was to Region 3 (Northwest Washington), which produced 50 percent of the total statewide impact for GA visitor spending excluding Sea-Tac. As shown in **Table 2.25**, tax revenues were generated in a variety of spending categories, most notably Food and Beverage ($89.6 million), followed by Accommodations ($75.3 million).

Table 2.24. GA Visitor Spending Tax Impacts Region, FY 2018 (Excluding Sea-Tac)

Region	Visitors (no.)	Visitor Spending ($Millions)	Tax Impact ($Millions)
1 – Eastern	94,186	$23.9	$1.5
2 – North Central	40,824	$13.8	$0.9
3 – Northwest	464,973	$154.6	$9.8
4 – Olympic	209,506	$57.7	$3.7
5 – South Central	92,227	$31.4	$2.0

[6] GA flying occurs both at GA airports and commercial service airports. The Sea-Tax Economic Impact Study did not report the economic impact of GA and it is thus assumed to be excluded from this analysis.

Region	Visitors (no.)	Visitor Spending ($Millions)	Tax Impact ($Millions)
6 – Southwest	92,699	$25.3	$1.6
Total	**994,414**	**$306.6**	**$19.4**

Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2019, EBP US 2019. Calculations by EBP US 2019

Table 2.25. GA Visitor Spending Tax Impacts by Spending Category, FY 2018 (Excluding Sea-Tac)

Spending Category	Visitor Spending ($Millions)	Tax Impact ($Millions)
Accommodation	$75.3	$4.9
Entertainment	$35.6	$2.3
Food and Beverage	$89.6	$5.8
Ground Transportation	$46.5	$2.5
Retail Food & Beverage*	$22.4	$1.5
Retail (except food & beverage)*	$37.2	$2.4
Total	**$306.6**	**$19.4**

Note: Taxes estimated based on unmargined retail spending (total retail cost to customers). *Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2019. Calculations by EBP US 2019*

2.5.3 State Aircraft Taxes

Total tax collections were obtained from the Washington State Department of Revenue. Tax collection details by airport or aircraft activity were not available. At the statewide level, the state collected $367,000 in aircraft excise tax and $2.81 million in aircraft fuel excise tax in FY 2018. The Department of Revenue does not maintain a record of tax collected specifically from tenants who lease hangars from airports. Hangar taxes are collected in Washington via the Leasehold Excise Tax, which is a tax on the use of public property (such as a hangar) by a private entity. All hangar taxes collected go into the leaseholders' tax fund without any way of apportioning out the hangar contribution for reporting purposes.[7]

2.5.4 Total Statewide Tax Impacts of Washington Airports

Table 2.26 presents a summary of tax impacts generated by Washington airports. Total tax impacts embody a four-way combination of state and local taxes that are generated on-airport and by off-airport visitor spending. Note that taxes on purchases made by airport and tenant employees from wages earned on-airport are counted as on-airport in this analysis.

[7] The Leaseholder Excise Tax is a Washington tax on the use of public property by a private party. Public property is property owned by the federal government, State of Washington, counties, school districts, and other municipal corporations. The Leasehold Excise Tax is not exclusive to publicly-owned airport facilities (e.g., hangars) and applies to a broad range of facilities such as school buildings and community centers.

Table 2.26. Total Statewide Tax Impacts of Washington Airports (Including Sea-Tac)

Tax Impacts	Local ($)	State ($)	Total ($)
On-Airport			
Airport Excise & Aircraft Fuel Tax[1]	Not available	$3,177,000	$3,177,000
Commercial & GA[2,3]	$48,148,230	$543,196,900	$591,345,130
Sea-Tac	Not available	$45,700,000	$45,700,000
Off-airport Visitor Spending			
Commercial & GA[2]	$14,235,190	$68,246,700	$82,481,890
Sea-Tac	Not available	$190,600,000	$190,600,000
Total			
Statewide Total	**$62,383,420**	**$850,920,600**	**$913,304,020**

Notes: (1) The Washington State Department of Revenue was only able to provide state-level estimates for this analysis. (2) Excludes Sea-Tac. (3) State taxes include sales and use taxes that were estimated from on-airport purchases and the portion of wages earned by airport workers spent on taxable goods and B&O taxes on businesses operating on each airport. Local taxes reflect municipal "local premium" sales and use tax. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2019, EBP US 2019, Washington State Department of Revenue 2019, Community Attributes 2018. Calculations by EBP US 2019

2.6 Summary

As this study illustrates, airports are much more than just a place to catch a plane. Instead, airports and the aviation industry more broadly serve as the foundation of regional and statewide economies. Directly, airports serve as job centers, facilitate recreational and business travel, and support the design and construction industries during capital improvement projects. As highlighted in **Section 2.4**, businesses in a range of industries not only depend on airports for the movement of goods and people, but also for economic benefits that flow through regional and statewide economies. In this way, aviation is interwoven into the economy—supporting its strength, vibrancy, and development.

Furthermore, multiple studies have found that aviation serves as a catalyst for the economic growth and development of cities, regions, and states. A study by economist Richard Green found that passenger activity "is a powerful predictor of growth" in terms of employment and population while controlling for other factors that may be expected to shape growth.[8] Another study by economist Jan Brueckner showed that access to airline service is an important factor in urban economic development by facilitating in-person meetings, attracting new firms to an area, and stimulating employment at existing businesses.[9] Brueckner's work found that a 10 percent increase in passenger traffic generates a one percent increase in regional employment.

[8] Green, Richard K. (February 2007). "Airports and Economic Development." *Real Estate Economics.*
[9] Brueckner, Jan K. (July 2003). "Airline Traffic and Urban Economic Development." *Urban Studies.*

While airports can be one of the biggest investments to that city or town can make, returns are realized in terms of generating employment and wealth, contributing to import/export markets, and stimulating tourism. Airports levy user taxes and fees, and visitors who travel by air bring new money to hospitality industries and retailers, as well as the workers they employ. The Washington AEIS reveals that the state's public-use airports generate $1.70 billion in total economic impact each year. As further highlighted in **Chapter 4. State Aviation Investment**, the Washington Airport Aid Grant Program annually invests approximately $1.4 million into its airports. These numbers speak for themselves—investing in airports provides a high return on an annual basis compared to the economic benefit that is derived from airports.

> *The Washington AEIS reveals that the state's public-use airports generate $1.70 billion in total economic impact each year. The Washington Airport Aid Grant Program annually invests approximately $1.4 million into its airports—providing a return on investment simply unheard of in other industries.*

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Chapter 3. Key Washington Aviation Activities

Washington's 134 airports support a wide range of aviation-related activities promoting the economic vitality; safety, security, and health; recreational; and other needs of state residents and visitors. Businesses rely on scheduled commercial service and general aviation (GA) airports to transport goods and people, as well as serve as locations to conduct research and development, manufacturing, warehousing, sales, and other commercial activities. Aviation is also an important element of Washington's agricultural sector through its support of aerial spraying and quick transport of valuable perishable products to global marketplaces.

Chapter 2. Economic Impacts of Washington Airports of the Washington Aviation Economic Impact Study (AEIS) presented the economic impact of these and other activities associated with on-airport economic activity and off-airport visitor spending. This chapter delves more deeply into the specific impacts associated with six key activities that are of fundamental importance to airports in their roles as economic engines in their communities, regions, and statewide. As such, this chapter contains the following sections:

- Key aviation activity forecasts
- Economic impacts of air cargo
- Economic impacts of aviation on the agricultural sector

> *This chapter provides a detailed look at specific activities that are of fundamental importance to airports in their roles as economic engines for the communities, regions, and statewide.*

The key aviation activity forecasts examine both the current impacts of the six key aviation activities deemed essential to the state's economic diversity and strength, as well as evaluates potential future impacts based on state-specific and national trends. In all cases, demand for these six key aviation activities is projected to grow over time which, in turn, is anticipated to generate significant economic impacts through the 20-year forecast horizon. The latter two sections of the chapter present the economic impacts of air cargo and aviation-related activities on the agricultural sector. Unlike previous analyses in the Washington AEIS, these evaluations capture the economic impacts of air cargo and agriculture occurring off-airport property. This demonstrates that aviation catalyzes business and commercial activities in a diverse variety of industry sectors outside of the airport boundaries.

The economic impacts of key Washington activities presented in the following section provide insight for WSDOT Aviation and airports as they seek to maximize their abilities to strengthen the links between aviation and the many industries that rely on the services and support it provides. This information can help guide resource allocation and planning decisions so airports can be developed in a manner that aligns with how they are being used today and anticipated to grow and expand over the next two decades.

3.1 Key Aviation Activity Forecasts

The 2017 *Washington Aviation System Plan (WASP)* identified 17 activities that commonly occur at the state's 134 system airports and provide "value to users".[1] From this list, the *WASP* identified the following six key activities with the most significant impacts on airport facility needs and serving the economic needs of the state:

- Commercial passenger service
- Agriculture
- Pilot training and certification
- Business and corporate travel
- Air cargo
- Aerospace manufacturing

These activities provide essential services to Washington's business community and/or are fundamental to the state's economic strength and diversity. As such, the Washington AEIS has taken a closer look at these activities to quantify their economic contributions in the state. Additionally, this analysis looks at the future of these activities to understand how the economic impact could change based on current trends and projected growth by industry. This evaluation assumes that airports are able to meet new demands with existing facilities and services or are able to obtain the resources needed to do so.

The Washington AEIS has taken a closer look at six key aviation activities that provide essential services to the state's business community, are fundamental to the state's economic strength and diversity, or both.

3.2 Direct Economic Impacts of Washington's Key Aviation Activities

The Washington AEIS conducted a comprehensive study to quantify the economic impacts of airports based on on-airport activities and spending by out of state or international visitors who have departed from the state via scheduled commercial service or GA. Additional in-depth analyses were conducted to calculate the economic impacts of air cargo and aerial spraying.[2] Based on these analyses, the Washington AEIS determined that Washington's key aviation activities support 163,343 direct jobs and contribute over $65.08 billion in direct business revenues across the state. This represents approximately half of all direct economic impacts of Washington airports—underlying the fact that these activities compose the foundation of Washington's aviation industry. Commercial passenger service led by Seattle Tacoma International Airport (Sea-Tac or SEA) comprises the largest percentage of direct impacts, followed by the aerospace manufacturing industry anchored by The Boeing Company.

[1] These activities include commercial passenger service; business and corporate travel; personal transportation; pilot training and certification; air cargo; blood, tissue, and organ transportation; medical air transport; search and rescue; firefighting; national security; emergency preparedness and disaster response; aircraft manufacturing; agriculture; scientific research; aerial photography; aerial sightseeing; and skydiving.

[2] Additional details about these analyses are available in Sections 3.3 and Section 3.4 below.

A summary of the direct economic impacts of Washington's six key aviation activities is provided in **Table 3.1.**

Table 3.1. Direct Economic Impacts of Washington's Key Aviation Activities

Key Aviation Activity	Jobs (no.)	Labor Income ($)	Value Added ($)*	Business Revenues ($)
Commercial passenger service	94,015	$3,752,745,000	$11,537,634,000	$11,537,634,000
Agriculture	251	$10,231,000	$117,845,000	$117,845,000
Pilot training and certification	1,079	$47,863,000	$139,848,000	$139,848,000
Business and corporate travel	690	$26,513,200	$80,725,400	$80,725,400
Air cargo	3,511	$296,313,000	$1,117,718,000	$1,117,718,000
Aerospace manufacturing	63,798	$9,435,516,000	$52,083,152,000	$52,083,152,000
Total	**163,343**	**$13,569,181,200**	**$65,076,922,400**	**$65,076,922,400**

**Note: Value added not calculated for Sea-Tac. Sources: Community Attributes 2018, EBP US 2020*

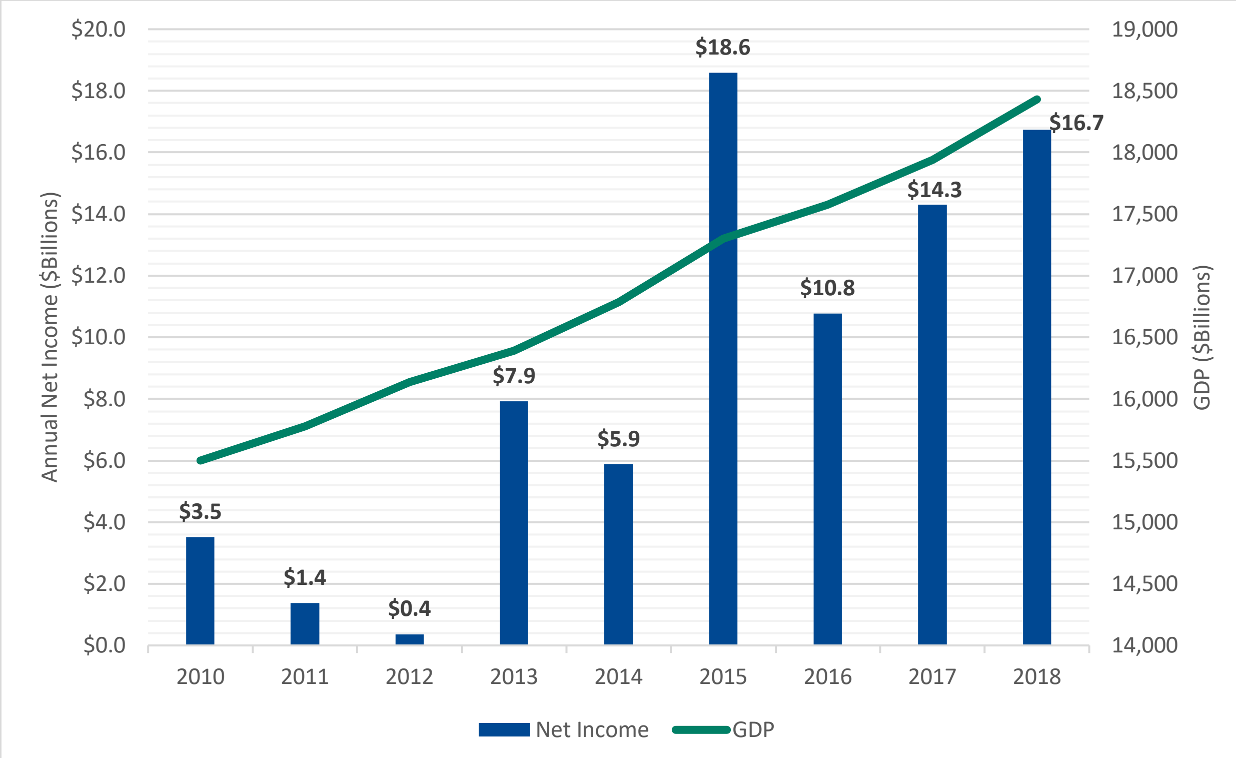
Washington's key aviation activities support 163,343 direct jobs and contribute over $65.08 billion in direct business revenues across the state. This represents approximately half of all direct economic impacts of Washington airports—underlying the fact that these six key aviation activities compose the foundation of the state's aviation industry.

The following presents the evaluation of each of these key aviation activities and their forecasted direct impacts on the Washington aviation system over the next two decades.

3.2.1 Commercial Passenger Service

In 2018, U.S. airlines experienced a remarkable year in terms of profit, growth, and expansion with $16.7 million in net income reported—up approximately 15.7 percent over the previous year. As shown in **Figure 3.1**, this growth mirrors the economic activity witnessed across the economy—as the Gross Domestic Product (GDP) grows, so too do the profits of commercial airlines. Despite these optimistic signs, recovery following the 2007 recession was cautious. Airlines lowered operating costs by eliminating unprofitable routes, grounded less fuel-efficient aircraft, and experimented with new pricing strategies. The number of domestic airlines operating also declined through mergers and bankruptcies.

Figure 3.1. Historic Domestic U.S. Scheduled Service Passenger Airlines Annual Net Income and GDP, 2010-2018

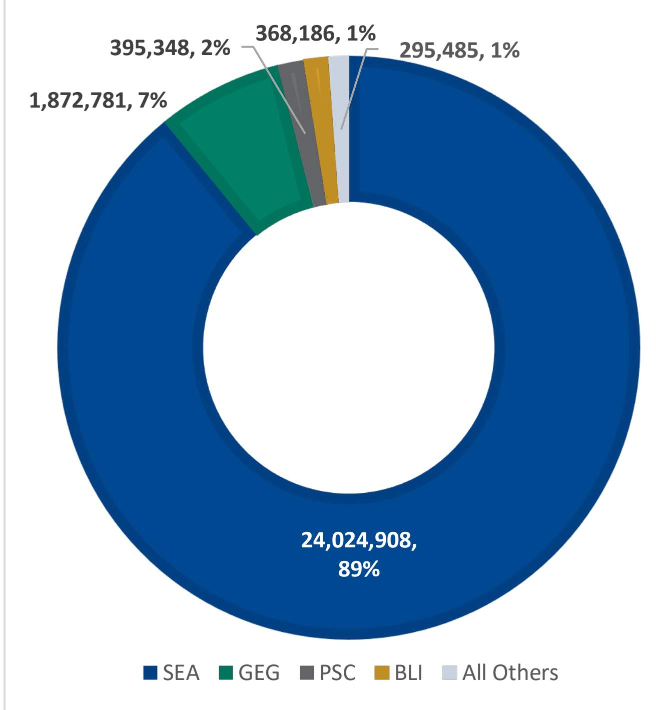


Note: Dollars normalized to 2012. Sources: IHS Markit 2019, U.S. Bureau of Transportation Statistics (BTS) 2019

These positive economic indicators are also apparent in Washington's travel trends. According to the Washington State Travel Impacts and Visitor Volume (2010-2018p) report prepared for the Washington Tourism Alliance (WTA), tourism spending in the state increased from $16.2 billion in 2010 to $24.4 billion in 2018 for a compound annual growth rate (CAGR) of 5.2 percent. Visitors arriving on domestic airlines increased from approximately 5.7 million to 8.3 million during that same time period. Recent years have also showed some of the steepest increases in visitor arrivals by air with a 6.5 percent year-over-year growth rate between 2017 and 2018 following a 4.3 percent increase between 2016 and 2017.

In terms of enplanements, 89 percent of air travelers rely on Sea-Tac, followed by Spokane International (GEG), Tri-Cities (PSC), and Bellingham International (BLI). **Figure 3.2** shows the number of enplanements at the four busiest commercial service airports in Washington, followed by a combined total of all other commercial service airports in Washington. Because of Sea-Tac's share of the market, it is appropriate to look at forecasted aviation specific to this airport to understand how the economic impact of commercial passenger service may change over time. In fact, Sea-Tac is responsible for 83,000 direct jobs, $3.3 billion in labor income, and $10.2 billion in business revenues. Interestingly, those figures represent 88 percent of all direct jobs, direct labor income, and direct business revenues associated with commercial passenger service in the state—remarkably similar figures to the percent of all Washington enplanements occurring at the facility. Sea-Tac's *2015 Sustainable Airport Master Plan* reports that the number of enplaned passengers at the airport is estimated to increase from 18.7 million passengers in 2014 to 32.8 million in 2034, increasing at an average rate of 2.8 percent per year. At all Washington airports, the FAA's Terminal Area Forecast (TAF) projects that air carrier enplanements will grow from 21.2 million in 2018 to 32.4 million in 2034 for an average growth rate of three percent.

Figure 3.2. Enplanements in Washington by Airport, 2018



Source: FAA 2019

In terms of estimating future commercial service activity, it is important to note that enplanements are not identical to out of state or international visitors arriving by air travel. Enplanements are defined as revenue-paying passengers boarding an aircraft. Only some of these passengers are visitors who have come to Washington from other states or countries, spent money, and returned home—and have accordingly brought new money into Washington's economy. In addition to these visitors, other passengers are Washington residents traveling to domestic or international destinations or, in some cases, airports in other parts of the state.

Despite the important distinction between out of state/international visitors and state residents for calculating economic impact, projected enplanement growth does provide a useful barometer for forecasting the future economic impact of commercial passenger service. It can be assumed that the overall composition of enplanements in terms of the percentage of residents versus visitors boarding an aircraft in Washington will remain constant over time. While out of state and international visitors to Washington may increase, so too will the number of Washington residents departing for other destinations—thereby likely keeping the ratio of visitor activity at a generally constant level.

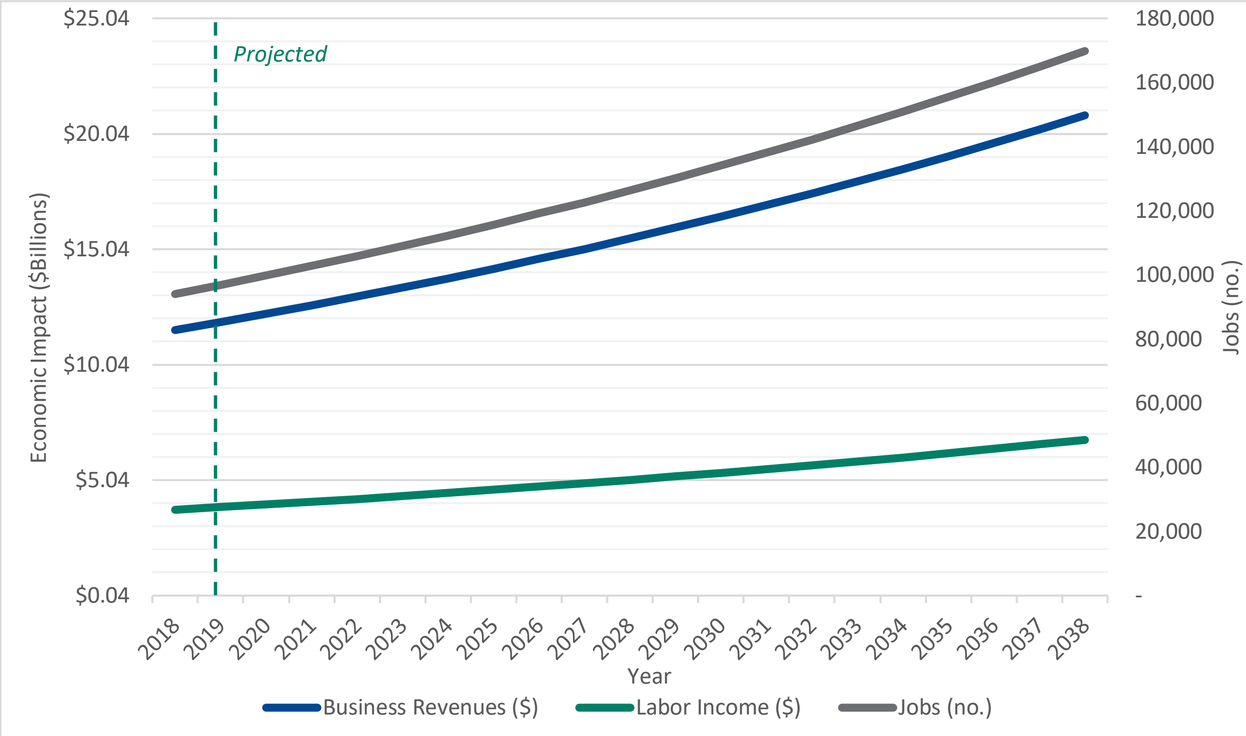
With this important assumption in mind, the Washington AEIS projects that the future economic impact of commercial passenger service in the state will grow by three percent annually. This projection was selected instead of the slightly lower Sea-Tac projection due in part to higher-than-anticipated activity at Snohomish County (Paine Field) which began commercial passenger service in 2019. If the economic impact of commercial passenger service in Washington grows at three percent annually, its overall economic impact will rise from $11.54 billion in 2018 to over $20.84 billion by 2038. The economic scenario forecast of commercial passenger activity in Washington is summarized in **Table 3.2** and shown in **Figure 3.3**.

Table 3.2. Economic Scenario Forecast Summary: Commercial Passenger Activity, 2018 - 2038

Year	Jobs (no.)	Labor Income ($)	Business Revenues ($)
2018 (Actual)	94,015	$3,752,745,000	$11,537,634,000
2019	96,836	$3,865,327,350	$11,883,763,020
2020	99,741	$3,981,287,171	$12,240,275,911
2021	102,733	$4,100,725,786	$12,607,484,188
2022	105,815	$4,223,747,559	$12,985,708,714
2023	108,989	$4,350,459,986	$13,375,279,975
2024	112,259	$4,480,973,786	$13,776,538,374
2025	115,627	$4,615,402,999	$14,189,834,525
2026	119,096	$4,753,865,089	$14,615,529,561
2027	122,669	$4,896,481,042	$15,053,995,448
2028	126,349	$5,043,375,473	$15,505,615,311
2029	130,139	$5,194,676,737	$15,970,783,771
2030	134,043	$5,350,517,039	$16,449,907,284
2031	138,065	$5,511,032,550	$16,943,404,502
2032	142,207	$5,676,363,527	$17,451,706,638
2033	146,473	$5,846,654,433	$17,975,257,837
2034	150,867	$6,022,054,066	$18,514,515,572
2035	155,393	$6,202,715,688	$19,069,951,039
2036	160,055	$6,388,797,158	$19,642,049,570
2037	164,856	$6,580,461,073	$20,231,311,057
2038	169,802	$6,777,874,905	$20,838,250,389

Sources: FAA TAF 2019, EBP US 2020, Kimley-Horn 2020

Figure 3.3. Economic Scenario Forecast: Commercial Passenger Activity, 2018 – 2038



Sources: FAA TAF 2019, EBP US 2020, Kimley-Horn 2020

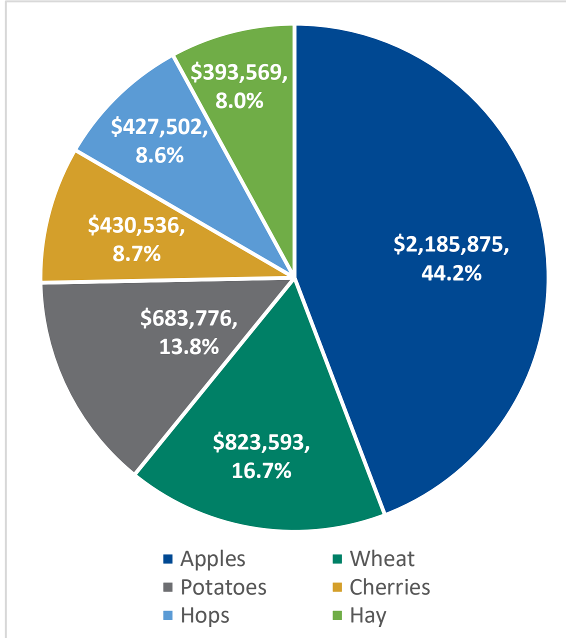
In 2018, the WTA and the Washington State Department of Commerce (Commerce) developed the Washington State Tourism Marketing Plan (Marketing Plan). According to this plan, tourism is Washington's fourth-largest industry—supporting more than 177,000 jobs and contributing more than $21.0 billion to the state's economy each year. However, Washington has historically invested little in attracting out of state and international tourists and is currently the only state without a state-funded tourism office. Additionally, most visitors stay in the urban center of western Washington and, to a lesser degree, the Spokane region. Commercial service airports are a key element in increasing the number of out of state visitors who choose Washington as their destination, whether for a family vacation or to bring colleagues together from around the globe for a business conference. Airports provide the first impression for many visitors arriving to the state. WSDOT Aviation, the WTA, Commerce, and airports each have a role to play in enhancing Washington's reputation as a world-class destination for business and leisure travel and an opportunity to bolster the economic impact of both airports and the tourism industry more broadly.

Washington State Tourism Marketing Plan reports that tourism is Washington's fourth-largest industry—supporting more than 177,000 jobs and contributing more than $21.0 billion to the state's economy each year. WSDOT Aviation, the WTA, Commerce, and airports each have role to play in enhancing Washington's reputation as world-class destination for business and leisure travelers.

3.2.2 Agriculture

Washington produces 3.6 percent of all crops in the U.S. in terms of cash receipts worth approximately $196.2 billion. Apples compose 44.2 percent of the state's domestic crop production in terms of cash value, followed by wheat (16.7 percent), potatoes (13.8%), cherries (8.7%), hops (8.6%), and hay (8.0%), as shown in **Figure 3.4**. On the national scale, Washington produces approximately two-thirds of all domestically-produced hops, apples, spearmint, and cherries; half of all domestically-produced rapeseed and pears; and one-third of domestically-produced asparagus, green peas, and peppermint oil (in value). Aviation benefits Washington's robust agricultural economy by supporting aerial application and serving as a key means of transporting high-value, perishable agricultural products to domestic and international markets.

Figure 3.4. Top Washington Crops by Cash Value, 2018 ($Thousands)



Source: USDA-ERS 2020

The U.S. Department of Agriculture (USDA)-Economic Research Service (ERS) prepares long-term forecast projections for various indicators of the agricultural economy such as the value of specific commodities (i.e., crops and animal products), global agricultural trade volume, U.S. export volume, and aggregated indicators including cash receipts and net farm income. At the global level, the USDA-ERS projects that prices for most crops will remain low over the 10-year forecast horizon driven by abundant supplies and competition from other exporting companies. At the same time, demand remains high, in part due to rising income growth in many developing countries as well as a strong but slowly weakening U.S. dollar. The U.S. agricultural sector is also strong due to efficiency gains affecting various crops.

To calculate the estimated future economic impact of aviation-related agricultural activity, the Washington AEIS assessed two of the USDA-ERS' primary indicators of the future economic value of domestic crops: cash receipts and net farm income.[3] Cash receipts are equal to open market sales and Commodity Credit Corporation (CCC) placement values.[4,5] Net farm income is the gross income from the production of farm commodities less expenses incurred during production. Net farm income accounts

[3] Note that the Washington-specific forecasts are not produced by the Washington State Department of Agriculture nor federal agencies. Additionally, the state farm economy is impacted by state-specific, domestic, and global forces that impact supply and demand. As a result, national-level forecasts have been used in the agricultural economic scenario forecast.
[4] USDA-ERS. (February 2009). Forecasting Farm Income: Documenting USDA's Forecast Model. Available online at www.ers.usda.gov/webdocs/publications/47556/10917_tb1924.pdf?v=41056 (accessed April 2020).
[5] CCC placement values are the value of crops used as collateral for a specific type of CCC loan, known as a nonrecourse loan. In this case, the farmer has immediate access to the CCC payment, and it is his or her decision to reclaim the commodity and repay the loan or allow the CCC to retain the commodity and keep the proceeds of the loan.

for cash receipts and government subsidies for specific commodities as well as expenses for inputs such as fertilizer, fuel, feed, rent, and labor.

Table 3.3 summarizes the USDA-ERS' 10-year projections for U.S. cash receipts for crops (i.e., non-animal products) and net farm income. Cash receipts for crops are anticipated to grow by 1.35 percent—indicating that farmers will earn 1.35 percent more for their products in the open market than they do today. Once other sources of income (e.g., government subsidies) and expenses are taken into consideration, net farm income is anticipated to grow at a rate of 1.47 percent, from $84.0 billion in 2018 to $98.6 billion by 2029. This indicates that income is growing faster than expenses, either due to higher income inputs (including government subsidies), lower expenses, or both.

Table 3.3. U.S. Cash Receipts – Crops and Net Farm Income ($Billion), 2018 - 2029

Year	Cash Receipts – Crops ($Billions)	Net Farm Income ($Billions)
2018 (Actual)	$195.5	$84.0
2019	$197.4	$92.5
2020	$197.1	$93.9
2021	$200.4	$88.8
2022	$202.0	$92.7
2023	$205.1	$92.4
2024	$208.5	$91.6
2025	$212.7	$92.4
2026	$216.4	$95.0
2027	$219.9	$95.9
2028	$223.3	$97.0
2029	$226.6	$98.6
CAGR	**1.35%**	**1.47%**

CAGR = Compound Annual Growth Rate; Source: USDA-ERS 2020

The Washington AEIS applied the CAGR for net farm income to forecast the future potential economic impact of aviation-related agricultural activity in the state (1.47 percent). This metric provides a comprehensive view into the performance of the agricultural sector by accounting for both income and expenses. The aviation forecast is only provided through 2029 because longer-term forecast activity is not available, presumably due to the highly volatile nature of the industry and many factors that impact farm production and prices. In 2018, aviation-related agricultural activity supported 251 jobs, generated $10.23 million in labor income, and contributed $117.85 million in Washington's economy. At a steady 1.47 percent annual growth rate, that figure is anticipated to rise to 294 jobs, $12.01 million in labor income, and $138.36 in economic impact. **Table 3.4** summarizes the economic scenario forecast for aviation-related agricultural activity in Washington.

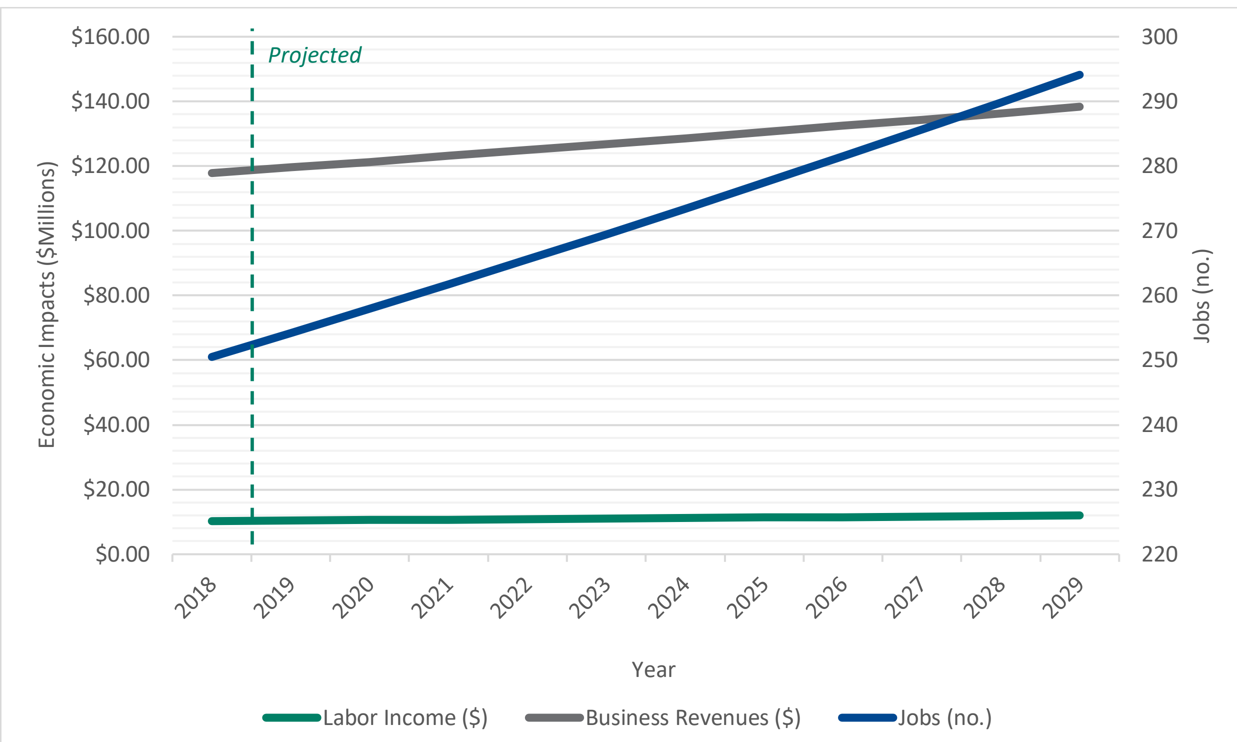
Table 3.4. Economic Scenario Forecast: Agriculture, 2018 – 2029

Year	Jobs (no.)	Labor Income ($)	Business Revenues ($)
2018 (Actual)	251	$10,231,000	$117,845,000
2019	254	$10,381,396	$119,577,322
2020	258	$10,534,002	$121,335,108
2021	262	$10,688,852	$123,118,734
2022	266	$10,845,978	$124,928,580
2023	269	$11,005,414	$126,765,030
2024	273	$11,167,194	$128,628,476
2025	277	$11,331,351	$130,519,314
2026	282	$11,497,922	$132,437,948
2027	286	$11,666,942	$134,384,786
2028	290	$11,838,446	$136,360,242
2029	294	$12,012,471	$138,364,738

Sources: USDA-ERS 2020, EBP US 2020, Kimley-Horn 2020

Figure 3.5 graphically depicts the economic scenario forecast of agriculture in Washington.

Figure 3.5. Economic Scenario Forecast: Agriculture, 2018 – 2029



Sources: USDA-ERS 2020, EBP US 2020, Kimley-Horn 2020

3.2.3 Pilot Training and Certification

According to Boeing's latest *Commercial Market Outlook 2019-2038* (Boeing Forecast), the global commercial fleet is anticipated to double over the next two decades—rising from 25,830 aircraft in 2018 to 50,660 in 2038 (3.4 percent growth rate). Fueled by a growing global middle class, urbanization, and the industry's move towards improving access to and accessibility of air travel, Boeing projects a major uptick in aviation demand over the next two decades. Boeing's forecast summary shows:

- Scheduled commercial passenger traffic will increase by 4.6 percent in terms of revenue passenger kilometers (RPK)
- Air cargo will increase by 4.2 percent in terms of revenue ton kilometers (RTK)
- Commercial aviation demand will increase by 4.2 percent in terms of dollars

As shown in **Table 3.5**, the FAA too predicts significant growth in commercial aviation by 2040. The *FAA Aerospace Forecast 2020 – 2040* reports that the demand for total scheduled U.S. passenger traffic will increase by 2.47 percent in terms of revenue passenger enplanements and 2.80 percent in terms of revenue passenger miles.

Table 3.5. U.S. Commercial Carriers, Total Scheduled U.S. Passenger Traffic Forecast, 2018 – 2040

Network Level	2018 (Actual)	2019 (Estimated)	2020	2025	2030	2035	2040	CAGR 2018-2040
Revenue Passenger Enplanements (Millions)								
Domestic	781	781	858	945	1,049	1,159	1,271	2.35%
International	100	100	106	119	141	167	197	3.28%
Total	**880**	**880**	**964**	**1,065**	**1,190**	**1,326**	**1,468**	**2.47%**
Revenue Passenger Miles (Billions)								
Domestic	720	752	795	889	999	1,119	1,244	2.64%
International	281	292	304	347	406	472	545	3.20%
Total	**1,001**	**1,044**	**1,099**	**1,235**	**1,405**	**1,591**	**1,789**	**2.80%**

CAGR = Compound Annual Growth Rate; Source: FAA Aerospace Forecast 2020 – 2040

To meet these growing demands, the Boeing Forecast estimates that 2.2 million commercial aviation personnel will be needed to fly and maintain the world fleet, including 645,000 pilots and 632,000 aviation technicians by 2038. Former Boeing CEO Dennis Muilenburg noted that the growing shortage of pilots is "one of the biggest challenges" facing the industry.[6] The *Aerospace in Washington: Economic Impacts and Workforce Analysis* observes that there will be an average annual demand for 130 additional commercial pilots in Washington alone between 2021 and 2026.[7]

Growing demands for commercial service and air cargo are major factors affecting the pilot shortage, but the issue has been exacerbated by a 2013 FAA rule that requires first officers to accumulate 1,500

[6] https://www.cnbc.com/2019/06/17/boeing-ceo-says-global-pilot-shortage-is-one-of-the-biggest-challenges.html
[7] Community Attributes, Inc. (March 2019). *Aerospace in Washington: Economic Impacts and Workforce Analysis.* Available online at aerospaceworksforwa.com/wp-content/uploads/2019/03/CAI.AWW-Econ-Impacts-and-Talent-Pipeline.Report.2019-0307.pdf (accessed April 2020).

The Boeing Forecast reports that the global commercial fleet is anticipated to double over the next two decades—rising from 25,830 aircraft in 2018 to 50,660 in 2038. To meet these growing demands, 2.2 million commercial aviation personnel will be needed to fly and maintain the world fleet by 2038.

hours of flight time to obtain an Airline Transport Pilot (ATP) certificate (up from 250 hours previously). Additionally, many pilots are reaching the mandatory retirement age of 65 and fewer pilots are coming out of the U.S. military. High educational costs and lengthy educational programs can also be a major deterrent for would-be pilots entering the field.

Table 3.6 summarizes the number of active pilots in the U.S. by certificate type. Note that the FAA's student pilot forecast is currently suspended due to an April 2016 regulatory change that removed the expiration date on new student pilot certificates. The change has resulted in a cumulative increase in the number of student pilots, growing from 128,501 in 2016 to 197,665 by 2019. The change also broke the link between student pilots and more advanced certificate holders. Because there is insufficient data to forecast student certificates under the new rule, the student pilot forecast was excluded from the table. While some bright spots are apparent in forecasted pilot activity, annual growth rates do not keep pace with growing demands.

Table 3.6. Active Pilots by Certificate Type, 2018 – 2038

Year	Recreational	Sport Pilot	Private	Commercial	ATP	Rotorcraft	Glider	Total Less Student
2018 (Actual)	144	6,246	163,695	99,880	162,145	15,033	18,370	465,513
2019 (Actual)	127	6,467	161,105	100,863	164,947	14,248	19,143	466,900
2020	125	6,740	161,700	100,950	166,900	14,100	19,350	469,865
2021	120	7,015	161,650	101,000	167,600	14,000	19,550	470,935
2022	115	7,290	161,150	101,000	168,500	14,050	19,700	471,805
2023	115	7,565	160,300	100,950	169,300	14,150	19,850	472,230
2024	115	7,840	159,200	100,900	170,200	14,300	19,950	472,505
2025	110	8,110	157,900	100,800	171,100	14,500	20,050	472,570
2026	105	8,375	156,500	100,650	172,100	14,700	20,150	472,580
2027	100	8,635	155,050	100,550	173,200	14,900	20,200	472,635
2028	95	8,895	153,550	100,400	174,400	15,150	20,250	472,740
2029	90	9,150	152,100	100,250	175,600	15,400	20,250	472,840
2030	90	9,405	150,700	100,100	176,900	15,700	20,300	473,195
2031	85	9,655	149,300	99,900	178,100	15,950	20,300	473,290
2032	80	9,905	148,000	99,750	179,400	16,250	20,350	473,735
2033	80	10,150	146,750	99,600	180,700	16,500	20,400	474,180
2034	75	10,385	145,550	99,450	182,100	16,750	20,400	474,710
2035	70	10,615	144,500	99,300	183,400	17,000	20,450	475,335
2036	70	10,840	143,450	99,150	184,800	17,300	20,450	476,060

Year	Recreational	Sport Pilot	Private	Commercial	ATP	Rotorcraft	Glider	Total Less Student
2037	65	11,060	142,550	99,000	186,100	17,550	20,500	476,825
2038	60	11,275	141,750	98,850	187,400	17,800	20,550	477,685
CAGR	**-4.28%**	**3.00%**	**-0.72%**	**-0.05%**	**0.73%**	**0.85%**	**0.56%**	**0.13%**

CAGR = Compound Annual Growth Rate; Source: FAA Aerospace Forecast 2020 – 2040

Table 3.7 shows the estimated number of active pilots and flight instructors in the state of Washington between 2013 to 2018. Early data suggests that the state may be bucking the trend: Washington cumulatively added 2,336 pilots and flight instructors between 2013 and 2018. Note flight instructors are most likely pilots as well, so some double-counting may be inherent in the totals. Pilots and flight instructors in the state represent between 3.39 and 3.57 percent of the U.S. total, indicating a minor upward trend over time. Seventy-two airports in the *WASP* reported supporting pilot training and certification, making it the most common activity found at Washington's airports.

Table 3.7. Historic Active Pilots and Flight Instructors, Washington and U.S., 2013 – 2018

Year	Type of Certificate								Percent U.S. Total
	Students	Private	Commercial	Airline Transport	Misc. Other	Flight Instructor	Remote Pilots	Total Pilots	
2013	3,393	6,160	3,437	5,594	169	3,392	NA	18,753	3.39%
2014	3,358	6,052	3,330	5,744	181	3,518	NA	18,665	3.42%
2015	3,492	6,010	3,271	5,923	192	3,619	NA	18,888	3.47%
2016	3,786	5,739	3,170	6,199	203	3,730	644	19,097	3.53%
2017	4,459	5,793	3,245	6,370	213	3,902	1,978	20,080	3.54%
2018	5,045	5,985	3,288	6,555	216	4,037	3,157	21,089	3.57%
Change	**+1,652**	**(175)**	**(149)**	**+ 961**	**+ 47**	**+ 645**	**+2,513**	**+ 2,336**	**NA**

Note: Remote pilot numbers are not available prior to 2016. Source: FAA Civil Airman Statistics 2013 – 2018

To estimate the future economic potential of pilot training in the state, the Washington AEIS looked to what the impact could be if Washington airports are able keep pace with the demand for pilots. Because the need for pilots will be driven by growth in air cargo—experiencing its own unprecedented boom in recent years—as well as commercial passenger service, the study selected Boeing's more aggressive growth rate of 4.2 percent to forecast the future economic potential of pilot training in the state. As shown in **Table 3.8**, pilot training supported 1,079 direct jobs, generated $47.86 million in labor income, and contributed $139.85 million in business revenues to the state in 2018. At an annual growth rate of 4.2 percent, the direct economic impact of pilot training could increase to 2,457 jobs, $108.98 million in labor income, and $318.42 million in business revenues by 2038.

Table 3.8. Economic Scenario Forecast Summary: Pilot Training and Certification, 2018 – 2038

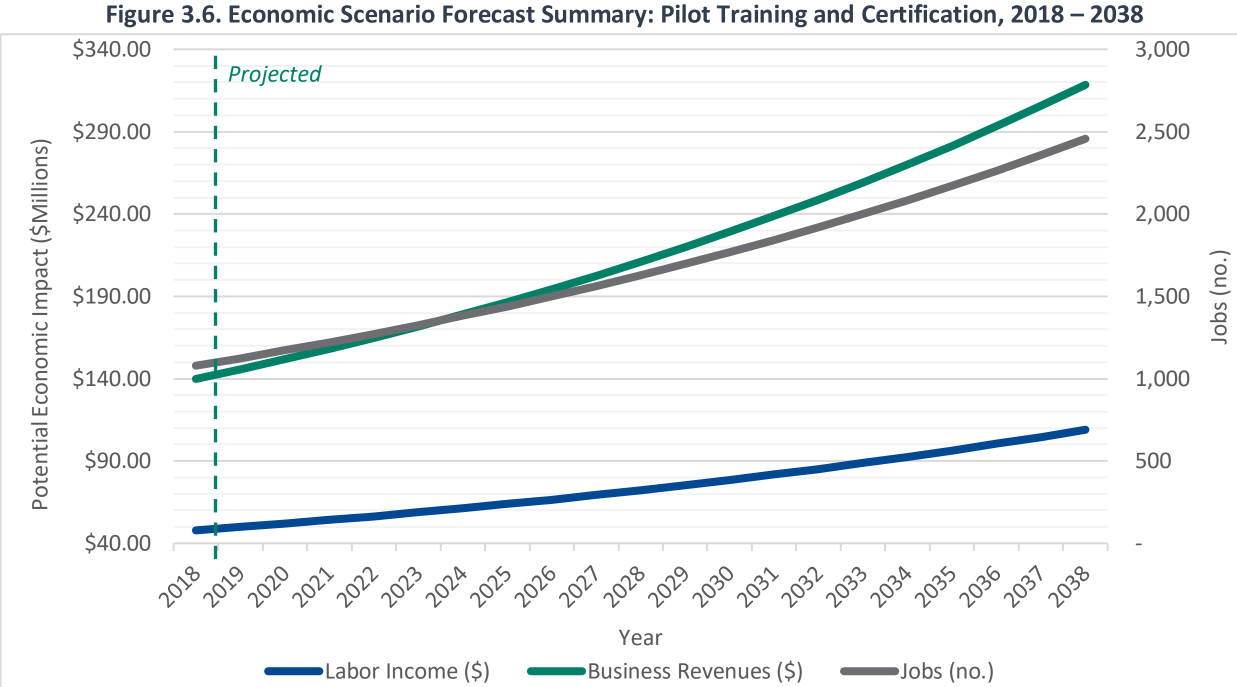
Year	Jobs (no.)	Labor Income ($)	Business Revenues ($)
2018 (Actual)	1,079	$47,863,000	$139,848,000
2019	1,124	$49,873,246	$145,721,616
2020	1,172	$51,967,922	$151,841,924

Year	Jobs (no.)	Labor Income ($)	Business Revenues ($)
2021	1,221	$54,150,575	$158,219,285
2022	1,272	$56,424,899	$164,864,495
2023	1,325	$58,794,745	$171,788,803
2024	1,381	$61,264,124	$179,003,933
2025	1,439	$63,837,217	$186,522,098
2026	1,500	$66,518,381	$194,356,026
2027	1,563	$69,312,153	$202,518,980
2028	1,628	$72,223,263	$211,024,777
2029	1,697	$75,256,640	$219,887,817
2030	1,768	$78,417,419	$229,123,106
2031	1,842	$81,710,951	$238,746,276
2032	1,919	$85,142,810	$248,773,620
2033	2,000	$88,718,809	$259,222,112
2034	2,084	$92,444,998	$270,109,440
2035	2,172	$96,327,688	$281,454,037
2036	2,263	$100,373,451	$293,275,106
2037	2,358	$104,589,136	$305,592,661
2038	2,457	$108,981,880	$318,427,553

Sources: FAA Aerospace Forecasts 2020 – 2040, EBP US 2020, Kimley-Horn 2020

Figure 3.6 depicts the estimated future economic impact of pilot training in Washington.

Figure 3.6. Economic Scenario Forecast Summary: Pilot Training and Certification, 2018 – 2038



Sources: Boeing Forecast 2019, EBP US 2020, Kimley-Horn 2020

Because of the significant and growing demand for pilots during the forecast horizon, Washington state should consider strategies to provide additional incentives or support to expand flight schools' abilities to matriculate new pilots. To support this effort, Congress appropriated $10 million for the U.S. Department of Transportation (U.S. DOT), FAA, and other federal agencies for two aviation workforce programs in fiscal year 2020. Additionally, the 2018 FAA Reauthorization Bill required the U.S. DOT to establish a program to support the education of future aircraft pilots and aviation maintenance technical workers through fiscal year 2023.

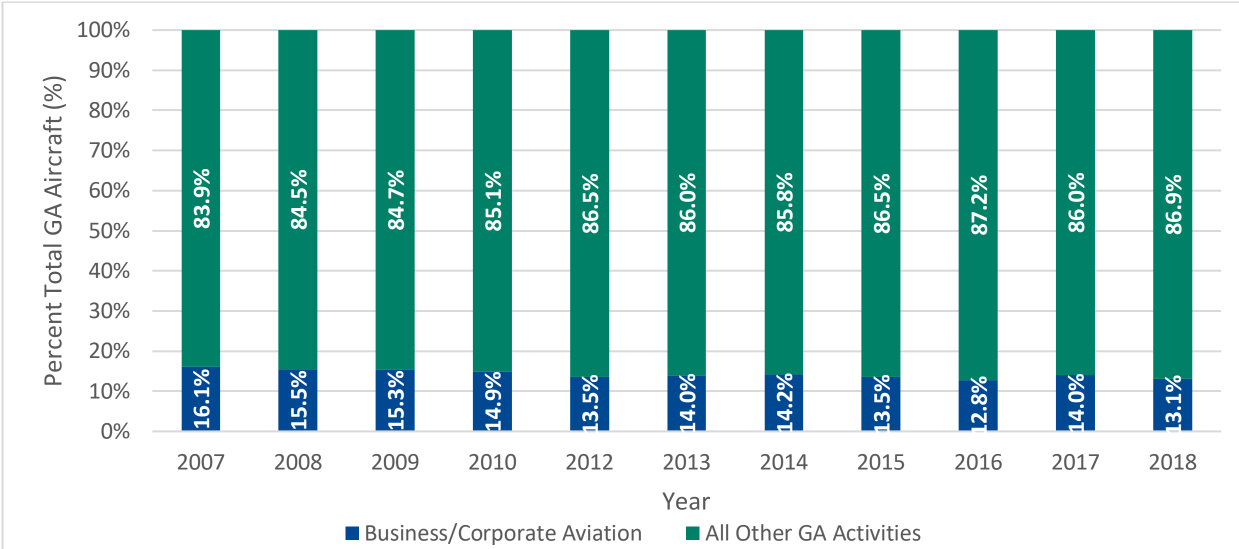
Congress appropriated $10 million for the U.S. DOT, FAA, and other federal agencies for two aviation workforce programs in fiscal year 2020. Additionally, the 2018 FAA Reauthorization Bill required the U.S. DOT to establish a program to support the education of the future aviation workforce through fiscal year 2023.

3.2.4 Business and Corporate Aviation

Business aviation activity, also referred to as corporate aviation and representing GA-specific flying, occurs at both commercial service and GA airports of varying sizes and is a key component to the local, state, national, and global economy. Business travelers take to the skies for a variety of essential business activity that spurs development and contributes to the economy. More than one million manufacturing and service jobs in the U.S. can be attributed to business and corporate aviation.

According to the FAA's GA and on-demand Part 135 activity survey, aircraft used for business and corporate aviation comprised between 13 and 16 percent of all GA aircraft flown in the U.S. between 2007 and 2018. **Figure 3.7** shows the number of aircraft used for business/corporate aviation compared to all other GA activities including personal flying, pilot training, aerial application, aerial observation, and medical flights.

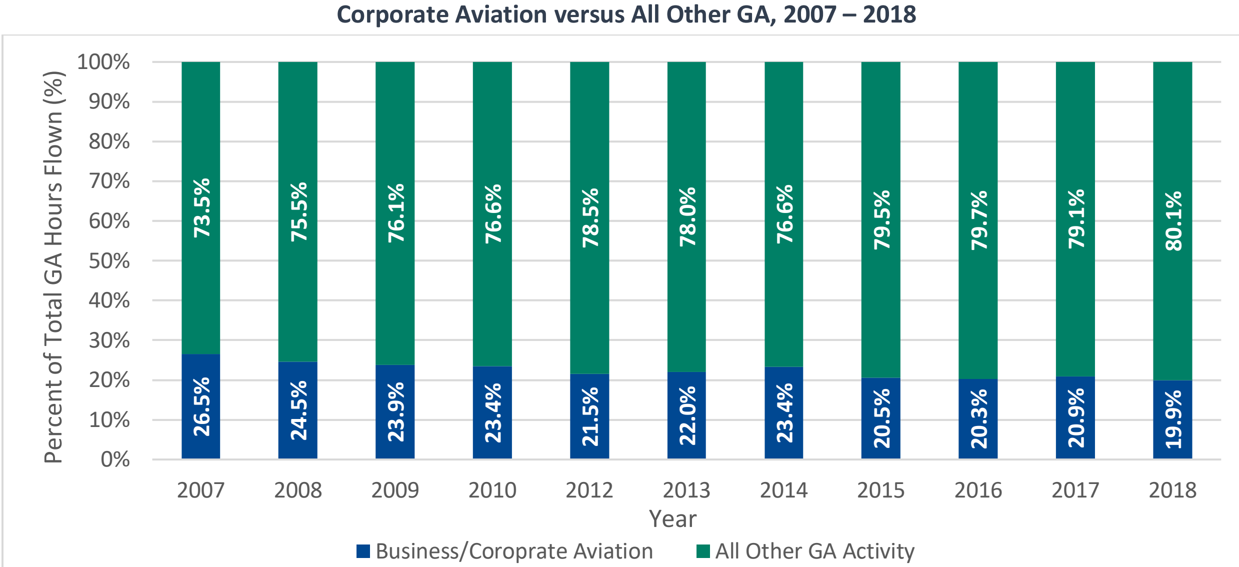
Figure 3.7. Percent of GA Aircraft Used for Business/Corporate Aviation versus All Other GA Activities in the Total U.S. Fleet Mix, 2007 – 2018



Notes: Number of aircraft reported in thousands. The GA survey was not conducted in 2011 and is thus excluded from this graphic. Source: FAA GA and Part 135 Activity Surveys 2018

Figure 3.8 depicts the number of GA hours flown (in thousands) for business/corporate aviation and all other GA activities as a percent of total hours. Between 2007 and 2018, the number of hours flown for business/corporate aviation has ranged from a high of 26.48 percent in 2016 to a low of 19.95 percent in 2018. On average, business/corporate aviation composed 22.44 percent of all GA activity in the U.S. during the study years. While GA aircraft compose a smaller percentage of the U.S. fleet, they generally log more hours compared to other types of GA activities.

Figure 3.8. Percent of Total GA Hours Flown Used for Business/ Corporate Aviation versus All Other GA, 2007 – 2018



Notes: Hours reported in thousands. The GA survey was not conducted in 2011 and is thus excluded from this graphic. Source: FAA GA and Part 135 Activity Surveys 2018

> *The* Honeywell Global Business Aviation Outlook (2020-2029) *predicts that 7,600 business jets worth approximately $248 billion will be delivered over the next decade.*

Over the next 10 years, the business jet market is anticipated to experience robust growth. The Honeywell *Global Business Aviation Outlook* (2020-2029) predicts that 7,600 business jets worth approximately $248 billion will be delivered over the next decade. That rising trend is already apparent: The General Aviation Manufacturers Association (GAMA) reports that business jet shipments increased from 703 units in 2018 to 809 units in 2019—the largest number of deliveries since 2009. **Table 3.9** provides GAMA's 10-year forecast of business jet hours flown as well as the number of jets in the U.S. GA fleet. In 2018, 14,596 U.S. business jets flew 4.59 million hours; by 2028, 18,695 aircraft are anticipated to fly 6.26 million hours annually.

Table 3.9. Historic and Forecast Business Jet Hours Flown (in thousands) and Fleet Forecast, 2018 – 2028

	Hours Flown		Business Jet Fleet	
Year	Hours (thousands)	Percent Change from Previous Year	No. of Aircraft	Percent Change from Previous Year
2018 (Actual)	4,592	-	14,596	-
2019	4,528	(1.39)%	14,970	2.56%
2020	4,754	4.99%	15,385	2.77%
2021	4,972	4.59%	15,795	2.66%
2022	5,172	4.02%	16,205	2.60%
2023	5,321	2.88%	16,610	2.50%
2024	5,571	4.70%	17,025	2.50%
2025	5,757	3.34%	17,445	2.47%
2026	5,928	2.97%	17,865	2.41%
2027	6,092	2.77%	18,280	2.32%
2028	6,255	2.68%	18,695	2.27%
CAGR		**3.14%**	**CAGR**	**2.51%**

CAGR = Compound Annual Growth Rate; Source: GAMA Databook 2019

Because of the number of Fortune 100 companies headquartered in Washington state and the high per-capita income of the state's urban residents, the Washington AEIS determined that the economic growth of corporate/business aviation in Washington will more closely reflect the higher CAGR associated with hours flown (3.14 percent). Additionally, aircraft usage—not the number of different aircraft—indicates their impact on the economy (beyond the initial purchase). Note that it is understood that many different types of aircraft can be used for business/corporate aviation, including piston, turboprop, and jet fixed-wing aircraft and rotorcraft. However, neither the FAA nor industry sources publish forecasts of GA activity by type. Accordingly, this 3.14 percent growth rate serves as a reasonable indication of businesses anticipated future use of business/corporate aviation. As shown in **Table 3.10**, business and corporate aviation currently support 690 jobs, generates $26.51 million in labor income, and contribute $80.73 million in business revenues to the Washington economy. Over the 20-year forecast horizon, the economic impact of business/corporate aviation in the state could increase to

1,280 jobs, generate $49.19 million in labor income, and contribute $149.78 million in business revenues.

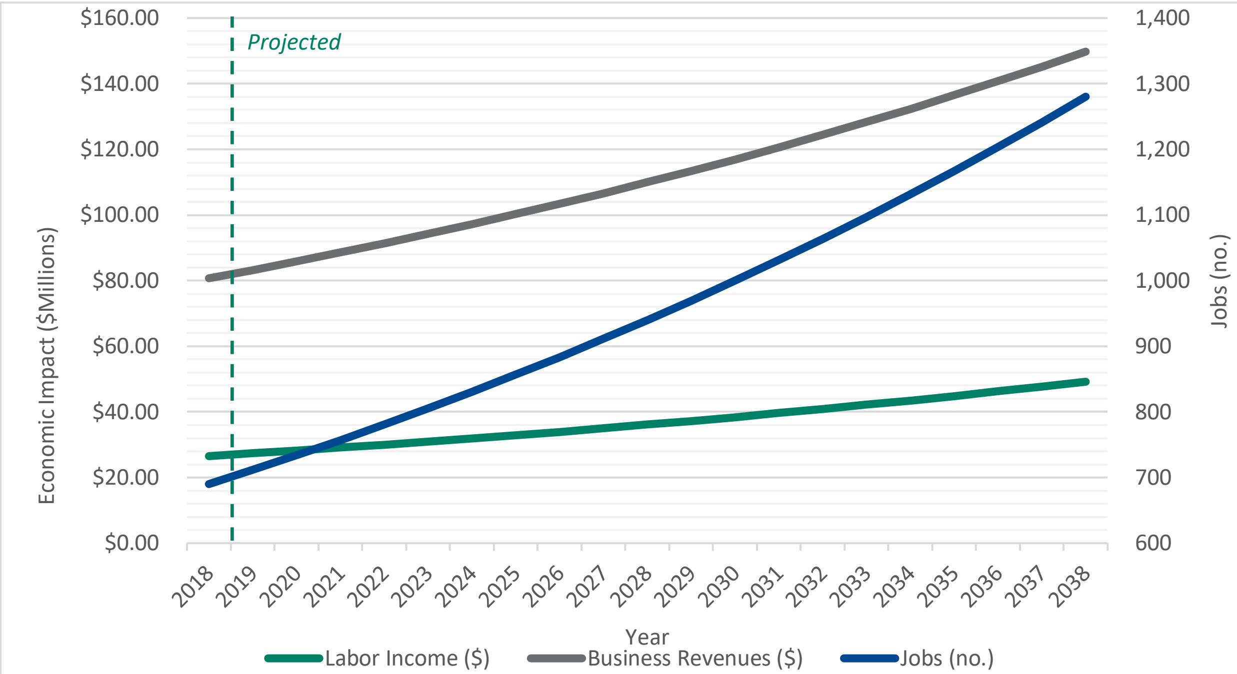
Table 3.10. Economic Scenario Forecast: Business and Corporate Aviation, 2018 – 2038

Year	Jobs (no.)	Labor Income ($)	Business Revenues ($)
2018	690	$26,513,200	$80,725,400
2019	712	$27,345,426	$83,259,299
2020	734	$28,203,775	$85,872,734
2021	757	$29,089,066	$88,568,204
2022	781	$30,002,146	$91,348,281
2023	805	$30,943,887	$94,215,623
2024	831	$31,915,188	$97,172,968
2025	857	$32,916,978	$100,223,141
2026	884	$33,950,212	$103,369,057
2027	911	$35,015,879	$106,613,720
2028	940	$36,114,997	$109,960,230
2029	969	$37,248,615	$113,411,784
2030	1,000	$38,417,816	$116,971,680
2031	1,031	$39,623,717	$120,643,317
2032	1,064	$40,867,470	$124,430,204
2033	1,097	$42,150,264	$128,335,958
2034	1,131	$43,473,324	$132,364,310
2035	1,167	$44,837,913	$136,519,109
2036	1,204	$46,245,335	$140,804,323
2037	1,241	$47,696,935	$145,224,046
2038	1,280	$49,194,100	$149,782,500

Sources: GAMA 2019, EPB US 2020, Kimley-Horn 2020

Figure 3.9 depicts the potential future economic impact of business and corporate aviation in Washington.

Figure 3.9. Economic Scenario Forecast: Business and Corporate Aviation, 2018 – 2038



Sources: GAMA 2019, EPB US 2020, Kimley-Horn 2020

3.2.5 Air Cargo

Air cargo often consists of high-value, time-sensitive shipments that are relatively lightweight. Common examples of air cargo are flowers and fish, electronic components, repair parts for the automotive and aerospace industries, medical devices, organs, and tissue delivery. The amount of air cargo handled by an airport is closely related to market catchment size, local market industries, and airport facilities. Air cargo uses one of three types of carriers: all-cargo, integrated express carriers, or in the belly compartment of passenger airlines. All-cargo carriers are cargo specialists and typically operate airport-to-airport on dedicated turboprops, regional jets, and narrow- or wide-body jets.

In Washington state, air cargo activity is dominated by activity at Sea-Tac, King County International, and Spokane International airports. Non-hub and small commercial passenger airports accounted for only four percent of total air cargo volumes moved in the state in 2016.[8] **Table 3.11** shows the Washington airports that handle one metric ton or more of air cargo annually.

[8] JTC (May 2018). *Washington State Air Cargo Movement Study*. Available online at http://leg.wa.gov/JTC/Pages/aircargo.aspx (accessed April 2020). p. 2-11.

Table 3.11. Washington Air Cargo Airports, 2006 – 2016

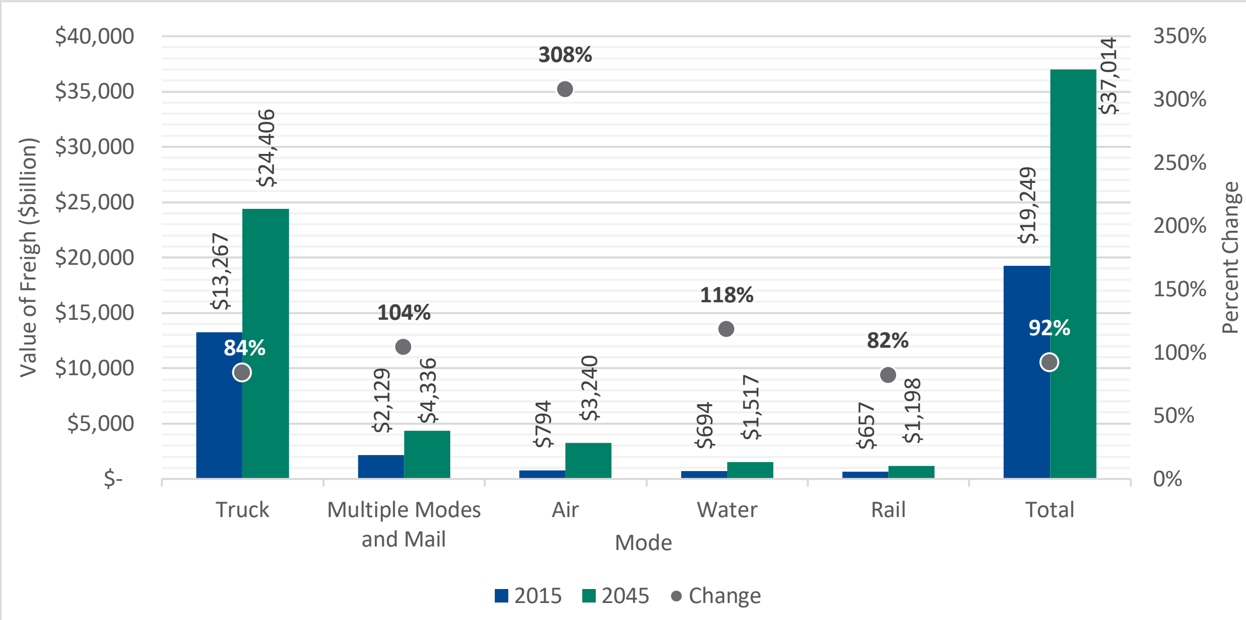
Associated City	FAA Identifier	Airport	2006	2011	2016	CAGR
Seattle	SEA	Seattle-Tacoma International	342,042	279,893	366,430	5.50%
Bellingham	BLI	Boeing Field/King County International	118,394	106,932	114,364	1.40%
Spokane	GEG	Spokane International (Geiger Field)	74,846	49,419	61,396	4.40%
Everett	PAE	Snohomish County (Paine Field)	38	4,481	15,410	28.00%
Pasco	PSC	Tri-Cities	3,049	3,452	2,299	-7.80%
Yakima	YKM	Yakima Air Terminal (McAllister Field)	2,138	1,836	1,926	1.00%
Bellingham	BLI	Bellingham International	980	1,111	997	-2.10%
Moses Lake	MWH	Grant County International	492	314	752	19.10%
Port Angeles	CLM	William R. Fairchild International	525	527	563	1.30%
East Wenatchee	EAT	Pangborn Memorial	612	605	505	-3.60%
East Sound	ORS	Orcas Island Airport	245	283	453	9.90%
Burlington	BVS	Skagit Regional	428	269	412	8.90%
Friday Harbor	FHR	Friday Harbor Airport	104	117	211	12.50%
Pullman	PUW	Pullman/Moscow Regional	20	12	5	-16.10%
Walla Walla	ALW	Walla Walla Regional	8	3	2	-7.80%
Sequim	W28	Sequim Valley	0	0	1	100.00%
Roche Harbor	W39	Roche Harbor SPB	—	1	1	0.00%
Seattle	W55	Kenmore Air Harbor Inc.	—	1	1	0.00%
		Total	**549,921**	**449,276**	**549,921**	**449,276**

CAGR = Compound Annual Growth Rate; Sources: JTC Washington State Air Cargo Movement Study 2018 based on the following sources: Port of Seattle, Spokane International Airport, DOT T-100 All Carrier Market data

Looking ahead, air cargo activity is anticipated to witness a major uptick in the coming years driven by global macroeconomic trends such as growing middle classes in emerging markets. The 2018 *Boeing Air Cargo Forecast* reports that air cargo traffic grew 10.1 percent in 2017 driven by three concurrent trends: global economic expansion, increasing industrial production, and world trade growth.[9] While the industry is not anticipated to sustain double-digit growth moving forward, the industry is well positioned for positive and continuous expansion through the forecast horizon. Goods typically associated with air cargo—namely, perishables and high-value, time-sensitive commodities—are some of the fastest-growing trade flows in the world. Further, e-commerce comprises a growing share of the market with some industry analysts projecting 265 percent growth by 2021, from $1.3 trillion in 2014 to $4.9 trillion in 2021. While cargo is inherently multi-modal as packages generally rely on some combination of aircraft, truck, rail, or ship, recent forecasts published by the BTS suggest that air cargo will grow far more rapidly than other modes. As shown in **Figure 3.10**, the value of freight transported by air shows a 308 percent increase between 2015 and 2045. Freight value transported by water, the next-highest percent change, is projected to grow 118 percent growth during this same timeframe.

[9] Boeing Air Cargo Forecast (2018)

Figure 3.10. Value of Freight by Mode, 2015 – 2045



Sources: U.S. DOT, BTS, and Federal Highway Administration (FHWA), Freight Analysis Framework (FAF), version 4.1 2016.

While there is great potential for air cargo, it is important to consider that the industry does face considerable volatility and uncertainty linked to a range of issues. Factors that impact the growth of air cargo markets include modal competition, environmental regulations, market liberalization, national development programs, inventory management techniques, and demand for commodities and perishables typically transported by air.[10] Accounting for both the opportunities and challenges in the market, the *Boeing Air Cargo Forecast* projects world air cargo traffic will increase at a rate of 4.2 percent per year over the next 20 years. The JTC *Washington Air Cargo Movement Study* forecasts that the Washington air cargo industry will grow at 4.4 percent through the study's 10-year horizon. Because of Washington's importance in the e-commerce industry due to Amazon and connection to Asian markets via Sea-Tac, the JTC's slightly higher growth rate has been selected to forecast the potential future economic impact of air cargo in Washington.

The 2018 Boeing Air Cargo Forecast *reports that air cargo traffic grew 10.1 percent in 2017 driven by three concurrent trends: global economic expansion, increasing industrial production, and world trade growth. The industry will continue to be well positioned for positive and continuous expansion through the forecast horizon.*

[10] Ibid.

As shown in **Table 3.12**, air cargo currently supports 3,511 direct jobs, generates $296.31 million in labor income, and $1.12 billion in business revenues. At a 4.4 percent growth rate over time, air cargo activities at Washington airports could support 8,307 jobs, generate $701.07 in labor income, and contribute $2.64 billion in business revenues to the state by 2038.

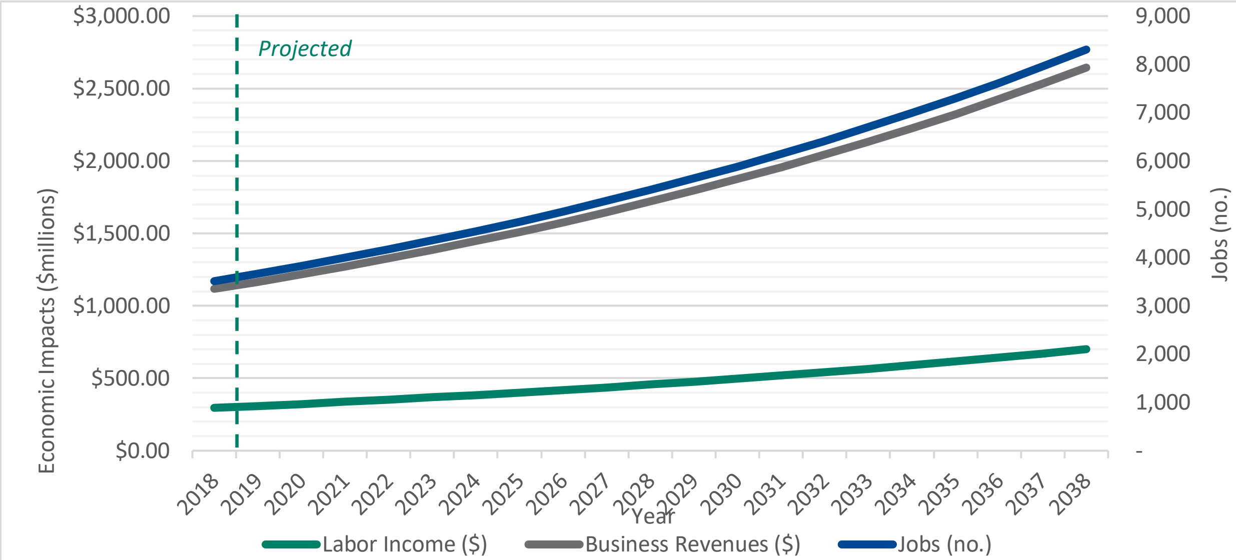
Table 3.12. Economic Scenario Forecast: Air Cargo, 2018 – 2038

Year	Jobs (no.)	Labor Income ($)	Business Revenues ($)
2018	3,511	$296,313,000	$1,117,718,000
2019	3,665	$309,350,772	$1,166,897,592
2020	3,827	$322,962,206	$1,218,241,086
2021	3,995	$337,172,543	$1,271,843,694
2022	4,171	$352,008,135	$1,327,804,816
2023	4,354	$367,496,493	$1,386,228,228
2024	4,546	$383,666,339	$1,447,222,270
2025	4,746	$400,547,657	$1,510,900,050
2026	4,955	$418,171,754	$1,577,379,652
2027	5,173	$436,571,312	$1,646,784,357
2028	5,401	$455,780,449	$1,719,242,869
2029	5,638	$475,834,789	$1,794,889,555
2030	5,886	$496,771,520	$1,873,864,696
2031	6,145	$518,629,467	$1,956,314,742
2032	6,416	$541,449,163	$2,042,392,591
2033	6,698	$565,272,926	$2,132,257,865
2034	6,993	$590,144,935	$2,226,077,211
2035	7,300	$616,111,312	$2,324,024,608
2036	7,621	$643,220,210	$2,426,281,691
2037	7,957	$671,521,899	$2,533,038,085
2038	8,307	$701,068,863	$2,644,491,761

Sources: GAMA 2019, EPB US 2020, Kimley-Horn 2020

Figure 3.11 shows the future economic scenario forecast of air cargo activities at Washington airports between 2018 and 2038.

Figure 3.11. Economic Scenario Forecast: Air Cargo, 2018 – 2038



Sources: JTC Washington State Air Cargo Movement Study 2018, EBP US 2020, Kimley-Horn 2020

3.2.6 Aerospace Manufacturing

> *The Teal Group's 2019* Aerospace Competitive Economic Study *named Washington top in the nation in terms of providing a competitive business environment for the manufacture of major aerospace platforms.*

Aerospace is an inherent element of Washington: not only a key driver of the economy, but the entire industry has fostered the state's reputation for innovation and technological know-how. In fact, this reputation was recently bolstered by a Teal Group report that named Washington top in the nation in terms of providing a competitive business environment for the manufacture of major aerospace platforms. Washington is a top-ten finisher in seven of the eight categories analyzed by the study including: cost (#1), industry (#1), economy (#1), labor and education (#2), risk to operations (#5), taxes and incentives (#5), and research and innovation (#6).[11] Anchored by The Boeing Company—which generated an estimated $54.8 billion in revenues in 2017—more than 1,400 aerospace-related companies in Washington serve in the supply chain for every major aircraft manufacturer and air carrier in the world.[12] Ninety percent of domestically-produced commercial service aircraft are manufactured in the state. The *Washington Aerospace Economic Impacts 2018 Update* reported that the total economic impact of Washington's aerospace industry included 226,130 jobs, $19.7 billion in labor income, and $89.6 billion in business revenues.

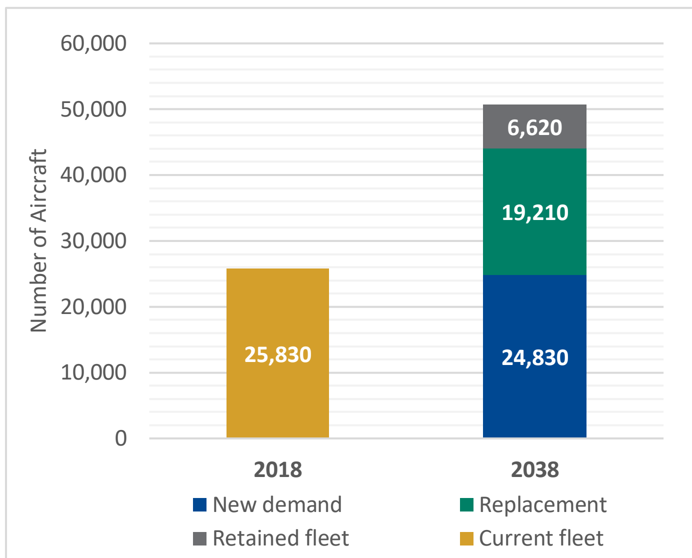
[11] Teal Group (2019). *Aerospace Competitive Economic Study*. Available online at http://choosewashingtonstate.com/why-washington/our-key-sectors/aerospace/ (accessed March 2020).
[12] http://choosewashingtonstate.com/why-washington/our-key-sectors/aerospace/

It is important to note that not all of Washington's aerospace businesses and jobs are located on airport property. Because the Washington AEIS exclusively calculated the economic impact of aerospace manufacturing within the airport footprint (that is, on-airport property or immediately adjacent to), the Washington aerospace economic impact is inherently different than the Washington airport economic impact. Nonetheless, Washington's public-use airports are a keystone to this thriving industry by providing the critical facilities and services needed for this industry to continue soaring. Boeing's on-airport activities include the final assembly lines for the 737 and P-8 aircraft at the Renton Municipal Airport (RNT); final delivery and test flights at King County International Airport/Boeing Field (BFI); and final assembly of the Boeing 747, 767, 777X, 787 Dreamliner, and the U.S. Air Force's KC-46 at Snohomish County Airport/Paine Field (PAE). In fact, Boeing's presence at these three sites comprise the majority of the entire aerospace manufacturing economic impact reported by the Washington AEIS.

Beyond Boeing, Washington airports host public and private institutions involved in the research and development of some of the most cutting-edge technologies today. Grant County International Airport (MWH) hosts the Moses Lake AeroTEC Flight Test Center, which supports test flights of the first four Mitsubishi regional jet airplanes and numerous others. The airport has also emerged as a center of innovation for electric aircraft. Eviation's Alice, powered by MagniX's all-electric propulsion system, is scheduled for testing on the airfield later this year.

As noted above in the pilot training section, Boeing is forecasting significant growth over the next two decades—much of which could occur within Washington.[13] By 2038, the company projects that airlines will need 44,000 new airplanes valued at $6.8 trillion to fulfill growing demand for air service. Narrow-body jets will compose 74 percent of demand (32,420 new aircraft), followed by wide-body jets (8,340 new aircraft, 19 percent of demand), regional jets (2,240 new aircraft, 5 percent of demand), and freighters (1,040 new aircraft, 2 percent of demand). As shown in **Figure 3.12,** the total global fleet is anticipated to reach 50,660 by 2038 for an annual growth rate of 3.4 percent.

Figure 3.12. Boeing Fleet Forecast, 2018 and 2038



Source: Boeing Commercial Market Outlook 2019

Given Boeing's strength in Washington state, major presence at Washington airports, and importance in the broader aerospace supply chain, the Washington AEIS anticipates that the economic impact of

[13] This analysis assumes that Boeing's recent issues associated with the 737 MAX will be resolved during the forecast period and the company will return to forecasted growth in the coming years.

aerospace manufacturing in Washington will keep pace with the company's forecasted fleet growth. In 2018, on-airport aerospace manufacturing supported 3,511 jobs, $296.31 in labor income, and contributed $1.12 billion in business revenues. At a 3.4 percent growth rate over the next 20 years, the potential economic impact of aerospace manufacturing would increase to 8,307 jobs, $701.07 million in labor income, and $2.64 billion in business revenues. **Table 3.13** provides the potential economic impact of on-airport aerospace manufacturing over the forecast horizon.

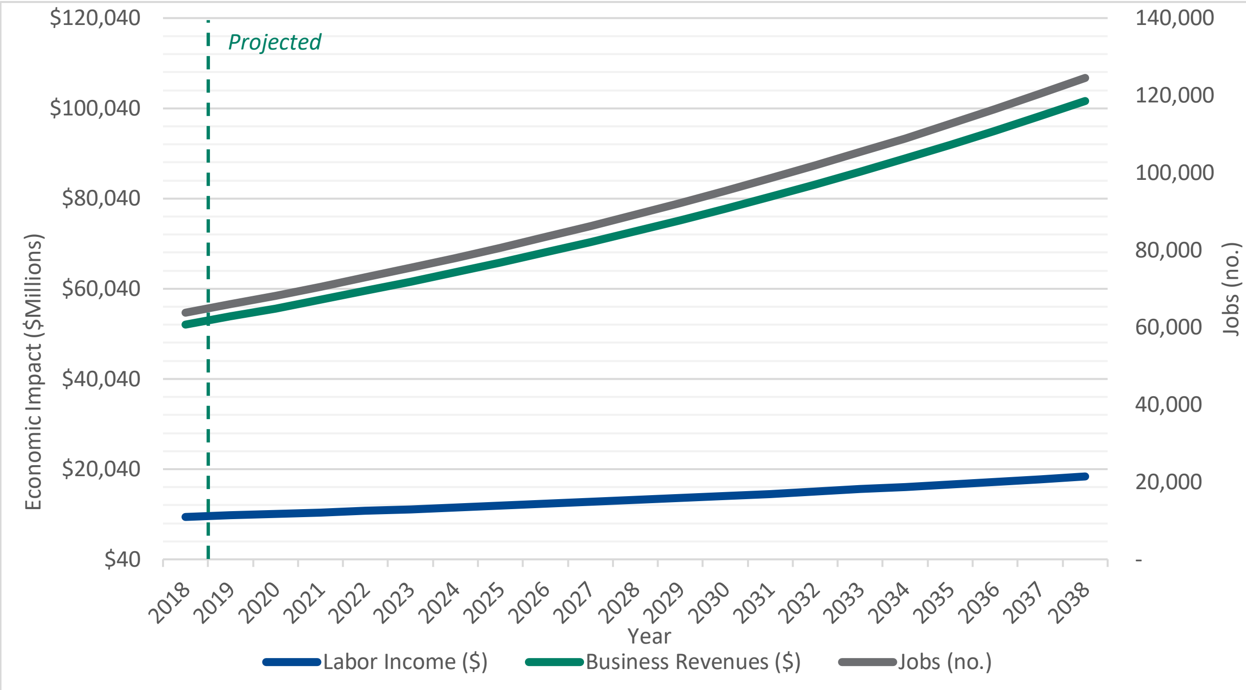
Table 3.13. Economic Scenario Forecast: Aerospace Manufacturing, 2018 – 2038

Year	Jobs (no.)	Labor Income ($)	Business Revenues ($)
2018	3,511	$296,313,000	$1,117,718,000
2019	3,665	$309,350,772	$1,166,897,592
2020	3,827	$322,962,206	$1,218,241,086
2021	3,995	$337,172,543	$1,271,843,694
2022	4,171	$352,008,135	$1,327,804,816
2023	4,354	$367,496,493	$1,386,228,228
2024	4,546	$383,666,339	$1,447,222,270
2025	4,746	$400,547,657	$1,510,900,050
2026	4,955	$418,171,754	$1,577,379,652
2027	5,173	$436,571,312	$1,646,784,357
2028	5,401	$455,780,449	$1,719,242,869
2029	5,638	$475,834,789	$1,794,889,555
2030	5,886	$496,771,520	$1,873,864,696
2031	6,145	$518,629,467	$1,956,314,742
2032	6,416	$541,449,163	$2,042,392,591
2033	6,698	$565,272,926	$2,132,257,865
2034	6,993	$590,144,935	$2,226,077,211
2035	7,300	$616,111,312	$2,324,024,608
2036	7,621	$643,220,210	$2,426,281,691
2037	7,957	$671,521,899	$2,533,038,085
2038	8,307	$701,068,863	$2,644,491,761

Sources: Boeing Commercial Market Outlook 2019, EPB US 2020, Kimley-Horn 2020

Figure 3.13 graphically depicts the economic scenario forecast of aerospace manufacturing through 2038.

Figure 3.13. Economic Scenario Forecast: Aerospace Manufacturing, 2018 – 2038



Sources: Boeing Commercial Market Outlook 2019, EPB US 2020, Kimley-Horn 2020

3.3 Economic Impacts of Air Cargo

Washington airports are essential for producers of agricultural and manufactured goods to access long-distance domestic and international markets. Air cargo services at airports enable Washington businesses to acquire raw materials and manufacturing inputs necessary for the fabrication and assembly of value added or final products. In turn, air cargo connects these final goods with markets outside of the state or country. As will be explained, the air cargo services provided by airports to off-airport businesses across Washington support over 38,000 jobs in the state. The sector most supported by air cargo services is transportation equipment manufacturing, which reflects Washington's strong aerospace industry.

This memo summarizes how air cargo services provided by Washington airports support local economic development through connectivity to distant markets. Each of the following sections helps to explain how the economic impact was determined:

- Data sources
- Washington's air cargo volume and value
- Methodology
- Total economic impact of air cargo

For this analysis of the impact of air cargo on the Washington economy, freight flows that used a Washington port but did not otherwise interact with the local economy were excluded. For example, goods that arrived in the U.S. from China at the Sea-Tac and then were flown to other states were excluded. As a result, the volumes provided in Washington's air cargo volume and value discussion below may be smaller than other estimates of air cargo volumes which report the cumulative total of air cargo either arriving at or departing from any Washington airport. The impacts of these commodity flows—which travel through airports but are not used in Washington—are accounted for in the element of this study that focus on the economic benefits of airport operations and tenants.

3.3.1 Data Sources

This air cargo analysis is based on industry-specific data from the U.S. Census Bureau's Foreign Trade Division (collected by WISERTrade) and the FAF, as well as county-level economic output (business revenue) data by industry sectors assembled by IMPLAN from federal sources. Using these data allow for estimates of commodities produced by Washington industries and sold out of state and avoids double-counting tonnage flown within Washington. A more detailed discussion of each data source is provided below:

- **WISERTrade.** Industry-specific data from the U.S. Census Bureau's Foreign Trade Division as collected by WISERTrade reports the value of each commodity shipped to or from international destinations. These reports are specific to airports and are classified according to the Harmonized System.[14]
- **FAF.** Jointly produced by the BTS and FHWA, the FAF integrates data from a variety of sources to create a comprehensive picture of cargo movements between U.S. geographic zones, including major metropolitan areas and the remaining nonmetropolitan areas of Washington. FAF provides data by all modes of transportation, including aviation for commodities at the two-digit level of the Standard Classification of Transported Goods (SCTG) codes.

WISERTrade and FAF data are used in conjunction with each other to provide the base data for determining a profile of air shipments to and from Washington by origin, destination, and commodity. These sources enable the estimation goods moving by air into and out of Washington.

Neither WISERTrade nor FAF data, however, provide county-level data on where shipped commodities are produced. Therefore, to determine point-of-origin data at the commodity level, federal data primarily collected from the U.S. Bureau of Economic Analysis [BEA] as assembled by IMPLAN were used to calculate the ratios of business revenue by commodity for each Washington county compared to the total revenues produced in the state. This calculation provides an estimate of the "share" of Washington-produced air shipments with an approximate point of origin by county. IMPLAN tracks commodity flows between industries using a different set of 536 sectors. EBP US generated a series of special commodity crosswalks to integrate the data of WISERTrade (organized in accordance with the Hamonized System), FAF (organized in accordance with SCTG codes), and IMPLAN (organized in

[14] The Harmonized System is the predominant international commodity classification used for international trade employed by over 200 countries for assessing tariffs.

accordance with 536 sectors). Estimating the value of air cargo commodities produced by county and shipped from Washington airports is possible by linking these three sources together.

Additionally, the JTC *Washington State Air Cargo Movement Study* (December 2018) and data from direct airport manager outreach to the top 20 airports in the state for air cargo (per the *Washington State Air Cargo Movement Study*) were also referenced to ensure data validity and continuity between sources. Note that economic modeling is necessary to capture the economic contribution of air cargo that occurs off-airport. Commodities flown from one Washington airport to another—while rightfully counted in total air cargo volumes at both airports—are counted once for their economic contributions to state industries. In addition, commodities that pass-through Washington (for example, flown from China to Bellingham and then to Ohio; or from Florida to Sea-Tac to China) do not contribute to the business revenues generated off-airport in the state.

3.3.2 Washington's Air Cargo Volume and Value

Table 3.14 and **Table 3.15** show the total enplaned (exported) and deplaned (imported) air cargo in Washington as determined using the data sources outlined above. This data shows that aircraft and other transportation equipment manufacturing industries in Washington are strongly supported by the robust air cargo services available in the state. As shown in Table 3.14, a total of 116,725 tons of goods were exported out of Washington with a value of almost $19 billion. While transportation equipment accounted for 8 percent of exported tonnage, it accounted for 53 percent of the value of products shipped from Washington by air.[15]

Table 3.14. Top Washington Exports (Enplaned) by Commodity, 2017

	Tons		Value	
Commodity	Tons	Percent Total	Value ($Millions)	Percent Total
Transportation Equipment	9,181	8%	$9,881	53%
Electronic & Other Electrical Equipment & Components	6,124	5%	$4,385	23%
Precision Instruments	8,575	7%	$1,517	8%
Machinery	9,463	8%	$644	3%
Metallic Ores & Concentrates	197	0%	$541	3%
Misc. Manufactured Products	3,579	3%	$471	3%
Agriculture	54,697	47%	$467	2%
Misc. Chemical Products & Preparations	1,790	2%	$157	1%
Pharmaceuticals	1,379	1%	$119	1%
Articles-base metal	2,879	2%	$112	1%
Total (All Commodities)	**116,725**	**100%**	**$18,753**	**100%**

Note: Columns may not add due to rounding. Sources: WISERTrade 2017 and FAF 2017

[15] 2017 data are used because it was the latest available at the time of the analysis.

Table 3.15 shows that 72,163 tons of goods valued at approximately $6.5 billion were transported (i.e., deplaned or imported) into the state for consumption. Transportation Equipment accounted for 23 percent of all deplaned tonnage and 50 percent of the value.

Table 3.15. Top Washington Imports (Deplaned) by Commodity, 2017

Commodity	Tons		Value	
	Tons	Percent Total	Value ($Millions)	Percent Total
Electronic & Other Electrical Equipment & Components	17,823	25%	$1,667	26%
Motorized & Other Vehicles	7,878	11%	$233	4%
Machinery	6,535	9%	$417	6%
Transport Equipment	6,411	9%	$2,102	32%
Agriculture	5,207	7%	$77	1%
Precision instruments	4,645	6%	$642	10%
Misc. Manufactured Products	3,333	5%	$333	5%
Pharmaceutical Products	1,698	2%	$321	5%
Textiles/Leather	5,214	7%	$154	2%
Other	13,418	19%	$539	8%
Total (All Commodities)	**72,163**	**100%**	**$6,485**	**100%**

Note: Columns may not add due to rounding. Sources: WISERTrade 2017 and FAF 2017

Table 3.16 and **Table 3.17** show the total volume and value of international and domestic exports (enplaned) and imports (deplaned) air cargo in Washington.

Table 3.16. Tonnage and Value of International Air Cargo Enplaning and Deplaning in Washington, 2017

International Exports (Enplaned)					International Imports (Deplaned)				
	Tons		Value			Tons		Value	
Commodity	Tons	Percent Total	$Millions	Percent Total	Commodity	Tons	Percent Total	$Millions	Percent Total
Transportation Equipment	2,922	4%	$1,255	28%	Electronic & Other Electrical Equipment & Components	10,745	32%	$1,308	45%
Electronic & Other Electrical Equipment & Components	2,987	4%	$897	20%	Machinery	4,589	14%	$348	12%
Precision Instruments & Apparatus	3,244	5%	$840	18%	Precision Instruments & Apparatus	1,525	5%	$248	8%
Machinery	5,951	9%	$488.7	11%	Transportation Equipment	815	2%	$185	6%
Misc. Chemical Products & Preparations	1,358	2%	$156.0	3%	Misc. Mfd. Products	1,313	4%	$164	6%
Other	51,673	76%	$905.5	20%	Other	14,444	43%	$674	23%
Total (All Commodities)	**68,135**	**100%**	**$4,543**	**100%**	**Total (All Commodities)**	**33,431**	**100%**	**$2,926**	**100%**

Note: Columns may not add due to rounding. Source: WISERTrade 2017

Table 3.17. Tonnage and Value of Domestic Air Cargo Enplaning and Deplaning in Washington, 2017

Domestic Exports (Enplaned)					Domestic Imports (Deplaned)				
	Tons		Value			Tons		Value	
Commodity	Tons	Percent Total	$Millions	Percent Total	Commodity	Tons	Percent Total	$Millions	Percent Total
Transportation Equipment	6,259	13%	$8,625	61%	Transportation Equipment	5,596	14%	$1,917	54%
Electronic & Other Electrical Equipment & Components	3,136	6%	$3,488	25%	Precision Instruments & Apparatus	3,120	8%	394	11%
Precision Instruments & Apparatus	5,331	11%	$677	5%	Electronic & Other Electrical Equipment & Components	7,078	18%	$359	10%
Metallic Ores & Concentrates	194	0%	$541	4%	Pharmaceutical Products	1,610	4%	$303	9%
Misc. Mfd. Products	3,193	7%	$391	3%	Motorized & Other Vehicles	7,667	20%	$216	6%
Other	30,477	63%	$487	3%	Other	13,661	35%	$369	10%
Total (All Commodities)	**48,590**	**100%**	**$14,209**	**100%**	**Total (All Commodities)**	**38,732**	**100%**	**$3,559**	**100%**

Note: Columns may not add due to rounding. Source: FAF 2017

Total deplaned and enplaned air cargo at Washington airports were valued at $25.3 billion, or almost $134,000 per ton. Significantly, given Washington's aerospace industries, the per-ton value of transportation equipment transported as air cargo exceeded $768,000, while accounting for almost 16,000 tons. Electronics accounts for the most tonnage of commodity groups enplaned and deplaned in Washington at almost 24,000 ton, with a per-ton value of about $253,000.

However, strictly accounting for the value of commodity movement does not show the true air cargo contribution to the industry. Other leading deplaned commodities such as electronics and precision instruments are inputs into the manufacturing of transportation equipment. As will be demonstrated, the methodology presented in this chapter accounts for how multiple commodities support industries.

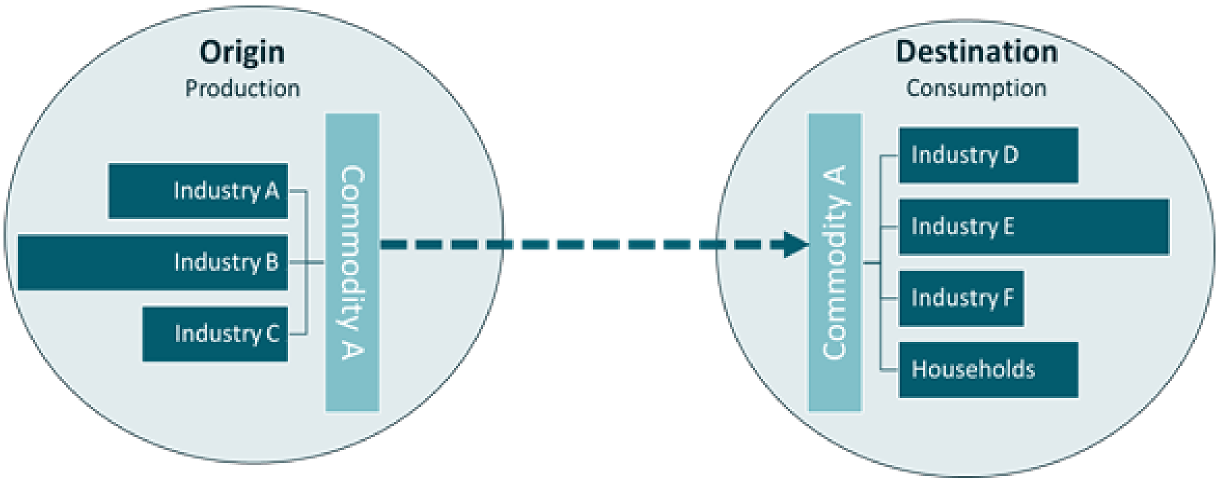
3.3.3 Methodology

Once the data inputs were established, the following processes were employed to calculate the economic impact of air cargo in Washington. For this process, the economic impact of air cargo is based on the proportion of incoming air cargo as a contribution to the production processes of industries or as final goods purchased by end consumers. The first process allocates commodities deplaned in Washington to specific industries, either as inputs to further production processes or as final goods purchased by end consumers. The second process calculates the value added of enplaned cargo by industry. By only counting value added in Washington, these two processes are separated to avoid double counting inputs that arrive in Washington by air, which are then embedded in products that are enplaned and shipped out of Washington.

3.3.3.1 Allocating Air Cargo to Industries of Production

Figure 3.14 illustrates the relationship between (1) industries and commodities; and (2) the process of shipping commodities for sale to points of purchase. Commodities produced in Washington by one or more industries are shipped to subsequent ultimate destinations. Once they reach those destinations, the commodities are consumed by one or more (potentially different) industries as inputs to their production (usually referred to as "intermediate inputs") or as final demand for households. An example of an intermediate input may be plastic produced in Washington and flown to Michigan where it is used as part of automobile production. An example of a product shipped for "final demand" is a pharmaceutical product manufactured in Washington and flown to Florida; the product itself may be handled by wholesalers and retailers, but it is purchased directly by consumers at drug stores without any further production required.

Figure 3.14. Inter-industry Commodity Flows (Cargo Flows) Between Regions



Source: EBP US 2020

3.3.3.2 Approach to Calculate Value of Enplaned and Deplaned Cargo

The air cargo analysis accounts for both inbound commodities shipped by air from international and out of state domestic origins into Washington, and outgoing products shipped as air cargo from Washington to customers (i.e., industries or households). As a conservative measure, calculations on economic reliance related to outbound flows were adjusted downwards to prevent any double counting by including only the value-added portion of activity as the sales receipts realized from sales of goods shipped by air from Washington.[16] Moreover, this approach credits the cargo operations of Washington airports with both their incoming and outgoing cargo as contributions the state economy (distinct from analyses that only credit outgoing cargo and ignore airports' roles in bringing commodities integral to production into a state).

Deplaned and enplaned air cargo play complementary roles in bolstering business revenues of companies in Washington. Incoming cargo are commodities purchased from suppliers that are used by Washington companies for production. These are often time-sensitive commodities and the use of air transport allows Washington firms to engage in competitive sourcing throughout the world. After commodities are turned into products, in-state airports enable Washington companies to turn around and sell high-value goods to customer markets throughout the U.S. and across the globe. The following paragraphs describe the role of commodities that are deplaned (i.e., flown into or incoming) versus enplaned (e.g., flown out of or outgoing) Washington on the state's economy:

- **Air Cargo Deplaned in Washington.** Deplaned cargo are inbound flows that represent commodities that are transported into Washington from out of state and used either as inputs for the production of goods, such as metal for manufacturing, or consumer goods. The total value of each commodity transported into Washington by air is divided by the total value of that commodity that is brought into Washington by all transportation modes (e.g., rail or trucking).

[16] Value added accounts for labor compensation (including benefits), profits, other business income and taxes but not the cost of purchased goods and services that are required for the production of productions.

This step is necessary to assess the dependence of Washington industries on air cargo (versus truck, rail, or ship when air is not involved). Economic data by industry from IMPLAN is then utilized to determine how these goods contribute to production and quantify the number of jobs supported by this activity across industries.

- **Air Cargo Enplaned in Washington.** Enplaned cargo are outbound flows that represent the sale of products by Washington businesses to out of state domestic or international customers. The value of the sale of these products includes the contribution of previously deplaned commodities (discussed in the above paragraph) *and* the subsequent production activities that take place in Washington. It is this latter measure (i.e., the value produced in Washington) that is counted when assessing the sales value of enplaned goods to long-distance customers.[17] This is measurable as value added in Washington. That value is then divided by the total value of all outbound cargo from Washington for all modes. This is repeated for each commodity to represent the proportion of Washington production supported by air cargo services. Economic data from IMPLAN is then utilized to determine the industries that produce the value added on the statewide economy from that production across various industries.

The precision instruments commodity group is used to illustrate this methodology in the section below. The example reviews the steps of how economic impact is calculated from deplaned (incoming) air cargo and enplaned (outgoing) air cargo.

3.3.3.3 Example Methodology: Precision Instruments

Across Washington, businesses spent $5.8 billion to purchase precision instruments in 2017. Instruments valued at $642 million were brought into the state by air, representing 11 percent of the total value of all incoming goods for this commodity group (that is to say, 89 percent of precision instruments were transported into the state by other modes such as ship or trucking). In contrast, total value of precision instruments shipped out of Washington was about $6.7 billion, of which $1.5 billion was by air, representing almost 23 percent of total value shipped (see **Table 3.18**).

Table 3.18. Value and Percent of Precision Instruments Shipped in and Out of Washington

Cargo Type	Total Value of Shipments		Percent Total Value Shipped by Air
	Transported by All Modes ($Billion)	Transported by Air ($Billion)	
Inbound	$5.813	$0.642	11.05%
Outbound	$6.662	$1.516	22.76%

Note: Totals are subject to rounding. Sources: WiserTrade 2017 and FAF 2017. Calculations by EBP US 2020

Precision instruments are used in the manufacturing processes of multiple Washington industries including Transportation Equipment Manufacturing, Machinery Manufacturing, and Computer and Electronics Manufacturing, as well as for consumer goods. Total business sales generated by these industries located in Washington were $112.68 billion and the value added of these industries totaled $44.33 billion (see **Table 3.19**).

[17] Counting the full sales value will double count a portion of the impacts with the value of inbound (deplaned) commodities.

Table 3.19. Profile of Industries that Acquire Precision Instruments (Industry-wide Value Added and Business Revenues in Washington)

Industry Name	Total Business Revenues ($Billion)	Total Value Added ($Billion)
Transportation Equipment Manufacturing	$76.91	$31.51
Machinery Manufacturing	$4.99	$1.69
Computer and Electronic Manufacturing	$8.70	$3.57
All Other Industries	$22.09	$7.56
Subtotal Industries	**$112.68**	**$44.33**

Note: Totals are subject to rounding. Source: WISERTrade as assembled by IMPLAN 2017. Calculations by EBP US 2020

The calculations that estimate direct business revenues attributed to precision instruments are shown in **Table 3.20**. The statewide data assembled by IMPLAN is used to estimate the percentage of Washington industries' total purchases of goods and services of precision instruments that are inputs to their manufacturing processes. Total business revenues per industry, presented above in Table 3.19, is multiplied by the percent of production represented by the value of precision instruments to Washington industries. The product of this multiplication is the estimated total value of precision instruments that are used in each industry's manufacturing process. This value is then multiplied by 11.05 percent, which is the percent of precision instruments brought into Washington by air (noted in Table 3.18 and Table 3.20).

Table 3.20. Industry Production Attributable to Inbound Air Cargo

Industry Name	Percent of Industry Production from Precision Instruments (IMPLAN data)	Percent of Industry Production x Total Industry Output (See Table 6) ($Millions)	Percent of Air Value of Inbound Precision Instruments (See Table 5)	Direct Output Attributed to Inbound Air Cargo ($Millions)
Transportation Equipment Manufacturing	1.09%	$837.89	11.05% (all industries)	$92.54
Machinery Manufacturing	0.48%	$24.13		$2.67
Computer and Electronic Manufacturing	3.45%	$300.03		$33.15
All Other Industries	Varies by industry	$1,582.61		$174.87
Total Production	Varies by industry	$2,744.26		$303.27

Note: Totals are subject to rounding. Sources: WISERTrade as assembled by IMPLAN 2017. Calculations by EBP US 2020

Figure 3.15 represents the role of precision instruments and deplaned (i.e., incoming) air cargo of that commodity in support of a single industry (transportation equipment manufacturing). Table 3.20 shows the overall value of precision instruments deplaned in Washington across industries. The formula is as follows, with the related values in parenthesis:

Figure 3.15. Example Formula: Calculating the Value Provided by Deplaned Precision Instruments on the Transportation Equipment Manufacturing Industry

Total Business Revenues In Washington Generated By Transportation Equipment Manufacturing **($76,905,550,000)** × Percent of Industry Production from Precision Instruments **(0.01089)** × Percent of Air Value of Precision Instruments Deplaned in Washington **(0.1105)** = **$92.54 million**

Source: EBP US 2020

To avoid double counting, this analysis includes only the value added portions of business sales shipped by air by industries that incorporate precision instruments. Methodologically, the calculation process for deplaned air cargo shown in **Table 3.21** is similar to the incoming procedures discussed above. IMPLAN is used to extract the total value added of precision instruments to the value added portion of total business sale (see Table 3.19) and to estimate the percentage of industries' total value added that is made up of precision instruments. Second, FAF and WiserTrade data are used to identify the value of precision instruments shipped from Washington and the proportion of those shipments made by air. Lastly, air value of precision instruments shipped from Washington as a percent of total value of that commodity is used to estimate the proportion of value added of air shipments that are business revenues to Washington.

Table 3.21. Industry Production Attributable to Outbound Air Cargo

Industry Name	Percent of Industry Value Added Attributed to Precision Instruments (IMPLAN Data)	Percent of Industry Value Added X Total Industry Value Added (See Table 3.19) ($ Millions)	Percent of Air Value of Precision Instruments Outbound from Washington (See Table 3.18)	Direct Business Revenues Attributed to Outbound Air Cargo ($Millions)
Transportation Equipment Manufacturing	0.66%	$206.35	22.76%	$46.96
Machinery Manufacturing	2.13%	$36.03		$8.20
Computer and Electronic Manufacturing	51.74%	$1,847.20		$420.423
All Other Industries Producing	Varies by Industry	$402.19		$91.54
Total Production	Varied by Industry	**$2,491.77**		**$567.12**

Note: Totals are subject to rounding. Sources: WISERTrade and FAF as assembled by IMPLAN 2017. Calculations by EBP US 2020

Direct business revenues attributable to air cargo movements of precision instruments shown in **Table 3.22** represent the sum of:

Use of this commodity for inputs into the manufacturing processes of industries in the state + Value added of outbound shipments by air

In other words, the economic impact of inbound goods is measured by the value of the incoming commodity arriving by air (in this example, precision instruments) as a portion of the value of industry sales across industries that incorporate precision instruments in their products.

Outbound economic impact is reflected by the value added in Washington before products are shipped to out of state or international customers by air.

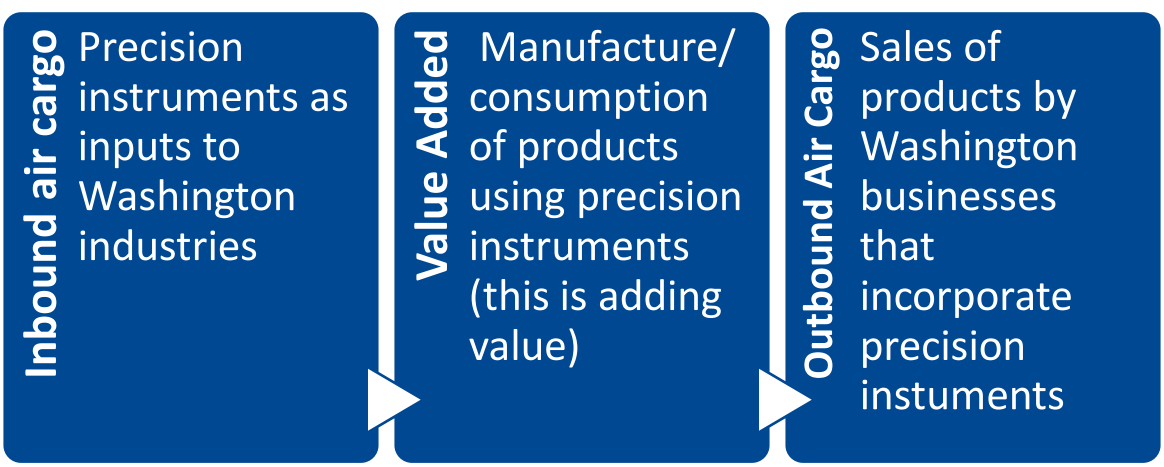
Table 3.22. Direct Impacts of Business Revenues Due to Inbound and Outbound Air Shipments of Precision Instruments

Industry Name	Direct Revenues Attributed Inbound Air Cargo (From Table 3.20) ($Millions)	Direct Revenues Attributed Inbound Air Cargo (From Table 3.21) ($Millions)	Total Direct Revenues Attributed to Air Cargo ($Millions)
Transportation Equipment Manufacturing	$92.54	$46.96	$139.55
Machinery Manufacturing	$2.67	$8.20	$10.87
Computer and Electronic Manufacturing	$33.15	$420.42	$453.57
All Other Industries	$174.87	$91.54	$266.41
Totals	**$303.27**	**$567.12**	**$870.39**

Note: Totals are subject to rounding. Sources: WISERTrade and FAF as assembled by IMPLAN 2017. Calculations by EBP US 2020

This flow of precision instruments entering Washington, being used as inputs to industry production and then sold to long distance customers is illustrated in **Figure 3.16**.

Figure 3.16. Flow of Precision Instruments in the Washington Economy



Source: EBP US 2020

Based on direct business revenues shown in Table 3.22, the IMPLAN model for Washington was applied to calculate jobs, labor income, and value added. These impacts are calculated from the portion of precision instruments associated with each industry that relies on air cargo to: (1) transport that commodity to support production in-state and (2) ship products for sales revenues to out of state or international customers. The direct economic impacts from the air transport of precision instruments to and from Washington are displayed in **Table 3.23**.

Table 3.23. Direct Impacts Attributed to Air Cargo Shipments of Precision Instruments

Industry Name	Direct Jobs (no.)	Direct Labor Income ($Millions)	Direct Value Added ($Millions)	Direct Revenues Attributed to Precision Instruments ($Millions)
Transportation Equipment Manufacturing	173	$ 24.21	$ 56.35	$ 139.55
Machinery Manufacturing	33	$ 2.79	$ 3.69	$ 10.87
Computer and Electronic Manufacturing	981	$ 105.15	$ 186.16	$ 453.57
All Other Industries	1,772	$ 117.33	$ 136.51	$ 266.41
Totals	**2,960**	**$ 249.47**	**$ 382.72**	**$ 870.39**

Note: Totals are subject to rounding. Source: EBP US 2020 using the 2017 IMPLAN model

The following section applies this methodology for all industries in Washington to calculate the total economic impact of air cargo in Washington, including direct impacts, supplier sales (i.e., indirect impacts), and the re-spending of worker income (induced impacts).

3.3.4 Total Economic Impacts of Air Cargo

The air cargo impacts shown in **Table 3.24** include both domestic and international air cargo, as well as supplier sales and the re-spending of worker income due to off-airport sales enabled by Washington airports. This analysis reveals that air cargo activities support 38,117 jobs in the state of Washington, the majority of which are due to activity in the Northwest Region of the state.

Table 3.24. Statewide Air Cargo Dependency

	Jobs	Labor Income ($Millions)	Value Added ($Millions)	Business Revenues ($Millions)
Direct	16,238	$ 1,741.8	-	$ 8,430.4
Supplier Sales	9,801	$ 761.3	$ 1,208.2	$ 2,198.3
Income Re-spending	12,078	$ 653.0	$ 1,200.6	$ 1,972.9
Total	**38,117**	**$ 3,156.2**	**$ 5,962.5**	**$ 12,601.6**

Note: Totals are subject to rounding. Source: EBP US 2020 using the 2017 IMPLAN model

Air cargo impacts are summarized according to the six WSDOT regions: Olympic, Northwest Southwest, North Central, South Central, and Eastern (see **Figure 3.17**). It is important to note that regional air cargo impacts are based on locations of companies using air cargo as inputs to production or as final goods for sale instead of the location of any particular airport.

Figure 3.17. Washington Transportation Regions

Source: WSDOT 2019

Table 3.25 shows the breakdown of cargo impacts by region; as noted above, these impacts are based on the locations of industries that rely on air cargo and not the location of airports. As expected, the impacts generated by air cargo are more pronounced in the Northwest region, accounting for 87 percent of total business revenues and 79 percent of total air cargo impacts in the state.

Table 3.25. Total Air Cargo Impacts by Region

Regional Impact		Jobs (no.)	Labor Income ($Millions)	Value Added ($Millions)	Business Revenues ($Millions)
South Central	Direct	806	$49.3	$63.6	$140.4
	Supplier Sales	349	$21.4	$32.7	$57.7
	Income Re-spending	329	$17.8	$32.7	$53.6
	Total	**1,484**	**$88.5**	**$129.0**	**$251.7**
Southwest	Direct	840	$57.5	$102.7	$293.9
	Supplier Sales	553	$41.9	$65.9	$117.6
	Income Re-spending	493	$26.6	$49.0	$80.5
	Total	**1,886**	**$126.0**	**$217.6**	**$491.9**
North Central	Direct	436	$22.3	$33.3	$71.0
	Supplier Sales	171	$10.2	$15.2	$26.2
	Income Re-spending	172	$9.3	$17.1	$28.0
	Total	**779**	**$41.7**	**$65.6**	**$125.3**
Northwest	Direct	12,048	$1,474.7	$3,145.8	$7,450.5
	Supplier Sales	7,873	$627.2	$997.5	$1,825.1
	Income Re-spending	10,096	$545.9	$1,003.7	$1,649.4
	Total	**30,017**	**$2,647.8**	**$5,147.0**	**$10,924.9**

Regional Impact		Jobs (no.)	Labor Income ($Millions)	Value Added ($Millions)	Business Revenues ($Millions)
Eastern	Direct	646	$41.1	$59.3	$148.1
	Supplier Sales	274	$19.7	$31.4	$55.5
	Income Re-spending	304	$16.4	$30.2	$49.7
	Total	**1,224**	**$77.2**	**$120.9**	**$253.3**
Olympic	Direct	1,461	$97.0	$149.0	$326.5
	Supplier Sales	581	$41.0	$65.5	$116.2
	Income Re-spending	684	$37.0	$68.0	$111.7
Total		**2,726**	**$175.0**	**$282.5**	**$554.5**

Note: Totals are subject to rounding. Source: EBP US 2020 using the 2017 IMPLAN model

Table 3.26 and **Table 3.27** present the impacts of air cargo by industry. Direct impacts show the industries that benefit most acutely from enplaned and deplaned cargo at the state's airports. Total impacts include the effects of supplier sales and income re-spending across Washington generated by the direct business revenues attributed to air cargo movements.

As shown in Table 3.26, the top five sectors supported by air cargo in terms of direct jobs account for 72 percent of the total. Conversely, the leading five sectors when looking at total jobs (direct, supplier sales, and re-spending of worker income) account for 48 percent of the total, attesting to how multiplier impacts spread both impacts from supplier sales and income re-spending throughout the state economy. Job creation is largest for the Transportation Equipment Manufacturing sector for both direct and total state impacts, and jobs in Health Care and Social Assistance also receive major support by air cargo in both direct and total impacts. In other cases, leading sectors are different. Computer and Electronics, Crop Production (agriculture), and Construction are among the top industries in which direct jobs are supported by air cargo. Leading sectors among total impacts generated by air cargo in Washington include Professional, Scientific and Technical Services; Other Business Services; and Retail.

Table 3.26. Leading Sectors by Job Generation from Air Cargo

	Direct		Total (including direct and multiplier effects)		
Industry	**Jobs (no.)**	**Percent**	**Industry**	**Jobs (no.)**	**Percent**
Transportation Equipment Mfg	7,070	44%	**Transportation Equipment Mfg**	7,854	21%
Computer and Electronic Mfg	1,886	12%	**Health Care and Social Assistance**	3,548	9%
Health Care and Social Assistance	1,085	7%	**Professional, Scientific & Technical Services**	2,693	7%
Crop Production	840	5%	**Business Services**	2,206	6%
Construction & Buildings	736	5%	**Retail Trade**	2,156	6%
Other (48 sectors)	4,621	28%	**Other (48 sectors)**	19,660	52%
Total	**16,238**	**100%**	**Total**	**38,117**	**100%**

Note: Totals are subject to rounding. Source: EBP US 2020 using the 2017 IMPLAN model

Table 3.27 shows the impacts of air cargo by all Washington industries and accounts for labor income, value added, and business revenues, as well as jobs for each industry by direct and total impacts. Note that the table is organized according to a 53-sector industry configuration to balance detail across all industries in Washington with readability.

Table 3.27. Air Cargo Impacts in Washington by Sector

Industry	Direct Impacts				Statewide Total Impacts			
	Jobs (no.)	Labor Income ($Millions)	Value Added ($Millions)	Business Revenues ($Millions)	Jobs (no.)	Labor Income ($Millions)	Value Added ($Millions)	Business Revenues ($Millions)
Crop Production	840	$38.4	$47.5	$75.5	938	$43.3	$53.4	$87.0
Animal Production	158	$13.1	$17.6	$26.8	218	$16.9	$22.9	$39.2
Forestry & Logging	6	$0.5	$0.6	$0.8	16	$1.5	$2.0	$2.4
Fishing, etc.	125	$2.9	$6.4	$6.5	140	$3.3	$7.2	$7.3
Support for Agric & Forestry	10	$0.4	$0.4	$0.4	235	$10.0	$9.8	$10.7
Oil and Gas Extraction	8	$0.0	$0.0	$0.6	21	$0.0	$0.0	$1.5
Mining, Quarrying, & Support	12	$1.1	$1.3	$2.6	37	$4.1	$5.1	$9.3
Utilities	1	$0.1	$0.3	$0.8	90	$13.6	$41.3	$94.4
Construction & Bldgs	736	$51.5	$72.9	$137.5	1,039	$72.5	$101.5	$191.4
Food Manufacturing	130	$8.4	$14.8	$73.1	209	$12.7	$22.3	$112.0
Beverage & Tobacco Product Mfg	44	$2.1	$4.3	$18.3	65	$3.4	$7.5	$31.0
Textile Mills & Products Mfg	24	$1.3	$1.5	$4.7	29	$1.5	$1.8	$5.7
Apparel Mfg	20	M $0.7	$0.9	$2.7	22	$0.8	$1.0	$2.9
Leather Product Mfg	3	$0.1	$0.1	$0.4	3	$0.1	$0.1	$0.4
Wood Product Mfg	32	$1.9	$2.9	$8.4	69	$4.2	$6.3	$18.3
Paper Mfg	23	$2.3	$4.0	$15.6	63	$5.7	$9.1	$36.4
Printing	41	$2.1	$2.7	$6.3	86	$4.3	$5.6	$13.3
Petroleum and Coal Products Mfg	2	$0.3	$1.0	$5.6	13	$2.4	$9.9	$56.4
Chemical Mfg	133	$10.2	$37.1	$114.9	160	$12.5	$43.6	$135.7
Plastics & Rubber Products Mfg	81	$5.1	$7.8	$27.5	129	$8.0	$12.2	$43.3
Nonmetal Mineral Product Mfg	61	$4.3	$7.7	$20.5	105	$7.5	$13.9	$36.3
Primary Metal Mfg	57	$4.9	$9.6	$33.9	83	$7.2	$14.0	$49.3
Fabricated Metal Mfg	359	$22.6	$31.4	$72.4	543	$34.0	$49.0	$114.9
Machinery Mfg	431	$37.9	$50.7	$144.8	445	$39.0	$52.2	$149.0
Computer and Electronic Mfg	1,886	$214.3	$382.0	$893.7	1,979	$223.5	$397.8	$933.9
Electrical Equipment & Appliance Mfg	310	$30.1	$34.8	$104.0	333	$32.0	$37.0	$111.4
Transportation Equipment Mfg	7,070	$1,033.0	$2,420.9	$5,828.6	7,854	$1,116.2	$2,589.0	$6,223.7

Industry	Direct Impacts				Statewide Total Impacts			
	Jobs (no.)	Labor Income ($Millions)	Value Added ($Millions)	Business Revenues ($Millions)	Jobs (no.)	Labor Income ($Millions)	Value Added ($Millions)	Business Revenues ($Millions)
Furniture Mfg	32	$1.6	$1.9	$5.7	41	$2.0	$2.4	$7.3
Miscellaneous Mfg	520	$35.7	$43.9	$128.5	547	$37.2	$45.5	$133.4
Wholesale Trade	137	$12.0	$24.4	$34.8	1,532	$132.6	$269.9	$387.0
Retail Trade	146	$6.8	$11.9	$17.3	2,156	$101.9	$167.7	$239.4
Air Transportation	12	$1.3	$2.8	$4.9	83	$9.4	$19.7	$34.6
Rail Transportation	10	$1.5	$2.2	$3.4	39	$5.9	$8.6	$13.1
Water Transportation	11	$1.0	$2.4	$8.1	17	$1.7	$3.8	$12.7
Truck Transportation	24	$1.6	$1.9	$4.0	366	$24.5	$29.4	$61.2
Transit and Ground Transportation	55	$3.8	$0.4	$3.2	252	$11.7	$4.6	$13.9
Pipeline Transportation	0	$0.0	$0.0	$0.0	1	$0.2	$0.3	$0.4
Scenic & Sightseeing Transport Support	25	$2.5	$3.0	$4.9	120	$11.7	$14.1	$23.3
Couriers, Messengers & Postal Service	19	$0.9	$1.2	$2.2	225	$13.3	$16.3	$24.5
Warehousing & Storage	8	$0.5	$0.6	$0.9	166	$10.1	$12.1	$17.8
Media & Information	211	$30.5	$92.2	$262.6	807	$117.1	$238.5	$592.5
Finance & Insurance	24	$1.5	$2.0	$4.7	1,114	$79.8	$135.0	$274.2
Real Estate, Rental & Leasing	23	$1.2	$17.7	$26.2	1,080	$37.2	$398.9	$574.3
Professional, Scientific & Technical	337	$23.0	$27.4	$44.7	2,693	$201.1	$245.3	$364.0
Management Services	33	$3.9	$4.5	$7.8	1,064	$131.2	$151.7	$256.9
Business Services (Admin, Support, Waste)	271	$13.5	$18.5	$29.6	2,206	$107.9	$138.5	$201.4
Education Services	151	$4.1	$3.9	$6.1	582	$18.1	$17.6	$28.1
Health Care and Social Assistance	1,085	$81.9	$93.8	$148.2	3,548	$250.0	$275.0	$426.4
Arts, Entertainment & Recreation	38	$0.7	$1.1	$2.2	653	$14.3	$23.9	$44.5
Lodging	22	$0.9	$2.1	$2.9	39	$1.5	$3.7	$5.2
Restaurants & Drinking Establishments	172	$4.9	$7.7	$12.3	1,872	$53.9	$87.3	$138.0
Other Services	224	$13.0	$17.4	$24.0	1,757	$81.7	$99.7	$139.0
Government (Public Administration)	46	$3.8	$7.4	$14.0	232	$19.7	$37.7	$71.4
Total	**6,238**	**$1,741.8**	**$3,553.7**	**$8,430.4**	**38,117**	**$3,156.2**	**$5,962.5**	**$12,601.6**

Note: Totals are subject to rounding. Source: EBP US 2020 using the 2017 IMPLAN model

3.4 Economic Impacts of Aviation on the Agricultural Sector

Washington State has nearly 39,000 farms spread across 14.7 million acres, or 32 percent of the state's total land area.[18] These farms grow over 300 crops. In order of value, Washington's top agricultural commodities include apples, milk, potatoes, cattle, and wheat. In 2018, the state produced 6.7 billion pounds of apples, more than any other state in the U.S. and over four times the amount of the next highest-producing state, New York. Washington is also the country's top producer of sweet cherries, Concord grapes, pears, spearmint, and hops, and the second-highest producer of seafood and wine.[19]

Over 90 percent of Washington farms sell less than $250,000 worth of products annually, and nearly two-thirds are less than 50 acres in size. These smaller farms cover 65 percent of total farmland across the state; nationally, the average is only 45 percent. This small-scale farming environment contributes to Washington's reputation as one of the nation's premier agricultural centers.

3.4.1 Agriculture's Economic Contribution

Agriculture is a significant driver of Washington's economy, generating $9.6 billion in revenue, not including sales generated by food processing, biotechnology, and other industries in the state that use agricultural products.[20] Crops produced in Washington are sold across the United States and internationally. These sales expand the Washington economy by bringing dollars from these markets into the state. In turn, earnings from the export of crops support jobs, wages, and profits in the agriculture sector, and are used in the following ways: (1) to purchase business supplies from other Washington businesses and (2) in the re-spending of wages and profits in local economies. Across Washington's agriculture industry, about 64,300 people are classified as "producers" and 228,600 additional people are listed as hired farm labor. Of these, about 25,600 producers' primary occupation is farming, and more than 57,800 hired laborers work 150 days or more.[21]

3.4.2 Aerial Application

Many of Washington's crops are treated by aerial applicators—planes that fly over fields and apply pesticides, herbicides, and fertilizers.[22] Aerial application businesses are an important part of Washington's agriculture sector and the state economy. Specifically, aerial application contributes to the economy in the following ways:

1. Preserving cropland value by preventing surface disruption associated with tractors
2. Supporting Washington industries by employing pilots and enabling crop production

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[18] Washington Agriculture Snapshot, Washington State Department of Agriculture, https://agr.wa.gov/getmedia/c7d8403c-a233-4b58-a006-d47a171d886b/641-WSDAAgInfographic-WEB.pdf and 2018 State Agriculture Overview for Washington, U.S. Department of Agriculture.

[19] https://www.washivore.org/we-are-number-one and http://choosewashingtonstate.com/why-washington/our-key-sectors/agriculture-food-processing/.

[20] United States Department of Agriculture, 2017 Census of Agriculture, Table 2.

[21] Ibid., tables 7 and 45.

[22] Aerial forest application is also common in Washington. Landowners use this method to apply herbicides that help improve the survival rates of newly planted tree seedlings in areas that were harvested for timber or used for other purposes. https://www.dnr.wa.gov/forest-chemical-applications

3. Increasing crop production yields efficiently and cost-effectively[23]

The following sections examine aerial application's statewide economic contribution in detail. This analysis demonstrates how aviation is important to Washington's agriculture sector and a variety of other sectors throughout the state.

3.4.2.1 Preserving Crop Value

There are approximately 1,560 aerial application businesses located in 45 states.[24] According to the Association of Washington Aerial Applicators (AWAA), 26 of these businesses are in Washington, where they employ 149 workers.[25] AWAA and the U.S. Department of Agriculture (USDA) both collect data on aerial crop protection. According to these organizations, most of Washington's major crops are treated by aerial application. Major crops include those that USDA collects annual production statistics on.

Aerial applicators preserve cropland value by preventing surface disruption by tractors. To estimate the value of crops preserved in Washington, an understanding of the extent of aerial application is needed. The National Agricultural Aviation Association (NAAA) estimates that on average, 28 percent of all cropland is treated by aerial applicators. By applying this national figure to acres harvested in Washington, it is estimated that 964,760 acres of Washington's major crops received aerial application at least once in 2018. **Table 3.28** shows estimated acres treated by crop.[26]

Table 3.28. Washington Field Crop Production and Pesticide Application, 2018

Crop	Acres Harvested	Aerial Application: Acres Treated (percent)	Aerial Application: Estimated Acres Treated
Wheat	2,165,000	28%	606,200
Alfalfa	350,000		98,000
Apples	170,000		47,600
Potatoes	160,000		44,800
Green Peas	90,400		25,310
Grapes	74,000		20,720
Sweet Corn	74,000		20,720
Canola	67,000		18,760
Barley	67,000		18,760
Lentils	59,000		16,520
Sweet Cherries	40,000		11,200
Hops	39,170		10,970

[23] Washington's State Legislature convened the Aerial Herbicide Application Working Group during its 2019 legislative session. The working group was tasked with reviewing best practices for applying herbicides to forestland using aerial applicators and will deliver a report including recommendations and draft legislation by December 31, 2019.
[24] National Agricultural Aviation Association, "Industry Facts," https://www.agaviation.org/industryfacts, accessed April 12, 2019.
[25] Erin Morse, Association of Washington Aerial Applicators, November 18 and December 18, 2019.
[26] No Washington-specific data were provided regarding aerial application rates by crop; therefore, the NAAA's national average of 28 percent was applied to all Washington acreage. It is assumed that similar crop protection practices are adopted across most states (i.e., farmers that grow certain crops know that aerial application provides certain benefits).

Crop	Acres Harvested	Aerial Application	
		Acres Treated (percent)	Estimated Acres Treated
Pears	20,600		5,770
Blueberries	14,400		4,030
Spearmint	12,300		3,440
Peppermint	11,000		3,080
Raspberries	9,500		2,660
Carrots	5,900		1,650
Asparagus	4,100		1,150
Oats	4,000		1,120
Beans	3,200		900
Pumpkins	2,400		670
Peaches	1,800		500
Strawberries	820		230
Total, major treated crops	**3,445,590**		**964,760**

Source: USDA Washington State Agricultural Overview 2018

3.4.2.2 Value of Aerial-Treated Crops

Using the crop production information contained in Table 3.28 combined with average per-acre crop yields, average dollar value by crop, and dollar loss due to crop surface disruption in 2018, an estimate can be made of the agricultural value of aerial application in Washington. For example, average wheat yields in Washington are nearly 71 bushels per acre, meaning that the 606,200 aerial-treated acres from Table 3.28 translate to an estimated 42.9 million bushels treated by aerial applicators. Priced at $5.51 per bushel in Washington, the estimated value of the state's aerial-treated wheat crop in 2018 was $236.5 million. Using this same methodology for other crops, the total value of Washington's major aerial-treated crops (including wheat) in 2018 was an estimated $2.8 billion as shown in **Table 3.29**.

Table 3.29. Washington Field Crop Yields and Dollar Value (2018$)

Crop	Per Acre Yield	Unit	Aerial-Treated Cropland Yield (units)	Price per Unit ($)	Value of Aerial-Treated Cropland ($)
Wheat	70.8	Bushels	42,919,000	$5.51	$236,483,700
Alfalfa	4.5	Tons	441,000	$184.00	$81,144,000
Apples	39,400.0	Pounds	1,875,440,000	$0.34	$643,275,900
Potatoes	630.0	Cwt	28,224,000	$7.82	$220,711,700
Green Peas	55.0	Cwt	1,392,200	$12.80	$17,820,200
Grapes	6.3	Tons	130,500	$774.00	$101,007,000
Sweet Corn	230.0	Cwt	4,765,600	$5.08	$24,209,200
Canola	1,790.0	Pounds	33,580,400	$16.90	$567,508,800
Barley	73.0	Bushels	1,369,500	$4.40	$6,025,800
Lentils	1,200.0	Pounds	19,824,000	$23.80	$471,811,200
Sweet Cherries	6.1	Tons	68,500	$1,750.00	$119,875,000
Hops	1,984.0	Pounds	21,759,700	$5.50	$119,678,400

Crop	Per Acre Yield	Unit	Aerial-Treated Cropland Yield (units)	Price per Unit ($)	Value of Aerial-Treated Cropland ($)
Pears	19.3	Tons	111,300	$535.00	$59,545,500
Blueberries	9,470.0	Pounds	38,183,000	$1.02	$38,946,700
Spearmint	142.0	Pounds	489,000	$16.70	$8,166,300
Peppermint	120.0	Pounds	369,600	$19.40	$7,170,200
Raspberries	7,980.0	Pounds	21,226,800	$0.48	$10,167,600
Carrots	620.0	Cwt	1,024,200	$5.46	$5,592,100
Asparagus	65.0	Cwt	74,600	$100.00	$7,460,000
Oats	46.0	Bushels	51,500	$2.18	$112,300
Beans	77.0	Cwt	69,000	$31.90	$2,201,100
Pumpkins	125.0	Cwt	84,000	$40.00	$3,360,000
Peaches	7.4	Tons	3,700	$696.00	$2,575,200
Strawberries	105.0	Cwt	24,100	$107.00	$2,578,700
Total, major treated crops					**$2,757,426,600**

Note: Cwt is the abbreviation for hundredweight. One Cwt equals 100 pounds. Source: USDA Washington State Agricultural Overview 2018

3.4.2.3 Effect of Surface Disruption

Zero surface disruption is one of the primary advantages of aerial application. Surface disruption occurs when tractors equipped with sprayers decrease crop yields through soil compaction. On average, three percent of total crop yield is lost to surface disruption when tractors apply crop protection products.[27] Applying this figure to the amount of aerial-treated cropland, it is estimated that $82.7 million in Washington crop value would have been lost if not for aerial application. **Table 3.30** shows the number of units and value by major crop that would have been lost without the services provided by Washington's aerial applicators.

Table 3.30. Effect of Surface Disruption on Washington Crop Yields and Dollar Value (2018$)

Crop	Aerial-Treated Cropland Yield (units)	Average Yield Loss Due to Surface Disruption (%)	Estimated Loss Due to Surface Disruption (units)	Price per Unit ($)	Value of Loss Due to Surface Disruption ($)
Wheat	42,919,000	3%	1,287,570	$5.51	$7,094,500
Alfalfa	441,000		13,230	$184.00	$2,434,300
Apples	1,875,440,000		56,263,200	$0.34	$19,298,300
Potatoes	28,224,000		846,720	$7.82	$6,621,400
Green Peas	1,392,200		41,766	$12.80	$534,600
Grapes	130,500		3,915	$774.00	$3,030,200
Sweet Corn	4,765,600		142,968	$5.08	$726,300
Canola	33,580,400		1,007,412	$16.90	$17,025,300

[27] Russ Gasper, "Agriculture, Aerial Applicators and Airports," 2015, *Agricultural Aviation*, http://www.agaviationmagazine.org/agriculturalaviation/september_october_2015?pg=54#pg54.

Crop	Aerial-Treated Cropland Yield (units)	Average Yield Loss Due to Surface Disruption (%)	Estimated Loss Due to Surface Disruption (units)	Price per Unit ($)	Value of Loss Due to Surface Disruption ($)
Barley	1,369,500		41,085	$4.40	$180,800
Lentils	19,824,000		594,720	$23.80	$14,154,300
Sweet Cherries	68,500		2,055	$1,750.00	$3,596,300
Hops	21,759,700		652,791	$5.50	$3,590,400
Pears	111,300		3,339	$535.00	$1,786,400
Blueberries	38,183,000		1,145,490	$1.02	$1,168,400
Spearmint	489,000		14,670	$16.70	$245,000
Peppermint	369,600		11,088	$19.40	$215,100
Raspberries	21,226,800		636,804	$0.48	$305,000
Carrots	1,024,200		30,726	$5.46	$167,800
Asparagus	74,600		2,238	$100.00	$223,800
Oats	51,500		1,545	$2.18	$3,400
Beans	69,000		2,070	$31.90	$66,000
Pumpkins	84,000		2,520	$40.00	$100,800
Peaches	3,700		111.0	$696.00	$77,300
Strawberries	24,100		723	$107.00	$77,400
Total, major treated crops					**$82,723,100**

Source: USDA Washington State Agricultural Overview 2018

3.4.3 Economic Impact of Washington's Agriculture Sector

USDA and U.S. Department of Commerce data assembled by IMPLAN show the overall size of Washington's agriculture sector. This sector includes fruit farming, vegetable farming, grain farming, and floriculture production (includes alfalfa and hops)—industries that grow crops treated by aerial application. Together, these industries provide 66,400 jobs and generate $3.2 billion in labor income, $3.8 billion in value added, and $6.8 billion in business revenues annually (see **Table 3.31**). Labor income is a component of value added and value added is a component of business revenues.[28]

Aerial application supports these industries by enabling farms to maximize their crop production. In this way, aerial application is partially responsible for the economic contribution of Washington's agriculture sector. Since aerial application covers 28 percent of cropland on average, this figure is used as a proxy measure to estimate the economic contribution of farms that benefit from aerial application.

When the 28 percent figure is applied to the total economic contribution of the agriculture industries mentioned above, it is estimated that farms benefiting from aerial application provide 18,590 jobs and generate $897 million in labor income, $1.1 billion in value added, and $1.9 billion in business revenues annually (see Table 3.31).

[28] Payroll is based on the U.S. BEA concept of Personal Income (called Labor Income in IMPLAN), which includes compensation and the value of employer-provided benefits.

The aerial application industry itself also generates economic impacts. As noted previously, Washington's 26 aerial application businesses support 149 jobs. Using state-specific ratios from IMPLAN, these jobs are associated with an additional $6.35 million in labor income, $6.39 million in value added, and $6.78 million in business revenues annually.

Table 3.31. Direct Economic Contribution of Washington's Agriculture Industries (2018$)

Industry	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
All Crop Production				
Fruit farming	52,220	$2,021,577,500	$2,477,832,800	$3,850,441,400
Vegetable farming	8,610	$782,709,900	$882,975,800	$1,611,054,900
Grain farming	2,000	$106,950,500	$97,225,100	$899,441,100
Floriculture production	3,570	$291,171,900	$330,848,600	$466,563,700
Total, all crop production	**66,400**	**3,202,409,800**	**3,788,882,300**	**6,827,501,100**
Aerial-Treated Crop Production				
Fruit farming	14,620	$566,041,700	$693,793,200	$1,078,123,600
Vegetable farming	2,410	$219,158,800	$247,233,200	$451,095,400
Grain farming	560	$29,946,100	$27,223,000	$251,843,500
Floriculture production	1,000	$81,528,100	$92,637,600	$130,637,800
Total, aerial-treated crop production	**18,590**	**$896,674,700**	**$1,060,887,000**	**$1,911,700,300**
Aerial Application Industry Only				
Aerial application industry	**149**	**$6,351,400**	**$6,388,800**	**$6,782,000**

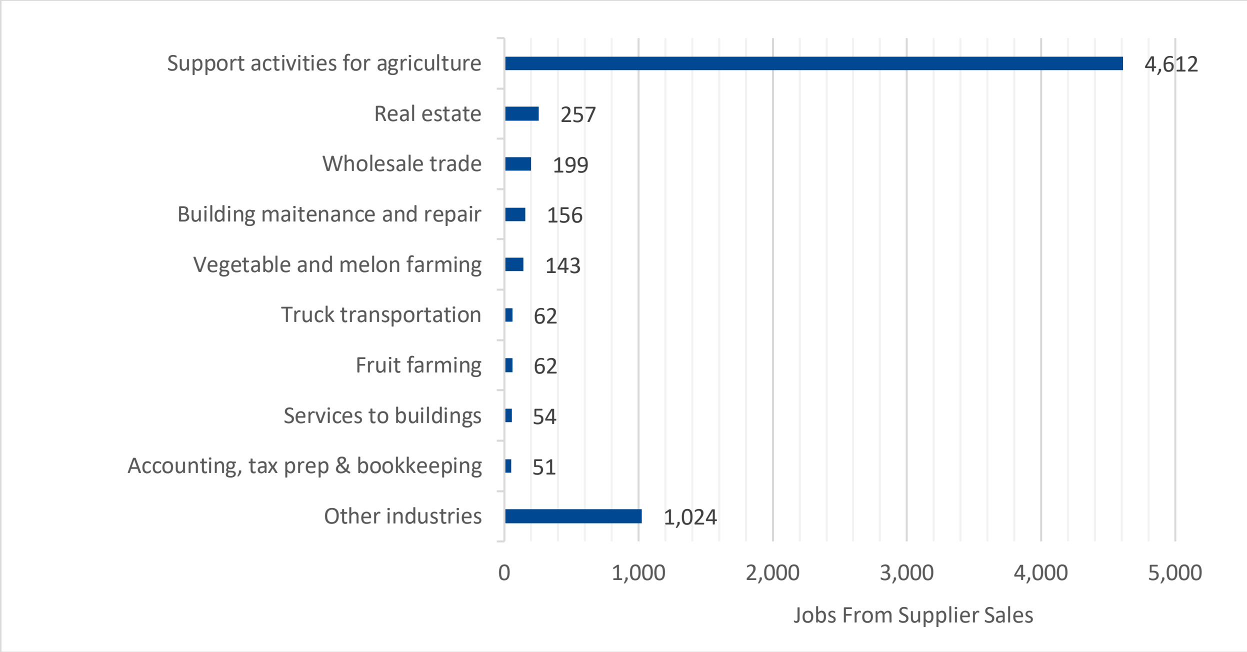
Source: EBP US 2020 using the 2017 IMPLAN model

3.4.4 Total Contribution of Industries Supported by Aerial Application

The direct activities of farms and aerial application businesses involve the purchase of supplies, equipment, and services from other Washington businesses. These supplier sales support 6,620 additional jobs. Over two-thirds of these additional jobs are in the industry that provides support activities for agriculture. This industry employs farmworkers and other laborers who operate equipment, maintain crops and nurseries, and care for farm animals, among other tasks.[29] The remaining jobs are in a range of industries as identified in **Figure 3.18**.

[29] https://www.bls.gov/iag/tgs/iag115.htm.

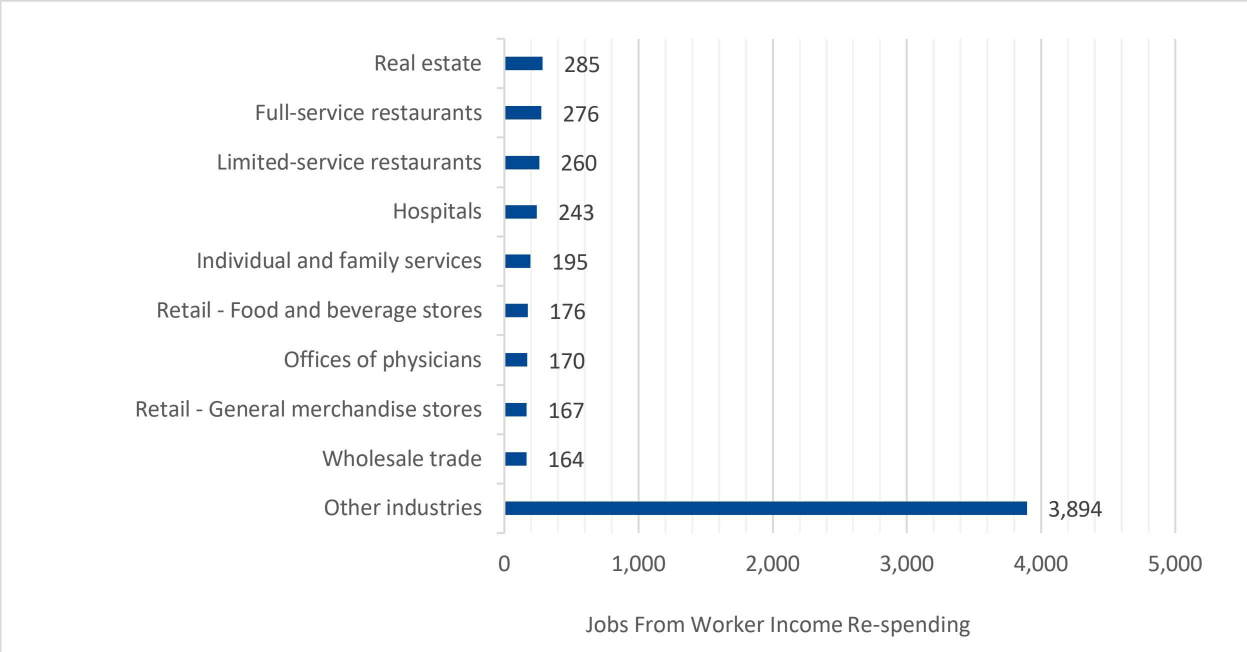
Figure 3.18. Jobs from Supplier Sales in Select Industries



Source: EBP US 2020 using the 2017 IMPLAN model

Re-spending of worker income supports another 5,830 jobs. These jobs are created when workers at farms, aerial application businesses, and their supplier companies spend their wages at Washington businesses. As a result, these jobs exist in dozens of industries. The industries with the largest number of worker income re-spending jobs are shown in **Figure 3.19**.

Figure 3.19. Jobs from Worker Income Re-spending in Select Industries



Source: EBP US 2020 using the 2017 IMPLAN model

By supporting Washington's agriculture industries, aerial application contributes significantly to the state economy. Industries that benefit from aerial application, plus the aerial application industry itself, contribute 31,190 jobs and $3.6 billion in annual business revenues to Washington's economy (see **Table 3.32**).

Table 3.32. Total Contribution of Aerial Application to the Washington Economy (2018$)

Impact Type	Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Direct impact	18,740	$903,026,100	$1,067,275,800	$1,918,482,300
Supplier sales	6,620	$338,703,800	$462,790,300	$703,807,600
Worker income re-spending	5,830	$320,401,400	$589,550,000	$965,443,000
Total contribution	**31,190**	**$1,562,131,300**	**$2,119,616,100**	**$3,587,732,900**

Source: EBP US 2020 using the 2017 IMPLAN model

3.4.5 Agricultural Impacts Conclusion

Aerial applicators generate significant economy activity in Washington. They not only protect crop value by preventing surface disruption, but also support the state's agriculture sector and a variety of other industries by purchasing supplies and paying wages that are spent at businesses throughout the state. The variety of industries that are supported by supplier sales and worker income re-spending within Washington demonstrates the extensive reach of the aerial application industry.

3.5 Summary

At the time of this writing, the aviation industry is facing one of the most significant challenges in its history. COVID-19 has reached nearly every corner of the world, causing major disruptions in most facets of the global economy. The only aspect that analysts seem to agree upon is that "business as usual" is a long way off and some aspects of life may never be the same. Few industries have been so acutely and severely affected by COVID-19 as aviation.

With much uncertainly, COVID-19 brings new opportunities to aviation as well. The industry has undergone major upheavals before and it is likely that as some segments of aviation contract, others will grow. Air cargo, for example, has witnessed a small uptick in activity as customers grow more accustomed to e-commerce for purchasing everything from furniture to groceries, pharmaceuticals, and nearly everything in between. The agricultural sector has experienced more limited disruptions associated with the virus—meaning that aviation's role in terms of protecting crop value and increasing yields will continue with fewer interruptions. Anecdotally, some airports have reported an increase in corporate and business aviation as companies stay apprehensive about flying employees on scheduled air carriers, while others report a decline. Commercial passenger service is undoubtedly the hardest-hit aviation activity. Passenger enplanements are down by 95 percent at the time of this writing in May 2020. Some industry analysts, including the Boeing and Delta Air Lines CEOs, predict a three-year recovery period for the aviation industry as a whole.

The CARES Act emergency relief funding of $10.0 billion for airports and $29.0 billion for airlines demonstrates that federal policymakers recognize aviation's central importance to the U.S. economy with functions that are deeply intertwined with

To catalyze recovery, protect jobs in the aviation industry, and ensure the industry's continued ability to provide air transport, the U.S. DOT was appropriated approximately $10.0 billion in economic relief funds for U.S. airports as part of the Coronavirus Aid, Relief, and Economic Security (CARES) Act (signed into law March 2020). These federal funds will cover 100 percent of all Airport Improvement Program (AIP) grants awarded in 2020, meaning that neither state nor local matches are required for the airports receiving AIP. In addition, airlines were granted $29.0 billion for payroll support to ensure the industry's ability to keep its employees and continue flying. This emergency relief demonstrates that federal policymakers recognize aviation's central importance to the U.S. economy with functions that are deeply intertwined with the country's economic stability, growth, and resiliency.

The impacts of COVID-19 bring into acute focus that aviation activities are impacted by numerous forces on a global scale. While forecasting based on historic trends is a valuable exercise, so too is considering the unforeseen. Airports, for example, with current planning documents are better positioned to access CARES funding to complete deferred maintenance projects or capital improvements. Air cargo companies with established contingency plans to ramp-up service are now growing their share of the market, while those without are falling behind. The current situation in aviation underlines the vital importance of long-term planning as a component of resiliency. This situation has put into sharp focus the ongoing importance of continual planning—not for the world we expect, but for the unexpected.

The current COVID-19 crisis places new emphasis on the importance of long-term planning as a key component of resiliency.

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Chapter 4. State Aviation Investments

> *To maintain Washington's position as a worldwide leader in the aviation and aerospace industry, continued investment in the aviation system is essential.*

Airports are economic engines that provide for the movement of goods and people, emergency services, and gateways into communities. The 134 commercial service and general aviation (GA) airports in the Washington aviation system support a wide variety of commercial, governmental, and personal aviation activities such as transporting passengers and cargo; flight instruction; agricultural spraying; and law enforcement, military, and search and rescue operations. Washington's airports also support much of the state's multibillion-dollar aircraft and aerospace manufacturing and repair industries anchored by the Boeing Company. All of these activities are supported by the investment that has been made by federal, state, local, and/or private companies who have developed infrastructure to support the wide-ranging aviation activity in Washington. Continued investment is essential to Washington's position as a worldwide leader in the aviation and aerospace industry.

This chapter provides an overview of the investment the Washington State Department of Transportation Aviation Division (WSDOT Aviation) has made in the aviation system. This includes studies that provide analysis of the system's needs, including development of performance measures that track how various investments are making a difference in the system. It is essential that WSDOT is able to monitor the system's performance to demonstrate enhancements that are occurring that are positioning the state for increased economic vitality. Beyond performance of the system, evaluating funding that is available to maintain and improve the system is an important component of understanding the needed investment in Washington's aviation infrastructure. An analysis of funding in Washington compared to other states was also conducted to evaluate how the state's investment in aviation compares to other states, including the federal investment that has been made. This information builds on the 2015 *Airport Investment Study* which is discussed in this chapter.

This chapter includes the following sections:

- Overview of system drivers
- Review of previous studies
- Economic performance measure considerations
- Performance measure recommendations
- Performance measure summary
- Comparative analysis of aviation funding

4.1 Overview of System Drivers

These activities, and the many others that occur at Washington's airports, are some of the key drivers of the economic impact that airports have on their communities, regions, and statewide. GA flying results in revenue generation through hangar and terminal leases, fuel sales, landing and tie-down fees, as well as ground leases from the aviation- and non-aviation-related business tenants located on airport property. Scheduled commercial service additionally generates revenue through airline ticket sales and by supporting a host of businesses that meet pilot and passenger needs, such as parking, rental cars, and other concessionaires. Airports are home to aviation and non-aviation-related businesses that employ skilled and non-skilled workers in a variety of sectors such as retail, manufacturing, and technology, as well as the many aerospace- and aerospace-related industries located in the state. Furthermore, businesses that are reliant on airports may choose to locate to a specific area based on its proximity to an airport. The quantification of the economic impacts associated with airports in the state is a primary reason the WSDOT Aviation Division initiated the Washington Aviation Economic Impact Study (AEIS) in 2018.

An airport's potential to maximize its economic impact depends, in part, on its ability to support business needs and cultivate an environment of economic prosperity. This ability is influenced by the investment made in facilities and services at the airport, the formal policies that govern its management and organization, and the implementation of various strategies and initiatives that enhance an airport's attractiveness to potential businesses. Creating a business-friendly environment is one critical element of helping airports support additional on-airport employees and enhance their abilities to serve as economic engines, which, in turn, can pay major dividends in terms of local community and state support.

The need for additional investment support is particularly acute in Washington: The *Airport Investment Study* reported that the state's 134 public-use airports will need an estimated $3.6 billion in preservation and capital project funds through 2034.[1] WSDOT's share of the overall program is $240 million. Based on funding forecasts, WSDOT's Airport Aid Grant Program will be able to contribute $1.4 million annually over the next 20 years, resulting in an average annual need of more than $12 million. Should airports' capital and preservation needs continue to be underfunded, the AIS anticipated that the state would not realize $2 billion in economic output, 13,600 jobs, and $74 million in tax revenues. Additionally, airports would only be able to address core infrastructure maintenance needs, and many GA airports without federal funding would lose the ability to implement a majority of planning capital projects. As a result, existing residents' and businesses' access to air service may diminish, and new infrastructure needs may go unmet as airports struggle with the needed investment and funding to provide the facilities and services required to meet growing demands.

The AEIS demonstrates that Washington's airports provide a significant return on investment, with economic and quality-of-life benefits that extend far beyond the fence. Further, *the Washington State Aerospace Economic Impacts 2018 Update* quantified $89.64 billion in business revenues and 226,130 jobs associated with the aerospace industry.[2] The industry has a direct relationship to aviation and relies

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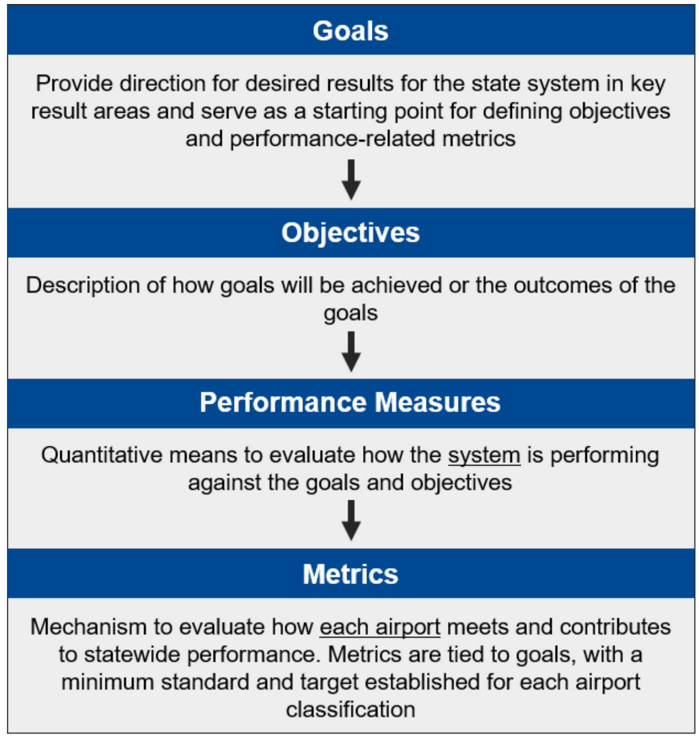
[1] CH2M. (June 2015). *Airport Investment Study*. Prepared for the WSDOT Aviation Division. Executive summary available online at www.wsdot.wa.gov/aviation/AirportInvestmentStudy.htm (accessed July 2019).

[2] Community Attributes. (December 2018). *Washington State Aerospace Economic Impacts 2018 Update.* Prepared on behalf of the Washington Aerospace Partnership. Available online at nma.choosewashingtonstate.com/wp-content/uploads/2018/12/CAI-AFA-2018-Aerospace-Update.pdf (accessed July 2019). p. 10.

on the support and facilities provided by airports, such as runway access and ground lease needs, for research, manufacturing, repair, testing, and related activities. Airports are also home to firms engaged in unmanned aerial vehicles, electric vehicles, space technologies, and other emerging fields existing at the forefront of aerospace. Taking proactive steps towards improving airports' economic contributions to their communities also supports departments of transportation and public-use airports in their roles as responsible stewards of taxpayer dollars.

Figure 4.1. Relationship and Definitions of Airport System Goals, Objectives, Performance Measures, and Metrics



Source: Kimley-Horn 2019

Recognizing the importance of actively supporting business development at Washington's airports, WSDOT Aviation Division established Economic Development and Prosperity as one of the key goals of the 2017 *Washington Aviation System Plan (WASP)*. According to the *WASP*, this goal is designed to "ensure airports are advancing the business opportunities leading to economic prosperity in the airport environment and within the surrounding community." Associated objectives, performance measures, and metrics were also developed to provide direction regarding specific desired outcomes and a means to evaluate the system's and specific airport's performance against this goal. The relationship between goals, objectives, performance measures, performance indicators, and metrics, and definitions of the terms, are depicted in **Figure 4.1.**

This element of the Washington AEIS was designed to review and potentially update the work of the *WASP* to ensure that the economic vitality goal elements established in 2017 continue to reflect the priorities of the WSDOT Aviation Division and meet current and anticipated future needs. The *Airport Investment Study* was also reviewed to identify alignment with the findings of this previous work. The outcomes of this task provide the WSDOT Aviation Division and airports with a roadmap for cultivating economic prosperity throughout the system and a framework for evaluating potential changes to the system and the efficacy of improvements over time.

> *A roadmap for cultivating economic prosperity throughout the system and a framework for evaluating potential changes to the system and the efficacy of improvements over time is an outcome of the AEIS.*

4.2 Review of Previous Studies

To set the stage for the development of the recommendations of the Washington AEIS, the following section reviews the findings of the *WASP* and *Airport Investment Study*. AEIS recommendations have been designed to align with these previous works.

4.2.1 WASP Economic Vitality Goal, Performance Measures, and Metrics

The AEIS builds upon the Economic Development and Vitality goal and associated elements of the *WASP*. This analysis assesses the *WASP* goals to ensure their continued ability to meet the WSDOT Aviation Division's current needs. As appropriate, *WASP* goals will be recommended to be maintained or updated based on the current Washington aviation environment and state legislative and WSDOT Aviation priorities. The *WASP* objectives include supporting and increasing the opportunity to transport goods and passengers via air service, enhancing collaboration between an airport and its community, and promoting on-airport businesses and aerospace manufacturing jobs to increase tenant revenue. The *WASP* also established three performance measures to evaluate the Washington airport system's ability to promote economic development, serve the business community, and maximize airports' economic impacts. **Table 4.1** summarizes the *WASP*'s Economic Development and Vitality goal and its associated objectives and system performance measures.

Table 4.1. WASP Economic Development and Vitality Goal and Associated Objectives and System Performance Measures

Goal	Objectives	System Performance Measures
Economic Development and Vitality	Support transport of goods and passengers by air, including increasing service opportunities	Airports with documented air cargo activity (by type) and strategy/market and airports with growing (>1%per year) commercial airline service
	Collaborate with airport sponsors and other agencies to maintain and support high, stable levels of community economic growth and development	Airports with active development partnerships with chambers of commerce, tourism bureaus, service organizations, industries, governments, and recreational user groups
	Increase airport tenant revenue growth, including promoting on-airport aerospace manufacturing jobs	Airports with business parks or landside real estate development (existing and available) and those with on-site aerospace manufacturing lessees

Source: WASP 2017

Table 4.2 summarizes the airport-specific metrics associated with this goal category. Recommended minimums and targets were established for specific airport classifications as shown below. The use of airport classifications allows metrics to be established that are obtainable by individual airports based on their classifications and abilities to contribute to the system. It is not reasonable to assume that an airport with limited resources and activity be held to the same standards or performance as an airport with greater resources and annual activity. Individual airport metrics can be compiled to evaluate the overall system's performance and determine adequacies, deficiencies, and redundancies.

Table 4.2. Airport-specific Metrics for WASP Economic Development and Vitality Goal

Classifications	Recommended Minimums	Target
Air Cargo Reporting		
Major	Track and annually report air cargo/freight activity (such as number of operations, tonnage, type of freight carried) to WSDOT; manage off-airport resources for air cargo support services (such as crossdock trucking, warehouse, etc.); examine feasibility of establishing airport logistics parks	Collaborate with WSDOT on air cargo facility and policy needs and investment strategies identified as a result of reported activity; collaborate with regional planning and economic development agencies on off-airport resource development
Regional	Track and annually report air cargo/freight activity (such as number of operations, tonnage, type of freight carried) to WSDOT; identify off-airport resources for air cargo support services	Collaborate with WSDOT on air cargo facility and policy needs and investment strategies identified as a result of reported activity; collaborate with regional planning and economic development agencies on off-airport resource development
Community	Track and report air cargo/freight activity (such as number of operations, tonnage, type of freight carried) to WSDOT	Collaborate with WSDOT on air cargo facility and policy needs and investment strategies identified as a result of reported activity
Collaboration with Government Agencies on Economic Opportunities		
All Classifications	Collaborate with state & local agencies to document economic and qualitative contributions of aviation	Documented plan for collaboration efforts; track and monitor efforts and results
Partner with Industry to Support Activities		
All Classifications	Collaboration with businesses to support airport activities	Documented plan for collaboration efforts; track and monitor efforts and results

Source: WASP 2017

Metrics were only established for the air cargo, government collaboration, and industry partnership objectives and measures. Airport-specific recommended minimums were not established for tenant revenue growth, business parks or landside development, nor on-site aerospace manufacturing lessees. While important for revenue generation and economic impact, individual airports have little control over the actual development of available property, other than making property available assuming there is property within an airport's boundaries that meets a lessees' needs while still providing sufficient room for future airport development to meet other demands. Businesses weigh many factors when determining where to locate their facilities, including geographic location/proximity to clients and suppliers, available staff, applicable tax and lease rates, local regulations, and other factors. While airports must take steps to improve attractiveness to potential tenants and create business-friendly on-airport environments, they cannot be held accountable for business decisions outside of their direct control. As a result, the *WASP* did not establish airport-specific metrics for these objectives and performance measures.

4.2.2 Airport Investment Study Recommendations

The *Airport Investment Study* was also reviewed to determine if any recommendations from that study could be incorporated into the AEIS. The *Airport Investment Study* assessed the state's historical and projected future federal and state funding levels, identified airport preservation and capital improvement needs, and quantified the potential funding gap between projected needs and demand, related to providing a functional statewide aviation transportation system. The study determined that the state will face a shortfall in excess of $12 million in meeting aviation investment needs through the 2034 planning horizon. To close this significant gap, the WSDOT Aviation Division and Study Advisory Committee developed a list of prioritized recommendations. These recommendations are summarized in **Table 4.3**.[3] All proposed *Airport Investment Study* solutions were organized into categories as shown below (i.e., new funding sources, refinements to current funding programs, other potential solutions).

Table 4.3. Prioritized Recommendations of the Airport Investment Study

	Priority-Rated Recommendation	Summary
	New Funding Sources	
1	**Public private partnership (P3)**	Develop an educational program for municipal and airport managers on P3 programs including funding level options, regulatory requirements, and an implementation guide.
2	**Alternative taxing of airport operationally-oriented uses**	Implement a state law that would allow airport operational activities to be taxed or levied a fee, with proceeds going to the Aeronautics Account. Applicable activities may include licensed motor vehicles at an airport, non-aviation fuel consumption, and airport parking.
3	**Alternative economic development-based consumption tax**	Establish a new state tax in communities that have commercial service airports that promote tourism with revenues earmarked for the state Aeronautics Account.
4	**State-sponsored Revolving Aviation Infrastructure Loan Fund (SRF)**	Establish a state-sponsored SRF loan program to fund debt-worthy capital infrastructure improvement projects including multimodal facilities and revenue-producing facilities.
	Refinements to Current Funding Programs	
5	**Realignment of current transportation revenue allocations**	Allocate a more equitable percent share of the Motor Vehicle Fuel fund revenues to the Aeronautics Account commensurate with the percent of motor vehicle fuel consumed by GA aircraft. Potentially reallocate a portion of the existing rental car tax revenues from the WSDOT Multimodal Account to the Aeronautics Account commensurate with rental car activity generated at airport locations.

[3] CH2M. (June 2015). *Airport Investment Study.* Prepared for the WSDOT Aviation Division. Executive summary available online at www.wsdot.wa.gov/aviation/AirportInvestmentStudy.htm (accessed July 2019).

	Priority-Rated Recommendation	Summary
6	Reallocate airport leasehold tax to the Aeronautics Account	Reallocate leasehold excise taxes generated by leases on publicly owned airports from the General Fund to the Aeronautics Account.
7	Increase select aviation tax rates	Increase the aviation fuel excise tax rate from $0.11 per gallon to $0.155 per gallon through a legislative change.
8	Revise fuel excise tax exemptions	Review and optimize existing exemptions on fuel excise tax to apply tax as uniformly as possible, keeping some exceptions in-place to avoid legal issues.
9	Modify the state aircraft excise tax program	Allocate 100 percent of aircraft excise taxes to the Aeronautics Account.
	Other Potential Solutions	
10	Develop a best management practices (BMP) guidebook/ toolkit for airports	Develop and distribute a BMP guidebook/toolkit for GA airports to improve airport self-sufficiency. Conduct training for interested airports and municipal managers.

Source: CH2M 2015

In addition to these 10 recommended strategies to close the gap between aviation need and resources, the study team identified an additional 23 preliminary solutions not recommended for further analyses during the study, but available for future consideration. These solutions are presented in **Table 4.4** (organized by category).

Table 4.4. Evaluated but Not Recommended Solutions of the Airport Investment Study

	Alternative Solution	Summary
	New Funding Sources	
1	Alternative taxation sources outside of aviation	Identifying new source industries to tax that derives some benefit from aviation. This concept would include a broad identification of ancillary industries that rely to some extent on aviation; i.e. mining; low weight/high value goods manufacturing; computer and IT product manufacturing.
2	Utilize "infrastructure exchange" financing	This source concept would entail exploring options to use private financing sources (e.g., pension funds, equity capital group funding) through the West Coast Infrastructure Exchange (WCX), a collaborative that has been set up across Washington State, Oregon, California, and British Columbia. WCX is intended to serve as a mechanism to help project sponsors and private sources identify where mutual interests and characteristics can lead to financing deals.
3	Corporate sponsorships	This new funding source would identify the potential for local corporations to sponsor an airport, a concourse, other airport facility improvements and including naming rights. This concept would allow for the use of corporate sponsorship revenues to help cover capital funding for specific projects and potentially local share requirements.
4	Establish a state Passenger Facility	This source concept entails the use of a passenger head tax, the revenues of which would be used for approved capital improvements. The PFC would be a state enacted program similar to the federal PFC program.

	Alternative Solution	Summary
	Charge (PFC) head tax program	
5	Establish wide-ranging state tax credits to airports	This source concept would entail the enactment of a state law that would be geared to relieving and equalizing the existing tax burden for airports. This source would allow for an equal across the board treatment for the state airports regarding the imposition of any and all state levied taxes that impact aviation.
6	Alternative taxing of on airport generated commercial activities	This source concept would tax on-airport generated commercial revenues with proceeds going to the aeronautics account. Potential sources for this tax could be inside the terminal activities, such as airport terminal food/beverage and retail concessions, etc.
7	Alternative taxing of the proportional value of transportation benefits derived	This source concept would attempt to derive a pro-rata share of tax from persons, properties, and business based on their specific derived benefit from air transportation. This type of taxing source would use an economic valuation to fix a benefit derived for those aviation users at all of the state airports.
8	Establish a through the fence access fee structure	This source concept would standardize all the state airports in dealing with and fairly charging for through the fence operations. This concept would need to set standard market rate charges for through the fence operations and provide a guide for airport managers to ensure that they are both getting a reasonable return for these operations and are also consistent with FAA guidelines for the same.
9	Direct aviation administrative-related fees	This source concept would be tied to a new fee structure directly tied to aviation administrative transactions, collected at the point source, and deposited into the aeronautics account. Potential aviation related fee categories could be aircraft license renewals fee, pilot license issue and renewal fee, airport licensing fee, etc.
	Refinements To Current Funding Programs	
10	Restructure the current state transportation and general funds	In this solution, the State Aeronautics Account and the State General Fund are completely restructured to fully account for the proportional value of aviation within the state of Washington.
11	Tiered airport aid funding	In this funding refinement, the state would modify the current funding model to take into account each airport's "ability to pay". In this new funding model, the state would pick up a larger percentage of local match and local requirements for airports that are "not" self-supporting versus those airports that "are" self-supporting. Larger airports would be providing more local funding to allow the allocation of matching funds to smaller airports.
12	Set self-sustaining fee requirements for airports receiving grant funding	In this refinement, airports would be held to a commercial best practice requirement that would ensure a proper market rate/return on investment for grant funded projects. Airports that fail to meet their commercial benchmark will pay a self-sustaining fee back into the program.

	Alternative Solution	Summary
13	Reduce sales tax exemption for other construction	In this refinement, the specific sales tax exemption for other construction (such as hangars) would be reduced. This refinement would increase the overall cost of other facility construction at the Washington state airports, with the marginal increase going into the Aeronautics Account to be used for other airport capital development needs.
14	State of Washington to petition to become an [FAA] State Block Grant Program (SBGP) participant	In this refinement, the state of Washington would be set up to administer all of the federal grant revenue flowing into the state annually. This program refinement would increase the administrative burden for the aviation department while offering the opportunity to enhance the current federal grant program by providing local control that could expand grant opportunities for specific airports.
15	Modify [state and federal] project screening and evaluation processes to allow for more project eligibility	This refinement would require modifications to the current process for screening projects. In this new process, the state would work with the FAA to set wider bounds for projects that could be "federally eligible" and "state funding eligible". The new parameters would look to expand project funding in both the federal and state buckets to include revenue producing projects, economic development projects, airport business/ strategic planning, and safety/security planning, etc.
Revisions to Current Funding Sources		
16	Utilize other state and federal grant funding sources	This optimization solution would require the state to analyze the availability of other grant sources that would be available for use in the capital development of Washington airports. The solution would also require the development of an alternative grant funding guide book that would be used by the airport management industry to increase their capital funding solutions. The types of grants that might be available would be federal and state multimodal grants, federal and state economic development grants for revenue producing/job producing projects, use of other public grant sources to cover local match, etc.
17	Eliminate aircraft registration exemptions and add new registration sources(s)	This refinement concept would roll back current aircraft registration exemptions. It would entail a fairer and consistent implementation of aircraft registration fees applicable to all businesses and user groups.
Other Potential Solutions		
18	Promote establishment of commissions/airport authorities	This concept is targeted toward airport structure and management. The concept involves using the outcome of the upcoming state airport system plan [i.e., WASP] to better define airport ownership pairs where one large and self-sufficient airport can take on one or several airports that are not self-sufficient as a means of helping the smaller GA airport(s) financially, operationally, and administratively.

	Alternative Solution	Summary
19	Leverage U.S. Department of Transportation (USDOT) paving contracts at airports	This concept involves the potential for airport projects to tie into federal- and state-executed roadway and highway contracts for paving that would take advantage of scale opportunities to lower the unit paving costs for airports.
20	De-federalize state airports for construction contracts	This concept considers the idea of opting out of the federally mandated contract provisions, while keeping safety/security provisions that the FAA would mandate.
21	Improve aviation educational/marketing and outreach programs	This concept utilizes the various electronic and traditional public outreach avenues to raise awareness in what aviation commerce brings to the state of Washington. The concept also applies to raising the understanding of how vital the Washington airport system is to the public welfare including safety, Security, and overall emergency operations in the state. This concept would also help to bring the message to the public that would be necessary to adopt and execute any funding solutions that would result from this process.
22	Right-size airport infrastructure	This concept utilizes the results of the upcoming airport system plan to generate and justify improvements to the state system of airports. Among the potential system plan answers, the following list could have a positive effect on the potential infrastructure funding gaps: optimize the number of NPIAS airports in Washington, balance the number of NPIAS airports and non-NPIAS in Washington along the lines of the balance that other states enjoy, work with the FAA to modify NPIAS standards for airport inclusion as necessary to improve the overall funding potential in Washington state.
23	Investigate FAA funding best practices by region	This concept will ensure that federal funding for airport improvements on a national basis are being administered on a standard basis with regard to the Northwest region. The concept will help to ensure that the Washington state airports are getting the same level of project approval regarding eligibility and funding priorities as all other states.

Source: CH2M 2015

All of the prioritized and preliminary solutions of the *Airport Investment Study* were compared with the Washington AEIS recommendations presented in a subsequent section to pinpoint areas of synergy between the two studies.

4.3 Economic Performance Measure Considerations

The first step in the economic performance measures task was a thorough review of the *WASP* economic vitality goal category performance measures and metrics to assess their continued ability to support enhancement and promotion of economic development within the Washington airport system. The *Airport Investment Study* was then reviewed to identify WSDOT Aviation's policy priorities and determine how or if the Washington AEIS could advance the study's recommendations. As such, AEIS performance measures are designed to support the agency's previous work, as well as establish new processes, and to provide the data and evaluation tools necessary to measure progress over time.

4.4 Key Considerations

As part of the AEIS performance measure recommendations development process, several considerations arose during discussions with WSDOT Aviation Division. All Washington AEIS performance measures must be:

- **Objective:** Data used to evaluate the performance of the system and individual airports must be factual and not open to interpretation
- **Actionable:** Airports and/or the WSDOT Aviation Division must have the ability to take concrete and clear steps to improve achievement against performance measures
- **Measurable:** Airports and/or the WSDOT Aviation Division must be able to obtain or update data so that performance can be assessed at regular intervals, or as required
- **Applicable:** Metrics must be applicable to all or nearly all airports within each classification
- **Attainable**: Airport sponsors need a realistic, feasible way to capture and track applicable information
- **Repeatable**: Airport sponsors need a program that is easily repeatable to consistently collect and maintain high-quality data over time

Underlining the importance of these considerations, WSDOT Aviation Division is developing a new policy that increases grant scores for airports achieving airport minimum recommended metrics and decreases scores for airports that do not meet minimum standards. In this way, airports will be incentivized for exceptional performance (i.e., achieving recommendations) and encouraged to improve when under-performing (i.e., not meeting minimum standards).[4] Considering the impact that economic performance measures will have on airports' abilities to obtain grant funding, it is particularly important that performance measures and metrics be appropriate, relatively simple, and germane in terms of purpose and benefits. The ability to obtain data on an ongoing basis is also key, as current data must be used during future funding processes.

4.4.1 Potential Preliminary Economic Measures Evaluated

Once these key considerations and current needs were established, the consultant team and WSDOT developed 10 potential performance measures to evaluate the Washington airport system's ability to promote economic development and five metrics to assess each individual airport's contributions to this overall goal. Additionally, five performance indicators were drafted. Performance indicators are similar to performance measures in that they provide a mechanism to assess the system, but indicators cannot be directly influenced by WSDOT or airport funding, policies, or other actions. While generally outside of these entities' spheres of influence, performance indicators provide valuable information regarding how the system is performing. Although the potential performance indicators may not be immediately

[4] Note that the WASP defines "minimum standards" instead of "recommended minimums" for some metrics. According to the WASP, "Some of the metrics are important to serve as minimum standards for the system's development, while others are recommended to serve as minimums to strive to achieve" (p. 6-9). WASP Figure 6-2. Summary of Airport Metrics provides a summary of metrics in terms of minimum standards versus recommended minimums (p. 6-27). In general, minimum standards imply a mandate or specific directive, while recommended minimums imply best practices for airport management and related topics.

actionable, they support future policy and program development to promote Washington state airport economic vitality.

Table 4.5 provides all performance measures, performance indicators, and metrics evaluated during the AEIS and summarizes the pros and cons of each in terms of the considerations outlined above. The table also provides an evaluation of each item's alignment with the existing measures of the *WASP*. None of these potential items are identical to the recommendations of the *WASP* except Collaboration Events with Agencies on Economic Development.

The potential AEIS performance measures, performance indicators, and metrics documented in Table 4.5 have also been evaluated in terms of correlation with the findings of the *Airport Investment Study*. In general, the proposed measures of the AEIS are more highly correlated with the *Airport Investment Study*, particularly when considering all 33 potential solutions (10 priority plus 23 preliminary). The AEIS recommendations indicated in **Table 4.5** as "medium" or "high" correlation suggest that data tracking that could directly advance WSDOT Aviation's objective of refining current funding programs. For example, tracking the economic impact of state investment dollars in terms of jobs creation could guide future refinements to the WSDOT Airport Aid Grant Program's priority rating system. Tracking the number of registered pilots in Washington could be used to evaluate progress towards enhancing aviation educational/marketing and outreach programs.

Proposed measures indicated as "low" correlation still advance the *Airport Investment Study's* overall purpose of enhancing the funding levels or mechanisms supporting aviation in the state and supporting airport economic self-sufficiency. However, they address aviation activities not explicitly discussed in the study. In this way, all performance measures, performance indicators, and metrics assessed for the Washington AEIS support WSDOT Aviation Division's and the FAA's abilities to meet airport funding needs and/or enhance the economic impact of Washington airports from a broader perspective.

Table 4.5. Potential Measures Assessed During the AEIS

	Measure / Indicator / Metric (potential unit[s] of measure)	Pros	Cons	Synergies with Previous Studies: WASP	Synergies with Previous Studies: Airport Investment Study
Performance Measures (Actionable)	**Annual FAA and/or WSDOT expenditures on airport projects (total dollars spent)**	– Quantifiable – Objective – Data is readily accessible from FAA and WSDOT sources	– Limited ability to influence FAA's expenditures – WSDOT funding /expenditures driven by legislature/external conditions	Low	Medium
Performance Measures (Actionable)	**FAA and/or WSDOT expenditures on maintenance versus capacity projects (total dollars spent, percent of total agency funding)**		– Limited ability to influence FAA funding, particularly with Primary and Nonprimary entitlements (NPE) – Not all maintenance projects are eligible for FAA/state funding	Low	High
Performance Measures (Actionable)	**FAA- and/or WSDOT-funded projects completed (total number of closed grants)**		– Limited ability to influence FAA's expenditures – WSDOT funding ability driven by legislature/external conditions	Low	Medium
Performance Measures (Actionable)	**Economic results of airport infrastructure investments (percent change in direct or total jobs)**	– Very useful information when issuing loans and grants (prioritization) – Good communications tool for WSDOT and airports – **Economic calculator prepared as part of AEIS can be used to analyze these changes**	– Ability to measure the number of jobs created and/or retained would require update of airport and tenant surveys	Medium	High
Performance Measures (Actionable)	**WSDOT aviation loans issued (number annually issued, amount of funding awarded)**	– Easy to track and measure	– WSDOT funding/expenditures driven by legislature and other external conditions	Low	Medium

	Measure / Indicator / Metric (potential unit[s] of measure)	Pros	Cons	Synergies with Previous Studies: WASP	Synergies with Previous Studies: Airport Investment Study
Performance Indicators (informational)	**Economic growth by region (percent annual change)**	– Results would support the need for investment in airports	– Difficult to measure – WSDOT cannot influence	Medium	Medium
	Air cargo moving in, out, and within Washington (annual tonnage)	– Growth in air cargo is a current trend in aviation as consumers' demands for near-immediate delivery continues to grow	– Data consistency across airports is problematic – Detailed data is not tracked in one singular location and relies on the input of airport managers	High	Low
	Crops supported by Washington aviation (acres or type/diversity of crop(s)	– Supports WSDOT's involvement with one of Washington's most important industries – Directly ties to one of the industry-specific analyses of the AEIS	– Data is difficult to obtain, as it relies on airports and aerial applicators	Low	Low
	Aerospace jobs within 10 miles (number)	– Supports WSDOT's involvement with one of Washington's most important industries – **WSDOT Geoportal can be used by airports seeking increased business use which would result in higher economic activity and impact** – Directly tied to policy recommendations	– Analyses likely more applicable to larger airports in the system – Duplicative of efforts of Commerce Department	High	Low

	Measure / Indicator / Metric (potential unit[s] of measure)	Pros	Cons	Synergies with Previous Studies	
				WASP	Airport Investment Study
Performance Measure (continued)	**Registered pilots (number)**	– Pertains to how WSDOT is working to address a current issue in aviation (pilot shortage) – Data is to easy obtain – Indication of economic opportunities for airports and aviation impact	– None	Low	Medium
Metrics (airport-specific)	**Air cargo activity (annual tonnage, percent growth/change)**	– Quantifiable – Objective – Indicates presence of facilities and/or services that support economic activities	– Data consistency across airports problematic – Detailed data is not tracked in one singular location and relies on the input of airport manager – Not applicable to all types of airports – Significantly driven by external/market forces – More reflective of local economic conditions than airport actions	High	Medium
	On-airport jobs (total number of direct jobs, percent change)	– Quantifiable – Objective – Indicates business-friendly on-airport environment – Applicable to many different types of airports – Could be an input for the Calculator to update aviation economic impact	– Data require update of airport and tenant surveys and can be difficult to obtain at regular intervals	High	High
	Aeronautical and non-aeronautical businesses on airport property (total number, percent growth/change, type)		– Data requires airports to report the number/type of businesses at the airport	High	High

	Measure / Indicator / Metric (potential unit[s] of measure)	Pros	Cons	Synergies with Previous Studies	
				WASP	Airport Investment Study
Metrics (airport-specific)	**Ability to support key industries (number of aerospace manufacturing, agriculture, and/or aviation education jobs within 10 miles)**	– WSDOT will have 10-mile buffers and only needs Community Analyst tool to update – Directly supportive of broader economic goals in the state – Correlation easy to communicate to stakeholders/ policymakers	– More reflective of local economic conditions than airport actions – Not applicable to all airport types – Could be subjective depending on criteria	High	High
Metrics (airport-specific)	**Collaboration events with agencies on economic development (number, type)**	– Data is easy to measure	– Data would need to be obtained from airports and/or local or state agencies – Outcomes of collaborative efforts challenging to assess	High	High

Source: Kimley-Horn 2019

In addition, the following measures were included in the scope of work for evaluation (many are duplicative as those listed in **Table 4.5**):

- The amount FAA and WSDOT Aviation spend annually on airport projects in Washington
- The amount of funding (FAA and State) on maintenance projects versus capacity projects
- The amount of economic growth by region since the last reporting cycle
- The number of jobs created
- The number of projects completed by WSDOT and/or FAA
- Amount of freight air cargo moving in, out, and within Washington state
- Economic results of airport infrastructure investment (loans and grants); for loans it would be particularly helpful to know the effects including jobs created and/or retained

4.5 Performance Measure Recommendations

Based on the assessment outlined above and extensive discussions with WSDOT Aviation Division, it has become clear that the performance measures and metrics of the *WASP* continue to be appropriate in terms of measuring progress towards the Economic Development and Vitality goal. These performance measures and metrics are summarized above in Table 4.1 and Table 4.2, respectively.

> *The AEIS analysis showed that the WASP performance measures and metrics continue to be appropriate.*

Building upon the work of the *WASP*, the WSDOT Aviation Division expressed particular interest in increasing air cargo tonnage tracking at airports across the state during the AEIS. As home to e-commerce giant Amazon, numerous major aerospace manufacturing firms including Boeing, and a robust agricultural economy, Washington is in a uniquely lucrative position to maximize economic impacts associated with air cargo activity.

As became evident during both the 2018 *Washington State Air Cargo Movement Study*[5] and the data collection process of the AEIS, air cargo data collection is problematic both at the industry and airport levels. No singular reporting mechanism exists at either the state or federal level. Yet only through accurate data reporting can trends be observed and performance be measured. Air carriers report data through the Bureau of Transportation Statistics (Air Carrier Statistics), but the data is incomplete and cannot be validated by airports. This is particularly true at small GA airports that may only receive intermittent mail service and the airlines providing this service are not required to file any statistics. Airports that independently track air cargo activity often lack confidence in the accuracy or completeness of the data captured. To address this issue, the *Air Cargo Movement Study* recommends the following:

[5] Washington State Legislature Joint Transportation Committee. (December 2018). *Air Cargo Movement Study*. Available online at leg.wa.gov/JTC/Pages/aircargo.aspx (accessed July 2019).

Introduce a standardized statewide air cargo data reporting form. At a minimum, the report form should include units of enplaned and deplaned air cargo, categorized as international or domestic by air carrier. The report form should also include landings by all-cargo aircraft, by aircraft type and air carrier. Other desirable air cargo metrics include enplaned and deplaned air cargo by combination carriers (belly carriers) and freighter operators, and number of truck trips to and from air cargo terminals.[6]

Underlining the critical need to advance the implementation of this recommendation, the AEIS developed three more specific elements of air cargo tracking designed to enhance the economic vitality of the state, as well as recognize the evolving nature of the industry in terms of demand and technology.

In addition to these air cargo-related recommendations, the AEIS revealed a need to assess and monitor the economic impacts of airport improvement project expenditures over time. This information will offer important insight into resource prioritization and justify additional investment into airports for WSDOT Aviation and airport owners and sponsors. The performance indicator aligns with the findings of the *Airport Investment Study* (see Table 4.3) by providing qualitative data that could be used to refine current funding policies.

The airport metrics and performance indicators developed by the AEIS, as well as the data necessary for implementation, are summarized in **Table 4.6**. Each recommendation is discussed in further detail in the sections that follow.

Table 4.6. Washington AEIS Recommended Economic Metrics and Performance Indicators

Type	Recommendation	Data Requirement
Metric	Value of enplaned and deplaned air cargo by tonnage and estimated commodity costs	Airport-specific air cargo activity by tonnage in accordance with the Air Cargo Movement Study recommendation (described above). WSDOT Aviation to estimate value using average commodity costs
Performance Indicator	Numbers of airports that report air cargo activity to WSDOT Aviation	Reporting mechanism within the Airport Information System (AIS)
Performance Indicator	Volume of cargo delivered via unmanned aerial vehicle (UAV) within Washington by weight and number of operations	Company-specific unmanned aerial system (UAS) activity by number of operations and weight
Performance Indicator	Impacts of annual FAA, WSDOT, and local capital expenditures on airport projects (total dollars spent)	Reporting mechanisms within the AIS using the outputs of the economic calculator

Source: Kimley-Horn 2019

[6] Ibid. Appendix D – Recommendations and Implementation Strategies, p. 17.

4.5.1 Metric: Value of Enplaned and Deplaned Air Cargo by Tonnage and Estimated Commodity Costs

Building upon the recommendations and insight of the *Air Cargo Movement Study*, it is not only useful to track the weight of air cargo but also the value of products being transported. Historically, air cargo has been typified by time-sensitive, high-value, low-weight items, as shipping by air is generally costlier than shipping via truck, rail, or water. Factors involved in deciding to transport via air include cost of transporting the material, level of service commitment to the end user, value of the product, and time-sensitivity or perishability of the material. Typical goods transported via air include electronics, pharmaceuticals, precision manufacturing equipment, meat/seafood, and fresh flowers.

The air cargo industry has seen a major uptick in demand over the last several years, with the most recent *Boeing World Air Cargo Forecast (2018-2037)* (Air Cargo Forecast) reporting that air cargo grew by 10.1 percent in 2017 over the previous year. In addition to ongoing worldwide economic expansion and other macroeconomic trends, the Air Cargo Forecast notes that strong growth in e-commerce will play an "increasingly strong role" in air cargo markets.[7] In 2012, global retail e-commerce sales were $1.1 trillion; by 2017 sales reached $2.3 trillion. The market is forecast to double again by 2021, reaching nearly $4.9 trillion.[8] In the U.S., much of this growth is driven by Amazon—not only because of its own investments, but also as other retailers such as Target and Walmart enhance their own online marketplaces and delivery to compete.[9] Many U.S. consumers now anticipate near-immediate delivery of everyday goods historically purchased in brick-and-mortar stores and transported along ground-based supply chains.

As a result, the composition of air cargo is expanding from "traditional" products (i.e., time-sensitive, high-value, low-volume goods) to also encompass lower-value durable and nondurable goods. With such rapid market changes, it is currently unclear if policymakers at state or local levels should revise existing data reporting requirements for air cargo carriers. This recommendation of the AEIS is thus designed to capture data not only on the volume of goods being transported via Washington's airports, but also the type of goods traveling into, out of, and within the state. This data may then be used to calculate the economic impact of the air cargo industry in the state. This is important to understand and justify the need for additional investments into air cargo handling facilities at commercial service and/or GA airports. Additionally, by understanding the composition of cargo, policymakers can assess if the overall volume of cargo is increasing or cargo is simply shifting between modes (e.g., from truck to aircraft). This could be used to inform multimodal policymaking and resource allocation at the statewide level.

It is recommended that WSDOT Aviation include a data field in the AIS for airports to report the weight of enplaned and deplaned air cargo, then estimate the type of commodities being handled by percent. WSDOT Aviation can then apply average commodity costs to estimate the total value of air cargo

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[7] Boeing (2018). *World Air Cargo Forecast (2018-2027).* Available online at www.boeing.com/resources/boeingdotcom/commercial/about-our-market/cargo-market-detail-wacf/download-report/assets/pdfs/2018_WACF.pdf (accessed January 2020).
[8] Ibid.
[9] https://www.fool.com/investing/2019/12/29/3-reasons-amazon-won-the-holidays.aspx

transported via the Washington aviation system. As one of the key activities that generate economic activity and support the statewide economy, it is crucial to obtain and monitor air cargo data. This metric provides WSDOT Aviation with more detailed information that can only be obtained from airports and is critical to understanding the changes to economic impact as a result of air cargo activity.

4.5.2 Performance Indicator: Number of Airports that Report Air Cargo Activity to WSDOT Aviation

While it will be the responsibility of individual airports to report the volume and type of air cargo being handled at their facilities (as described in the metric recommendation above), it is recommended that WSDOT Aviation track the percent of airports achieving this metric. The agency will thus be able to assess the efficacy of its airport reporting expectations and systems (i.e., the AIS) as part of a process of continual improvement. This performance indicator is essential to WSDOT Aviation to track the economic changes of air cargo and the corresponding economic impact of aviation.

4.5.3 Performance Indicator: Volume of Cargo Delivered via UAV within Washington by Weight and Operations

In October 2019, Wing—a subsidiary of Google's parent company Alphabet, Inc.—became the first commercial UAS delivery service in the U.S. when it began delivering products to residents of Christiansburg, Virginia. The company first made headlines when it became the first UAS operator certified as a commercial air carrier by the FAA in April 2019.[10,11] Wing's electric UAVs are currently limited to a payload of just 3.3 pounds and are designed to delivery small goods such as snacks and personal care items between distribution centers and consumers' homes.[12] Wing's operations in Virginia are the first step in an industry anticipated to burgeon in the coming years in key market segments including retail, food, medical supplies, and industrial materials.[13] Companies like FedEx, Walgreens, United Parcel Service, DHL Express, AirBus, and many more are heavily investing in this emerging technology—promising a future where UAV package delivery becomes as ubiquitous as Amazon Prime trucks are today.[14]

As an aerospace leader and home to numerous companies playing a major role in commercial UAS development, WSDOT Aviation is taking a proactive approach to commercial delivery services made by UAV in the state. UAS represent a new mode of transportation; while the technology shares some similarities to traditional manned aircraft, UAS will also intersect with the ground-based trucking industry. UAVs are anticipated to replace trucks as the last-mile delivery mode to transport goods between distribution centers to end consumers. In effect, UAS represent a hybrid mode of transportation that mirrors aircraft in terms of operations but trucks in terms of function.

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[10] https://www.theverge.com/2019/10/18/20921310/wings-delivery-drones-virginia-first-flight
[11] https://medium.com/wing-aviation/wing-becomes-first-certified-air-carrier-for-drones-in-the-us-43401883f20b
[12] https://www.npr.org/2019/04/23/716360818/faa-certifies-googles-wing-drone-delivery-company-to-operate-as-an-airline
[13] https://dronelife.com/2019/11/07/droneii-the-drone-delivery-market-map/
[14] Ibid.

The AEIS recommends that WSDOT Aviation develop a new reporting system for industry (i.e., UAS operators) to collect data on the number of commercial UAV operations conducted in the state as well as the weight of cargo delivered. If such a recommendation is incorporated into state policy prior to commercial UAS entering Washington's airspace, the state will be better positioned to request industry compliance. Such a policy sets up the foundation for the safe and efficient incorporation of UAV into the National Airspace System (NAS) over Washington. This policy also recognizes the increasing importance and use of UAS in air cargo delivery and the new reporting system is needed to complement the data obtained from airports on air cargo movements. As UAS usage for air cargo movements grows, it is important for WSDOT Aviation to be able to monitor how and where air cargo is being transported, including the type of cargo, and ensure that the economic value that is associated with aviation is calculated. This performance indicator is directly tied to one of the key aviation industries (air cargo) and WSDOT Aviation needs to be able to monitor the changes and reflect these in the economic impact of the industry.

As one potential reporting mechanism for industry, WSDOT Aviation could work with city and county planning agencies to tie UAV operation reporting requirements to local land use policies. It is anticipated that UAVs will be deployed from sub-distribution centers within existing urban centers. If these deployment centers are permitted by local jurisdictions, users (i.e., UAS operators) could be required to submit reports on the type and volume of UAS activity occurring there—just as air cargo, trucking, and rail operators are required today. Because UAS technologies and their impacts on the industry are changing rapidly, it is important that WSDOT Aviation continue to review and refine UAS-related policies to improve their efficacy over time.

4.5.4 Performance Indicator: Impacts of Annual FAA, WSDOT, and Local Expenditures on Airport Projects (Total Dollars Spent)

One of the most important purposes of conducting an aviation economic impact study is being able to communicate the quantitative value of airports to policymakers and community members. This, in turn, helps support additional investment into airports so they can continue to enhance the economic vitality of the state. Beyond dollars and cents, supporting airports allows them to safely and efficiently host unique and often lifesaving aviation activities—such as disaster recovery efforts, search and rescue operations, and medical transport.

To support WSDOT Aviation's continued ability to demonstrate how investing in airports supports Washington's economy, the Washington AEIS recommends tracking the economic impact of federal (i.e., FAA), state (WSDOT Aviation), and local expenditures on airport improvement projects. WSDOT Aviation has access to federal and state expenditures on aviation via existing sources. The agency should add a field in the AIS to obtain annual data on all local expenditures made by airport owners/sponsors or other entities supporting capital improvements at public-use airports. Use a five-year rolling average, WSDOT Aviation can then use the Washington Aviation Economic Calculator to estimate the total jobs supported and labor income and business revenues generated due to increases or decreases in airport capital improvement spending. This will be a clear indication to policymakers on how investing in airports makes a tangible difference in Washington's communities.

It is important to note that the expenditures on airport projects creates two types of impacts: construction which are associated with the near-term as well as impacts associated with new business activities that are supported as a result of the expenditure. As an example, if a new corporate hangar is constructed, there are the near-term construction impacts, but in the long-term, this hangar generates rent for the airport as well as could support new employees of the business that owns the hangar. That business' aircraft will likely purchase fuel and other services on the airport, creating additional economic impacts that last beyond the construction period.

The Washington Aviation Economic Calculator was most recently updated as part of this AEIS (2018 study year) and is an important planning tool to estimate the potential economic impact of changes in airport activity levels and capital investments. The calculator is available online via the WSDOT Aviation homepage at www.wsdot.wa.gov/aviation/default.htm.

4.6 Performance Measure Summary

Taken together, the airport metrics, performance measures, and performance indicators of the *WASP*; recommended solutions of the *Airport Investment Study*; and the recommendations of the Washington AEIS provide a framework of best practices to help airports and WSDOT Aviation take actionable steps towards increasing the economic impacts and address the serious funding shortfall affecting the Washington aviation system. By monitoring these benchmarks, airports and the state can identify strategies that are moving the needle in terms of maximizing airports' abilities to enhance the financial vibrancy, diversity, and overall output of their communities. Together, these studies offer a comprehensive roadmap to leverage available state and federal funding, enhance airports' economic self-sufficiency, and track progress over time.

Implementing these measures now is particularly important, as the entire aviation industry is facing significant technological, economic, and social changes that are impacting not only the way people fly but also complete everyday tasks. Electric aircraft and Urban Air Mobility (UAM) solutions may alter where people chose to live—opening new areas of Washington to development as intrastate and regional travel becomes cheaper and more convenient. Commercial UAS activities may soon entirely change the way people obtain medicine and other lightweight nondurable goods; in the long-term, the concept of driving to a brick-and-mortar store may become a historical memory. The demand for air services, especially cargo, is already experiencing a sharp upsurge with the growth of e-commerce, and the pace of those new demands is only anticipated to rise in the coming years.

Existing resource shortfalls further underline the need to monitor progress and performance over time. The state is experiencing a funding gap that may widen as new and evolving demands are placed on the system, new businesses relocate to the state, and the population continues to grow. By taking actionable steps to promote the economic vitality of airports, particularly those related to air cargo, WSDOT Aviation can work together with airports to close this gap and assure the vitality of the aviation system no matter what the future may bring.

4.7 Comparative Analysis of Aviation Funding

The economic vitality goal of the *WASP*; performance measures, indicators, and airport metrics of the *WASP* and AEIS; and recommendations of the *Airport Investment Study* all shed light on the actionable steps that airports and WSDOT Aviation can take to maximize the economic vitality and impact of the state airport system. Such recommendations promote fiscal responsibility and ask airports and the state to play their part in leveraging all available state and federal resources.

As a companion analysis, it is also important to analyze airports' abilities to apply for aviation funding in the first place. Airports do have a responsibility for promoting on-airport revenue generation for economic self-sufficiency, tracking economic indicators, and implementing best management practices. However, many airports—particularly small GA facilities—have limited potential to optimally operate, maintain, and improve their facilities without local, state, and/or federal support. Further, WSDOT Aviation is tasked with allocating limited resources to 134 airports across the state. As the *Airport Investment Study* reveals, needs will likely continue to go unmet and deficiencies will grow over time without additional state investment into airports.

> *As this analysis reveals, Washington's airports have the least access to state aviation funding, which is then allocated to the second-largest airport system within the comparison.*

The following section compares Washington's federal and state investment into airports with seven other states. The analysis compares FAA Airport Improvement Program (AIP) grant funds, supplemental AIP funds, and state aviation grant funds. With few exceptions, states and airports cite insufficient resource availability as one of their greatest challenges. Yet as this analysis shows, this statement could not be truer than in Washington. The state's airports have the least access to state aviation investment. When the high number of Washington airports that are eligible for state aviation funding, which represents the second-highest number of airports in the comparison, is considered, this low amount of available state aviation investment and high number of eligible airports exacerbates the insufficiency of the financial resources. This comparative analysis includes the following states:

- Colorado
- Illinois
- North Carolina
- Oregon
- South Carolina
- Texas
- Wyoming

Table 4.7 summarizes basic information about each state's aviation program. This includes the number of airports in each aviation system, the number of NPIAS airports in the system, if the state participates in the FAA's State Block Grant Program (SBGP), and the reason(s) for including the state in the comparison. The table also highlights the number of airports in each state eligible for state funding, which–in some cases–is different from the number of airports included in the state system due to state funding eligibility requirements. The numbers presented in the "Airports Eligible for State Funding" column have been used in the analyses of state funding presented in Section 6.2. In most cases, these states' airport systems are comprised primarily of NPIAS airports. Texas has the largest system of airports (294) while Wyoming (40) has the smallest.

Table 4.7. States Included in Comparative Analysis

State	Airports in System (no.)	Airports Eligible for State Funding (no.)	NPIAS Airports (no.)	SBGP (yes/no)	Reason(s) for Inclusion
Washington	134	134	64	No	N/A
Colorado	74	74	49	No	– Flexible funding program related to project eligibility – Similar geographic location to WA – Same FAA region
Illinois[1]	89	77 (75 participate in the program)	86	Yes	– Similar sized NPIAS/non-NPIAS aviation system to WA
North Carolina	72	72	62	Yes	– Large UAS program – Unique legislative change where capital projects from all transportation modes compete for state funds
Oregon	97	97	57	No	– Same FAA region – Geographic proximity – Similar sized NPIAS airport system – Similar urban/rural composition as WA
South Carolina[2]	58	54	53	No	Significant Boeing presence
Texas	294	294	210	Yes	Large aviation system
Wyoming	40	40	33	No	100 percent of aviation fuel taxes go back into aviation

Notes: (1) There are 89 publicly- and privately-owned airports included in the Illinois aviation system. However, only 77 current and proposed future Primary and Nonprimary commercial service, GA, and Reliever airports are eligible to receive funding under the Illinois State/Local Airport Improvement Program (AIP). Of those 77 airports, Chicago O'Hare (ORD) and Midway (MDW) do not participate in the program. As such, 75 airports are used in the comparison of state aviation funding section below. (2) South Carolina has 58 airports in its state system. However, only 52 GA and two commercial service airports (Florence Regional Airport [FLO] and Hilton Head Airport [HXD]) are eligible for state funding. As such, 54 airports are used in the comparison of state aviation funding section below. Sources: FAA NPIAS Report 2019-2023, WSDOT Aviation 2019, Colorado Department of Transportation (CDOT) Division of Aeronautics 2019, IDOT 2020, North Carolina Department of Transportation's (NCDOT) Division of Aviation, Oregon Department of Aviation (ODA) 2019, South Carolina Aeronautics Commission 2019, Texas Department of Transportation (TxDOT) Aviation Division 2019, WSDOT Aviation 2019, Wyoming Department of Transportation Aeronautics Divisions (WYDOT Aeronautics) 2019

Airport funding is available through the federal AIP for NPIAS airports; state grants; local investments; and airport-specific revenue streams obtained from tenant leases, fuel sales, landing fees, and other revenue-generating activities. Access to these various sources depends on several factors including but not limited to airport ownership, inclusion in the FAA's NPIAS, and eligibility requirements for various state and local funding sources. Project eligibility can likewise differ by funding source. While funding is available from multiple sources, many airports are faced with funding shortfalls, especially as preservation needs arise and major capital improvements are required with shifting demands over time.

This analysis first takes a closer look at federal entitlement and discretionary grants under the AIP. State-specific grant and loan program information is then provided. It is important to note that this comparison does not include local matches or airport-generated revenue streams. In general, that information can only be provided by specific airports and is thus outside the scope of the AEIS.

4.7.1 FAA AIP Overview

The AIP provides grants to public agencies for certain planning and development projects at public-use airports included in the NPIAS. In some cases, a NPIAS airport can be owned and/or operated by a private entity, in which case the grant can be awarded to a private entity, but these are limited cases. The FAA awards AIP grants to airports for a variety of projects. **Table 4.8** shows a list of typical projects that are eligible and ineligible to receive AIP funds.

Table 4.8. Eligible and Ineligible AIP Projects

Eligible	Ineligible
Runway construction/rehabilitation	Maintenance equipment and vehicles
Taxiway construction/rehabilitation	Office and office equipment
Apron construction/rehabilitation	Fuel farms[1]
Airfield lighting	Landscaping
Airfield signage	Artworks
Airfield drainage	Aircraft hangars[1]
Land acquisition	Industrial park development
Weather observation stations (AWOS)	Marketing plans
Navigational aids (NAVAIDs)	Training
Planning studies	Improvements for commercial enterprises
Environmental studies	Maintenance or repairs of buildings
Safety area improvements	Maintenance of pavements
Airport layout plans (ALPs)	Roads not on airport property
Access roads only located on airport property	Non-aeronautical development
Removing, lowering, moving, marking, and lighting hazards	
Glycol Recovery Trucks/Glycol Vacuum Trucks[2]	

Notes: (1) May be conditionally eligible at Nonprimary airports. (2) To be eligible, the vehicles must be owned and operated by the Airport and meet the Buy American Preference specified in the AIP grant.
Source: https://www.faa.gov/airports/aip/overview/#eligible_projects

As Table 4.8 demonstrates, eligible projects are wide-ranging and generally enhance airport safety, capacity, security, and environmental concerns. Eligible projects can be capital improvements, rehabilitation projects, occasionally nonaviation development and certain planning or design projects. Ineligible projects are projects that are generally related to revenue-producing improvements or operational costs such as salaries, equipment, and supplies. When an airport does receive an AIP grant, it is only for a certain percentage of the project, with the remaining project costs being covered by state and/or local matching funds. Primary airports classified as Large and Medium Hubs are awarded 75 percent of eligible project costs (80 percent for noise projects). Small and Nonhub Primary, as well as Nonprimary Commercial Service, Reliever, and GA airports receive 90 to 95 percent of funding for eligible projects.[15,16]

4.7.1.1 AIP Funding Amounts and Grant Types

The information that follows provides an overview of AIP funding dispersed to airports across the country, and for the states included in the comparative analysis. Information provided is for fiscal years (FY) 2016, 2017, and 2018. **Table 4.9** shows the total amount of AIP funding available for FY 2016, 2017, and 2018 for all states. National AIP funding availability remained consistently above $3.2 billion since FY 2016. Between 2016 and 2017 there was a one percent increase in available national funds, which amounted to an approximate $37 million increase. Funding increased approximately four percent between FYs 2017 and 2018 ($127 million). This large increase is attributable to Supplemental Appropriation funds as discussed below.

Table 4.9. Total FAA AIP Funding Available for FYs 2016, 2017, and 2018

Year	Total ($)	Change from Previous Year	
		Amount ($)	Percent (%)
2018	$3,460,467,200	$127,667,791	4%
2017	$3,332,799,409	$36,995,146	1%
2016	$3,295,804,263	N/A	N/A

Source: FAA AIP Summary Tables (all grants) 2016, 2017, 2018

AIP funding is dispersed via entitlement funds and discretionary funds. Entitlement funds are automatically awarded to NPIAS airports based on a strict set of criteria by three categories: Primary airports, cargo, and GA. Once entitlement funds are distributed, discretionary funds are then in accordance with a national prioritization formula.

In addition to the regular distribution of entitlement and discretionary funds, a third category of funding was first distributed in 2018. Referred to as supplemental discretionary funding, these additional funds were authorized by the FAA Reauthorization Act of 2018. This legislation provided an additional $1.0 billion to the FAA's AIP funding to remain available for obligation through September 3, 2020. The Consolidated Appropriations Act of 2019 appropriated $500 million of that $1.0 billion to remain

[15] FAA Order 5100.38D, AIP Handbook (dated September 30, 2014). Available online at www.faa.gov/airports/aip/aip_handbook/media/AIP-Handbook-Order-5100-38D-Chg1.pdf (accessed March 2020).

[16] Note that supplemental appropriations awarded to Nonprimary airports in FYs 2018 through 2020 fund 100 percent of eligible and allowable costs, with no local match required.

available for obligation until September 30, 2021.[17] Supplemental funding is distributed as discretionary funds with priority consideration given to projects (a) Nonprimary airports classified as Regional, Local, or Basic and not located within a Metropolitan or Micropolitan Statistical Area or (b) Primary airports classified as Small or Nonhub airports.[18] **Table 4.10** shows the number and amount of FAA AIP grants by type awarded nationally in FYs 2016 through 2018.

Table 4.10. FAA Grant Types and National Award Amounts, FYs 2016 – 2018

	Entitlement		Discretionary		Supplemental Appropriation	
Year	Awards (no.)	Total Amount ($)	Awards (no.)	Total Amount ($)	Awards (no.)	Total Amount ($)
2018	2,502	$1,581,068,389	497	$1,674,251,754	46	$205,147,057
2017	1,615	$1,653,913,136	426	$1,678,886,273	N/A	N/A
2016	1,628	$1,559,688,982	416	$1,736,115,281	N/A	N/A

Note: Numbers rounded to nearest whole dollar. Source: FAA Grant Histories 2016-2018

4.7.1.2 Comparative Analysis: Entitlement Grants

Table 4.11 summarizes information on the eight states being compared in this analysis in terms of the number and amount of AIP funds awarded through entitlement funds during the three study years. On average, Washington received the highest number of entitlement grants over the three study years (50), followed by Oregon (44) and South Carolina (41). This same trend was witnessed in both FYs 2017 and 2018, with Oregon and South Carolina oscillating between the second and third positions during both years. Texas received the highest average funding amount ($114,606,727), although their state system is significantly larger than another other states in this evaluation.

Table 4.11. AIP Entitlement Funds by State, FYs 2016 – 2018 and Average

		FY 2016		FY 2017		FY 2018		Three-Year Average	
State	NPIAS Airports	Total ($)	No.	Total ($)	No.	Total ($)	No.	Total ($)	No.
WA	64	$30,293,974	31	$33,939,144	46	$44,519,948	72	$36,251,022	50
CO	49	$33,534,224	36	$31,255,945	30	$34,677,239	43	$33,239,136	36
IL	86	$47,616,620	17	$46,777,478	13	$47,771,667	19	$47,388,588	16
NC	62	$48,121,596	13	$50,613,039	14	$39,340,034	17	$46,024,890	15
OR	57	$21,822,445	29	$27,035,642	33	$25,768,771	69	$24,875,619	44
SC	53	$27,577,236	30	$22,884,977	34	$23,308,686	59	$24,590,300	41
TX	210	$112,033,929	31	$112,896,629	30	$118,889,624	53	$114,606,727	38
WY	33	$18,423,232	23	$16,505,733	24	$17,034,747	27	$17,321,237	25

Note: Numbers are rounded to whole dollars. Source: FAA Grant Histories 2016-2018

[17] www.faa.gov/airports/aip/aip_supplemental_appropriation_2019/media/Frequently-Asked-Questions-FY-2019-2021-Supplemental-Appropriation.pdf
[18] Ibid.

> *On average, Washington received the highest number of entitlement grants over the three study years (50) with an average annual award of $36.25 million; however, this was not the highest average among the states.*

In addition to looking at the total number of entitlement grants by year, it is also important to consider the average funding award per NPIAS airport, which provides more granular insight into how Washington compares to other states. As shown in **Table 4.12**, North Carolina received the highest average entitlement grant funding ($742,337), followed by Colorado ($678,350) and Washington ($566,422). While South Carolina and Oregon received some of the highest total numbers of awards during the study years (as shown in Table 10), these states received the two lowest entitlement award amounts by number of NPIAS airports ($463,968 and $436,414, respectively). This same information is presented graphically in the following **Figure 4.2**.

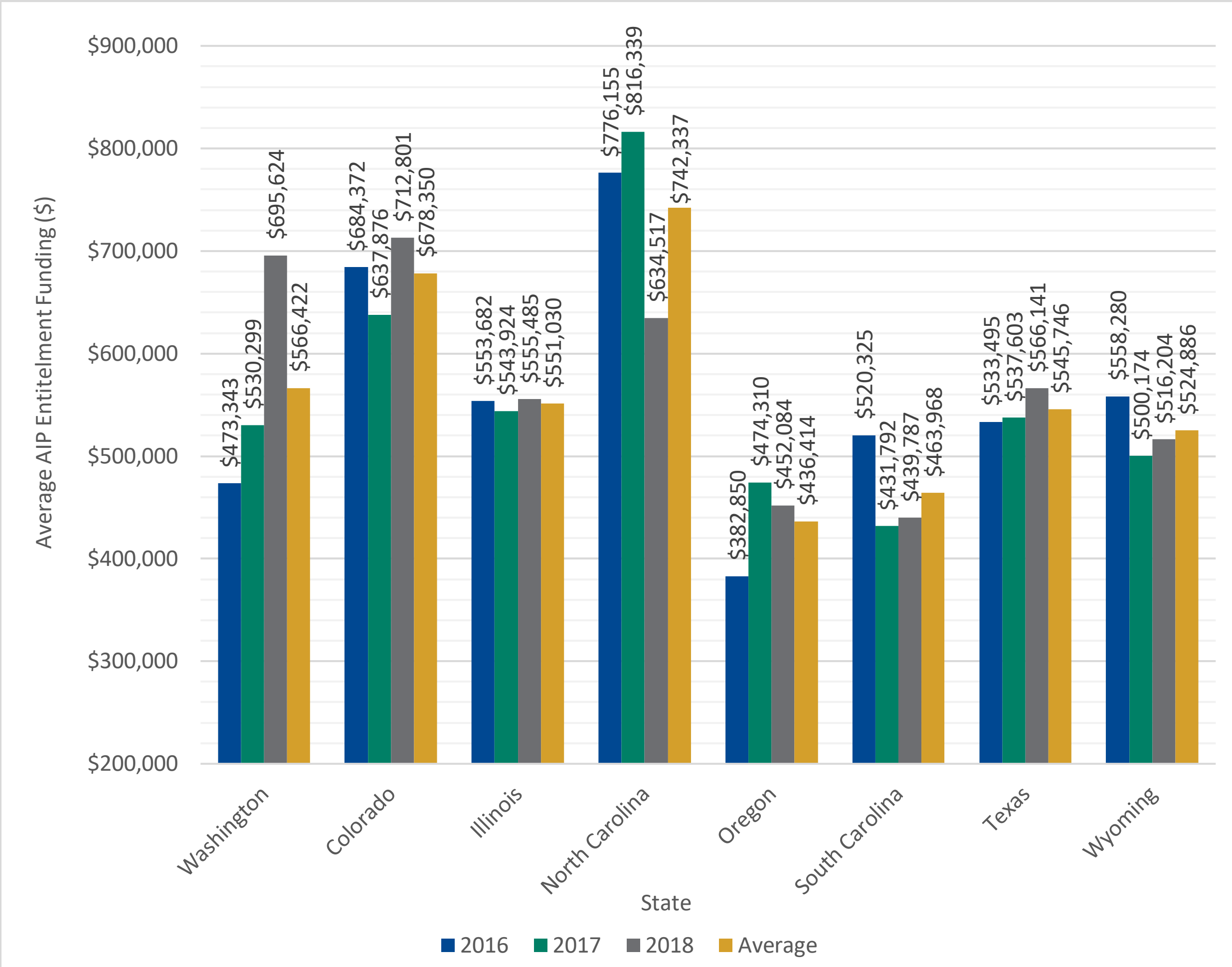
States cannot necessarily affect entitlement funding for airports, Primary or Nonprimary, since there are formulae that determine the amount of entitlement funding airports receive.

Table 4.12. Average AIP Entitlement Funds per NPIAS Airport by State, FYs 2016 – 2018 and Average

		Average Dollars per NPIAS Airport ($)			
State	NPIAS Airports	FY 2016	FY 2017	FY 2018	Three-Year Average
WA	64	$473,343	$530,299	$695,624	$566,422
CO	49	$684,372	$637,876	$712,801	$678,350
IL	86	$553,682	$543,924	$555,485	$551,030
NC	62	$776,155	$816,339	$634,517	$742,337
OR	57	$382,850	$474,310	$452,084	$436,414
SC	53	$520,325	$431,792	$439,787	$463,968
TX	210	$533,495	$537,603	$566,141	$545,746
WY	33	$558,280	$500,174	$516,204	$524,886

Note: Numbers are rounded to whole dollars. Source: FAA Grant Histories 2016-2018

Figure 4.2. Average AIP Entitlement Funds per NPIAS Airport by State, FYs 2016 – 2018 and Average



Note: Numbers are rounded to whole dollars. Source: FAA Grant Histories 2016-2018

4.7.1.3 Comparative Analysis: Discretionary Grants

Table 4.13 shows the total AIP discretionary grant funding awarded to states in FYs 2016, 2017, and 2018; the total number of grants for those same years; and the three-year averages. The number of grants dispersed per state ranged from a low of three in Wyoming (during all study years) to 29 in Illinois (in 2016). In fact, Wyoming received the lowest number of grants during all study years, while Illinois or Texas received the highest number of grants during all study years. Similarly, Wyoming received the lowest average total grant funding ($11.0 million), while Texas received the highest ($126.2 million) followed by Illinois ($110.1 million). These findings are not surprising, as Wyoming has the fewest NPIAS airports (33), while Texas and Illinois have the most (210 and 86, respectively).

> *On average, Washington received $43.4 million in annual discretionary funding between 2016 to 2018, ranking the state fourth within the comparative analysis.*

Excluding the highest and lowest discretionary award recipients, the remaining five states all received very similar amounts of discretionary funding. These five states received between $31.2 million to $44.1 million in average discretionary grant funding over the three study years. On average, Washington received $43.4 million in annual discretionary funding between 2016 to 2018, ranking the state fourth within the comparison.

Table 4.13. AIP Discretionary Funds by State, FYs 2016 – 2018 and Average

State	NPIAS Airports	FY 2016		FY 2017		FY 2018		Three-Year Average	
		Total ($)	No.	Total ($)	No.	Total ($)	No.	Total ($)	No.
WA	64	$34,900,839	5	$47,999,642	8	$47,227,180	11	$43,375,887	8
CO	49	$46,060,827	8	$19,843,140	4	$45,892,144	12	$37,265,370	8
IL	86	$132,026,506	29	$80,808,667	15	$117,402,944	23	$110,079,372	22
NC	62	$26,304,056	4	$65,631,186	11	$40,459,267	11	$44,131,570	9
OR	57	$43,203,714	8	$21,951,444	8	$28,683,300	19	$31,279,486	12
SC	53	$48,935,775	9	$38,618,226	9	$40,502,487	9	$42,685,496	9
TX	210	$131,741,700	20	$142,177,790	17	$104,633,384	19	$126,184,291	19
WY	33	$12,590,667	3	$16,081,889	3	$4,563,122	3	$11,078,559	3

Note: Numbers are rounded to whole number. Source: FAA Grant Histories 2016-2018

Like the entitlement funding discussion above, Table 4.14 provides the average AIP discretionary funds per NPIAS airport. This does not imply that each airport received this amount of funding, but instead relativizes the dollar figures to provide for a peer comparison. Illinois received the highest average discretionary grant funding over the three study years per NPIAS airport ($1.28 million), while Wyoming received the lowest ($452,065). South Carolina, which received an average amount of total discretionary grant funding, received the second-highest discretionary grant funding per NPIAS airport ($805,387). Washington falls in the middle of the comparison, receiving an average of $677,748 in discretionary grant funds per NPIAS airport during the three-year study period. **Figure 4.3** graphically depicts this same information.

Discretionary funds are awarded in accordance with a National Priority System (NPS) equation as described in the FAA Order 5090, *Field Formulation of the NPIAS.*[19] In general, projects that are more consistent with FAA goals and objectives receive a higher score. Unlike entitlement funding, which is automatically awarded to NPIAS airports based on classification, airports do have some level of control over discretionary funding by aligning project requests with the FAA's current priorities. As such, NPIAS airports and WSDOT Aviation should work closely with the Seattle Airports District Office (ADO) to align improvement project needs with the national Airport Capital Improvement Plan (ACIP) to maximize the potential of state airports to receive federal support in the form of discretionary funding. Identifying projects that align with FAA goals and objectives, especially those that are safety-related, can improve the amount of discretionary funding that is awarded to airports in a state. This increased FAA funding

[19] FAA Order 5090.5, *Field Formulation of the NPIAS* (September 2019). Online at https://www.faa.gov/documentLibrary/media/Order/Order-5090-5-NPIAS-ACIP.pdf (accessed April 2020).

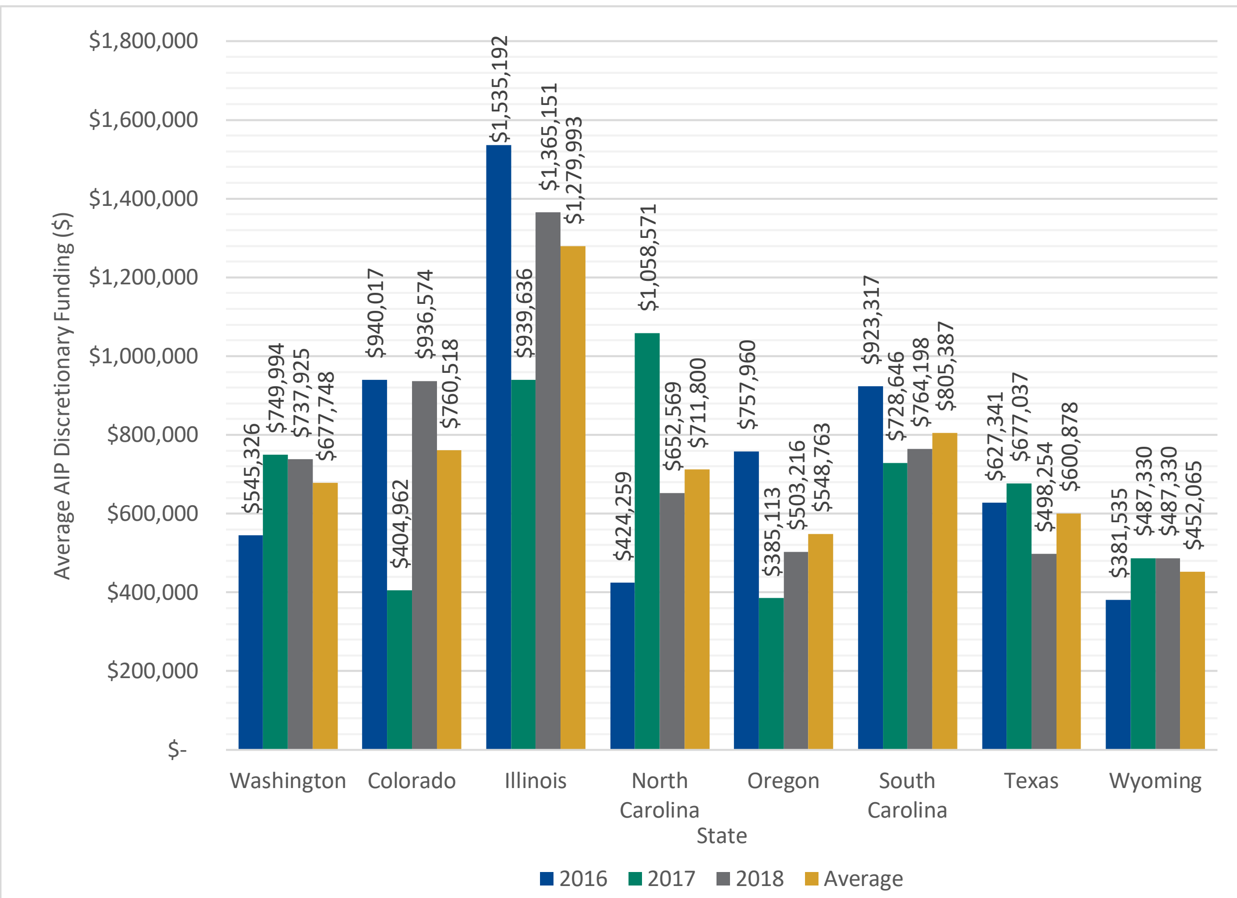
leads to short-term economic impact increases and potentially longer term benefits if the projects allow the airport to support activity by larger aircraft that can purchase more fuel and may be used by businesses in a community that are generating jobs and economic activity.

Table 4.14. Average AIP Discretionary Funds per NPIAS Airport by State (FYs 2016 – 2018 and Average)

State	NPIAS Airports	Average Dollars per NPIAS Airport			
		FY 2016	FY 2017	FY 2018	Three-Year Average
WA	64	$545,326	$749,994	$737,925	$677,748
CO	49	$940,017	$404,962	$936,574	$760,518
IL	86	$1,535,192	$939,636	$1,365,151	$1,279,993
NC	62	$424,259	$1,058,571	$652,569	$711,800
OR	57	$757,960	$385,113	$503,216	$548,763
SC	53	$923,317	$728,646	$764,198	$805,387
TX	210	$627,341	$677,037	$498,254	$600,878
WY	33	$381,535	$487,330	$487,330	$452,065

Note: Numbers are rounded to whole dollars. Source: FAA Grant Histories 2016-2018

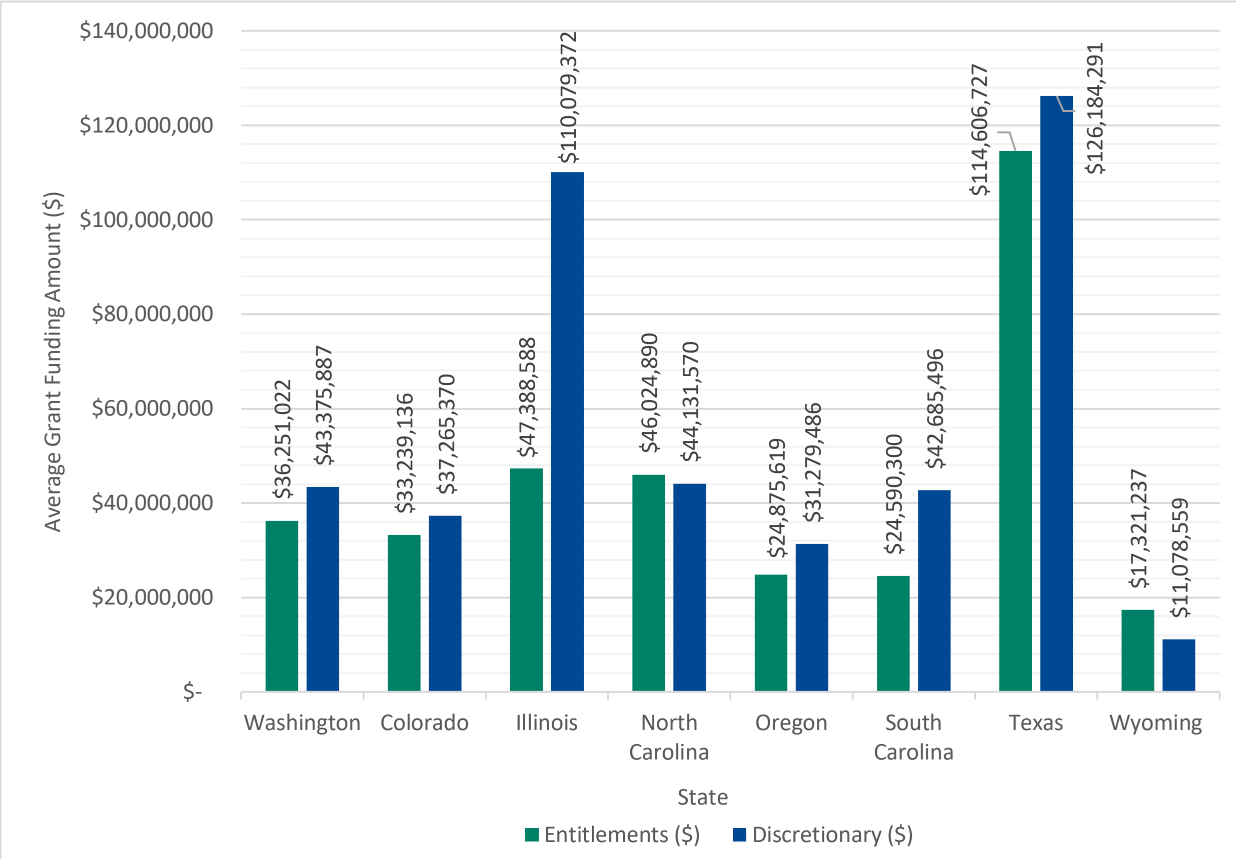
Figure 4.3. Average AIP Discretionary Funds per NPIAS Airport by State, FYs 2016 – 2018 and Average



Note: Numbers are rounded to whole dollars. Source: FAA Grant Histories 2016-2018

Figure 4.4 compares all eight states in terms of the average amount of discretionary and entitlement funds awarded between FY 2016 and 2016. The figures presented are on average over the study years.

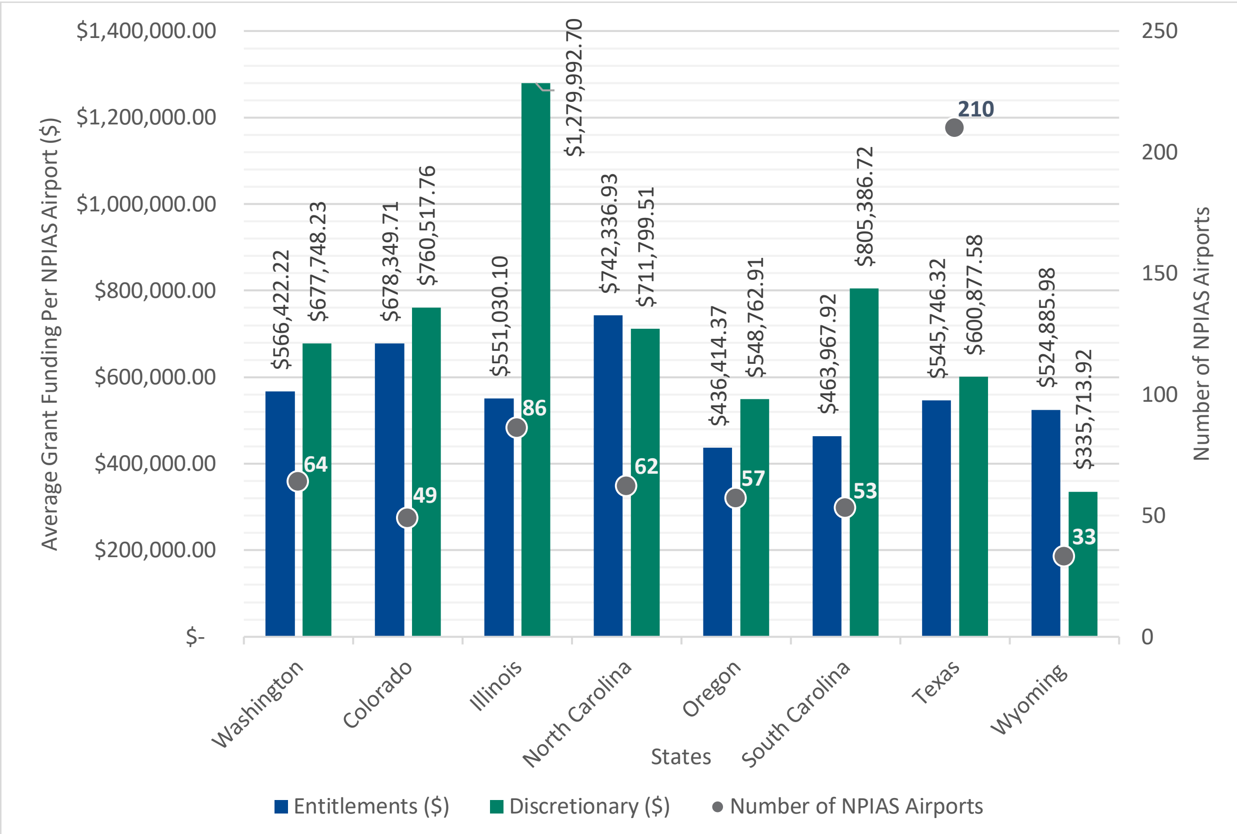
Figure 4.4. Entitlement and Discretionary Grant Funding of Comparison States, FYs 2016 - 2018 Average



Source: FAA Grant Histories, FYs 2016 – 2018

Figure 4.5 compares the eight states of the analysis in terms of average entitlement and discretionary grant funding awarded per NPIAS airport over the three study years. As this summary graphic depicts, Washington falls in the middle range for both entitlement funding (third of eight) and discretionary grant funding (fifth of eight). In the case of discretionary grant funding, it is important to observe that Illinois appears to be an outlier, receiving significantly more funding at $1.3 million than the next highest state (South Carolina at $805,387). Additional research would be required to identify the project(s) or other circumstance that resulted in the ostensibly high funding amount awarded to Illinois.

Figure 4.5. Entitlement and Discretionary Grant Funding Per NPIAS Airport of Comparison States, FYs 2016 - 2018 Average



Source: FAA Grant Histories, FYs 2016 – 2018

4.7.1.4 Comparative Analysis: Supplemental Appropriation Grants

As mentioned in a previous section, supplemental appropriation grants are a result of recent legislation that provided that $1.0 billion to be distributed as part of the AIP program to NPIAS airports through September 2021. Supplemental appropriation grants are distributed similarly to discretionary grants; however, special prioritization was initially given to airports that are generally lower priority or receive less funding through other federal mechanisms. This comparison only includes supplemental appropriation grants for FY 2018, the first funding became available. Airports with current Airport Layout Plans (ALPs) with "shovel-ready" projects best position to leverage additional funding as it becomes available, underlining the importance of continuous planning by all airports in the system.

Table 4.15 shows supplemental appropriation grants distributed to the states within the comparison for FY 2018. **Figure 4.6** compares the amount of supplemental appropriation funds distributed to each state in the analysis. Texas received the most supplemental appropriation funding in FY 2018, with Washington and North Carolina following closely at $7.0 million each. Colorado and South Carolina received $5.8 million and approximately $6.4 million, respectively. Illinois generally received some of the most entitlement and discretionary funding over the study years but received one of the lowest amounts of supplemental appropriation funds at $2.2 million. Oregon was the only state in the comparison that received no supplemental appropriation funding, despite also being on the lower end of entitlement and discretionary funding. Additionally, Illinois was the only state in the comparison that received multiple supplemental appropriation grants; the FAA awarded just one supplemental appropriation grant all other states (excluding Oregon with no grants). This information is presented graphically in **Figure 4.6**.

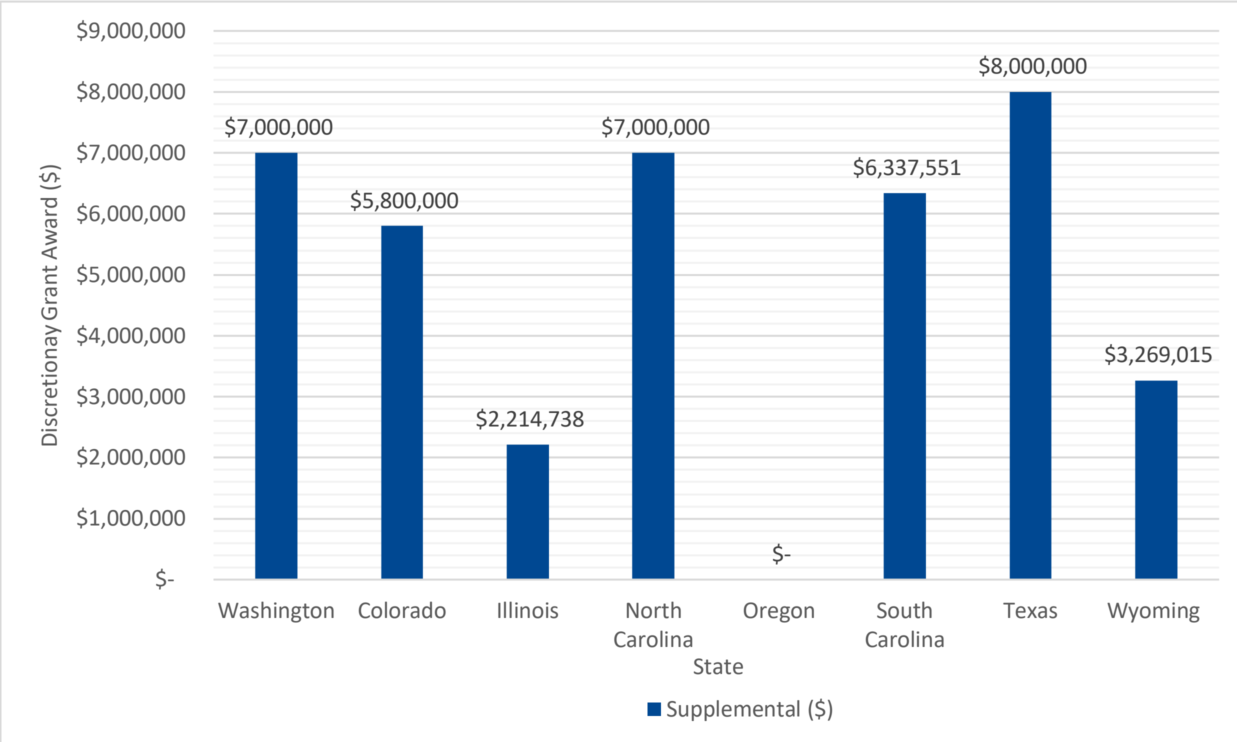
Supplemental appropriations were awarded to airports that applied based on priorities of the FAA. It is unknown how many airports in each state submitted applications to the FAA for this funding, nor how many had projects identified that were aligned with FAA priorities and likely to rank high amongst projects across the U.S. The important takeaway is the need for WSDOT Aviation and the airports to be positioned to maximize FAA funding mechanisms, timing, and guidelines, as well as to determine projects that are needed in Washington and would compete well at the national level.

Table 4.15. Supplemental Appropriation Grants by State, FY 2018

State	NPIAS Airports	FY 2018 Total $	FY 2018 No.
WA	64	$7,000,000	1
CO	49	$5,800,000	1
IL	86	$2,214,738	4
NC	62	$7,000,000	1
OR	57	$0	0
SC	53	$6,337,551	1
TX	210	$8,000,000	1
WY	33	$3,269,015	1

Source: FAA Grant Histories 2016-2018

Figure 4.6. Supplemental Appropriation Grant Funding by State, FY 2018



Source: FAA Grant Histories 2016-2018

Because states generally received only one award, and due to the unique prioritization structure of supplemental appropriate grants, an analysis of supplemental appropriation funding for NPIAS airports has not been conducted.

4.7.1.5 AIP Program Conclusion

The FAA AIP disperses funds through two main grant programs: entitlement grants and discretionary grants. A new grant program was established under the AIP in 2018, referred to as the supplemental appropriation grant, to distribute additional $1.0 billion FAA allocation by September 2021. The section above provides an overview of each of these programs for the eight states included in the comparative analysis over three years (FY 2016, FY 2017, and FY 2018). Through the comparative analysis, Washington emerges in the middle of the pack for both entitlement and discretionary funds in terms of total of funding received. Washington had the highest number of entitlement grants distributed compared to the other states for FY 2017, FY 2018, and over the three-year average. FY 2018 was a particularly noteworthy year, as the FAA distributed 71 entitlement grants and the second-highest amount of supplemental appropriation grants to Washington's NPIAS airports.

To better understand what this means for WSDOT Aviation and the state's NPIAS airports, it is important to analyze these figures in terms of award funding by the number of NPIAS airports per state. Washington has 64 NPIAS facilities, ranking it third amongst the comparison states—falling below only Texas (210 NPIAS airports) and Illinois (86 NPIAS airports). When these NPIAS airports are divided by total award funding, Washington again falls generally in the middle of the comparison. On average, the state ranks third and fifth for entitlement and discretionary grant funding (respectively). Washington's Pullman/Moscow Airport (PUW) received a $7.0 million supplementary grant in 2018 for its runway reconstruction program, ranking it (and Washington) one of the top grant recipients in the comparison.

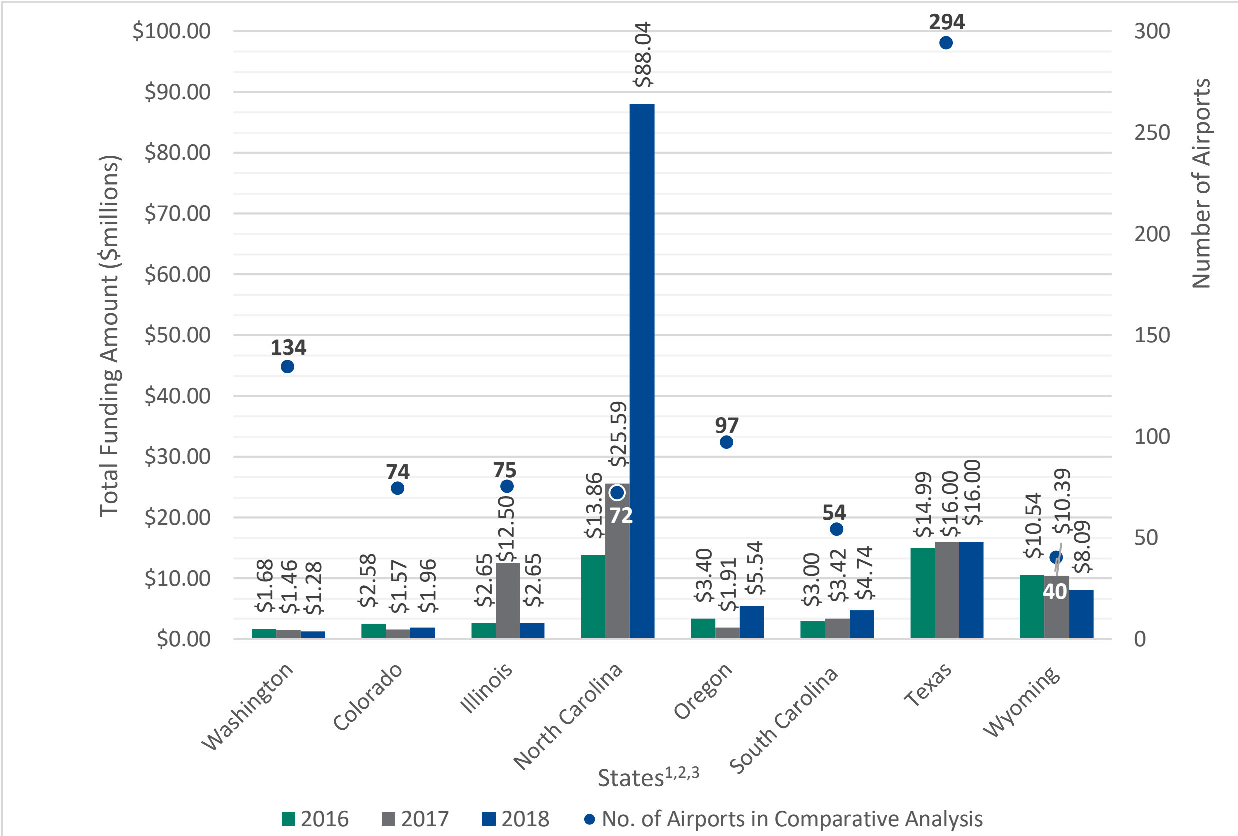
The importance of providing funding to airports, whether from the FAA or WSDOT Aviation, is that construction projects and capital spending generate short-term economic impacts as a result of the money that is spent. Beyond these short-term economic impacts, longer term impacts can be generated as a result of providing facilities that are in good condition and meet the needs of users such as longer and/or wider runways, additional instrumentation and/or weather systems, and other projects that may attract more users to an airport. These users could be new businesses, new based aircraft, or new visitors that use an airport to access the region's tourism offerings. Additional investment in airports translates to a greater economic impact, particularly as it relates to direct on-airport capital improvement spending, indirect effects associated with supplier purchases, and induced effects of the re-spending of worker wages.

4.7.2 State Aviation Funding

The following section specifically compares the levels and types of state funding distributed to airports included in the comparative analysis. This follows a similar format to the analysis in the FAA AIP section above, in that a summary graph is first presented that shows the total number of grant-eligible airports in each state system and the total amount of state money awarded for each study year. Following this high-level analysis, each state is presented in turn with an overview of available funding programs and levels. Additionally, information about any state funding mechanisms designed to support revenue-producing or economic development projects at airports is presented, as applicable.

Figure 4.7 summarizes the total amount of state aviation funding awarded to airports in 2016, 2017, and 2018, as well as the number of grant-eligible airports in each system. Texas has the largest airport system in the analysis with 294 publicly- and privately-owned airports. Texas also awarded the highest total amount of state aviation funds in 2016 and 2017. North Carolina invested significantly more funding than any other state to its airports in 2018. However, it is important to note that over $50.0 million of the state's $88.0 million investment was specifically appropriated to the state's 10 commercial service airports, with the remaining funding designated for 62 GA facilities. While Wyoming has the smallest system, with just 40 publicly-owned facilities eligible to receive funding, the state invests the third-highest amount of funding into its airports, averaging approximately $9.7 million per year. Also note that Illinois received a $9.9 million appropriation for a state-local capital program in FY 2017 in addition to its standard $2.65 million program, causing a one-time spike in annual aviation investment. Washington received the lowest funding amount in all study years with the second-highest number of airports eligible for state funding.

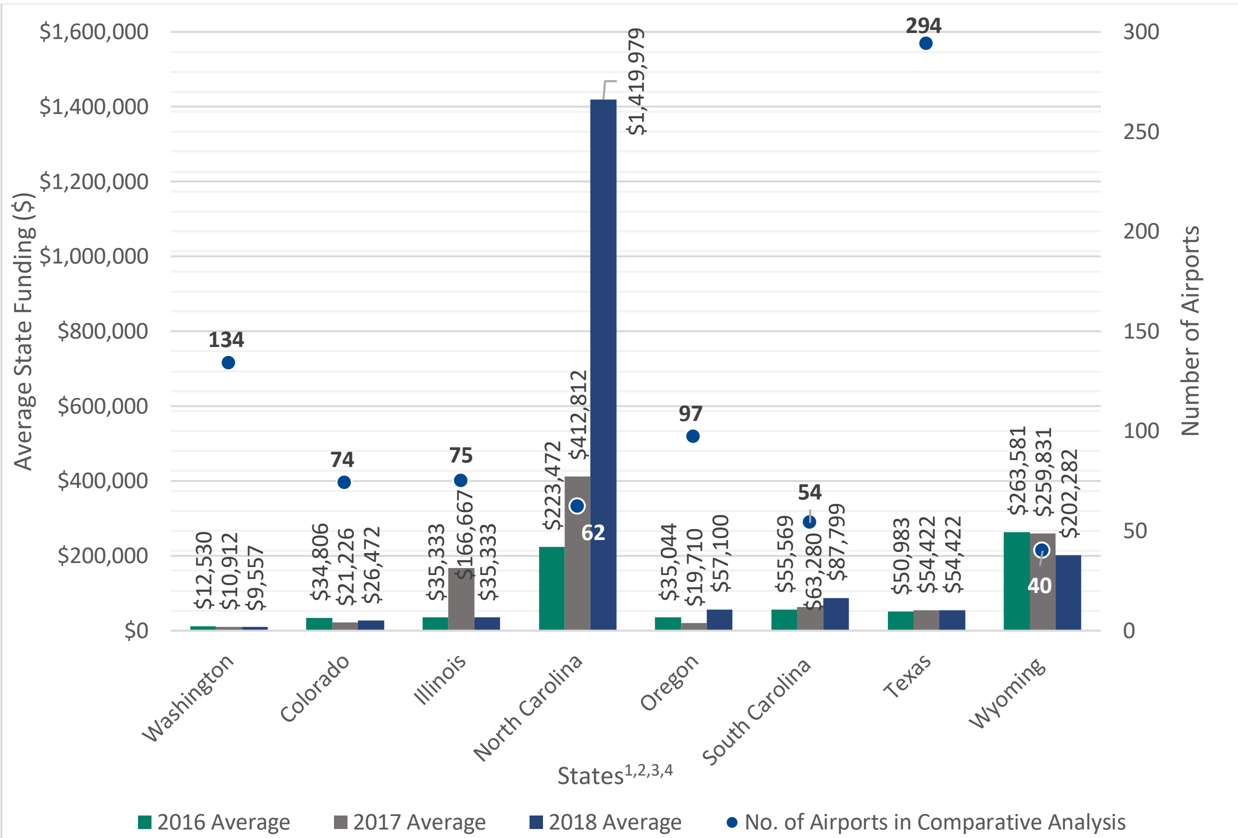
Figure 4.7. State Aviation Funding (2016 – 2018) and Number of Airports Eligible for or Participating in State Funding Programs



Notes: (1) Illinois has 77 airports eligible to receive state funding; however, only 75 airports participate in the state grant program and are included in the analysis here. (2) South Carolina has 58 airports in its state system; however, 54 airports are eligible to receive state funding and are included in the analysis above. (3) Texas aviation funding for 2017 and 2018 are reported as the annual average state aviation fund, as specific figures are unavailable at the time of this writing. Sources: CDOT Division of Aeronautics 2019, IDOT 2020, NCDOT Division of Aviation, ODA 2019, South Carolina Aeronautics Commission 2019, TxDOT Aviation Division 2019, WSDOT Aviation 2019, WYDOT Aeronautics 2019

Because each state supports a different number of airports, **Figure 4.8** offers insight into the average amount of funding available per airport during each study year. This comparison is not intended to imply that each individual airport actually received that amount of funding. Instead, this analysis allows a relative "apples-to-apples" comparison between state investment into airports. Additionally, because North Carolina appropriated $50.0 million specifically to its 10 commercial service facilities in 2018, these airports and funds were removed from the analysis to normalize the comparison (i.e., the analysis shows $38.0 million awarded to 62 GA airports). Even with this normalization, North Carolina provided significantly more state funding to airports in 2017 and 2018, and nearly as much as the highest-funding state (Wyoming) in 2016. North Carolina and Wyoming emerge as outliers in this analysis—generally providing two to four times as much average funding per airport as the next-highest contributor. Illinois did witness a significant uptick in aviation funding in 2017; however, this spike was due to a one-time $9.9 million appropriation in addition to its standard annual $2.65 million aviation grant program. All of these states have recognized the importance of investing in the aviation systems and the fact that these investments yield contributions, both short and long-term, to the state and local economies. Washington provided the lowest amount of funding per system airport in all study years, followed by Colorado and Illinois (2016), Oregon and Colorado (2017), and Illinois and Colorado again (2018).

Figure 4.8. Average Available State Funding by State Funding Eligible or Participating Airport (2016 – 2018)



Notes: (1) Illinois has 77 airports eligible to receive state funding; however, only 75 airports participate in the state grant program and are included in the analysis above. (2) North Carolina has 72 airports in its aviation system and awarded approximately $88.0 million to its airports in 2018. However, $50.0 million was earmarked for commercial service airports. As such, this analysis looks only at $38.0 million awarded to 62 GA facilities to normalize the comparison. (3) South Carolina has 58 airports in its state system; however, 54 airports are eligible to receive state funding and are included in the analysis above. (4) Texas aviation funding for 2017 and 2018 are reported as the annual average state aviation fund, as specific figures are unavailable at the time of this writing. Sources: CDOT Division of Aeronautics 2019, IDOT 2020, NCDOT Division of Aviation, ODA 2019, South Carolina Aeronautics Commission 2019, TxDOT Aviation Division 2019, WSDOT Aviation 2019, WYDOT Aeronautics 2019

The following sections provide a brief overview of state funding programs and noteworthy economic development investment mechanisms, including low-interest loan programs.

4.7.2.1 Washington

The WSDOT Aviation Division administers state grant funding for the 134 public-use airports included in Washington's aviation system through the Airport Aid Program. While not a SBGP participant, WSDOT also has a special partnership with the FAA's Seattle Airports District Office (ADO) to coordinate AIP funding through the Statewide Capital Improvement Program (SCIP). By synchronizing state and federal programs, WSDOT can more effectively and strategically allocate available resources.

The Washington Airport Aid Grant Program uses a competitive application process to distribute funds in three major categories including pavement; safety; and maintenance, security, and planning projects. **Table 4.16** shows the state funding amounts awarded by the WSDOT Airport Aid Grant Program for FYs 2016, 2017, and 2018, as well as a three-year average of those same years.

Table 4.16. Washington State Aviation Investment, FYs 2016 – 2018

Year	Funding ($)
2016	$1,678,976
2017	$1,462,180
2018	$1,280,675
Average	$1,473,943

Source: WSDOT Aviation 2019

In addition to the Washington Airport Aid Grant Program, the agency began administering the Community Aviation Revitalization Board (CARB) revolving loan program in 2019. CARB funding is designed to provide low-interest loans to support revenue producing projects at system airports with fewer than 75,000 annual commercial service enplanements. The CARB program was initially funded via a $5,000,000 appropriation from the state legislature in 2019. WSDOT Aviation accepted its first round of applicant projects in December 2019, with a second review process completed in March 2020.

4.7.2.2 Colorado

The Colorado Aeronautical Board (CAB) administers the distribution of the Colorado Aviation Fund through individual airport grants and statewide aviation system initiatives. Established to support Colorado's system of 74 publicly-owned, public-use airports, these programs are as follows:

- Colorado Discretionary Aviation Grant (CDAG) Program
- Airfield Maintenance and Crack Sealant Program
- Aviation Management Internship Program
- Denver International Airport (DEN) Surplus Airport Equipment Program
- U.S. Department of Agriculture Wildlife Hazard Mitigation Program
- Remote Air Traffic Control Program (established in 2017)
- Airport Inspections (5010 and Pavement Condition Index)
- Communications, Pilot Outreach, and Safety
- Automated Weather Observing System (AWOS) Development and Maintenance
- GA Airport Sustainability Program (ended in 2016)
- Web-based Information Management System (2018 only)

The CDAG Program is Colorado's primary grant funding mechanism to airports, which was first established in 1991 to channel aviation fuel taxes to "aviation purposes". Sixty-five percent of those taxes have been reimbursed back to airports as entitlement funding, with the remaining 35 percent distributed to serve airports' maintenance, capital equipment, and developmental needs. **Table 4.17** summarizes funding awarded to Colorado airports for each study year through the CDAG Program.

Table 4.17. CDAG State Aviation Funding, 2016 – 2018

Year	Funding ($)
2016	$2,575,667
2017	$1,570,745
2018	$1,958,919
Average	$2,035,110

Source: CDOT Division of Aeronautics 2019

It is important to note that the study years represent an anomaly in Colorado, as the balance of the Colorado Aviation Fund was significantly higher prior to 2016 and post-2018. In 2019, the CDAG Program awarded $5.11 million in individual airports grants and contributed $1.34 million via other statewide initiatives for a total of $6.44 million. The average balance of the Colorado Aviation Fund between 2012 and 2014 was $21.30 million.

In addition to the individual airport grants awarded through the CDAG Program, CDOT's Division of Aviation administers a number of statewide initiatives that benefit airport safety, pavement maintenance, and communication outreach to the GA community. The DEN Surplus Airport Equipment Program is a particularly unique program. In this program, CDOT partners with Denver International Airport to coordinate and administer the sale of the airport's used equipment such as snow plows, snow blowers, and dump trucks to other airports in the state. CDOT provides up to 80 percent grants to purchase this equipment, allowing many Colorado airports to obtain equipment they would not otherwise be able to afford.

The Remote Tower Project is a pilot program to provide remote air traffic control at Northern Colorado Regional Airport (FNL) using a combination of visual/camera with radar/track-based input technologies. Established in 2017 as a joint initiative between CDOT's Division of Aeronautics, the FAA, National Air Traffic Controllers Association, and Searidge Technologies, remote tower technology may provide a cost-effective solution to challenging issues associated with airspace and air traffic congestion.

In addition to these various aviation-related grant programs, CDOT has administered the State Infrastructure Bank (SIB) Loan program since 1999. This low-interest revolving loan program is designed to assist in financing highway, transit, aviation, and rail projects. For the aviation account, loans can be awarded to public-use airports to support a variety of capital airport improvements, air traffic control towers, snow removal equipment purchases, and airport pavement construction. SIB loans have also been used for land acquisition expenses deemed crucial in protecting the state's airports from incompatible land-use activities.[20] As of June 30, 2019, six Colorado communities were participating in the SIB program with $13.5 million in outstanding loan balances at an interest rate of 3.25 percent.

[20] CDOT Aero P-P Manual 2019 Final, pg. 38

4.7.2.3 Illinois

IDOT's State/Local AIP provides state funding for capital improvements and development at 75 of the state's publicly-owned, public-use airports.[21] In addition to this primary program, IDOT administers several small programs that benefit airports such as paying to uplink a system of weather stations throughout the state. State/Local AIP funds are used to provide a five percent match on eligible federal projects (excluding Chicago O'Hare [ORD] and Midway [MDW]), as well as support other projects that receive low priority ranking scores or ineligible for federal funding.[22] Additional priority ranking points are awarded for airports in economically depressed communities, result in immediate job creation (other than immediate construction jobs), and/or support revenue-generating activities designed to make the airport more self-sufficient.

Table 4.18 summarizes the state funding awarded to Illinois' system airports through the State/Local AIP between 2016 to 2018, in addition the average funding awarded during those study years. These funds do not include federal money administered by IDOT as a SBGP participant. As noted previously, IDOT received an additional $9.9 million in 2017 appropriated for a one-time state/local capital program, which significantly increased the average annual award reported below.

Table 4.18. Illinois State/Local Program Funding, 2016 – 2018

Year	Funding ($)
2016	$2,650,000
2017	$12,500,000
2018	$2,650,000
Average	$5,933,333

Note: Numbers are rounded for simplicity. Source: IDOT 2020

4.7.2.4 North Carolina

The NCDOT Division of Aviation administers multiple aviation-related funding programs for its 72 publicly-owned, public-use airports as follows:

- North Carolina AIP Grant
- Statewide Funding Assistance: Safety/Regulatory/Operations Projects
- Statewide Funding Assistance: Capital Improvement Projects
- Airport Safety Preservation Program
- Wildlife Hazard Management Program
- AWOS Program
- Aviation Funding Safety Enhancement Program

[21] As noted previously, the Illinois state system officially comprises 89 airports including a mix of publicly- and privately-owned NPIAS and non-NPIAS facilities. However, only 11 current and proposed future Primary commercial service and 66 Nonprimary commercial service, GA, and Reliever airports are eligible to receive funding. Of these 77 state-funding-eligible airports, Chicago O'Hare (ORD) and Midway (MDW) have not participated in the program since the early 1980s due airport grant caps, program requirements, and other considerations. Accordingly, 75 Illinois airports are reported in the state comparison.
[22] Federally-eligible or prioritized projects are selected from the Transportation Improvement Program (TIP) submittals and evaluated based on the FAA's National Priority Rating system.

- North Carolina State Airport Aid
- North Carolina Airport Economic Development Funding Program

Table 4.19 summarizes the total state funding provided for aviation investment in 2016 through 2018. As noted previously, the state legislature began special appropriations of approximately $50.0 million to 10 commercial service airports in 2018, resulting in a dramatic increase in expenditures that year. Additionally, North Carolina is a participant of the FAA's SBGP; these federal funds have been removed from the analysis.

Table 4.19. North Carolina State Aviation Funding, 2016 – 2018

Year	Funding ($)
2016	$13,855,241
2017	$25,594,371
2018	$88,038,713
Average	$42,496,108

Source: NCDOT Division of Aviation 2019

The North Carolina Airport Economic Development Funding Program administered by the NCDOT Division of Aviation is particularly interesting. This program provides grant funding for time-sensitive capital improvement projects at publicly-owned and -operated GA airports for economic development. Eligible projects can be either landside or airside and must result in net job growth within the state. Projects submitted for consideration are modeled to determine the estimated economic benefits prior to project selection. Projects are evaluated quantitatively in terms of the amount of funds per job supported and annual employee earnings relative to the county mean wage per dollar of NCDOT Division of Aviation funds.

4.7.2.5 Oregon

The ODA administers aviation grant programs, airport planning, and development at 97 publicly- and privately-owned, public-use airports in the state. Oregon's Statewide Capital Improvement Plan (SCIP) is an FAA/ODA joint partnership for the management of the FAA's NPE transfer program. This program is responsible for the implementation of the FAA's five-year capital improvement program for all Oregon GA NPIAS airports. In addition to these federal monies, state level funding is available through the Aviation System Action Program (ASAP), which distributes funds through the following vehicles:

- Critical Oregon Airport Relief (COAR)
- State Owned Airport Reserve (SOAR)
- Rural Oregon Aviation Relief (ROAR)

The ROAR program has been on-hold pending ongoing rulemaking processes and the development of a statewide plan for the use of grant funds targeting commercial air service in rural Oregon. **Table 4.20** summarizes statewide aviation funding distributed by the COAR and SOAR programs during each study year, as well as the average annual funding awarded. Note that while the ODA is responsible for administering federal funds via the SCIP, these funds are not reflected in the table below.

Table 4.20. Oregon ASAP Funding, 2016 – 2018

Year	Funding ($)
2016	$3,399,256
2017	$1,911,914
2018	$5,538,677
Average	$3,616,615

Source: ODA 2019

Economic development is one of the three main purposes the COAR Grant Program with support provided for the following purposes:

- Services critical or essential to aviation including (but not limited to) fuel, sewer, water, and weather equipment
- Aviation-related business development including (but not limited to) hangars, parking for business aircraft, and related facilities
- Airport development for local economic benefit including (but not limited to) signs and marketing

Applicant airports are specifically asked to describe a proposed project's economic benefit to the state using metrics such as the number of jobs and/or businesses created, the overall increase in GDP, and anticipated increases in property values or tax bases. Unlike some other state economic development programs, COAR is not only targeted exclusively at economic development but includes this metric as a key evaluation measure.

4.7.2.6 South Carolina

The South Carolina Aeronautics Commission provides several funding programs and opportunities for 54 publicly-owned, public-use airports eligible for state funding as follows:[23]

- South Carolina Aid Grant
- AWOS Monitoring and Maintenance
- Safety Inspections
- Vegetation Management Program (VMP)
- Pavement Maintenance Program (PMP)

The majority of state funding is awarded via the South Carolina Aid Grant program. In addition to providing the state match for AIP funding, the program supports airport maintenance and capital improvements that align with the Aeronautics Commission's goal and objectives, with the highest priority placed on safety. **Table 4.21** summarizes the total expenditures of all state funding programs administered the South Carolina Aeronautics Commission by study year, as well as the three-year average.

[23] South Carolina has 58 airports in its state system. However, only 52 GA and two commercial service airports (Florence Regional Airport [FLO] and Hilton Head Airport [HXD]) are eligible for state funding. As such, 54 airports were used in the comparison of state aviation funding presented in this section.

Table 4.21. South Carolina Aid Grant Program Funding, 2016 – 2018

Year	Funding ($)
2016	$3,000,731
2017	$3,417,123
2018	$4,741,133
Average	$3,719,662

Source: South Carolina Aeronautics Commission 2019

4.7.2.7 Texas

The Texas Department of Transportation (TxDOT) Aviation Division administers federal and state grant funding at 292 public and private airports and two heliports that perform an essential role in the economic and social development of Texas. As a State Block Grant Program (SBGP) participant, TxDOT administers the federal AIP and NPE at the state's Nonprimary NPIAS airports. State money is distributed by the Texas Aviation Facilities Development Program. Projects are prioritized for funding based on their abilities to enhance safety, preserve existing facilities, respond to present needs, and provide for anticipated future needs. Additionally, the TxDOT Aviation Division provides funding for "lower cost" airside and landside maintenance needs via the Routine Airport Maintenance Program (RAMP). RAMP works in conjunction with TxDOT's Pavement Management Program, which is used to identify necessary maintenance projects. **Table 4.22** summarizes Texas' state aviation investment during the three study years, as well as average funding for all three study years. Texas is a SBGP participant; federal money has been removed from the funds reported below.

Table 4.22. Texas State Aviation Investment, 2016 – 2018[24]

Year	Funding ($)
2016	$14,989,000
2017	$16,000,000
2018	$16,000,000
Average	$15,663,000

Source: TxDOT Aviation Division 2020

4.7.2.8 Wyoming

WYDOT Aeronautics provides support to the state's 40 publicly-owned, public-use airports through the administration of two primary programs:

- Grant-In-Aid
- Air Service Development Program (ASDP)

Grant-In-Aid from state funds to be used in the construction and development of projects including construction projects, maintenance projects, equipment grants, planning projects, and marketing grants. The ASDP promotes commercial air service across Wyoming through sponsorships and by helping

[24] The 2016 and 2017 Texas aviation state funding are the annual average expenditure, as more specific figures are unavailable at the time of this writing.

communities financially support new or existing air service. **Table 4.23** summarizes the total amount of state aviation funding distributed in Wyoming during FYs 2016, 2017, and 2018.

Table 4.23. Wyoming State Aviation Investment (2016 – 2018)

Year	Funding ($)
2016	$10,543,241
2017	$10,393,233
2018	$8,091,264
Average	$9,675,913

Source: WYDOT Aeronautics 2019

In addition to these state grant programs, WYDOT Aeronautics also administers the Wyoming Aeronautics Loan Program. This program provides low-interest loan opportunities to eligible airports in the state for the construction, development, and improvement of airport facilities generating user fees. Applications are evaluated based on if project's return is deemed a reasonable and prudent investment of state funds and other criteria as defined by state law. [25]

4.8 State Comparison Summary

The above section provides an overview of the different funding opportunities available to the eight states within this comparative analysis, including Washington. While states can have limited input or effect on FAA funding, there is opportunity for WSDOT Aviation to work with airports to identify projects that compete well for discretionary funding, potentially bringing more dollars to the state. Beyond federal funding, states provide a variety of different programs, some similar in structure and some uniquely their own. Each comes with its own set of award criteria and eligibility requirements. Despite the many differences between state investment in airports, both in terms of the programs offered and funding available, airport needs nearly always exceed available funds. With few exceptions, policymakers and state agencies across the U.S. are faced with the difficult task of allocating limited state dollars to transportation infrastructure that is generally aging and in need of maintenance, capacity enhancements, or both. To close the gap between needs and resources, many state aviation divisions administer grant and/or loan programs for revenue-producing projects in a move towards airport self-sufficiency. WSDOT Aviation has most recently done this through the CARB revolving loan program.

WSDOT Aviation has had the lowest amount of grant funding available to airports in all study years and the second-highest number of airports eligible to receive state support.

Despite this important step, the CARB program will not be able to close the funding gap in Washington. This analysis reveals that few, if any, states experience a funding deficiency so acute as in Washington. WSDOT Aviation had the lowest amount of grant funding available to airports in all study years and the second-highest number of airports eligible to receive state support (second only to Texas with 294 airports). The Washington Airport Aid Grant Program

[25] Rules and Regulations State Loan and Investment Board, Chapter 36 Wyoming Aeronautics Loan Program

awarded between $0.75 to $1.0 million less to its airports than Colorado during all three study years. Further, Colorado received an exceptionally low appropriation from the legislature during the referenced study years, making the comparison anomalous at best. WSDOT Aviation and Washington airports are uniquely strained to maintain and improve their aviation assets and will be increasingly challenged to keep up with aviation demands brought by population growth and the burgeoning e-commerce industry. Additionally, the emergence of electric aircraft will most likely lower the cost of flying and increase activity associated with recreational flying, pilot training, corporate/business aviation, air cargo, short-haul scheduled and unscheduled commercial service, and other types of aviation activity. While these aircraft will not in and of themselves require new major infrastructure, other than electric charging stations, they may increase demand which will require airfield pavements to be well maintained and landside facilities to store the aircraft. Furthermore, investment into emerging technologies could be substantial in Washington for many years to come. The state is a leader for aviation- and aerospace-related research, development, and manufacturing. As such, the continued development of electric aircraft, UAS/UAV, and related technologies could significantly contribute to the state's economy while creating new workforce opportunities for Washington residents.

The *Airport Investment Study* shows that the economic impact of an airport is strongly correlated with the level of funding it receives. The study projects that if state funding for airports in Washington increased to $4.0 million, direct business revenues per GA airport would increase from approximately $3.9 million to $4.5 million (15 percent increase per GA airport). If investment increased to $12.0 million, direct business revenues per GA airport would increase to $6.3 million. Those same increases also represent an increase of 12 to 42 percent increase in direct jobs per airport.[26] It is important to note that the *Airport Investment Study* was developed in 2014. When adjusting the figures presented in the study to 2020 dollars:

- If state investment in the airport system increased to $4.35 million, direct business revenues per GA airport would increase to $4.25 million.
- If state investment in the airport system increased to $13.1 million, direct business revenues per GA airport would increase to $6.86 million.

> *At its current average funding level of $1.4 million annually, the findings of the Washington AEIS reveal that the state's airports contribute $107.0 billion in annual economic impact and $913.3 million in direct tax revenues. Even a moderate increase in state investment would make a tangible difference to Washington's economic prosperity and result in thousands of new jobs for Washington workers.*

[26] CH2M (2015). Section 5 – Solutions Performance Analysis, p. 29.

These increases represent a cumulative 8.9 percent inflation rate between 2014 and 2020 based on the U.S. Bureau of Labor Statistics' Consumer Price Index (CPI). In addition to inflation, the state has experienced population growth, economic expansion, and other developments typically indicative of higher aviation demands. As demands increase, so too do the needs associated with airport improvement projects for maintenance, capacity enhancements, or both. Because state funding has remained generally remained static while demand has grown, the state's share of the aviation funding shortfall has only increased since the *Airport Investment Study* was published.

4.9 Summary

This analysis of the Washington AEIS demonstrates that the economic impact of Washington's GA and commercial service airports could substantially increase over current levels should Washington aviation investment reach the level of support provided to other state aviation systems. Not only would additional investment promote safety, security, preservation of infrastructure, capacity improvements, mobility, and other airport-related benefits, but returns would benefit all of Washington's residents and businesses. Investment would create thousands of new and often high-paying jobs across the state—a particularly germane need in consideration of the recent and significant economic downturn associated with COVID-19. At its current average funding level of $1.4 million annually, the Washington AEIS shows that the state's system airports contribute $107.0 billion in annual economic impact and $913.3 million in direct tax revenue.[27] An even moderate increase in state investment would make a real and significant difference to the state's economic prosperity, Washington workers, and their families.

[27] Kimley-Horn (2020). *Washington AEIS*.

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Chapter 5. Future Aviation Opportunities

The aviation industry has experienced tremendous advancement in aircraft technology since the inception of flight at the turn of the 20th century. While the first flights lasted only a few minutes, aircraft today are lighter, more fuel efficient, and can travel farther distances than ever before. Recent technological advancements allow for aircraft to run on alternative, more sustainable fuels including electricity. Moreover, the technology of flight has advanced to the point that in some cases pilots are not even necessary in the aircraft, as seen in the development of Unmanned Aircraft Systems (UAS) and related Urban Air Mobility (UAM) applications. These emerging technologies will play important roles in the future of aviation activity and economic impact, and therefore command further investigation into their uses; potential impacts on the current aviation environment; and other considerations related to their development, implementation, and integration into the National Airspace System (NAS). The emerging technologies discussed in this chapter are as follows:

- Electric aircraft
- UAS
- UAM
- Alternative aviation fuel

> *Each of these technological advancements (electric aircraft, UAS, UAM, and alternative aviation fuel) presents an exciting new horizon for the aviation industry that brings a range of benefits such as investment and workforce development opportunities, a reduction in harmful emissions, improved mobility and access to aviation services, and more.*

Each of these technological advancements presents an exciting new horizon for the aviation industry that brings a range of benefits such as investment and workforce development opportunities, a reduction in harmful emissions, improved mobility and access to aviation services, the potential for increased economic vitality in communities large and small, and more. As these new technologies come to market, transitional impacts are likely to arise during the development and implementation phases. Future impacts will need to be addressed by a number of industry stakeholders, including potential users, regulatory agencies like the Federal Aviation Administration (FAA), state policymakers, airports, and more.

This chapter presents the key opportunities and challenges associated with these emerging technologies with an emphasis on the potential impacts affecting the Washington State Department of Transportation Aviation Division (WSDOT Aviation) and the state airport system. As a component of the 2020 Washington Aviation Economic Impact Study (AEIS), this analysis provides a forward-looking perspective on the economic and qualitative benefits of the aviation system in Washington. While **Chapter 2. Economic Impacts of Washington Airports** and **Chapter 3. Key Aviation Activities** look at the aviation environment of today, this chapter looks ahead to the aviation environment that is showing signs of becoming the new reality.

In some cases, emerging technologies could provide new or additional economic impacts to the state and its airports. Washington's reputation as a hub for cutting-edge aviation- and aerospace-related technologies has already brought new, high-wage jobs into the state economy. The connectivity brought by electric aircraft and UAM will improve rural communities' access to urban economic centers. This shift could open new opportunities for statewide equity, foster business development across the east/west divide, and connect workers with jobs that had previously been inaccessible to them. Further, less time on congested roadways means more time for productive workdays and quality time outside of the office. At the same time, the role of "traditional" aviation activities in the economy may also change. Unmanned aerial vehicles (UAV) could displace the use of conventional aircraft for agriculture spraying. Workers in industries such as trucking may have to invest in workforce training as their jobs become either automated or conducted by UAS operators (of UAVs) who sit in front of computers instead of behind the wheel. Aviation fuel revenues may decrease during the transition to electric aircraft as policymakers and airports update revenue mechanisms to become better suited to the modern aviation environment.

Washington's reputation as a hub for cutting-edge aviation- and aerospace-related technologies has already brought new, high-wage jobs into the state economy.

These and other changes will impact Washington's aviation- and aerospace-related industries with ripple effects that flow through the entire transportation network and economy. Understanding these future, somewhat near-term issues will provide WSDOT Aviation and airport with the greatest opportunity to maximize future economic benefits and implement solutions to mitigate any negative impacts on existing sectors. While previous chapters of the Washington AEIS looked at the Washington airport and aviation industry in terms of activity and spending type, this chapter looks at aviation through the lens of time to contribute an additional dimension to the analysis. This chapter presents an overview of each emerging technology and its applications. It is then analyzed under a framework that focuses on key opportunities and challenges related to these elements or considerations:

- Financial
- Environmental
- Infrastructure needs
- Staff and workforce
- Mobility and access
- Safety

An overview of the opportunities is presented in **Figure 5.1**, with more detailed considerations for each emerging technology provided in the sections that follow.

Figure 5.1. Overview of Emerging Technologies – Opportunities and Challenges

Potential Types of Impacts	Electric Aircraft	UAS	UAM	Alternative Aviation Fuels
Financial (On- and Off-Airport)				
Stability of fuel costs	●	●	●	●
Lower cost of fuel	●	●	●	
Reduced maintenance costs	●			
Demand for commercial service	●			●
Demand for general aviation	●		●	
Demand for air cargo	●	●		●
Environmental				
Reduced carbon/greenhouse gas emissions	●	●	●	●
Electronic waste concerns	●	●	●	●
Battery manufacturing and disposal	●	●	●	
Human health and air quality benefits	●	●	●	●
Infrastructure Needs				
Airside				●
Landside	●			
Off-airport		●	●	
Staff and Workforce				
Pilot training opportunities	●			
Existing workforce displacement		●	●	
Workforce development opportunities	●	●	●	●
Mobility and Access				
Urban/rural connectivity	●	●	●	
Airport access			●	
Reduced urban congestion		●	●	
Safety				
Shared airspace concerns		●	●	
Emergency response and law enforcement applications		●	●	

Source: Kimley-Horn 2020

5.1 Electric Aircraft

Electric aircraft development is driven by the world's growing concern for carbon (or CO_2) emissions related to air travel, new advancement in battery capacity, and the rising and volatile cost of petroleum-based fuels. Electric aircraft are significantly less expensive to operate and maintain as well as quieter, resulting in less impact on noise sensitive populations and associated land uses.

Electric aircraft represent the cutting-edge of aviation technology, driven by the world's growing concern for carbon emissions related to air travel, new advancement in battery capacity, and the rising and volatile cost of petroleum-based fuels.

Information presented here on electric aircraft builds upon the work of the WSDOT Electric Aircraft Working Group (EAWG), which was convened by the Washington legislature to explore the feasibility of introducing electric or hybrid-electric aircraft for regional air transportation in the state. The EAWG submitted its report in June 2019, which explores issues including operations, manufacturing, and infrastructure requirements associated with electric aircraft in Washington. The EAWG report is available online at wsdot.wa.gov/sites/default/files/2019/07/15/ElectricAircraftWorkingGroupReport-June2019.pdf.

The report found that given potential market, sustainability, access and mobility, and other benefits associated with electric aircraft, an aerospace consultant should continue the work of the EAWG. As such, WSDOT Aviation is actively working with WSP to conduct the Electric Aircraft Feasibility Study at the time of this writing (May 2020). The study will provide a detailed assessment of the potential benefits and challenges of electric aircraft in terms of infrastructure demands, workforce development, economic impact, and regional passenger service. Anticipated for completion in late 2020, the Electric Aircraft Feasibility Study will provide a framework for WSDOT Aviation and airports to advance this promising technology at the statewide level.

5.1.1 Overview Technology and Applications

In 2016, the Solar Impulse II completed a 16-and-a-half-month circumnavigation around the world to become the first solar-powered fixed-wing aircraft to achieve such a feat. Hailed as an innovation equal to Charles Lindbergh's first solo non-stop transatlantic flight in 1927, the Solar Impulse II ushered in a new era of aviation history. With a 236-foot wingspan, Solar Impulse II used 17,248 photovoltaic solar cells to charge four 41-kilowatt hour (kWh) lithium-ion batteries powering the four 17.4-horsepower electric motors. Powered by the sun, the aircraft was slow (an average of just 45 miles per hour [mph]) but flight was sustainable, and the aircraft was able to store sufficient power to fly at night.

In 2012, the Flight of the Century's customized Burt Rutan Long-EZ clocked a top speed of 202.6 mph to become the first all-electric aircraft to break the 200-mph barrier. The aircraft was powered by a custom-designed 258 horsepower (HP), liquid-cooled DC brushless electric motor producing 400 feet per pound of torque.[1] The same team is continuing to develop its Infinite Range Electric Flight (IREF) technology by installing a front-mounted recharging probe and related equipment for mid-air recharging. Together, the Solar Impulse II and Flight of the Century show that a future where fossils fuels are no longer the only source of power for the world's ever-growing demand for air travel is not only possible, but already upon us.

An estimated 170 to 200 different models of electric aircraft are currently under development, each of which is vying to become the first to become viable for large-scale commercial use. While players include industry giants like Boeing and Airbus, start-ups are responsible for an estimated 46 percent of aircraft electrification research and development.[2] Companies like Joby Aviation, Eviation, Ampaire, and Wright Electric are all venture-backed firms making major headway in the field. The state of Washington is rapidly becoming a hotbed for this innovation. Industry-

An estimated 170 to 200 different models of electric aircraft are currently under development, each of which is vying to become the first to become viable for large-scale commercial use.

[1] http://www.flightofthecentury.com/long-esa/
[2] https://www.statista.com/chart/11439/start-ups-propelling-the-electrification-of-air-transport/

leading electric-propulsion company MagniX shifted its headquarters from Australia to Redmond in March 2019 to take advantage of the Seattle area's top engineering and aerospace talent. According to CEO Roei Ganzarski, "You can't be a world leader in aerospace from Australia…We decided the most logical place for us would be Seattle, Washington."[3] AeroTEC's Moses Lake Flight Test Center at Grant County International/Moses Lake International Airport is quickly becoming an international center for the testing and certification of electric aircraft. MagniX began test flights of its 750-horsepower magni500 all-electric propulsion system on a Cessna Caravan 208B at Moses Lake in May 2020. Eviation began flight tests of its Alice aircraft in Prescott, Arizona in early 2020, with test flights planned for the Moses Lake Flight Test Center later in the year.


Pipistrel's Alpha Electro 2. *Source: Pipistrel*

Electric aircraft encompass a variety of technologies and applications, sometimes with only minor differences. Some aircraft, such as Ampaire's TailWind, are designed to carry less than 10 passengers or light cargo loads at a time. The company is leading the way in converting existing models of aircraft to hybrid-electric, including the Cessna 208B Grand Caravan, Cessna 337 Skymaster, and Viking Twin Otter.[4] UberAir's proposed air taxi is designed to ferry upwards of 150 passengers between Los Angeles and San Francisco on electric power.[5] Wright Electric and the airline EasyJet have partnered to develop an all-electric airliner carrying 120 and 186 passengers and traveling distances of up to 335 miles. Airbus is working on two aircraft planned to support urban air mobility for passengers and cargo. **Figure 5.2** highlights the major categories of electric aircraft under development and their target application in the marketplace. Additionally, small, two-seater aircraft with short (generally one- to four-hour) flight times are also under development specifically designed for the pilot training market. Examples include Pipistrel's Alpa Electro 2 and Bye Aerospace's eFlyer 2 (see **Section 5.1.2.4** for details about this type of aircraft).

[3] https://www.geekwire.com/2019/magnix-revs-electric-motors-tesla-like-move-aviation-industry/
[4] https://transportup.com/headlines-breaking-news/vehicles-manufactures/ampaire-to-electrify-caravan-twin-otter/
[5] https://mashable.com/feature/electric-airplanes-future-flight/

Figure 5.2. Major Categories of Electric Aircraft

Source: Mashable.com 2019

Each company is making a strategic play in terms of the type of technology and application that will be the first to achieve large-scale commercial application in the field of electric aircraft. While their approaches may differ, they are all working to overcome the same key challenge. Batteries do not have the same energy density of fuel. Israeli company Eviation's electric aircraft Alice carries three electric motors, distributed on each wingtip and tail, powered by a 900-kWh lithium-ion battery weighing 3.8 metric tons. With a total weight of 14,000 pounds, Alice's battery accounts for 60 percent of its load.[6] Aircraft typically devote 30 percent of total weight to fuel, and that number drops as fuel is spent over the course of a flight. Batteries, however, simply become dead weight once they have been expended. Airbus' chief technology officer Grazia Vittadini recently stated in a BBC interview that even if batteries became 30 times more energy dense than they are today, it would only be possible to fly an A320 airliner for a fifth of its range with half its payload. [7]

The industry also faces technological challenges in terms of thermal management. The integrated power modules of high-powered electrics require a system that can dispel anywhere from 50 to 800 kW of heat during flight. This includes materials to improve thermal performance and a system to cool the electrical

[6] https://mashable.com/feature/electric-airplanes-future-flight/
[7] https://www.bbc.com/news/business-48630656

system.[8] This system will also have to be lightweight to not unnecessarily increase the aircraft's payload. Superconductivity and supercooled electronics will be required to reduce the electrical resistance of the aircraft. It is important to note that electric motors lose far less potential energy to heat than piston and turbine engines and operate at cooler temperatures with fewer moving parts. These and other factors lead to an estimated 50 percent reduction in maintenance costs compared to conventional aircraft—in addition to the significantly lower operating costs associated with the use of electricity instead of fossil fuels (see **Section 5.1.2.1** below).

The NASA X-57 "Maxwell" is the agency's first all-electric aircraft and is used to validate and demonstrate the benefits of distributed electric propulsion. *Source: NASA*

These challenges may well be the limiting factors in the electronic aircraft revolution, but its many benefits and applications for commercial and military aviation have led to significant investments by the federal government and other public institutions. Combined with the investments made by private industry, battery capacity continues to improve by five to eight percent each year. The National Aeronautics and Space Administration's (NASA) Glenn Research Center's Electrified Aircraft Propulsion (EAP) research is approaching the issue from numerous concurrent and complementary perspectives to enhance the efficiency of transport-class aircraft; improve the economics associated with small, short-range aircraft; and develop new on-demand aviation systems.[9] In particular, NASA—like other industry players—is focusing much of its research on the various types of propulsion systems that could drive the electric revolution; namely, full, partial, and hybrid turboelectric.

Boeing Sugar Volt. *Source: NASA*

This latter technology, also known as a parallel hybrid, has a relatively decoupled airframe and propulsion system that uses a combination of electricity and fossil fuel. Parallel hybrids show the greatest promise in the near- and medium-terms for large commercial service passenger aircraft. Boeing's Sugar Volt, for example, is a 150-passenger jet with the ability to fly 900 nautical miles on batteries for a 60 percent fuel burn reduction as compared to the traditional fossil fuel burn of conventional aircraft.[10] NASA expects parallel hybrid candidates to become viable for commercial service in 2035, and the agency has a long-term vision for a

[8] https://techcrunch.com/2018/07/08/the-electric-aircraft-is-taking-off/
[9] https://www1.grc.nasa.gov/aeronautics/electrified-aircraft-propulsion-eap/
[10] https://www1.grc.nasa.gov/aeronautics/electrified-aircraft-propulsion-eap/eap-for-larger-aircraft/aircraft-configurations-technologies/hybrid-electric/

full turboelectric system. The agency is also coordinating efforts between the FAA and Department of Defense on additional research as well as regulatory issues that will affect the future of electric aircraft.

Public and private aerospace industry stakeholders including researchers, manufacturers, and analysts generally agree that the electrification of large commercial passenger jets may still be a number of years off. Regional carriers operating mid-range flights up to 1,000 miles are already introducing electric aircraft into their fleets. At the 2019 Paris Airshow, Cape Air signed a multimillion-dollar contract with Eviation to purchase Alice—becoming the first airline in the world to order commercial airplanes that run on electric batteries. Alice could be in service by 2023.[11] Cape Air is one of the largest regional carriers in the United States (U.S.), operating in 35 cities in the U.S. and Caribbean. The nine-seater aircraft offers a range of 650 miles on a single charge at 240 knots (267 mph).[12] The aircraft uses an electric motor produced by Washington-based MagniX currently being tested at the Moses Lake Flight Test Center.

Several months prior, MagniX announced its own partnership with Harbour Air to convert the carrier's existing fleet to all-electric, powered by the 750-HP magni500 motor.[13] Based in Vancouver, BC, Harbour Air operates 12 routes across the Pacific Northwest in the U.S. and Canada. Flights are less than 30 minutes, making Harbour Air an ideal testbed for electrification. Its over 40-aircraft fleet comprises de Havilland Beavers, Otters, Twin Otters, and one Cessna Grand Caravan EX.[14] A six-passenger DHC-2 de Havilland Beaver will be the first aircraft converted, with first test flight successfully completed in December 2019. Once complete, the Harbour Air/MagniX partnership is expected to result in the world's first all-electric airline.

Harbour Air. *Source: Cleantechnica*

5.1.2 Opportunities and Challenges

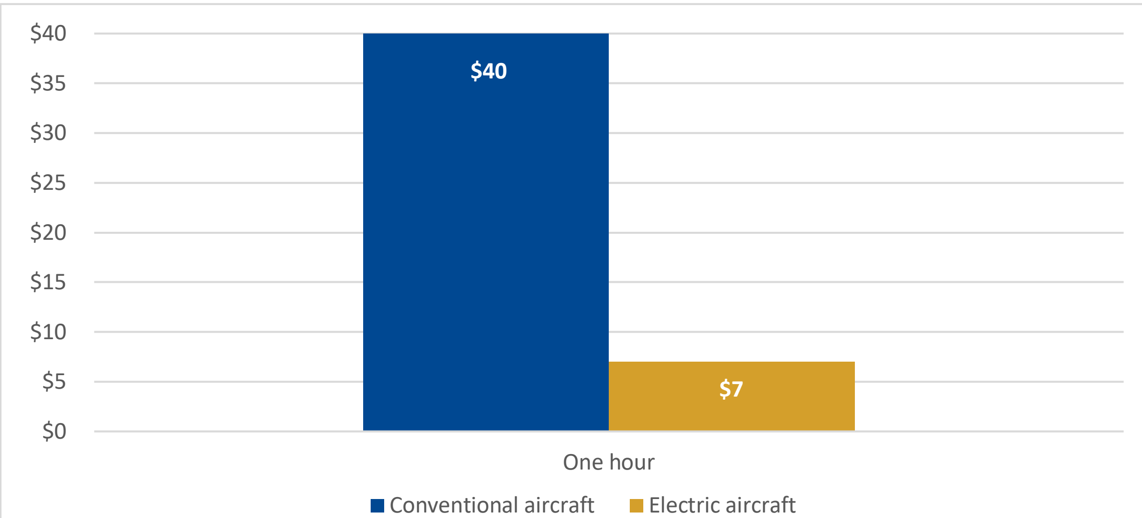
Cape Air and Harbour Air are both operating on the cutting edge by bringing electric aircraft from the laboratory into commercial use. There are still many steps and significant investments required to fully transition the global fleet from fossil fuels to all-electric, and the industry is likely decades away from powering transoceanic, long-haul flights. While this evolution will face challenges, it is clear that the long-term future of aviation includes electric flight. This section highlights the key concepts that are driving this conclusion.

[11] https://www.wbur.org/earthwhile/2019/08/08/cape-air-eviation-alice-electric-plane
[12] https://electrek.co/2019/06/18/eviation-electric-cape-air/
[13] https://www.harbourair.com/harbour-air-and-magnix-partner-to-build-worlds-first-all-electric-airline/
[14] https://www.harbourair.com/harbour-air-and-magnix-partner-to-build-worlds-first-all-electric-airline/

5.1.2.1 Financial

While initial investment in bringing electric aircraft to markets will be substantial, the potential financial upside is tremendous. In short, the cost of electricity is significantly less than traditional hydrocarbons. MagniX CEO Roei Ganzarski estimates that a small turboprop like a Cessna Caravan uses approximately $400 on conventional fuel for a 100-mile flight while that same flight would use between $8 and $12 worth of electricity. H55, a Swiss start-up developing the Bristell Energic plane, projects that it will cost just $7 in electricity to fly its aircraft for one hour.[15] The Aircraft Owners and Pilots Association (AOPA) estimates that it costs $40 per hour in 100LL fuel to operate a small, GA aircraft for one hour.[16] **Figure 5.3** depicts the estimated operational cost difference between electric and conventional aircraft based on these projections.

Figure 5.3. Estimated Operating Cost of Conventional versus Electric Aircraft



Source: Wired.com 2019 (https://www.wired.com/story/aviation-pioneer-goes-all-electric-planes/), AOPA 2020 (https://www.aopa.org/go-fly/aircraft-and-ownership/buying-an-aircraft/tips-on-buying-used-aircraft/hypothetical-operating-cost-calculation);

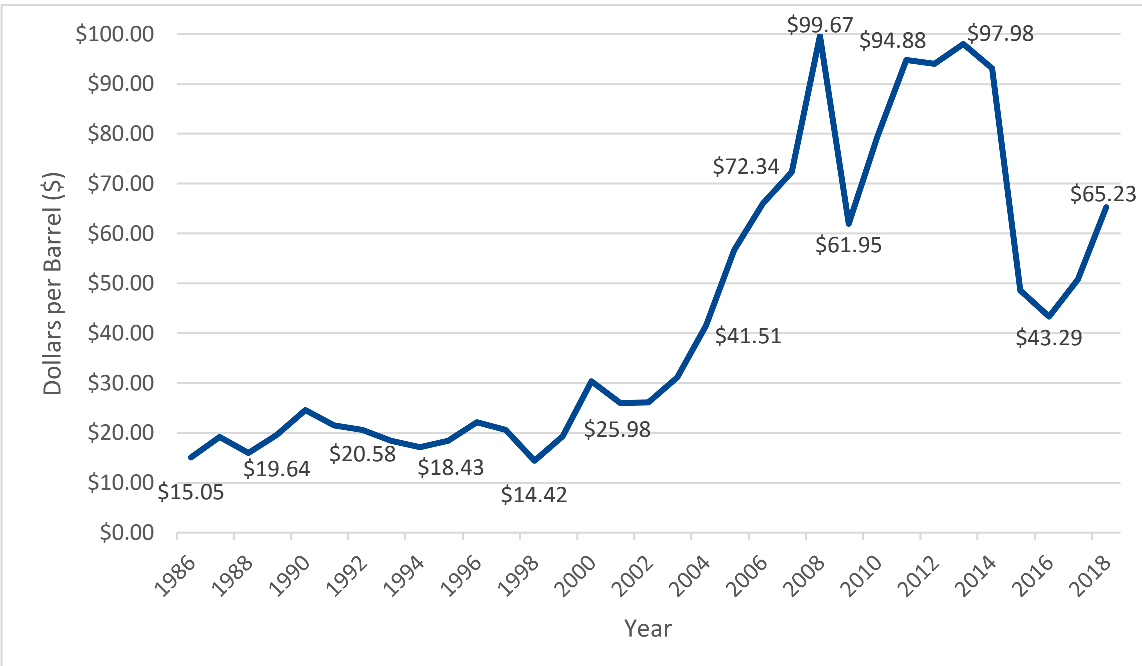
The FAA reports that there were approximately 1,001B revenue passenger miles (domestic and international), 42,759M air cargo revenue ton miles (domestic and international), and 25,647K GA and air taxi hours flow (domestic only) in 2018.[17] Add global aviation activity outside of the U.S., and the business case for electric aircraft is clear. As MagniX's Roei Ganzarski states, "We're not an environmentalist company, the reason we're doing this is because it makes business sense."[18]

In addition to lower costs, electricity brings stability to an industry plagued by market volatility impacted by global economic forces outside of air carrier's control. As it is the largest operating expense for aircraft operators (e.g., commercial service, GA, and air cargo), the price of oil currently affects all sectors of the aviation industry. Over the past 20 years, the price of oil per barrel has swung significantly

[15] https://www.wired.com/story/aviation-pioneer-goes-all-electric-planes/
[16] https://www.wired.com/story/aviation-pioneer-goes-all-electric-planes/
[17] FAA Aerospace Forecast 2019-2039
[18] https://www.bbc.com/news/business-48630656

from a low in 1997 of $20.59/barrel to a high of $99.67/barrel in 2008 before the economic downturn. Since 2008, oil prices have fluctuated but remained high until 2014 when prices dropped below the $50/barrel mark, as shown in **Figure 5.4**. The FAA *Aerospace Forecast 2019-2039* reports that the average crude oil price in 2018 was up 28 percent from the year prior to $65 per barrel. The FAA anticipates costs to moderately decrease until 2021, before gradually rising to over $100 per barrel by the end of the 20-year forecast period.

Figure 5.4. Average Cost of Crude Oil, 1986 – 2018



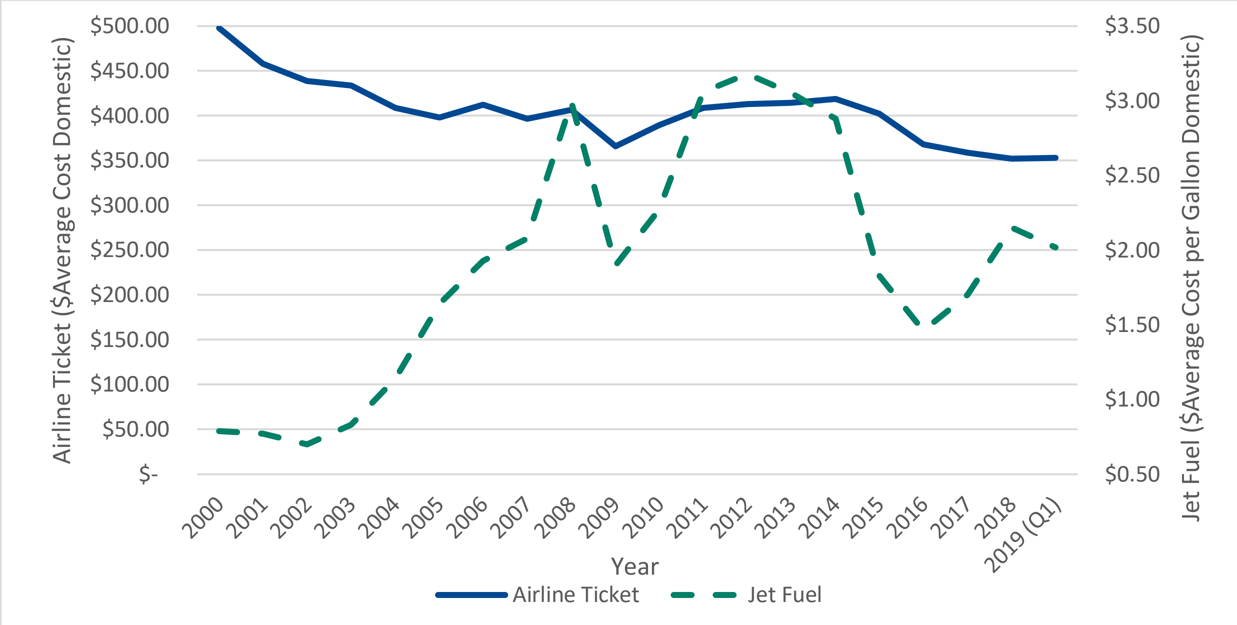
Source: U.S. Energy Information Administration (EIA) 2019

To protect themselves against unexpected spikes, many airlines hedge jet fuel prices on at least a portion of their fuel volume. Hedging allows airlines to pay a consistent price for fuel and results in lower operating costs for airlines when spikes do occur. However, when fuel costs unexpectedly drop—as they did between 2014 and 2016—airlines that hedge ultimately pay more than the market demands.

Airlines have employed several other measures to mitigate against fuel price fluctuations as well. Delta Air Lines purchased a Pennsylvania oil refinery in 2012 to obtain greater control over its supply train. This purchase came with a high initial price tag, and the endeavor's overall success is yet unclear. Most notably, while the refinery offers Delta control over refining margins, it does not provide any protection against the price of crude oil—the largest factor in jet fuel price.

Figure 5.5 depicts the relationship between the cost of jet fuel and airline ticket prices. While not as dramatic as oil or jet fuel price variations, airline ticket cost fluctuations generally mimic those in fuel markets.

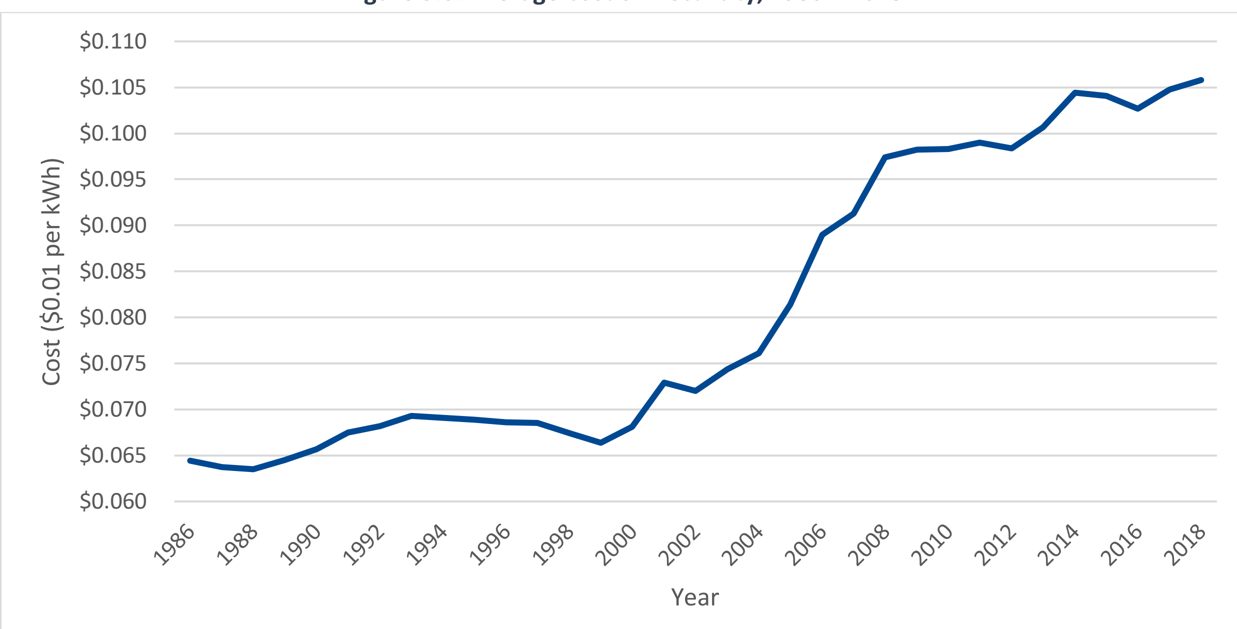
Figure 5.5. Jet Fuel Price vs. Airline Ticket Price Index, 2000 - 2019



Source: U.S. Bureau of Transportation Statistics (BTS) 2019

Consider the costs and level of instability associated with global oil markets relative to electricity. **Figure 5.6** depicts the cost of electricity between 1986 and 2018, the same period as depicted for crude oil in Figure 5.4 above. The average cost of electricity in 1986 was $0.06 per kWh. Over the next two decades, the cost per kWh showed moderate peaks and dips during its gradual ascent to $0.106 in 2018.

Figure 5.6. Average Cost of Electricity, 1986 – 2018



Source: U.S. EIA 2019

While a unit comparison between crude oil and electricity cannot be made, several important observations are evident. Electricity experienced far less volatility and reflected a level of independence from other economic and political forces, such as the economic boom and bust of the early 2000s. Further, most electricity in the U.S. is generated using domestic sources (primarily coal and natural gas, followed by nuclear and renewable sources). In Washington, most electricity is generated by hydropower—a power source that is clean, readily available, and reliable. Whether generated using coal, natural gas, hydropower, or another domestic source, electricity brings a level of stability to the market that far outweighs the global geopolitical forces that can batter international oil markets. Finally, while the cost of both energy sources rose over time, electricity increases were far less severe than crude oil. The cost of electricity increased by 64.29 percent from 1986 to 2008—from $0.06 per kWh in 1986 to $0.106 in 2018. During that same period, crude oil rose from $15.05 to $65.23 per barrel for 333.42 percent increase.

With electricity, hedging or other measures to mitigate against price volatility—like those undertaken by Delta—may be less critical, although some market players may hedge electricity prices in efforts to keep costs low. The transition to electricity would effectively decouple the cost of an airline ticket from fuel. Stability is important not only to airlines and their investors, but also to end users including businesses and leisure travelers and freighters in facilitating more accurate budgeting. For commercial air travelers, the significantly lower cost and greater stability of electricity markets should result in lower ticket prices. GA activities such as personal and recreational flying, corporate and business aviation, medical flights, and wildland firefighting should also witness a precipitous decrease in operating costs. Lower operating costs would also make air cargo cheaper for both shippers and, accordingly, consumers. In short, the transition to electric aircraft is anticipated to increase demand in all sectors. In the commercial service and air cargo sectors, carriers would likely respond by adding more routes and increasing the frequency of operations.

Air shippers may be the first to witness the financial gains associated with electric aircraft, especially those operators transporting parcels along short- and mid-range routes. In addition to lower costs, the public and regulatory agencies will likely be more comfortable flying packages on an electric aircraft instead of people, especially until more time has passed demonstrating a high reliability and safety record. "As much we don't like to admit it, aviation is a risky business," said MagniX CEO Ganzarski, postulating that air cargo aircraft serve as "the perfect canary" for 100-mile range trips. In the long-term, the air cargo industry has much to gain. In fact, the *Boeing Air Cargo Forecast, 2018-2037* cites high and volatile fuel costs as one of the only challenges limiting industry growth, second only to trade tensions.

> *Air shippers may be the first to witness the financial gains associated with electric aircraft, especially those operators transporting parcels along short- and mid-range routes.*

Over the next 20 years, the report projects that world air cargo traffic will double, expanding from 256 billion revenue tonne-kilometers (RTKs) in 2017 to 584 billion RTKs in 2037 (see **Figure 5.8**). Should the cost of fuel not only drop but also remain stable, the financial impacts to this industry could be staggering—revenues already reached $100 billion in 2018. It is important to note that large aircraft such as the 747 and 777 freighters will be responsible for much of this growth. Because electrification of this type of aircraft is not anticipated until 2035 and beyond, the most substantial financial gains will be realized in the long-term.

Figure 5.7. Boeing World Air Cargo Forecast, 2007 - 2037

Sources: IHS Markit, IATA, ICAO, Boeing

Many major players in air cargo have already recognized the future market potential of electric aircraft. Washington-based Amazon.com, which accounts for nearly half of the U.S.'s $450 billion e-commerce industry (2017),[19] has made major investments in both air cargo and electric aircraft. Driven by demand for the Amazon Prime one-day delivery service, the company's dedicated air cargo fleet is on-track to reach 70 aircraft by 2021.[20] With a pledge to be carbon neutral by 2040 to help meet the goals of the Paris Climate Accord 10 years early, the electrification of these transport-class aircraft could be the next evolution of Amazon's investment in this emerging technology. The company announced Shipment Zero in February 2019, which includes the goal of 50 percent net zero carbon shipments by 2030, and the company already placed an order of 100,000 electric delivery vans from Rivian as part of this initiative.[21] Additionally, the company announced plans to begin package deliveries by UAV in select U.S. cities by late 2010;[22] however, the service is yet to materialize at the time of this writing in July 2020.

Amazon Air over Seattle. *Source: GE*

Electric aircraft will no doubt change the financial outlook of all aspects of air travel, but not all players will realize benefits equally or within the same timeframe. Because the technology will be best suited to short- and mid-range flights, regional carriers; air taxi/commuter operators; and

[19] *Boeing Air Cargo Forecast, 2018-2037*
[20] https://www.fool.com/investing/2019/06/18/amazon-air-adds-15-more-leased-cargo-planes.aspx
[21] https://www.supplychaindive.com/news/amazon-electric-vans-sustainability-carbon-net-zero/563378/
[22] https//www.komando.com/happening-now/571255/look-up-in-the-sky-its-my-package-amazon-to-start-drone-delivery-within-months

other GA users such as recreational and business/corporate aviators, pilot trainers, and agricultural sprayers will be first to realize the financial benefits of electric aircraft. Washington's Part 121 and Part 135 operators will likely closely watch the outcomes of Harbour Air's transition to electric seaplanes to assess the feasibility of their own fleet conversation. Operators like Kenmore Air and San Juan Airlines, which only fly short distances within the region using GA aircraft, may be ideal candidates for electrification.

> *Because the technology will be best suited to short- and mid-range flights, regional carriers; air taxi/commuter operators; and other GA users such as recreational and business/corporate aviators, pilot trainers, and agricultural sprayers will be first to realize the financial benefits of electric aircraft.*

Key Challenge: Impact to Traditional Airport and WSDOT Revenue Structures

Yet while small, regional carriers, their passengers, and many GA users will likely be the first to benefit from electric aircraft, the GA and non-Primary commercial service airports that support these operations may face a critical challenge. ***Airports may see fuel sales fall or even disappear entirely as aircraft become electrified. The sale of AvGas (100LL) and Jet A is a primary revenue-generating activity at many airports, and these facilities rely on fuel sales revenue for operating expenses, capital expenditures, or both.***[23]

With electrification, increased electricity sales would primarily benefit utility companies with little to no revenue being passed to the airport. While Washington cities are authorized to impose a tax of up to six percent without voter approval on electric utilities, these funds are typically used for general fund purposes.[24] Similar to electric car charging stations, airports can consider charging aircraft operators a fee for using their infrastructure based on the time it takes to charge or as a standard, per-use fee. In most cases, charging station operators are not allowed to charge per kWh, as only electric utilities are permitted to do so. However, such laws are changing around the country and ***airports should carefully evaluate the available options in terms of who is responsible for the cost of electricity used by aircraft owners and operators.*** It is important to note that utilities are highly regulated at state and federal levels.[25] Any such move would have to carefully assess all pertinent regulations to identify potential legal implications.

[23] Scheduled commercial service operators are exempt from paying aircraft fuel tax (RCW 82.42.030). Thus, lost tax revenue would only result from aircraft operating from charter/on-demand service as well as GA activities.
[24] http://mrsc.org/Home/Explore-Topics/Finance/Revenues/Utility-Tax.aspx
[25] The Federal Energy Regulatory Commission (FERC) is responsible for wholesales sale and transmission of electricity in interstate commerce, while state public utility commissions generally have jurisdiction over local distribution, retail sales of electricity, and other intrastate activities. In Washington, the Washington Utilities and Transportation Commission regulates investor-owned utilities such as Puget Sound Energy, Avista Utilities, and Pacificorp, while publicly-owned utilities such as Seattle City Light, Tacoma Power, and Snohomish Public Utility District are self-regulated. Source:

Decreases in fuel sales could be detrimental not only to individual airports but could also impact WSDOT Aviation's ability to invest into airports via the Washington Airport Aid Grant Program. WSDOT Aviation receives a portion of its funding from aircraft fuel excise tax (currently set at $0.11 per gallon of gas sold) (Revised Code of Washington [RCW] 82.42.020). In fiscal year 2018, the Washington Department of Revenue reported that the state collected $2.81 million in aircraft fuel excise taxes, which is transmitted from the state treasury to the Aeronautics account (RCW 82.42.090). Aviation fuel taxes as well as aircraft excise taxes and registration fees are used to support the Washington Airport Aid Grant Program.[26] On average, this program annually invests between $1.2 and $1.4 million into the state's aviation system. According to the 2015 *Airport Investment Study*, the state and its airports already experience a severe funding deficiency—with an average annual need of more than $12.0 million every year through 2034.[27] Even a small decrease in revenue into the Aeronautics fund would further widen the funding gap to continue to maintain and improve the airport system as currently experienced by WSDOT Aviation and Washington's public-use airports.

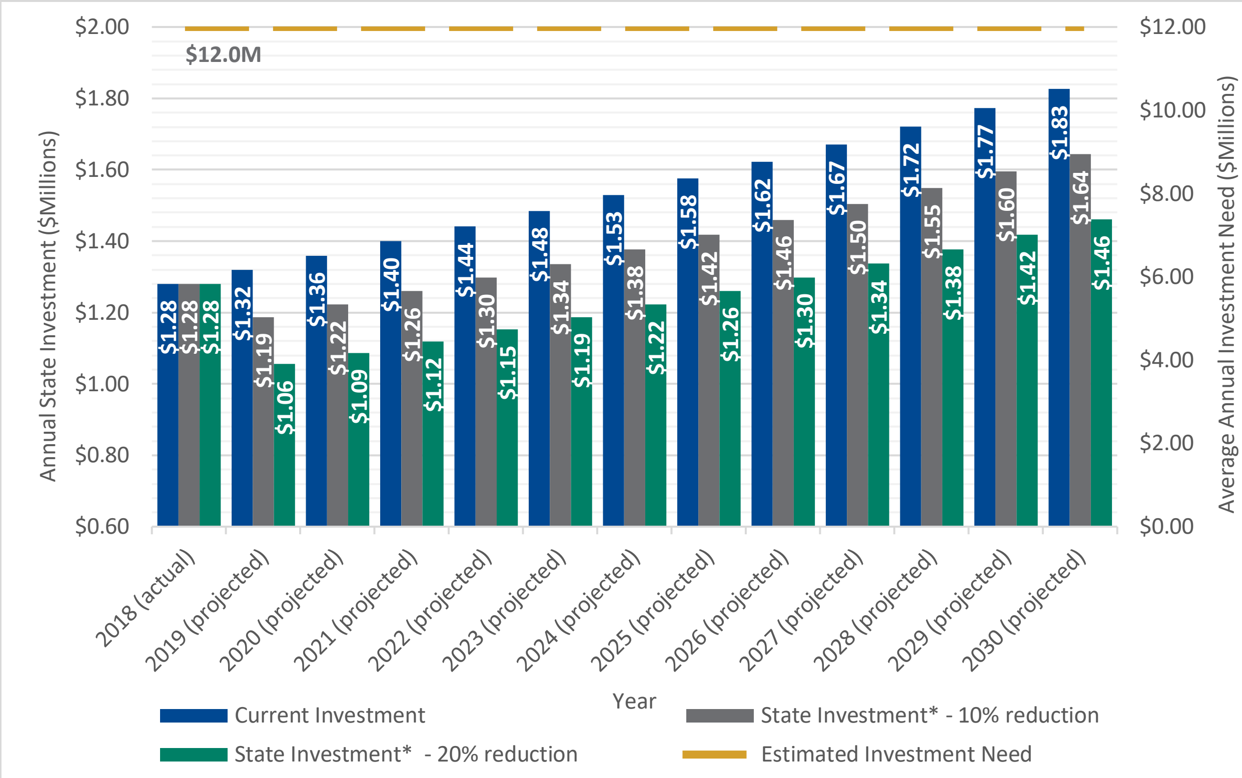
Figure 5.7 shows the current state investment into airports through the Washington Airport Aid Grant Program as well as potential revenue decreases of 10 and 20 percent; a three percent annual increase has been applied for inflation. The projected annual funding need of $12.0 million is also depicted. This graph illustrates the ever-widening gap between need and available investment and emphasizes the funding challenges the state could face should revenues fall over time. This funding deficiency would likely result in material effects on airports' abilities to complete ongoing maintenance and capital improvement projects unless an alternative revenue generation strategy is implemented.

https://www.atg.wa.gov/utilities-regulated. https://content.next.westlaw.com/Document/Ieb49d7b91cb511e38578f7ccc38dcbee/View/FullText.html?contextData=(sc.Default)&transitionType=Default&firstPage=true&bhcp=1

[26] WSDOT Aviation collects revenue via aircraft excise taxes and registration fees in accordance with RCW 82.48.80. In FY 2018, the Washington Department of Revenue reported that $367,000 in aircraft excise taxes and registration fees were collected in Washington. Dealer license and certification fees are also deposited into the Aeronautics account per RCW 14.20.050. These fees are set at $75 for the first dealer certificate and $10 for additional certificates requested from the state.

[27] CH2M. (June 2015). *Airport Investment Study*. Prepared for the WSDOT Aviation Division. Executive summary available online at www.wsdot.wa.gov/aviation/AirportInvestmentStudy.htm (accessed July 2019).

Figure 5.7. State Investment Need versus Funding Availability with Projected Revenue Decreases, 2018 (Actual) - 2030 (Projected)



**Note: Projected state investments include a 3 percent annual increase to account for inflation. Sources: Kimley-Horn 2020, CH2M 2015, WSDOT 2019*

This issue for airports and WSDOT Aviation may be compounded should demand for regional air transport and GA increase as the primary operating expense associated with flying (i.e., fuel) falls. If electrification does result in a significant decrease in state aviation tax revenues as demand increases, fewer resources would be available to help airports keep pace with new and growing aviation infrastructure needs (primarily airfield maintenance and expansion) bolstered by the lower cost of flying. Airports, WSDOT Aviation, state and local policymakers, airlines, and other industry players will need to work together to rebalance the revenue/demand structure as the entire industry shifts.

As one potential strategy to address this potentially serious concern, WSDOT Aviation and state policymakers may want to look to the state's roadway network and the adaptation being considered, as aircraft are not the only mode of transportation being electrified. Electric vehicles are becoming increasingly popular due to many of the same advantages offered by electric aircraft including lower operating and maintenance costs and fewer GhG emissions. States, however, are already feeling the impact of lower gasoline tax revenues. These revenues are generally used to fund highway and bridge improvements. While electric vehicles cause the same amount of wear and tear on infrastructure, drivers do not contribute to their upkeep through the gasoline tax.[28]

[28] https://www.ncsl.org/research/energy/new-fees-on-hybrid-and-electric-vehicles.aspx

To address this disparity, 21 states have enacted legislation requiring a special registration fee for some hybrid and plug-in electric vehicles. These fees range from approximately $50 to $200, with four states' fees structured to grow over time.[29] Washington enacted such a law on March 23, 2012 (Engrossed House Bill 2660 – Transportation Revenue) recognizing that,

> *The fee under this section is imposed to provide funds to mitigate the impact of vehicles on state roads and highways and for the purpose of evaluating the feasibility of transitioning from a revenue collection system based on fuel taxes to a road user assessment system, and is separate and distinct from other vehicle license fees. Proceeds from the fee must be used for highway purposes and must be deposited in the motor vehicle fund created in RCW 46.68.070. (p. 19)*

The fee was first set at $100 and was increased to $150 in 2015 (Senate Bill 5987 – Transportation Revenue, enacted July 16, 2015). As electric aircraft begin to comprise a larger percent of the state's total fleet, implementing an additional fee for electric aircraft registration may be a feasible and prudent path forward. Other states have considered implementing vehicle miles traveled (VMT) fees to make-up for lost gasoline revenues as vehicles have become more fuel efficient and alternative fuel options are introduced and gain market share.[30] As an aviation counterpart, new fees could be introduced based on aerial miles traveled. Perhaps more appropriately, airport-specific operations could be tracked, with pilots being charged a fee for take-offs and landings conducted. These latter solutions may be increasingly feasible with the deployment of NextGen technologies across the U.S.

What if electric aircraft affect airports' key revenue-producing activity?

Could we assist airports diversify revenue streams and decrease expenses through state guidance and programs?

Like some airports and state agencies, air carriers that primarily operate large jet aircraft carrying over 150 passengers will also struggle to realize the financial benefits of electric aircraft until the technology significantly improves in the long-term. In general, short- and mid-range flights cannot replace the need for long-haul service. However, if regional travel proliferates with electric aircraft, smaller carriers may have new opportunities to gain market share in an industry historically dominated by just a few key players (namely, American, Delta, Southwest, and United).[31] Additionally, leisure travelers—who are generally willing to spend additional time traveling to save money—could choose to take a series of short- and mid-range flights to reach their final destinations should the total ticket cost become lower than non-stop service on a long-haul carrier.

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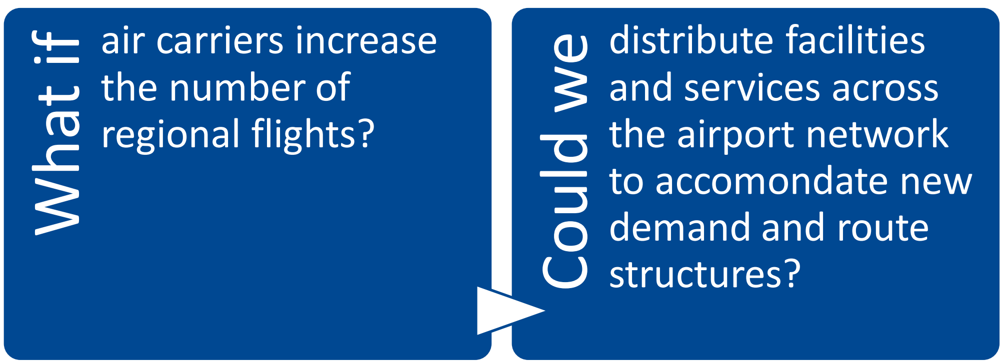
[29] Ibid.
[30] https://www.rand.org/pubs/research_briefs/RB9576.html
[31] Bureau of Transportation Statistics, Domestic Airline Market Share, June 2018 to May 2019.

These changes would additionally affect the existing airport network in which few Primary commercial service airports support the majority commercial service operations and enplanements. With a higher number of short- and mid-range flights, operations could be pushed to non-Primary commercial service and larger GA airports. In Washington, this may include airports in the Major, Regional, and Community classifications. These airports may then need to evaluate the adequacy of the facilities and services required by passengers and a higher number of operations, including parking, security, concessionaires, and other terminal facilities, as well as hangar storage facilities and apron space. Air traffic may also become an issue if routes and frequencies are modified in response to new demand structures precipitated by electric aircraft. Additional information about the potential infrastructure impacts of electric aircraft is provided in **Section 5.1.2.3** below.

With a higher number of short- and mid-range flights, operations could be pushed to non-Primary commercial service and larger GA airports.



Beyond air travel, the electrification of aircraft carrying cargo or passengers would also likely impact existing logistics chains: namely, one in which first- and last-mile operations are conducted by truck. The *Boeing Industry Outlook* notes that ground transportation is still far less expensive than air transport and remains the industry's biggest competitor. Electric aircraft including UAV delivery services could shift that dynamic to entirely uproot the supply chain. As the cost of air cargo decreases as a result of electric aircraft, the value of goods transported by air would concurrently fall. Lower-value and non-time-sensitive goods traditionally shipped via rail, ship, or truck may be moved by air transport, especially in the far-term as long-haul aircraft enter commercial use.

While there will certainly be winners and losers when such a revolutionary change hits the market, there is still one important fact that must be noted when projecting the future of electric aircraft: While the cost of electricity is a fraction of fossil fuels, electricity is not free, and costs could rise should demand burgeon with electrification. Along with aircraft, other modes of transport such as cars, trucks, light and commuter railways, and ships are likewise becoming electrified. Most of the electricity in the U.S. is generated by coal and natural gas, as well as nuclear and renewable sources such as hydroelectric, solar photovoltaics, geothermal, and wind. Coal is a petroleum-based commodity like oil, and none of the other sources are inexpensive considering large capital investments and ongoing maintenance and transmission requirements. It is insufficient to simply look at historic pricing trends when evaluating future costs as demand increases—the market may very well adjust upwards. According to Eviation CEO Bar-Yohay, "It's basically turning on a Costco" just to charge a 500-kilowatt battery. [32]

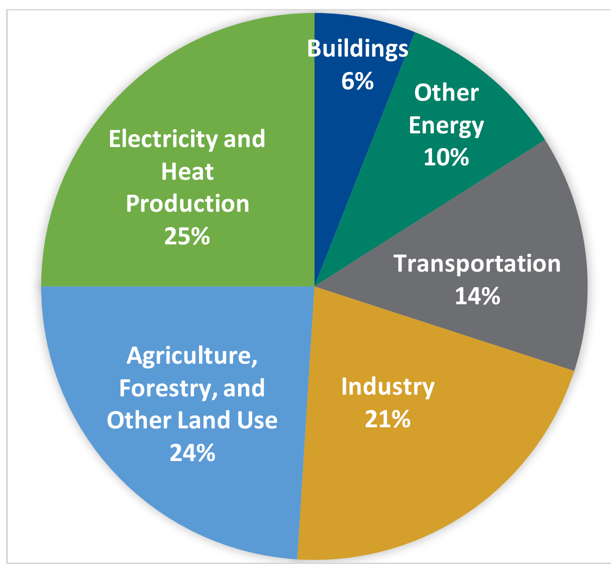
Before full-scale electrification, hybrid-electric vehicles may offer a viable and more technically feasible near-term solution. These vehicles combine a conventional combustion engine with an electric motor, which reduces fossil fuel consumption, noise, and associated emissions while overcoming many of the engineering challenges that currently limit aircraft electrification.[33] If hybrid-electric vehicles were combined with sustainable aviation jet fuel (SAF), the benefits would be even greater (see **Section 5.4** for additional details about alternative aviation fuels).

> *Hybrid-electric vehicles may offer a viable and more technically feasible near-term solution as full-scale electrification evolves. These vehicles reduce fossil fuel consumption, noise, and associated emissions while overcoming challenges that currently limit aircraft electrification.*

5.1.2.2 Environmental Considerations

Along with financial considerations, environmental concerns are the most important and widely cited advantage of electric aircraft. According to the latest report published by the International Panel on Climate Change (IPCC) (2018), global climate change is likely to reach 1.5 degrees Celsius above pre-industrial activities between 2030 and 2052 if GhG emissions continue at their current rates. The transportation sector is responsible for 14 percent of the world's GhG emissions (see **Figure 5.8**), with air transport specifically contributing two to three percent of global totals. As a result, aviation has been identified as one of the key targets to slow or cease the production of GhG emissions.

Figure 5.8. Global Greenhouse Emissions by Economic Sector



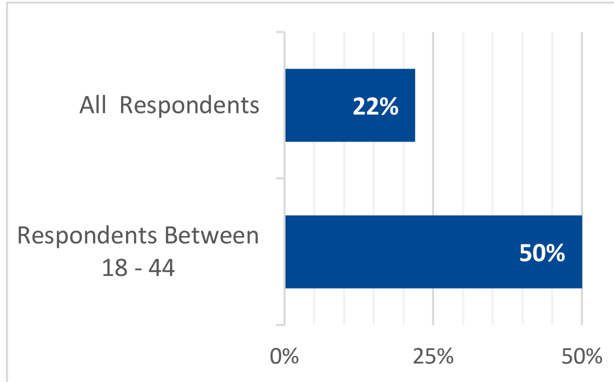
Sources: IPCC 2014, U.S. EPA 2019

> *The transportation sector is responsible for 14 percent of the world's GhG emissions, with air transport specifically contributing two to three percent of global totals.*

[32] https://mashable.com/feature/electric-airplanes-future-flight/
[33] https://www.forbes.com/sites/oliverwyman/2019/09/03/why-tomorrows-aircraft-will-be-hybrids/#d3aa715cc0fb

Driven by these statistics, Sweden and Norway have announced plans to make all short-range flights electric by 2040. Scotland, the Netherlands, California, and the United Kingdom have all begun to establish financial incentives to reduce aviation emissions. Further, investment bank UBS reports that 22 percent of all people surveyed in the U.S. and Germany report that they are cutting back on air travel for environmental reasons. Over 50 percent of respondents between the ages of 18 and 44 reported reducing air travel for this same reason (see **Figure 5.9**).[34,35] Electric aircraft are touted as a zero-emissions alternative to fossil fuels.

Figure 5.9. Percent of People (U.S. and Germany) Reducing Air Travel Due to Environmental Reasons

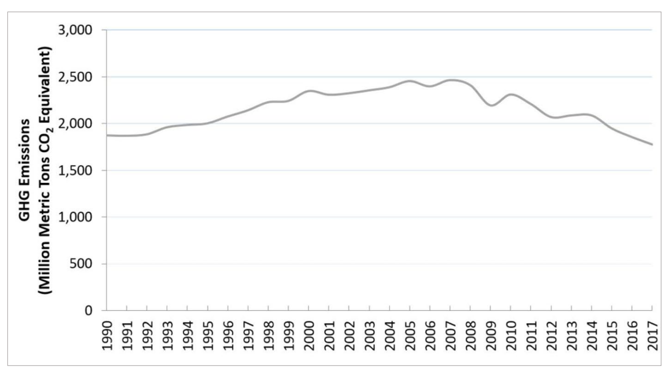


Source: UBS 2019

Yet while the total emissions produced by electric aircraft are less than their fossil fuel-powered counterparts, it is important to consider that most electricity production globally is not carbon neutral. As shown in the figure above, electricity and heat production are responsible for 25 percent of global GhG emissions—over 10 percent more than the transportation sector. In the U.S., that figure is even higher, at 27.5 percent of the domestic total.[36] Although coal supplies 31.2 percent of electricity in the U.S., it contributes 67.9 percent of domestic CO_2 emissions in the energy production sector. Other sources of domestic electric generation include natural gas (31.2 percent), fuel oil (>1.0 percent), nuclear (21.0 percent), and renewable sources (16.2 percent).

As shown in **Figure 5.10**, GhG emissions from electricity decreased by 5.2 percent between 1990 and 2017 due to lower- and non-emitting sources of electricity generation and an increase in end-use energy efficiency (e.g., switching to a lower-energy appliance in one's home).[37] With the electrification of aircraft—as well as many other modes of travel—the U.S. energy grid may be challenged to keep pace with new demands. The downward energy trend may be short-lived if thousands of electric aircraft enter U.S. airspace as hundreds of thousands of electric automobiles

Figure 5.10. U.S. GhG Emissions from Electricity, 1997-2000



Sources: U.S. EPA, U.S. Inventory of GhG Emissions and Sinks, 1990-2017

[34] https://www.ubs.com/global/en/investment-bank/in-focus/2019/electric-planes.html
[35] https://qz.com/1650449/electric-airplanes-take-flight-at-the-paris-air-show/
[36] https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#electricity
[37] Ibid.

With the electrification of aircraft—as well as many other modes of travel—the U.S. energy grid may be challenged to keep pace with new demands.

enter the roadways. Sales of electric cars increased 81 percent between 2017 and 2018 to reach approximately 381,000 and car manufacturers including Tesla, Toyota, and others are continuing to heavily invest in the field.[38] Climate watchers are already warning of impacts to the grid precipitated by rising temperatures; a widespread increase in demand driven by the electric vehicle revolution could exacerbate the issue. With the U.S. government Executive Branch plans to bolster the coal industry already underway, "clean" electric aircraft may not be as clear-cut as some industry advocates argue.

The institutions are in-place to minimize the environmental concerns associated with vehicle electrification. Natural gas is far more clean-burning than coal, and nuclear and renewable power are virtually emissions-free. With nearly 70 percent of the grid already powered by low- and zero-emitting sources, it is important to remember that the promise of zero-emissions aircraft is only possible with an underlying commitment to clean energy production.

In addition to environmental concerns regarding electric generation, the lithium-ion batteries that are at the core of this emerging technology may too pose environmental risks. In general, batteries require replacement after 1,500 charge cycles, and today's electric aircraft can generally operate for about one hour before needing to be charged. Even at just two, two-hour flights per day, an aircraft's battery would need to be replaced at least every two years. Not only are batteries expensive, but the extraction of lithium, nickel, and cobalt at their cores all come with a host of potential environmental concerns. Mineral prices have also increased dramatically over the past several years with the uptick in demand to support an increased number of lithium-ion batteries.

Researchers are currently working on ways to replace the minerals in batteries with more common, less toxic minerals. Additionally, minerals in spent batteries can be recycled with the proper facilities. Some aircraft manufacturers are instituting recycling programs for their specific products so toxic minerals do not end up in landfills and these valuable non-renewable resources are reused. Alternatively, Cape Air is considering ways to use its batteries on the ground after their two-year in the air lifespan instead of recycling its used batteries.[39] They are also pursuing a plan to purchase energy from Vineyard Wind, the nation's first utility-scale off-shore wind energy project proposed off the coast of Massachusetts. If that plan falls through, Cape Air will look to expand its existing solar array to power its aircraft.

[38] https://www.greentechmedia.com/articles/read/us-electric-vehicle-sales-increase-by-81-in-2018
[39] https://www.wbur.org/earthwhile/2019/08/08/cape-air-eviation-alice-electric-plane

Thus, while the environmental impacts of electric aircraft may be complex, early adopters and researchers are already developing strategies to minimize and mitigate potential concerns. Electric aircraft must also be evaluated from a lifecycle perspective compared to their fossil fuel-powered counterparts. As the technology becomes more prevalent, it will be critical for the public and private sectors to continue to work together to identify and implement environmental best practices so the benefits of electric aircraft are most fully realized.

What if electric aircraft increase demands on Washington's grid?

Could we incentivize renewable energy generation at airports through state funding and regulatory assistance?

5.1.2.3 Infrastructure Needs

Electric aircraft may entirely reshape the ways that people and goods move into, out of, and within Washington. The following section addresses the major infrastructure elements that may be needed to support these changes.

Primarily restricted by today's battery technology, small, fixed-wing aircraft with limited passenger capacity and ranges and UAVs will likely be the first electric aircraft to enter the market. As discussed in **Section 5.1.2.1**, this will create new market opportunities for non-Primary commercial service and GA facilities that have historically experienced just a fraction of overall operations in Washington. In addition to the facilities required to support higher numbers of passengers and pilots (either the introduction of new service requiring passenger terminals or expansion of the terminals and associated passenger facilities), airports may need to expand aircraft aprons and add hangar storage capacity. Planning for additional ramp space may be particularly important, as this space may need to be devoted to aircraft charging stations as demand warrants.

> *Small, fixed-wing aircraft and UAVs will likely be the first electric aircraft to enter the market, creating new market opportunities for non-Primary commercial service and GA facilities that have historically experienced a fraction of overall operations in Washington.*

Electric aircraft manufacturers also cite the need for smaller runways as a major advantage to electric aircraft.[40] Lithium-ion batteries provide near-instant power, so take-off speeds can be reached more quickly.[41] Unlike

[40] http://www.bbc.com/future/story/20180814-norways-plan-for-a-fleet-of-electric-planes
[41] Note that required take-off distances are generally longer than stop distances. However, this is a function of engine versus brake power as well as elevation, temperature, and wind conditions. If engine power increases, then required landing distances

combustion engines, electric motors are also able to maintain performance at higher altitudes where air resistance is less, so aircraft are anticipated to fly faster or require less power to generate equivalent airspeeds. It is important to note that runway length is a function of the demands of the specific aircraft using it (i.e., the Airport Approach Category [AAC] and Aircraft Design Group [ADG]), as well as the airport's elevation and average temperature during the hottest month of the year. Airports will still need to undergo detailed runway length analyses during planning studies to ensure each airport's Airport Reference Code (ARC) (or the Runway Design Code (RDC) specific to the runway the electric aircraft will utilize) corresponds with its specific critical design aircraft. The FAA may need to assess current runway design criteria to ensure existing regulations are appropriate for electric aircraft.

In additional to scheduled commercial service and GA operations, airports across the network will likely witness an uptick in air cargo activities. This change may drive the need for additional air cargo handling facilities, as well as improved roadway networks in the vicinity of the airport to minimize traffic bottlenecks as trucks travel to and from the airport, assuming trucks are used for the first and last mile. In the long-term, that need may diminish as packages are transported via UAV to their final destinations.

Potentially affecting infrastructure needs both on- and off-airport property, one of the most important considerations for airports and airport sponsors/owners; aircraft manufacturers, owners, and pilots; regulatory agencies; and others will be figuring out how to charge the new fleet of electric aircraft entering the skies. At least initially, aircraft will have to be charged after every flight. Aircraft could use charging stations powered by the grid or renewable energy sources located on- or off-airport property. WSDOT already manages the Electric Vehicle Infrastructure Partnership Program to deploy electric vehicle charging infrastructure along the state's highway corridors in accordance with RCW 47.04.350.[42] WSDOT Aviation could consider working with the state legislature to implement a similar grant program to help fund electric aircraft charging stations at airports.

Slovenia-based Pipistrel, an electric aircraft designer targeting the pilot training market, installed the world's first aircraft charging station in Europe on August 30, 2017.[43] The company installed its first charging station in the U.S. at Woodley/Compton Airport in Los Angeles County, and has since installed several more in southern California. While an important step in the evolution of electric aircraft, these stations are designed specifically for the company's own Alpha Electro pilot training aircraft. Charging stations should have the ability to charge more than one type of aircraft as more pilots adopt the technology and different aircraft are used throughout the system. Aircraft-specific stations would not only be impractical for airports in

Pipistrel electric aircraft charging station. *Source: SustainableSkies.org*

could exceed the aircraft's take-off distance. In general, it is important to consider both take-off and landing distances when conducting runway length analyses.

[42] https://www.wsdot.wa.gov/Funding/Partners/EVIB.htm

[43] http://sustainableskies.org/pipistrel-opens-worlds-first-true-airplane-charging-station/

terms of apron and/or hangar space but could also cause major operational delays if multiple aircraft of the same type need to be charged simultaneously. With most aircraft taking about an hour to fully charge, such bottlenecks would prove a major hindrance to commercial development for the air transport, GA, and air cargo sectors.

What if electric aircraft are limilited by the availability of charging stations?

Could we implement a competitive state grant program to help fund this critical infrastructure?

Alternatively, aircraft could be charged by renewable power via generating stations on or near airport property. Many airports own undeveloped land within their property boundaries, and renewable energy generation is generally considered an airport compatible land use. If renewable energy is used to charge aircraft batteries, airports would have to consider on-site storage capacity needs to ensure aircraft could charge when renewable sources were unavailable, such as at night or during inclement weather conditions for solar.

Electricity is not only a matter of generating power but also transporting that power to where it is needed. If aircraft charging stations are grid-connected, increased electricity demands may drive the need for new transmission lines, transformer stations, or both, especially in rural areas without sufficient existing infrastructure. Opponents to overhead powerlines cite serious concerns related to human health, property values, and bird strikes. Powerlines can also be buried; however, costs can be prohibitive and such a major infrastructure project can bring its own environmental and social justice concerns, as well as concerns specific to their location in relation to airports. Rural airports will generally have the least access to grid-connected power, raising concerns about which communities will have access to the benefits of electric aircraft and when.

What if the demand for electricity exceed supplies currently available at Washington's airports?

Could we develop partnerhips with private industry to increase renewable energy generation in rural areas?

Instead of aircraft charging stations, some industry stakeholders advocate battery-swapping to maximize aircraft utilization rates (e.g., replacing an aircraft spent battery with a battery that has been charged off-site). At least one manufacturer has considered plans to operate a fleet of trucks ferrying these pre-charged batteries to airports.

As an additional issue for consideration, airports will also need to evaluate airspace control if fixed-wing, rotorcraft, and UAS operations increase. Currently, recreational and commercial UAV operators with vehicles less than 55 pounds must obtain preauthorization before flying in controlled airspace near airports.[44] Despite existing regulations, the potential for mid-air incursion between vehicle types may increase as more aircraft take to the NAS. Some aviation stakeholders have expressed concern that current rules insufficiently mitigate shared airspace concerns, particularly because some UAV operators are either unaware of or noncompliant with them. Such risks may be particularly acute for low-flying aircraft such as agricultural sprayers and emergency service providers.

5.1.2.4 Staff and Workforce

As the demand for air travel increases—as it most certainly will with the coming of electric aircraft—so too does the need for qualified aviation professionals including pilots, mechanics, air traffic controllers, and others. Over the past 60 years, the overall U.S. labor pool has been on the decline, and fewer former military personnel are available for transition from military to civilian employment to fill positions in the aviation industry. Additionally, the traditionally high costs of specialized training and licensure can deter or prevent a potential student or professional from pursuing a career in aviation. This section addresses electric aircraft's potential impacts on the aviation workforce.

5.1.2.4.1 Pilots

To consider the potential impacts of electric aircraft on pilots, it is important to first review the current state of the industry. Industry analysts have long warned of an impending pilot shortage that will cause ripple effects through the entire global economy. By 2022, nearly 20,000 U.S. airline pilots will reach the FAA's mandatory retirement age of 65. New FAA training regulations have increased flight time requirements for commercial pilots and fewer military-trained pilots are entering a civilian aviation career. In 2013, the FAA implemented a rule that all first officers of commercial airline flights hold an Air Transport Pilot (ATP) license requiring a minimum of 1,500 flight hours. Prior to the 2013 rule, entry-level first officers could be employed with a commercial pilot license requiring 250 hours. Prospective pilots also face high educational costs, extensive and lengthy educational and licensing requirements, and relatively low entry-level salaries.

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[44] FAA regulations mandate that recreational UAV operators obtain preauthorization before flying in controlled airspace near airports, and aircraft must fly at or below 400 feet when in uncontrolled (i.e., Class G) airspace. Preauthorization is available through the Low Altitude Authorization and Notification Capability (LAANC) system. Small UAVs less than 55 pounds operating for commercial purposes are subject to Part 107 rules. Among other provisions, Part 107 rules establish that unmanned aircraft operations must remain within visual line of sight of the operator or an observer, not be conducted over people, and occur during or within 30 minutes of daylight hours. Additionally, operations in controlled (i.e., Class B, C, D, and E) airspace must obtain air traffic control permission. Federal, state, and Tribal government, law enforcement, and public safety entities can fly UAVs less than 55 pounds under Part 107 rules or under the statutory requirements for public aircraft (49 United States Code §40102[a] and §40125). Additional information and the latest UAS regulations are at https://www.faa.gov/uas/.

As a result of these and other issues, student pilots are not matriculating quickly enough to fill commercial pilot positions. The shortages are particularly acute for regional carriers, as pilots often transition to larger, long-haul carriers offering higher wages and better benefits as they obtain more flight hours. **Table 5.1** shows the number of active pilots by type of certificate between 2010 and 2018. The total number of pilots has decreased by 1.1 percent, with declines experienced specifically in the recreational, private, and commercial categories. The sport pilot and ATP categories did show 6.8 and 1.7 percent growths, respectively.

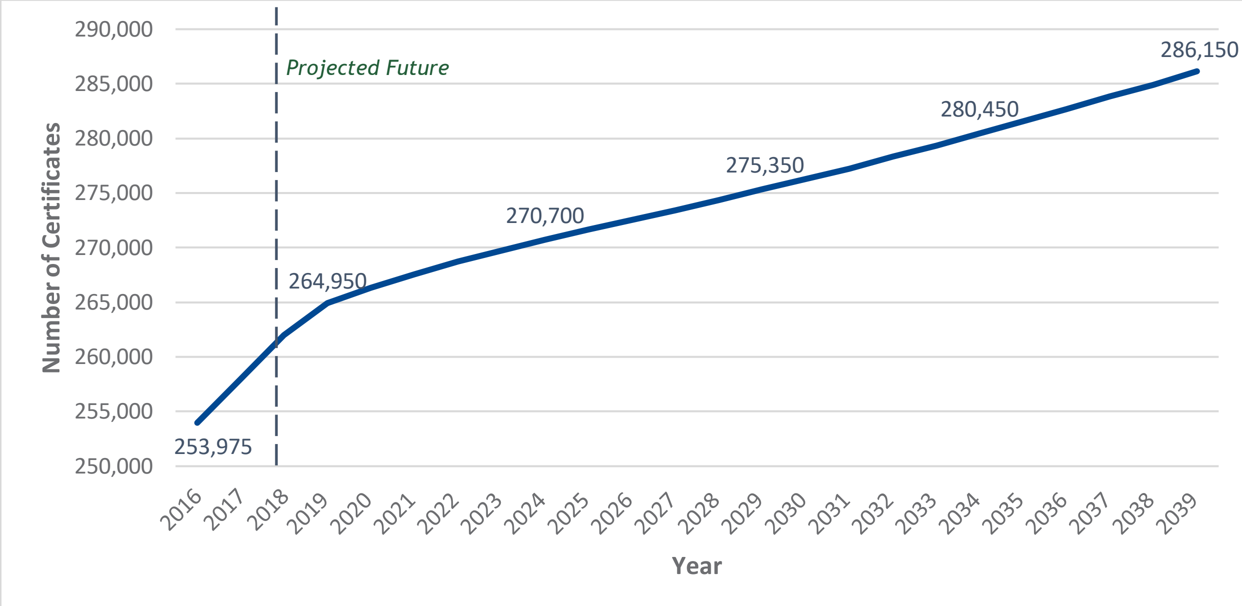
Table 5.1. Active Pilots by Type of Certificate, Excluding Student Pilots, 2010 - 2018*

Year	Recreational	Sport Pilot	Private	Commercial	ATP	Rotorcraft Only	Glider Only	Total Less Students	Instrument Rated
2010	212	3,682	202,020	123,705	142,198	15,377	21,27	508,469	318,001
2011	227	4,066	194,441	120,865	142,511	15,220	21,14	498,471	314,122
2012	218	4,493	188,001	116,400	145,590	15,126	20,80	490,630	311,952
2013	238	4,824	180,214	108,206	149,824	15,114	20,38	478,801	307,120
2014	220	5,157	174,883	104,322	152,933	15,511	19,92	472,953	306,066
2015	190	5,482	170,718	101,164	154,730	15,566	19,46	467,310	304,329
2016	175	5,889	162,313	96,081	157,894	15,518	17,99	455,861	302,572
2017	153	6,097	162,455	98,161	159,825	15,355	18,13	460,185	306,652
2018	144	6,246	163,695	99,880	162,145	15,033	18,37	465,513	311,017
Average Annual Growth (Percent)									
	-4.7%	6.8%	-2.6%	-2.6%	1.7%	-0.3%	-1.8%	-1.1%	-0.3%

**Note: Starting with April 2016, there is no expiration date on the new student pilot certificates. This generates a cumulative increase in the student pilot numbers and breaks the link between student pilot and private pilot or higher-level certificates. As the implementation is very new and there is not sufficient data to forecast the student certificates under the new rule, student pilot forecast is suspended and excluded from this table. Source: FAA Aerospace Forecasts 2019-2039*

This latter point may be most relevant in regard to the impending pilot shortage. The ATP growth witnessed since 2010 is anticipated to continue through the FAA's 2039 forecast horizon. **Figure 5.11** depicts the FAA's projected growth in U.S. commercial and ATP licenses over the next two decades.

Figure 5.11. Historical and Projected Future U.S. Commercial and ATPs, 2016 – 2039



Source: FAA Aerospace Forecast 2019-2039

Indications likewise suggest that the number of student pilot certificates are growing, although the FAA's student pilot forecast is currently suspended. The number of student pilots has been affected by two recent regulatory changes (in 2010 and 2016), which have cumulatively resulted in significant growth in the number of student pilots from 119,119 in 2010 to 167,804 in 2018. It is important to note that the 2016 change removed the expiration date on new student pilot certificates and effectively broke the link between students and advanced certificate levels of private pilot or higher. The FAA reports that the 2016 change is too new to perform a reliable forecast for student pilots.

Considering this broader context, electric aircraft will likely offer both opportunities and challenges for the pilot workforce. Like many of the issues associated with electric aircraft, this issue will shift over time as the type and number of electric aircraft enter recreational/personal and commercial markets. As noted, regional carriers are anticipated to take the brunt of the pilot shortage because pilots tend to transition to larger carriers as they gain more experience. These same carriers are likely best positioned to first leverage the benefits of electric aircraft due to the type of aircraft utilized and more limited geographic ranges and durations. Some types of GA activities such as medical flights and short-range corporate/business aviation are similarly positioned. If electric aircraft lead to greater demands for air transport, the impending pilot shortage could worsen.

> *Electric aircraft will likely offer both opportunities and challenges for the pilot workforce, shifting over time as the type and number of electric aircraft enter recreational/ personal and commercial markets.*

This trend, however, is likely to be short-lived. While GA and commercial service operators will need ample ramp-up time to ensure an adequate pipeline of students is available to meet future demand, the lower cost of flying will translate to pilot training. With short-duration flights and limited payload requirements (i.e., student pilot and instructor), flight training is especially well suited for electric aircraft. In fact, some manufacturers are targeting this industry specifically. Pipistrel's two-seat Alpha Electro is tailored to the needs of flight schools with a lightweight composite body, 20 kWh battery packs, and a max payload of 200 kilograms. [45] The aircraft was the first all-electric plane to receive its FAA Part 23 airworthiness certificate from the FAA in spring 2018. Four Pipistrel Alpha Electros are now based at the Fresno Chandler Executive Airport as part of the Sustainable Aviation Project of CALSTART, a nonprofit clean transportation advocacy group. The group submitted a petition to the FAA in September 2019 to recertify the aircraft to Special Category Light Sport Aircraft (SLSA) so they can be used for normal flight training operations.[46] The public comment period closed on December 30, 2019 and review is still underway as of July 2020.[47]

Sun Flyer 2 prototype at the Centennial Airport, CO. *Source: wikipendia.org*

Colorado-based Bye Aerospace is similarly developing the two-seater Bye Aerospace eFlyer 2 for the pilot training market. The eFlyer 2 aircraft is intended to receive its Part 23 certification in 2020. With an anticipated 3.5-hour flight duration, Bye Aerospace reports that the aircraft will cost about $5 an hour to operate and sell for $180,000 to $200,000. A Cessna 172, a four-seater aircraft frequently used for training today, costs approximately $73 an hour to operate and sells for $370,000 new.[48] However, it is important to note that many flight schools use older aircraft that sell for between $50,000 to $100,000 and operate with very thin margins. Flight schools with newer aircraft generally have much higher rental rates for students. Taken together, the business case for electric aircraft in the pilot training market may not be as clear-cut as some analysts and manufacturers have projected. Manufacturers will need to address these key challenges should electric aircraft be to adopted by this potential market.

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[45] https://electrek.co/2018/04/27/all-electric-trainer-plane-airworthiness-certification-faa-us/
[46] https://sustainableaviationproject.com/blog/
[47] https://www.regulations.gov/document?D=FAA-2019-0691-0004
[48] https://www.wired.com/2015/01/electric-airplanes-future-pilot-training/

5.1.2.4.2 Other Aviation Professionals

In addition to pilots, the aviation workforce comprises maintenance technicians, air traffic controllers, airport operators, air cargo handlers, flight attendants, and others who keep aircraft safely and efficiently flying. **Table 5.2** reports the FAA's non-pilot aviation certificates by category between 2007 and 2016 (latest data available). As shown, the aviation workforce is declining in nearly all categories. There was a significant increase in the number of flight attendants, presumably due to domestic and global increases in commercial air travel.

Table 5.2. FAA Non-Pilot Certificates Issued by Category

Year	Mechanic	Repairman	Parachute Rigger	Ground Instructor	Dispatcher	Flight Navigator	Flight Engineer	Flight Attendant
2007	322,852	40,277	8,186	74,544	19,043	250	54,394	147,013
2008	326,276	41,056	8,248	74,983	19,590	222	53,135	154,671
2009	329,027	41,389	8,362	75,461	20,132	181	51,022	156,741
2010	308,367	41,196	8,009	70,560	16,576	171	48,569	156,368
2011	335,431	40,802	8,491	74,586	21,363	146	47,659	167,037
2012	337,775	40,444	8,474	73,599	21,862	141	46,639	172,357
2013	338,844	39,952	8,491	72,493	22,401	126	45,319	179,531
2014	341,409	39,566	8,702	71,755	23,113	115	43,803	188,936
2015	342,528	39,363	8,846	70,957	23,754	102	42,460	200,319
2016	279,435	34,411	5,851	65,053	19,758	67	35,761	212,607
Delta, 2007-2016	**-40,858**	**-5,619**	**-2,299**	**-9,325**	**+1,679**	**-231**	**-21,995**	**+87,575**

Source: General Aviation Manufacturers Association (GAMA) 2016 General Aviation Statistical Databook & 2017 Industry Outlook

Table 5.3 summarizes the potential impacts of electric aircraft on each of these categories should industry analysts' projections about their future growth prove accurate. Because electric aircraft are anticipated to increase demand in all sectors of air transportation, including scheduled commercial service, GA, and air cargo, the need for aviation professionals will increase in nearly all categories. It is important to note that existing aircraft skillsets may not apply to electric aircraft, so professionals currently in the industry should carefully consider their specific roles to stay up-to-date with emerging technologies. WSDOT Aviation and other state agencies could consider developing workforce training programs to ensure the state's labor force continues to support this burgeoning industry. Such programs could be implemented in partnership with educational institutions and the many industry partners located in the state.

Table 5.3. Summary of Electric Aircraft's Potential Impacts on the Aviation Workforce

Type	Opportunities	Challenges
Mechanic	While ongoing maintenance needs may lessen, increased demand for air transport may result in an overall higher number of aircraft in operation. Mechanics with experience working with electric aircraft will be in high demand as a new workforce is trained. Avionic specialists may have increased work opportunities.	Because electric motors do not have gearboxes, electric aircraft are anticipated to have fewer maintenance needs than piston- or turbine-powered engines.[49] This would reduce the need for some aircraft mechanics, particularly those with specific training and expertise in aircraft powerplants.
Parachute rigger	Electric aircraft will likely increase demand for GA activities like parachuting and can fly at higher altitudes than traditional aircraft. Thus, demand for parachute riggers will increase.	None anticipated, although the most significant benefits will occur in the mid- and long-terms as larger GA aircraft transition to electric.
Ground instructor	Pilot training will become cheaper, increasing demand for ground instructors. Pilot training will be one of the first segments of aviation to benefit from electric aircraft.	None anticipated.
Dispatcher	As operational fleet mixes become more complicated and UAS enter the NAS, new roles for flight dispatchers will arise to ensure aircraft can safely and efficiently share airspace.	None anticipated.
Flight navigator	No change.	None anticipated. Although outside of electric aircraft, the demand for flight navigators will likely decrease with NextGen.
Flight engineer	No change.	The role of flight engineers has decreased over time, as the complex systems of modern aircraft are monitored and adjusted by computer. This trend is anticipated to continue with electric aircraft.
Flight attendant	The demand for flight attendants will increase with additional air travel. If operating costs decrease, then air carriers and corporate/business aviation providers may increase the level of passenger service available since more people will be willing pay for "amenity" services.	None anticipated. The greatest benefits will be experienced in the long-term with the electrification of long-haul flights on aircraft carrying over 150 passengers.

Source: Kimley-Horn 2019

[49] In one example, Ampaire reports its electric aircraft will have 50 percent less maintenance needs than traditional aircraft.

What if electric aircraft change the skillsets required by aviation professionals?

Could we proactively develop programs to ensure Washington's aviation workforce remains on the cutting edge?

5.1.2.5 Mobility and Access

The concepts of mobility and access are founded on the core belief that the benefits of air transportation should be available to all residents, visitors, and businesses within a state or region. Providing a network of airports that supports economic growth, safety, security, mobility, and other benefits is an important role for any department of transportation. Indeed, the Washington Aviation System Plan identifies *Modal Mobility, Capacity, and Accessibility* as one of its goals to ensure airports are easily accessible to the general public and provide the connectivity that facilitates the predictable movement of goods and people throughout the state.

With electric aircraft, the number of Washington residents and businesses with access to air transportation could and is likely to dramatically rise. Regional air carriers are anticipated to open new routes, and some electric aircraft may be able to operate safely on shorter runways—providing new opportunities for aviation activity levels at Washington's smallest airports. Additionally, airports will no longer be limited by the availability of aviation fuel—all facilities will be on a "level playing field" in terms of their abilities to leverage the benefits of electric aircraft for their communities. Communities may be less impacted by noise concerns and airports may receive fewer noise complaints from residents and visitors in their vicinities. Ampaire reports its aircraft will produce 60 percent quieter take-offs and landing compared to their fossil fuel-powered counterparts.[50] Additional information about the role of electric aircraft in mobility and access is presented in the UAM section of the Washington AEIS (see **Section 5.3**).

5.1.2.6 Safety

Before electric aircraft can be considered ready for widespread deployment each aircraft must meet safety and design requirements associated with FAA Airworthiness Certifications. The first electric aircraft to receive FAA airworthiness certification was the Pipistrel Alpha Electro, which received certification in April of 2018.[51] This development is a good indication that electric aircraft technology and design has the ability to achieve strict safety requirements. In order for an aircraft to receive airworthiness certification, it must pass the certification process which includes ground and flight tests,

[50] https://www.ampaire.com/
[51] https://electrek.co/2018/04/27/all-electric-trainer-plane-airworthiness-certification-faa-us/

an evaluation of the aircraft's required maintenance and operational suitability for service needs, a review of the aircraft design, and collaboration with other civil aviation authorities on their approval of the aircraft for use in their jurisdiction.[52]

By all measures, if an aircraft meets FAA airworthiness certifications, then passengers and pilots should have the same confidence in an electric aircraft as they would with conventionally powered aircraft. However, a significant amount of the population report that they would not fly in an electric aircraft due to concerns for safety. In fact, according to a study by UBS Investment Bank, only 38 percent of people reported that they would travel in an electric aircraft. When this study looked at the age group of 18-44, the percentage increased to 50 percent. These somewhat low percentages are not unsurprising in consideration of how new electric aircraft technology is. Often times new technology can make people hesitant as they may feel it has not been properly tested and does not have an established safety record. However, safety concerns can be lessened through raising public awareness and education. Concern will likely continue to decrease over time as electric aircraft are deployed for air cargo usage with no safety issues, thereby increasing public confidence in the technology's safety and reliability for passengers.

What if commercial deployment of electric aircraft is limited due to the public's concerns regarding safety?

Could we establish a publc awareness campaign to communicate the strict FAA requirements associated with the aircraft certification process?

5.1.3 Summary of Electric Aircraft Considerations

> *With electric aircraft, society is on the brink of witnessing a massive shift in how we fly.*

The electrification of aircraft is a major shift in a cornerstone industry of today's globalized marketplace. New routes and flight frequency will open for both goods and people, bringing new economic growth and quality-of-life benefits to Washington's more rural communities. Because many airports will initially face the same infrastructure, regulatory, and other potential challenges associated with electric aircraft, airport owners and sponsors today all have the opportunity to make the proactive planning choices to facilitate this evolution and fully leverage the benefits for their communities.

Indeed, the financial, environmental, and mobility benefits of this emerging technology are potentially staggering. While electric aircraft still face many obstacles, including limited power and charging

52 https://www.faa.gov/aircraft/air_cert/airworthiness_certification/

sources, lagging airport infrastructure, and regulatory hurdles, society is on the brink of massive shift in how we fly. All players in the industry—including federal and state agencies, research institutions, aircraft manufacturers, and end users—must now work together to fully transition electric aircraft from the lab and into the skies. **Table 5.4** summarizes the potential economic impacts of alternative aviation fuels in Washington in terms of the key focus areas presented in this paper.

Table 5.4. Summary of Economic Impacts of Electric Aircraft in Washington

Potential Area of Economic Impact	Potential Type of Economic Impact	Description of Impact
Financial (on- and off-airport)	Positive and Negative	Initial investments into electric aircraft may be high. However, electric aircraft will be less costly to fly due to low cost of energy compared to the high cost of jet fuel. This could promote more passenger trips, increase GA business aviation and encourage the use of aviation for cargo, or other commercial uses.
Environmental	Positive and Negative	Electric aircraft can contribute to a decrease in GhG emissions as it does not rely on jet fuel usage. However, it is important to note that electric aircraft are not carbon neutral as the production of electricity contributes to the release of harmful emissions into the atmosphere. Further, near-term electric propulsion will likely be coupled with combustion engines as a hybrid- electric solution until battery energy density increases substantially.
Infrastructure	Neutral	Limitations on today's battery technology constrains the type of aircraft that can enter the electric aircraft market. Electric aircraft have faster take-off speeds allowing for the use on shorter runways. Airports would be to be outfitted with aircraft charging stations.
Staff & Workforce	Positive	Emergence of electric aircraft will require a need for qualified aviation professionals, including pilots, mechanics, and air traffic controllers to receive proper training on electric aircraft functionality. This could mean there is a shortage of qualified professionals until they receive proper training. However, the emergence of electric aircraft also means there will be more aviation career opportunities available.
Mobility & Access	Positive	Electric aircraft are becoming lighter, more fuel efficient, and may soon have the potential to travel further distances which means there is an opportunity for increased access and mobility. Electric aircraft may make aviation more accessible to business users, for air cargo needs, and increase commercial ridership.
Safety	Neutral	No electric aircraft will be used in a commercial setting without first receiving FAA air worthiness certification and there is precedent for electric aircraft receiving this precedent. This indicates the low level of safety concerns related to traditional aircraft should correspond to electric aircraft. However, there is an opportunity to increase public awareness of the safety of electric aircraft as that may currently be lacking.

Source: Kimley-Horn 2019

5.2 Unmanned Aircraft/Aerial Systems

Unmanned Aircraft Systems (UAS) use Unmanned Aerial Vehicle (UAV) technology and support an array of applications for commercial, government, educational, and recreational purposes. UAV and UAS technologies are evolving quickly and their usage is becoming more prolific as the technology continues to emerge into the commercial market. Therefore, this section focuses on an array of UAS usages, ground support equipment, personnel, infrastructure, operations, software, data, and more. UAS implementation is associated with a number of benefits, such as increased safety, decreased costs, and improved efficiency on a variety of tasks, both for public and private sectors.

5.2.1 Overview of Technology and Applications

Federal law legally acknowledged the potential proliferation of UAS in 2012 when former President Barack Obama signed into law the FAA Modernization and Reform Act of 2012. As part of this legislation, Congress included a provision requiring the FAA to safely integrate UAS into the National NAS by September 2015.

The Washington State Patrol is estimated to have the largest law enforcement UAV fleet in the country.

Today, UAS are used for a variety of commercial, government, educational, and recreational purposes, with the opportunities continually growing as new markets for UAS emerge. UAS are used to enhance public safety, particularly for police, firefighters, and other first responders. UAS can offer optimized situational awareness while minimizing danger to those involved in an emergency. UAS are also deployed by the U.S. military, U.S. Customs and Border Protection, and other federal and state agencies for national security purposes. In addition, UAVs are used by law enforcement agencies for search and rescue missions, natural disaster recovery, and documenting crime scenes and car crashes. In other public safety applications, UAS have been deployed to mitigate natural and manmade disasters.

Washington State Patrol is estimated to have the largest UAV fleet in the nation of any law enforcement and uses the technology for a variety of reasons, particularly for assessing vehicle accident scenes and mapping out other crime scenes.[53] Other examples of UAS usage around the country occurred in Alaska when a three-pound UAS collected three-dimensional data that aided in oil spill clean-up efforts, or when a UAS captured real-time images of flooding of the Red River in the upper Midwest to provide data for rescue, research, and future planning efforts. UAS can be used to protect the environment, with applications that monitor forests for illegal logging, observe wildlife, and monitor erosion. UAS has been used to examine power plants and other industrial sites for leaks that could pose environmental risks. Scientific research has benefited from UAS technology, such as when UAS were deployed to count salmon nests in Idaho waterways after researchers were killed in a helicopter accident attempting to collect the same data. NASA uses UAS to measure greenhouse gases to better understand carbon cycling between the land, ocean, and atmosphere. UAS have been used for agricultural purposes. UAS can

[53] https://mynorthwest.com/1454530/police-drones-washington-state/

provide farmers with a cost-efficient way to spray for pests and diseases, as well as high-tech imagery to monitor crops and check for signs of distress.[54] UAS applications extend into the commercial market in a variety of ways, such as last-mile package delivery, commercial photography (e.g., wedding or real-estate), industrial or factory inspections, and more. One of the newly emerging usages is the last-mile package delivery which utilizes UAS technology for more efficient package delivery by automatically delivering parcels to doorsteps or delivery hubs. Using UAV for last-mile delivery could drastically decrease labor costs and could alter the traditional parcel delivery industry. Commercial UAS applications open new business venture opportunities in the private sector.

> *Commercial usage is the fastest growing UAS market, estimated to contribute more than $30 million to the national GDP by 2026.*

As the potential of UAS becomes more realized and frequency of use grows, particularly for commercial, private, and recreational use, the FAA has enacted policies and procedures to guide safe and responsible UAS use. More information about regulatory updates is provided in **Section 5.2.2.6** when UAS safety considerations are discussed.

5.2.2 Opportunities and Challenges

Washington is well-positioned to capture significant benefits from the growing UAS market as the state has a strong aerospace presence and forward-thinking approach to emerging technologies. Additionally, a variety of other influential companies call Washington home, including Amazon—a company already on the cutting-edge of commercial deployment of small UAVs for package delivery. The following subsections assess the opportunities and challenges associated with UAS proliferation and its potential impacts on Washington's airports.

5.2.2.1 Financial

The market forecasts for UAS are strong and are being realized more rapidly than predictions initially indicated. The U.S. market for UAS, which includes civil government, recreational, and commercial uses, experienced growth from $40 million in 2012 to approximately $1 billion by 2017. Moreover, it is expected that by 2026 the impact of commercial UAS applications (corporate and consumer uses) is expected to add between $31-$46 billion on the nation's Gross Domestic Product (GDP).[55] Along with this upward trend, commercial UAS activity is anticipated to become the largest global market for UAS use behind military applications. This considerable increase, and the market forecast, is anticipated to grow larger still should regulatory barriers and other factors become more favorable. An Industry Week publication notes that while these economic benefits will not be distributed equally across the 50 states, Washington state is expected to receive the second-most economic benefits from the UAS industry, falling only behind California.[56] The reason Washington has been placed so high on this list is due to its

[54] AUVSI, The Benefits of Unmanned Aircraft Systems, 2012
[55] https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/commercial-drones-are-here-the-future-of-unmanned-aerial-systems
[56] https://www.industryweek.com/technology-and-iiot/emerging-technologies/article/21960764/what-is-the-importance-of-unmanned-vehicles-to-our-economy

current aerospace activity and advanced infrastructure that supports the industry. In addition, states that are proactive about state laws, tax incentives, and regulations to support these technological advancements will further improve their position to participate in the economic impacts associated with UAS.

From an investment perspective, U.S. firms have put more venture capital toward UAS development than any other country in the world. U.S. firms ventured 76 percent of the total capital invested into the global UAS market between 2012 and 2018, with much of this funding going to support the development of software, analytics, and services. With many tech leaders taking charge of this industry—including two companies with strong bases in Washington (Amazon and Microsoft)—the outlook for UAS is extremely positive.[57] With a strong tech presence and an eager group of investors led by these powerhouse firms, Washington is likely in a position to maximize the financial opportunities associated with UAS.

As with any new emerging technology, initial investments can be high and prohibitive. However, UAS have already been implemented for a wide array of applications across many sectors, so much of the initial technology has already been established. Further investments will likely go into software development that allow UAS to perform highly specialized or specific tasks, or software development that allows the industry to grow in scale, creating a national network of service providers and improved analytics to make UAS easier to use.[58]

Another financial challenge associated with UAS is the cost of federal and state aviation resources being utilized as UAS administration and analysis are conducted, with no current mechanism for UAS to contribute to the funding of the agencies. The primary focus of the resources has been on determining the impacts on current aviation and airport infrastructure and operations, including airspace, and how to safely integrate UAS into the National Airspace System (NAS). Neither federal nor state agencies have established a fee or tax on UAS activity; therefore, government agencies are not receiving associated revenue to cover the costs associated with resources being expended. This is very different from the tax model for traditional manned aircraft, where the tax on fuel and other types of user or registration fees are collected and used to support staffing and other needs for aviation development at the state and federal level. Additionally, an associated reporting mechanism for UAS users is similarly unavailable—making ongoing monitoring of the level and type of activity occurring in the NAS difficult. For additional information, please see the associated Economic Performance Measure section of the Washington AEIS (available in **Chapter 4: State Aviation Investment**), which offers a specific recommendation for the need for a state-level reporting mechanism for industry.

[57] https://insideunmannedsystems.com/investors-chase-uas-market/
[58] https://insideunmannedsystems.com/investors-chase-uas-market/

5.2.2.2 Environmental Considerations

If UAS can be used for tasks previously conducted by traditional fossil fuel-powered vehicles, there will likely be environmental benefits associated with their usage. For example, UAS is now being tested as an effective alternative to traditional ground-based package delivery (as discussed in the associated Urban Air Mobility [UAM] section). If package delivery can be automated and completed by UAS, then it could reduce conventional transportation options that emit damaging pollutants. The hidden cost to reduce delivery times is an increase in CO_2 emissions, as more trucks need to be on the road to accommodate more frequent package delivery. When delivery times are longer, packages can be more effectively consolidated resulting in fewer total trips. However, this becomes more difficult as customers increasingly expect near-immediate or next-day service—resulting in fewer opportunities to consolidate deliveries.[59]

> *UAS last-mile delivery applications could help to reduce carbon emissions that have increased with the trend of shorter delivery times in the e-commerce industry.*

Last-mile delivery via UAS could help to increase efficiencies while reducing associated CO_2 emissions. In this scenario, a ground transportation vehicle would bring packages to a neighborhood sub-distribution station. UAVs would then be deployed to complete last mile package delivery. This reduces the number of times the ground-based vehicle has to stop and start and reduces its time on the road, therefore reducing its emissions. Further, since UAS relies on electric-powered aircraft, there has been a considerable amount of research and testing focused on increasing the duration of UAS battery-life to reduce charging needs. The less charging a UAS device needs, the more environmentally friendly it becomes.

What if WSDOT increased its use of UAS to conduct routine safety inspections on infrastructure, including bridges, roadways, ports, and airports?

Could we Reallocate funding to address additional state needs?

While there are several environmental benefits to UAS, it is important to consider environmental challenges presented by UAS. Once UAS devices and related technologies are retired or become unusable, they are discarded and add to the ever-growing problem of electronic waste (e-waste). E-waste concerns associated with UAS are generally limited to the vehicles that rely particularly on lithium polymer batteries. Concerns related to e-waste will be mitigated if UAV can operate using solar power.

[59] https://www.cnn.com/2019/07/15/business/fast-shipping-environmental-impact/index.html

E-waste is now the world's fastest growing trash stream, with the U.S. being the second-highest producer in the world. E-waste production is particularly concerning from an environmental standpoint because of the toxic substances found inside electronics, particularly lithium polymer batteries. When these electronic devices are discarded in landfills, toxic substances can be released into the environment. In addition to irresponsibly discarding of toxic substances, e-waste also discards the very valuable precious metals found inside many electronic devices. It is estimated that more than a tenth of the gold mined globally each year is discarded as e-waste.[60]

While e-waste is an environmental challenge, it also presents an opportunity to recycle precious metals sourced from natural resource mining. The State of Washington's Department of Ecology has implemented an e-cycle program to reduce some of the impacts of e-waste in the state. E-cycle is a free program that makes it easy for Washington residents to recycle electronics so the valuable materials can be recycled and the toxic materials responsibly discarded. To date, e-cycle has collected over 400 million pounds of electronics for responsible discarding.

What if concerns of e-waste caused by retired UAS continues

Could we could WSDOT implement a recycling and refurbishing program for the retired vehicles to minimize waste?

5.2.2.3 Infrastructure Needs

Infrastructure needs for UAS in terms of size and complexity will vary based on how the technology is used. Infrastructure needs for small UAS will be fairly limited; however, needs for larger UAS applications could be significant. Infrastructure needs will also vary greatly based on the application. For example, last-mile delivery will likely need a delivery hub, where the UAS are stored awaiting deployment for delivery pick-up. Other large infrastructure investments could be such items as new vertiports to handle vertical takeoff and landing (VTOL) procedures. In addition, depending on the size of the UAV, a user may need to build covered storage for the vehicle. Corporate-owned UAV fleet would need to acquire appropriate space to store their vehicles. Challenges for UAS infrastructure may occur due to funding restrictions, or limited space for necessary development. With high costs of real estate in many cities there could be obstacles in acquiring space to develop vertiports or package delivery stations. Moreover, there would be little to no opportunity for public funding for these infrastructure developments unless the application was associated with widespread public benefit.[61]

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[60] https://www.nytimes.com/2018/07/05/magazine/e-waste-offers-an-economic-opportunity-as-well-as-toxicity.html

[61] https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/infrastructure-barriers-to-urban-air-mobility-with-VTOL.html

5.2.2.4 Staff and Workforce

UAS activity has spurred job growth in a number of sectors due to research and development needs, software development, real estate, insurance, UAV development and maintenance, and piloting. Moreover, there are several dangerous jobs, such as climbing buildings and other tall structures, that can now be accomplished with UAS technology. It is expected that the commercial business ventures represent the fastest-growing opportunity, and with that comes a variety of new job prospects. UAS-related job growth is expected to be the highest in terms of the service, operations, and management aspects of UAS.

What if commercial operators establish frequent UAS operations in urban areas

Could we obtain operations data through zoning and permitting processes to better understand the impacts of UAS on the urban environment?

> *FAA certification for UAS pilot licenses remain affordable and can be relatively easy to acquire which encourages individuals to pursue this licensure and adds to the available workforce for the growing UAS market.*

UAV pilot certifications remain affordable and can be relatively easy to acquire which has facilitated the rapid proliferation of UAS for recreational and commercial use. To be eligible for UAV training, an applicant must be at least 16 years old, physically able to fly a drone, and pass an initial aeronautical knowledge exam. An applicant must then submit FAA Form 8710-13 for remote pilot certification.[62] It is important that the pipeline of trained UAV pilots match the technology's growth, and with a booming certified UAV pilot population the outlook is favorable that there will be adequate operators for a growing market.[63]

[62] https://www.faa.gov/uas/commercial_operators/become_a_drone_pilot/
[63] https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

It is important to note that pilot certifications could change and become more difficult to attain as UAVs become more complex. As with any new emerging technology or industry there are both opportunities for job growth and challenges associated with potential job disruptions in existing sectors. As UAS becomes more heavily relied upon in the surveying, agriculture, or delivery/cargo sectors, the more disruption these industries may experience. Job disruptions can generally be overcome with effective strategies in place to provide re-training opportunities in the UAS sector that allows for career transitions for displaced workers. Existing education programs that focus on aircraft maintenance and repair should also consider integrating UAV maintenance and repair skills or offer programs focused solely on those needs to spur skill development related to UAS.

What if UAVs replace trucks for the majority of last-mile deliveries in Washington?

Could we provide workforce development opportunities to train displaced delivery people as certified UAV pilots?

5.2.2.5 Mobility and Access

UAS can promote mobility and access with a number of different applications. The associated UAM section discusses the use of UAV for passenger transportation. Outside of this application, UAS could be used to collect real-time traffic data that could be used by traffic control centers to make informed, real-time decisions about traffic flow. In this way, this UAS application could be considered a component of intelligent transportation systems (ITS) designed to use real-time data to more effectively manage the flow of traffic in urban areas. Managing traffic flow can result in reduced congestion, which makes the transportation system more efficient and less impactful on the environment. UAS applications can promote emergency response efforts during and after natural disasters that are overly dangerous or difficult for humans to access. Additionally, UAS can be used to assess the conditions of a flood, fire, or other event to determine the optimal search and rescue procedures for individuals in distress.

As UAS applications become increasingly widespread, there is a growing need to address policies associated with their use to control or monitor their access to address potential privacy concerns. These issues have yet to be adequately addressed, particularly in terms of their operations over residential and urban areas. Policies for use on a local level are not the FAA's responsibility other than airspace, and it is up to local or regional authorities to outline appropriate uses, methods for monitoring UAS, and any potential penalties for not complying with established policies.

UAS proliferation into populated areas could create a need for policies that address citizens' privacy rights, address potential noise control, and concerns associated with safety and security. While many UAV are much smaller than traditional aircraft, there is still a very real potential for an accident that could cause serious injury, or loss of value to property. An aircraft could strike a UAV in the sky, or a malfunctioning or poorly operated UAV could collide with an object on the ground. Despite these concerns, there are considerable challenges associated with each local authority implementing UAS-use policies. This issue is addressed in the FAA's "State and Local Regulation of UAS Fact Sheet", which indicates "if one or two municipalities enacted ordinances regulating UAS in the navigable airspace and a significant number of municipalities followed suit, fractionalized control of the navigable airspace could result. In turn, this 'patchwork quilt' of differing restrictions could severely limit the flexibility of FAA in controlling airspace and flight patterns, ensuring safety and efficient air traffic flow."[64] Implementing effective UAS policies is particularly challenging because the NAS is controlled by the FAA, but needs, concerns, other associated UAS issues differ at the local community level.

What if UAS were used to assess ground transportation congestion in urban areas

Could we use real-time traffic data to make strategic traffic operations decisions (detours/signal timing) to increase traffic flow and reduce congestion?

5.2.2.6 Safety

UAS enhance safety in a variety of ways including public safety and law enforcement, many of which are described earlier in **Section 5.2.1**. Additionally, UAS may offer an alternative solution to tasks that are dangerous for humans. As noted above, the safety concern most commonly associated with UAS is related to how UAVs are incorporated into the NAS without causing potential safety risks to conventional aircraft, pilots, and passengers. Just as there are systems in place that support safe operations of traffic on the ground by way of traffic management centers, there will likewise need to be systems established for unmanned air traffic management (UTM). There has been considerable development in this space, largely made by the FAA. In May 2019, the FAA implemented a new rule that requires UAV operators to obtain preauthorization before flying in uncontrolled airspace around airports. This new requirement replaces an old requirement that simply mandated operators notify the airport operator and air traffic control tower (ATCT) prior to flying within five miles of the facility.

[64] https://www.faa.gov/uas/resources/policy_library/media/UAS_Fact_Sheet_Final.pdf

LAANC is a data sharing tool that allows for near-immediate authorization of UAV operations in controlled airspace.

Related to preauthorization and sharing airspace is the Low Altitude Authorization and Notification Capability (LAANC) program. LAANC was designed to directly support UAS integration into the NAS. LAANC is a data-sharing tool that allows for a near-immediate application for and authorization of UAV usage in controlled airspace. A UAV user downloads a mobile or desktop application to request authorization to operate in controlled airspace. The request goes to an FAA-approved UAS Service Supplier (USS) which coordinates with multiple airspace data sources to identify potential safety risks. These data sources include the FAA UAS Data Exchange comprised of UAS Facility Maps, Special Use Airspace data, and Airports and Airspace Classes, as well as Temporary Flight Restrictions (TFR) and Notices to Airmen (NOTAMs). If the request passes through each of these data sources with no issues, then the request is approved, and the user is authorized to operate a UAV in controlled airspace. LAANC is a relatively new technology and is currently in nationwide beta testing. LAANC is available at approximately 400 air traffic facilities that cover about 600 airports.[65] **Table 5.5** shows the airports in Washington where LAANC is currently available.

Table 5.5. Washington Airports with LAANC Availability

Associated City	Airport Name	FAA ID
Bremerton	Bremerton National	PWT
Ephrata	Ephrata Municipal	WA
Everett	Snohomish County (Paine Field)	PAE
Deer Park	Deer Park	DEW
Hoquiam	Bowerman	HQM
Moses Lake	Grant County International	MWH
Olympia	Olympia Regional	OLM
Pasco	Tri-Cities	PSC
Pullman/Moscow	Pullman/Moscow Regional	PUW
Walla Walla	Walla Walla Regional	ALW
Seattle	Boeing Field/King County International	BFI
Seattle	Seattle-Tacoma International	SEA
Spokane	Felts Field	SFF
Spokane	Spokane International	GEG
Vancouver	Pearson Field	VUO
Wenatchee	Pangborn Memorial	EAT
Yakima	Yakima Air Terminal/McAllister Field	YKM

Source: FAA 2019

[65] FAA, UAS Data Exchange (LAANC). 2019

What if UAS applications continue to grow and their usage becomes spread throughout the state

Could we increase the number of airports in the Washington system with LAANC availability?

5.2.3 Summary of UAS Considerations

UAS applications provide a variety of benefits across multiple sectors. As the market grows, so too will the applicability of this technology. Since UAS first entered the market, there have been several policy and procedural developments established by the FAA and states to support safe and responsible UAS usage. However, there is still work to be done to optimize this technology through infrastructure development, strategic investments, proper workforce training, and policy implementation. Washington has a strong technology sector, as well as a proactive aviation community that could create strategic partnerships across multiple sectors to maximize the economic benefits of UAS operations. **Table 5.6** summarizes the potential economic impacts of UAS in Washington in terms of the key focus areas presented in this report.

Table 5.6. Summary of Positive and Negative Impacts of UAS Applications in Washington

Potential Area of Economic Impact	Potential Type of Economic Impact	Description of Impact
Financial (on- and off-airport)	Positive and Negative	UAS is a growing industry with great potential in private and public sectors. UAS can be used for infrastructure monitoring and surveying, which could mean additional funding may become available for redistribution across the state for other needs. Federal and state resources being used for UAS development are not being compensated by associated revenues from taxes or user fees, which means valuable public resources are being expended without an associated funding mechanism.
Environmental	Positive and Negative	UAS applications could replace tasks that are currently completed by CO_2 emitting vehicles (particularly for last-mile applications). Potential negative environmental concerns stem from reliance on lithium polymer batteries that are difficult to dispose of and contribute to the growing global e-waste concern.

Potential Area of Economic Impact	Potential Type of Economic Impact	Description of Impact
Infrastructure	Neutral	Infrastructure needed to support many UAS applications will need to be privately funded as many of the cases are for commercial use. In instances were UAS applications serve the public then existing infrastructure such as aprons and other pavements can be used.
Staff & Workforce	Positive and Negative	With growing industries comes growing job opportunities—particularly for jobs pertaining to the service, maintenance, and operations of UAS. Minor workforce disruptions could occur in industries where tasks are being replaced by UAS applications.
Mobility & Access	Positive and Negative	UAS technology has the potential to be used in ground transportation traffic management to reduce congestion and promote traffic flow. UAS applications can also aid in search and rescue procedures by increasing access to individuals in distress during emergency response and disaster relief scenarios. Challenges associated with local authorities' abilities to monitor or govern UAS access and impacts on local communities should be addressed in the near-term.
Safety	Positive and Negative	The FAA has taken some steps to monitor UAS use to mitigate airspace incursions between conventional aircraft and UAV. UAS applications can replace hazardous or dangerous jobs that pose risks to human health and safety. Conflicts over airspace integration have yet to be resolved, which could have safety implications for people and objects.

Source: Kimley-Horn 2019

5.3 Urban Air Mobility

Urban Air Mobility (UAM) is a new type of transportation option aimed at alleviating heavily congested urban areas with the use of on-demand and highly automated (unmanned) aircraft with vertical take-off and landing (VTOL) capabilities. The UAM concept relies on electric or hybrid-electric vehicles that operate in low-altitude (500 to 5,000 feet above ground level) airspace and can potentially carry hundreds and perhaps thousands of pounds in cargo or passengers. The potentials of UAM bring the once far-fetched imaginations of flying cars as depicted in popular science fiction closer to reality.[66]

5.3.1 Overview of Technology and Applications

Explorations in UAM are well underway with a number of stakeholders and UAM partners working diligently on opportunities to develop UAM into a viable alternative mode of transportation in urban environments. UAM generally relies on the technology of unmanned electric VTOL vehicles, which have witnessed significant advancements in recent years. Note that information provided in this section specifically pertains to the advancements made in technology that support UAM. Additional details on

[66] https://www.mitre.org/publications/project-stories/urban-air-mobility-adds-a-new-dimension-to-travel

the different types of electric vehicles (including aircraft, quadcopters, helicopter, and more) currently under development are discussed in **Section 5.1**.

In May 2019 Uber hosted its second Elevate Summit in Los Angeles that brought a number of stakeholders together to build a foundation of technical, financial, and community support around urban aviation. Events like these will build the necessary foundation for future UAM implementation. NASA announced the UAM Grand Challenge during this event, which is a sequence of activities designed to advance the safety and effectiveness of a UAM transportation system. During that same summit, the Kitty Hawk Corporation, a start-up funded by Google co-founder Larry Page, also announced two VTOL projects now capable of conducting flight operations. The first project, named Cora, is a remotely piloted two-passenger air taxi prototype that was unveiled in March after undergoing testing and development in New Zealand and California. The other Kitty Hawk project is a refined version of the original Kitty Hawk flyer appropriately named the "Kitty Hawk Flyer 2.0" that was first announced in 2017. The refined version is a 10-rotor multicopter that can be operated without an FAA pilot's license. The Flyer is considered an ultralight aircraft that provides simplified controls and automatically enforces various safety limits such as 10-foot maximum altitude and geofencing capabilities. A third project funded by Page known as the Blackfly was announced in July 2019. Developed by the Opener company, the Blackfly is an ultralight aircraft that has already performed 1,400 test flights covering approximately 12,000 miles.[67]


Kitty Hawk Corporation's Cora Vehicle.
Source: CNBC.com


Kitty Hawk Corporation's Flyer 2.0.
Source: CNet.com

Industry stakeholders generally agree that commercially-viable UAM operations could occur within the next 10 years with significant investment in the field.

UAM is gaining attention on the federal policy level as well. The U.S. House of Representatives Science Committee held a hearing in July of 2019 called "UAM – Air Flying Cars Ready for Take Off?". The hearing heard testimony from major industry players including NASA, Georgia Tech, Uber, Bell, and Terrafugia on the potential challenges and opportunities associated with UAM. Speakers generally agreed that commercial UAM operations could occur within a 10-year horizon, although significant investments and major

[67] https://aerospaceamerica.aiaa.org/year-in-review/dozens-of-urban-air-mobility-projects-underway/

developments are still needed for operations to reach a commercially-viable scale.[68]

In order to assess UAM feasibility, NASA completed a UAM Market Study (Market Study) that evaluates three "use-cases" or applications for UAM technology.[69] **Table 5.7** presents the three use-cases and includes the purpose of the application, the type of technology or infrastructure required, and potential regulatory requirements needed for advancement of the technology. Each use-case presents differently: While they share some basic technology, infrastructure needs, and potential regulatory requirements, the demand for and feasibility of each means that the year of anticipated profitability or widespread commercial use are different. NASA's Market Study predicts that last-mile delivery could become profitable by 2030, assuming the number of deliveries reaches 500 million operations and the number of UAM vehicles reaches 40,000 at a cost of $4.20 per delivery.

Surprisingly, the Market Study predicts air-metro feasibility to occur two years prior to last-mile delivery, occurring in 2028. In order for air-metro profitability to occur, there needs to be a minimum of 130 million passenger trips, each costing $50 with 4,100 vehicles operating. The Market Study reports the air-taxi use case will not achieve profitability by the year 2030 and under current constraints the model points to air-taxis remaining unprofitable for widespread consumption in the short- and mid-terms. Based on this assessment, UAM will most likely not provide meaningful relief to traffic gridlock and urban congestion in the foreseeable future. However, there are some alternative scenarios where the air-taxi business may be viable based on a number of considerations to do with localized or niche market scenarios.[70]

[68] Ibid.
[69] NASA Market Study, 2018
[70] Ibid.

Table 5.7. Summary of NASA's UAM Use-Cases

Use-Case	Purpose	Infrastructure	Technology Needs	Potential Regulatory Requirements	Year of Anticipated Profitability or Widespread Use
Last-mile parcel delivery	Uses small UAS to complete deliveries of packages around five pounds with approximately 10-mile roundtrip capabilities. Deliveries would be unscheduled and routes determined as orders are received.	Receiving vessels, distribution hubs, docking/charging stations, unmanned traffic management (UTM)	Improvements in battery, autonomous flight, detect-and-avoid capabilities, electric propulsion, GPS-denied technologies	Beyond Visual Line of Sight (BVLOS), air worthiness, UTM, flight above people/altitude restrictions, operator certification, identification, environmental restrictions	2030
Air-metro	Resembles current public transit options and relies on pre-determined routes/regular schedules with stops in high-traffic areas. Transports two to five passengers per autonomous VTOL operations. Provides a weight capacity of approximately 1,000 pounds with travel distances between 10 and 70 miles.	Approximately 100-300 vertiports (transit stops) per metropolitan statistical area (MSA) located in high-traffic area capable of handling three to six VTOLs at once. Charging stations, service stations, and UTM		Land-use policy, noise restrictions, airspace deconfliction/policy	2028
Air-taxi	Serves as a ride-hailing application that provides door-to-door transportation from desired pick-up and drop-off locations on rooftops throughout a given area.	Requires a VTOL with similar capabilities as an air-metro VTOL, with the addition of more vertistops on or near buildings for "door-to-door" services. Charging stations, service stations, and UTM		Same regulatory requirements as other use cases with added significant original equipment manufacturer (OEM) requirements for air worthiness	>2030

Sources: Kimley-Horn 2019, NASA UAM Market Study 2019

5.3.2 Opportunities and Challenges

Based on the overview of potential applications of UAM technology, the remainder of the section looks more closely at the opportunities and challenges associated with UAM in more detail, including the potential impacts to Washington airports.

5.3.2.1 Financial

The rise and eventual widespread implementation of UAM technology could create a new sector of transportation that boosts access and mobility within congested urban areas and potentially between rural and urban areas. It is reported that there was $1 billion invested in UAM in 2018 from over 70 companies, which indicates there is a strong market to advance and implement this technology.[71] In addition to private-sector investments, there is a proposal to direct federal funding specifically towards UAM development in 2020.[72] While the prospects of federal funding and significant private-sector investments indicate a positive outlook for UAM development, the initial capital overhead and required investments for UAM will be incredibly costly in the emerging market. However, industry analysts project that overhead costs will drop as the market matures.[73] According to the NASA Market Study the national estimates for profitability shows some promising figures. The report estimates that UAS last-mile delivery and related industry is expected to return $8 billion in profits by 2030, the estimated first year of profitability. Moreover, when the NASA Market Study looked at profitability of the air metro use case, it was estimated that by the year 2028 a profit of $0.9 billion can be expected for the industry, and by the year 2030 that profit is expected to increase to $2.8 billion.[74]

> *The impacts of UAM on air transportation are anticipated to be minimal, especially in the short- and mid-terms.*

While these financial indicators could point to potential UAM air-taxi applications, impacts on air transport are anticipated to be minimal, especially in the short- and mid-terms. Other modes designed to transport people and goods relatively short distances within urban environments will experience the most significant impacts with the introduction of UAM technology into the transportation system. Since air-taxi applications are more of a replacement for urban public transit, such as buses, rideshare applications, subway systems, and light rails, widespread usage will likely not impact commercial service air travel. However, it is important to note that while the air-taxi applications are designed to serve as another form of public transit the current model of electric vehicle identified for this purpose can carry one to five passengers. Therefore, it is not an immediate replacement for public transit services like buses, light rail, subway systems, and other modes.

Additionally, the last-mile delivery application of UAM technology are not anticipated to negatively impact cargo operations at commercial service or GA airports, as UAM delivery is intended to drop off one or two parcels at a time. Larger cargo shipments will still be dependent on traditional aircraft.

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[71] https://www.aia-aerospace.org/future-of-uam/
[72] https://www.akingump.com/en/news-insights/communications-and-information-technology-alert-drones-and-urban.html
[73] https://www.nasa.gov/sites/default/files/atoms/files/uam-market-study-executive-summary-v2.pdf
[74] NASA UAM Market Study, 2019

However, there is an opportunity for a last-mile delivery hub to be co-located at airports that handle considerable cargo shipments. Currently, ground-based freight haulers lose significant revenue if they are caught in traffic bottlenecks traveling to and from airports. Parcel delivery could become more efficient if the UAM VTOL vehicles were used to transport packages directly from the airfield to its next recipient, such as a customer, fabricator, manufacturing plant, or retailer. Creating efficiencies for deliveries could decrease costs on the user end. This application would have to carefully consider shared airspace concerns if operating in the vicinity of an airport. UAM operators would have to carefully coordinate with state and federal regulators, aircraft operators, and air traffic controllers (as applicable) to maintain the highest levels of safety and operational efficiency for all vehicles in the NAS.

> *Demand may shift between airports or increase at some commercial service facilities if air travelers can quickly travel to and from airports using UAM technologies.*

While UAM air-taxi is unlikely to replace traditional air travel, there is an opportunity to potentially increase revenue at commercial service airports if it becomes a popular way for users to travel to and from the airport. Sea-Tac International Airport (Sea-Tac) is the busiest commercial service airport in the state and handles the majority of commercial service enplanements in Washington. Vehicular traffic to and from Sea-Tac is prone to congestion, particularly during peak travel times. A UAM air-metro option could drastically reduce the time and stress of driving to and from and parking at the airport. However, since parking fees are a considerable revenue-generating opportunity for airports, there would need to be additional fees associated with establishing UAM air-metro opportunities at airports. The precedent is already set for this type of fee structure, as many airports have implemented user fees for Lyft, Uber, and other rideshare services to off-set the potential loss of revenue due to fewer people parking in pay lots on or near the airport.

What if UAM air-metro becomes a frequent way for airport users to arrive at the airport?

Could we charge a fee for this service to generate a new revenue stream for airports?

In addition to the financial considerations mentioned above, UAM air-metro applications could strengthen connectivity between urban and rural communities. This could promote access to employment centers and consumer activities and boost economic vitality.

> *Airport compatible land use guidelines currently designed to monitor noise pollution at airports would need to be considered during implementation phases of UAM development, particularly since UAM has the potential to bring air traffic to areas currently protected from noise pollution.*

5.3.2.2 Environmental Considerations

A discussion of the potential environmental impacts of UAM can be found in the affiliated electric aircraft section, as considerations for UAM applications are generally reflected in discussions pertaining to electric aircraft. Beyond the environmental impacts discussed in **Section 5.1.2.2**, the potential impacts of noise pollution relating to UAM applications needs to be considered. Noise pollution is a controversial environmental impact associated with UAM development. Auditory and visual disturbances in residential neighborhoods could create strong, localized pushback as the market expands.[75] While UAM vehicles are significantly quieter than conventional aircraft (since they are electric), UAM would still bring aerial vehicles into urban and likely residential areas that had previously not experienced such activities. Noise pollution has the potential to contribute to community annoyance, sleep disturbance, and speech and school learning interference. While there are guidelines in place to manage and analyze noise pollution created by airports, these same regulations as currently established may not extend to the use of UAM in all cases.

As such, it will be important for the FAA, WSDOT Aviation, and other policymakers to work with airports and local zoning authorities to develop, implement, and enforce land use and other policies to mitigate potential UAM compatibility concerns. Technologically germane and enforceable UAM land use compatibility guidelines will ensure this technology can be integrated into the NAS without undue noise, safety, and emissions impacts on local citizens and businesses. In particular, land use compatibility guidelines that address noise pollution at airports would need to be considered during implementation phases of UAM development because UAM has the potential to bring air traffic to areas that are currently largely protected from noise pollution like heavily suburban or residential areas. Measures to mitigate noise pollution on airports can include operational measures such as changing flight tracks or runway usage and implementing voluntary noise abatement procedures; however, not all directly translate to noise pollution mitigation for UAM. Limiting hours of operation and altering routes to avoid sensitive areas could help with noise pollution concerns.

What if Local authorities proactively plan for widespread UAM deployment during ongoing planning and zoning efforts

Could we mitigate noise pollution concerns by establishing policies to mitigate impacts prior to widespread implementation?

[75] NASA UAM Market Study 2018

While noise pollution presents itself as an environmental challenge when considering widespread UAM usage, an environmental opportunity is the reduction in single occupancy vehicles (SOVs) and roadway congestion. More vehicles that sit idling in traffic correlates to an increase in CO_2 emissions. If traffic can flow more freely because UAM air-metro proliferation provides an alternative electric transportation option, than urban centers, particularly Seattle's city urban core, could see a reduction in CO_2 emissions caused from traffic congestion. As mentioned in the above **Section 5.3.2.1**, UAM air-metro applications could also reduce commute times to and from airports. Actual CO_2 reductions will be a factor of the specific technology being deployed, as well as the total number of travelers who adopt this transportation option. Initial UAM vehicles will likely be hybrid-electric, and a fairly significant number of travelers would need to adopt the technology to result in a meaningful improvement to traffic congestion. Further, UAM will enter the market as an increasing number of drivers choose electric or hybrid-electric cars. Because of these and other mitigating factors, potential CO_2 reductions should be comprehensively assessed within specific contexts and applications.

5.3.2.3 Infrastructure Needs

A variety of infrastructure developments would need to occur to support UAM applications of any purpose. Most UAM vehicles will need charging and service stations, as well as vertiports to support VTOL operations for passenger applications. Costs to develop infrastructure for UAM could be high and would likely require a mix of public and private money to integrate UAM applications as a viable public transit option.

What if	Could we
Seattle showed interest in capturing the emerging market of UAM air-metro capabilities	retrofit current transportation hubs with vertistops for easier integration of air-metro as a viable transit option?

While infrastructure needs could be costly, the infrastructure required for UAM may spur investment from technology and transportation design firms into targeted/interested cities, with the possibility of repurposing some current infrastructure to fit UAM needs if limited development opportunities are available.[76] Moreover, there could be opportunities for airports to make infrastructure changes to support UAM development if there is potential revenue generation from such investments. Airports could become hubs for service or charging stations for last-mile delivery and charge a fee for companies to use those services to support their last-mile delivery operations. As noted previously, airspace

[76] https://www.aia-aerospace.org/future-of-uam/

concerns must be evaluated to ensure UAM operations do not conflict with airport operations nor pose any undue risks for people and property in the sky and on the ground.

5.3.2.4 Staff and Workforce

The potential for increased jobs through emerging UAM markets is high. As the UAM market emerges, new jobs from a variety of industries will be in high demand. Jobs related to architecture, navigation, manufacturing, hub operating facilities, maintenance, transportation, software development, engineering, construction, and more could grow as UAM emerges into more widespread applications.[77] In meantime, there are considerable opportunities for research and development jobs, as the technology and operations of UAM need to be optimized before the workforce sees significant growth in the previously mentioned sectors relating to UAM.

What if Existing educational programs in Washington could integrate UAM operational knowledge into their courses

Could we train a new sector of aviation professionals that are prepared for this emerging market?

While the outlook for job and workforce development is positive as UAM emerges and becomes more mainstream, there is public perception that UAM proliferation may cause job disruptions in multiple industries, such as the truck, ground-based transportation, and other such industries.[78] While some moderate disruptions may occur in the short-term, these disruptions could be offset by the proliferation of new job opportunities for both skilled and unskilled labor associated with UAM development as well as the planning, design, and construction of landing facilities. Additionally, workers in suburban or rural areas may have access to higher-paying jobs in the urban core should UAM provide new opportunities to travel between where people live and work (see **Section 5.1.2.5** below for additional details).

> *Vertiports could allow for demand-driven routes that improve access between rural communities and employment centers.*

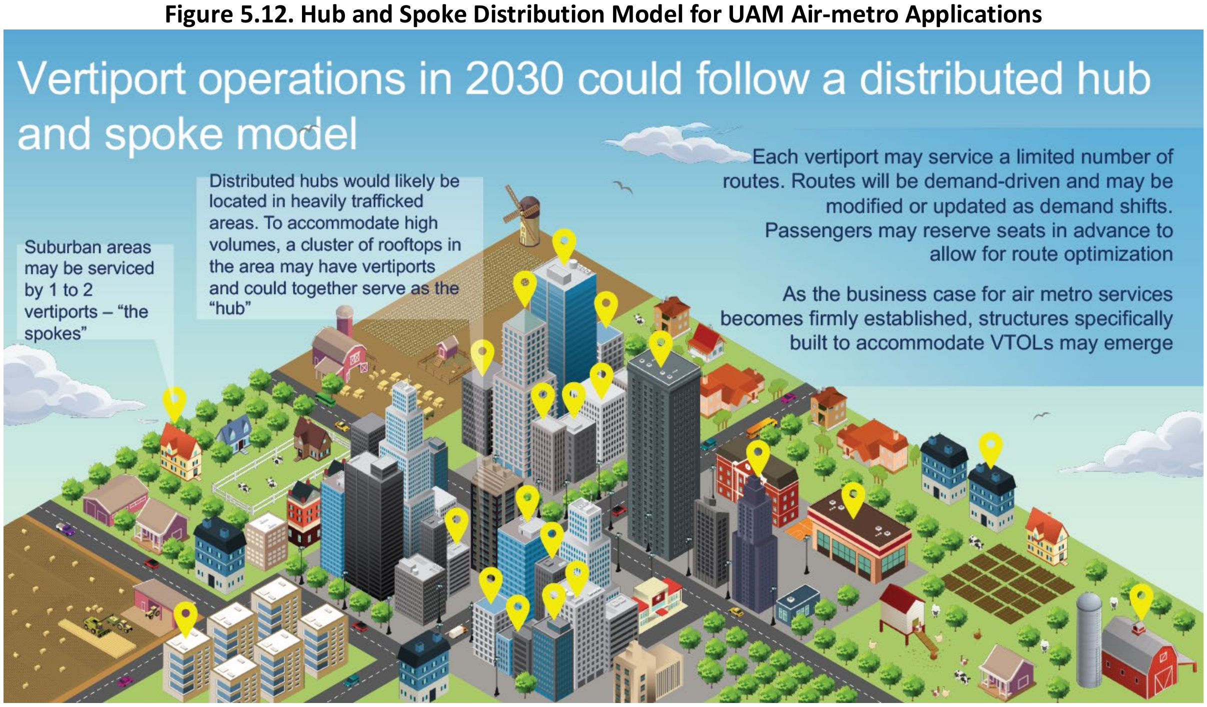
5.3.2.5 Mobility and Access

UAM applications aimed at passenger trips are designed to improve mobility and access, particularly within urban areas, from suburban to urban areas, and could even facilitate transportation between rural and urban areas. Vertiports could allow for demand-driven routes that improve access between rural communities and

[77] https://www.marketresearchfuture.com/reports/urban-air-mobility-market-7685
[78] NASA UAM Market Study 2018

employment centers. Moreover, as the cost of living in urban areas like Seattle continues to rise, more Washington residents are opting to live outside of the city in more affordable suburban areas. Commutes become longer as residents move further away from the city, further disconnecting people from employment opportunities. UAM air-metro vertiports could reduce commute times and improve connectivity for residents living outside of the city. **Figure 5.12** from the NASA UAM Market Study details the hub-and-spoke model that UAM vertiport operations could follow to promote mobility within a region.

Figure 5.12. Hub and Spoke Distribution Model for UAM Air-metro Applications



Source: NASA UAM Market Study 2019

While the potential to improve access and mobility with UAM applications is considerable, there are other emerging markets that could pose some challenges for UAM proliferation. Existing and near-market transportation alternatives such as autonomous vehicle or efficient ground transportation options such as high-speed commuter rails may be more attractive to consumers. Moreover, as UAM emerges there could be considerable costs to the user for the service, which could limit usage to those consumers in higher income brackets.[79] In order for UAM air-metro and air-taxi applications to be accessible to all users, it would need to be an attractive and affordable alternative for all Washington residents.

[79] https://www.nasa.gov/sites/default/files/atoms/files/uam-market-study-executive-summary-v2.pdf

What if UAM air-taxi and air-metro is used to transport passengers from rural communities into urban areas

Could we create more connectivity between rural communities and urban areas to promote economic growth throughout the state?

5.3.2.6 Safety

UAM technologies offer significant opportunities to improve safety and security with widespread implementation. As UAM usage means travelling through congested areas with few obstructions, response times for emergency medical services, disaster relief, law enforcement, and firefighting services would be greatly decreased.[80]

UAM as an emerging technology presents some safety concerns to the general public, addressing issues such as malfunctioning vehicles or vehicles not properly navigating, colliding with people or structures. However, considerable work has gone into support safe UAM operations, with sensing technologies addressing safety concerns in terms of beyond visual line of sight (BVLOS) navigation, obstruction identification, and the immobilization of malfunctioning vehicles. Before UAM is implemented for widespread use, these safety enhancing technologies will need to be optimized. Along with optimizing safety-enhancing technologies during vehicle development, UAM will need to be regulated through a variety of policy mechanisms at the federal, state, and local government levels during the implementation phase.

What if WSDOT Aviation developed policy recomendations to inform UAM regulations at local and state levels?

Could we improve standards and promote positive public perception that UAM technologies are a safe and effective transportation alternative?

[80] https://medium.com/aviaryproject/urban-air-mobility-a-promising-technology-for-the-developing-world-af0193221551

5.3.3 Summary of Urban Air Mobility Considerations

UAM technologies can provide a variety of different services that promote connectivity in urban areas, as well as provide opportunities to close the gap between suburban/rural and urban divides. This increased connectivity may result in new economic growth and prospects, particularly in rural areas of the state with more limited access to substantially developed commercial markets. With the potential to travel longer distances more rapidly and at a lower cost, residents in rural areas may be able to connect with educational opportunities and higher-wage, more skilled jobs. UAM could also facilitate business connections, whether that be conducting more frequent in-person meetings with clients, colleagues, or suppliers or visiting work sites or other company office locations. Visitors to Washington may also have a better chance of traveling to areas across the state and spending money in local establishments. This may be particularly impactful to eastern Washington and help to close the economic and mobility gap faced by some residents and businesses.

UAM may be the future of transportation, yet there is a considerable amount of work that needs to be done before this emerging technology can be feasibly deployed for widespread use. Unmanned VTOL vehicles need to be designed to carry multiple passengers, vertiports need to be established to support air-metro or air-taxi applications, charging and service stations need to be developed, safety technologies need to be optimized, and regulations must be established to ensure safe integration into the NAS. Moreover, positive public perception of the possibilities of what UAM can provide needs to be generated to have public support for the integration of this technology into the existing multimodal transportation network.

Despite the many hurdles to overcome, UAM technology brings many benefits and will likely be pursued as a viable transportation option in the coming years. Washington can prepare for these developments by following advancements made in this technology and stay ahead of developments with policies and procedures in place to support UAM opportunities and efficient implementation when UAM is available for widespread use.

Table 5.8 summarizes the potential economic impacts of UAM in Washington in terms of the key focus areas presented in this paper.

Table 5.8. Summary of Economic Impacts of UAM in Washington

Potential Area of Economic Impact	Potential Type of Economic Impact	Description of Impact
Financial (On-airport)	Neutral/ Positive	UAM will not replace traditional commercial service or GA air transportation as a transportation mode. Some increase in demand for air travel may be associated with increased access to airports provided by UAM. Airports may need to consider new revenues steams as parking fees are lost to other modes due to passengers using UAM to access the airports.
Financial (Off-airport)	Positive	UAM will increase connectivity between rural and suburban areas, promoting economic activity and access to higher-paying jobs in the urban core.
Environmental	Positive	UAM will rely on electric-powered vehicles with significantly lower CO_2 emissions as compared to conventional (i.e., fossil) fuel types. Traffic idling and commute times may decrease as passengers and goods are transported via VTOL capability.
Infrastructure	Negative	Significant new infrastructure will need to be developed including (but potentially not limited to) vertiports, receiving vessels, distribution hubs, docking/charging stations, and UTM systems.
Staff & Workforce	Positive	Numerous job opportunities will be created associated with the infrastructure needs of UAM technology. Workers in suburban/rural areas will have improved access to job opportunities in the urban core. Some ground transportation-related jobs (e.g., trucking) may be lost with the proliferation of UAM.
Mobility & Access	Positive	Significant improvements will be witnessed between suburban/urban and rural/urban divides, as well as reduced travel time within metropolitan areas.
Safety	Positive	UAM technologies are anticipated to undergo the same rigorous safety testing procedures as traditional aircraft and ground-based vehicles (i.e., cars and trucks) before commercial deployment. In the long-term, access to safety and security services including emergency medical care, law enforcement, and firefighting will likely improve.

Source: Kimley-Horn 2019

5.4 Alternative Aviation Fuel

In 2016, Alaska Airlines made history by using the world's first renewable energy on a commercial flight on a route between Sea-Tac International Airport and Reagan National Airport in Washington, D.C. This development asserted Washington state as a pioneer in alternative aviation biofuel production.

Growing concern about the impacts of CO_2 and other GhG emissions, fluctuating oil and fuel costs, and the aviation industry's overall sustainability goals have led to rising interest in alternative fuel production for both piston- and turbine-powered aircraft. In 2010, the U.S. announced an ambitious goal of carbon-neutral growth for U.S. commercial aviation by 2020 using 2005 emissions as a baseline. While this goal was set under a previous administration, the FAA continues to advocate for emissions reductions by providing tools and resources to the aviation community. Although ambitious, this goal shows a strong commitment to drastically reducing aviation-related CO_2 emissions.[81] Considerable advances have been made for alternative jet fuel solutions through the use of biofuel for Jet A-reliant aircraft that largely serve the commercial service and air cargo sectors, as well as select general aviation (GA) activities such as corporate/business aviation, medical flights, and wildland firefighting. Moreover, it is important to note that alternative jet fuel solutions could also be considered as a bridging strategy that alleviates emissions concerns during the transition from traditional fossil fuel usage to electric aircraft usage. Using alternative fuels in hybrid-electric aircraft would be particularly impactful while providing the additional benefit of noise reduction. This eventual transition is experiencing increased public demand as goals for reduced and ultimately zero emission impacts are targeted.

In addition to sustainable aviation jet fuel (SAF) advancements, there is a need to address an alternative fuel solution for aircraft reliant on 100LL fuel, which make up a considerable percentage of GA fleet. The environmental and health concerns associated with emissions from piston aircraft fueled with 100LL (100 Low Lead, often referred to as AvGas) have motivated the FAA and the Environmental Protection Agency (EPA) to phase out AvGas usage as soon as possible. However, the impacts of phasing out AvGas prior to having clear alternative solutions in place would pose major challenges to the GA community. Therefore, the advancements being made in alternative aviation fuels are twofold, as they must address alternative solutions for both Jet A and AvGas-reliant aircraft.

5.4.1 Overview of Technology and Applications

The state of Washington has a strong history of biofuel production, and aviation and aerospace are a major part of the state's economy. It is therefore not surprising Washington is poised to become a leader in producing the clean fuels needed to help the U.S. commercial aviation industry reach its goal of carbon neutrality. Some steps Washington state has made in becoming a leader in this emerging field include establishing the Aviation Biofuels Working Group in 2012, which was a public-private

[81] https://www.faa.gov/about/office_org/headquarters_offices/apl/environ_policy_guidance/policy/media/Aviation_Greenhouse_Gas_Emissions_Reduction_Plan.pdf

partnership committed to developing policy recommendations that support the state's sustainable aviation biofuels industry. When RCW 43.333.800 expired in 2015, it ended the Innovate Washington Program that established the Aviation Biofuels Working Group. Moreover, in 2018, the Port of Seattle, the authority that operates Seattle-Tacoma International Airport (Sea-Tac), partnered with 13 airlines to develop a plan for bolstering access to sustainable biofuel alternatives that could replace jet fuel. [82]

In 2016, Washington state-based Alaska Airlines made history by using the world's first renewable energy on a commercial flight on a route between Sea-Tac International Airport and Reagan National Airport in Washington, D.C. This historic flight used a biofuel produced from forest waste feedstock. The forest waste came from forest residuals unique to the Pacific Northwest. This alternative jet fuel was produced as a part of the Northwest Advanced Renewables Alliance (NARA) affiliated with Washington State University (WSU). NARA was able to make these advancements in alternative jet fuel because of a $39.6 million grant awarded by the U.S Department of Agriculture's National Institute of Food and Agriculture (NIFA). This development asserted Washington as a pioneer in alternative aviation biofuel production.[83] Additionally, WSU and the University of Washington have formed a research partnership through the Commercial Aviation Alternative Fuels Initiative (CAAFI) to research the performance and safety of potential SAF alternatives.[84]

Since 2016, advancements in sustainable alternative jet fuels have continued, with the FAA approving five different types of alternative jet fuels. **Table 5.9** shows the five alternative jet fuels and provides a brief description of the product source and the FAA qualification date of the fuel. The qualification dates in the table relate to the American Society for Testing and Materials (ASTM) standards used to determine if the alternative fuel solution is a viable product for use. All alternative jet fuels must complete the rigorous process of being qualified by ASTM standards before they can be used for any flights. As the table shows, a variety of different and generally discarded (i.e., waste) products can be used in the production of alternative jet fuels.

Table 5.9. FAA-approved Alternative Jet Fuels

Fuel Type	Brief Description	Qualification Date
Alcohol to Jet Synthetic Paraffinic Kerosene (ATJ-SPK)	Created from isobutonal, an alcohol derived from renewable feed stocks such as sugar, corn, or forest wastes	April 2016
Synthesized Iso-parafins (HFS-SIP)	Converts sugars into jet fuel	June 2014
Hydro-processed Esters and Fatty Acids Synthetic Paraffin Kerosene (HEFA-SPK)	Converts fats, oils, and greases (FOG) into a biofuel product	July 2011

[82] https://www.ucsusa.org/sites/default/files/attach/2018/11/Clean%20Fuels%20for%20Washingtion%202018_web_final.pdf
[83] https://news.wsu.edu/2016/11/14/forest-powered-biofuel-flight/
[84] https://ascent.aero/project/methods-for-the-fast-quantification-of-oxygenated-compounds-in-alternative-jet-fuels/

Fuel Type	Brief Description	Qualification Date
Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK)	Uses a variety of biomass, such as municipal solid, agricultural, or forest wastes; wood or energy crops*; or fossil resources such as coal and natural gas	September 2009
Fischer-Tropsch Synthetic Kerosene with Aromatics (FT-SPKA)	Uses a variety of biomass, such as municipal solid, agricultural, or forest wastes; wood and energy crops; or fossil resources such as coal and natural gas	November 2015

**Note: Energy crops are low-cost, low-maintenance crops grown solely for energy production. Sources: FAA, "New Alternative Jet Fuel Approved," https://www.faa.gov/news/updates/?newsId=85425*

Alternative jet fuel usage becomes more feasible in terms of economics and infrastructure when the fuel developed is considered a "drop-in" alternative. This means that no changes to the aircraft need to be made to use the alternative fuel. In order for the approved fuels to reach drop-in compatibility, they are blended with conventional Jet A fuel at varying blend levels. **Table 5.10** shows the blend limitations necessary to achieve drop-in compatibility for the same five fuels as Table 5.9. As the table shows, the blend limitations vary from 10 percent to 50 percent, indicating that **some fuel alternatives may be more effective at reducing CO_2 emissions than others**. The blend limitation amounts shown in Table 5.10 demonstrate the percent of the SAF that is pure biofuel. The remaining percent of the total fuel is conventional Jet A fuel.

Table 5.10. Alternative Fuel Types and Blend Limitations

Alternative Fuel Type	Biofuel Blend Limitations
ATJ-SPK	30%
HFS-SIP	10%
HEFA-SPK	50%
FT-SPK	50%
FT-SPKA	50%

Source: Commercial Aircraft Propulsion and Energy System Research 2016

The efforts placed on deploying alternative jet fuel is not siloed to commercial service operations; in fact, the GA business community is similarly committed to implementing SAF into their operations where possible. GAMA established the following goals:

- To achieve carbon-neutral growth by 2020
- To improve fuel efficiency by two percent per year from 2010 until 2020
- To reduce CO_2 emissions by 50 percent by 2050 relative to 2005[85]

Achievements in these goals can be seen throughout the GA community that use jet fueled aircraft. In January 2019, members of the business aviation community and civic leaders of the Los Angeles area gathered at the Van Nuys Airport for a series of events related to SAF research and usage. The Van Nuys Airport became the first GA airport in the U.S to offer SAF on a trial basis and serves as a model for other

[85] https://docs.wixstatic.com/ugd/7730ab_d501d6feb5eb45e7b5a326111078412e.pdf

GA airports committed to providing SAF at their facilities.[86] Washington's bustling and well-established GA business community could provide opportunities for GA airports in the state to establish a similar SAF trial period, similar to the model created at the Van Nuys Airport. Washington hosted the Washington SAF Summit in March 2019, and one of the sessions at this summit directly related to business jet aviation and fuel logistics demonstrating Washington's commitment to pursue SAF options for both commercial service and GA sectors.[87]

While the GA business community is making progress in the advancements of alternative jet fuel solutions, those benefits are not carried over to the significant portion of GA operations conducted by piston engine aircraft. Most piston engine aircraft still rely on AvGas, also referred to as 100LL, which contains a toxic substance used to prevent engine knocking (detonation) called tetraethyllead (TEL). As environmental and health concerns grow for the impacts of AvGas usage, federal authorities have been working to find an appropriate alternative solution. The FAA established the Piston Aviation Fuel Initiative (PAFI), an initiative that aims to find a suitable unleaded fuel replacement for piston aircraft that satisfies safety and operational standards.

The most recent update on this effort provided by PAFI is from June 2019. PAFI has been conducting a wide range of testing at the William J Hughes Technical Center in New Jersey. The testing included an optimized Shell fuel and three other fuels not previously tested as part of the PAFI program. **None of the four alternative AvGas fuels were successful.** However, PAFI remains committed to testing all possible alternatives. Moreover, Shell is committed to further research and development to complete the refinements required to make a safe and viable unleaded AvGas alternative.[88]

5.4.2 Opportunities and Challenges

Washington has positioned itself well to be a pioneer state in the advancements of sustainable alternative fuels, yet there is still significant work to be done to transition SAF into more routine commercial and GA operations. Moreover, the advancements in finding alternative unleaded AvGas solutions have been minimal despite significant efforts and investment. The following subsections assess the opportunities and challenges associated with fully integrating alternative fuel solutions into airports and aircraft in Washington and across the country.

5.4.2.1 Financial

While there are many benefits associated with decarbonizing air travel, sustainable alternative fuels commercialization must grapple with a number of economic and market challenges. The prices associated with SAF can be considerably higher than conventional fuel types. As such, costs are often cited as a key reason for the industry's relatively slow adoption of the new technology and minimal large-scale production. According to the 2017 Port of Seattle Biofuel Final Report, the price of SAF is

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86 https://www.prnewswire.com/news-releases/civic-aviation-leaders-showcase-viability-of-alternative-jet-fuels-in-live-demo-300780540.html
87 https://www.washingtonsaf.org/
88 https://www.faa.gov/about/initiatives/AvGas/

approximately three times the price of conventional jet fuel.[89] High SAF costs are generally attributed to lack of infrastructure to produce the fuel in large quantities. SAF is currently produced in small quantities and therefore the cost is high. If production could be optimized for commercial distribution on the same level as Jet A fuel, then costs would likely decrease, and possibly become lower than Jet A fuel if production occurs domestically.

As SAF is produced as a drop-in fuel, there are no anticipated financial burdens associated with retrofitting current fuel farms or aircraft to accommodate this alternative fuel. Because fuel is the largest operating expense for airlines and the industry generally operates with relatively low profit margins, there is often little room for an airline to take on additional expenses without significantly increasing fees for end users (air fares). The feasibility study produced for Sea-Tac determined there are four potentially promising mechanisms that could help to assuage the cost of SAF implementation. Additionally, the Washington state petroleum products tax (PPT) and/or hazardous substance tax (HST) collected from aviation fuel sales could be used to fund airport infrastructure upgrades associated with SAF and electric aircraft. These potential funding mechanisms are listed in **Table 5.11**.

Table 5.11. Potential SAF Funding Mechanisms

Potential Funding Mechanism	Brief Description
Corporate Support	Corporations contribute to offset their flight emissions ($1 million to $2.5 million per year)
Port Taxing Authority	Funds support air quality benefits, similar to the Port's Clean Truck Program
Use of General Non-Aeronautical Revenue (requires FAA approval)	Use non-aeronautical fees and revenue sources that could be directed toward SAF co-benefits
Airline Agreement (requires FAA approval)	Implement a fund via the airline operating agreement that is not subject to revenue sharing, or create a new fee
PPT/HST	When collected for aviation fuels, the FAA requires that these Washington state taxes be used for airports or state aeronautics programs.

Sources: Port of Seattle Biofuel Finance Report July 2017; WSDOT 2020; Washington Department of Revenue 2020

The use of general, non-aeronautical revenue and airline agreement mechanisms generally require FAA approval. In addition, much of the success in procuring funds for SAF development is dependent on the ability to leverage co-benefits. Co-benefits are benefits produced by SAF that are not considered commercial profits such as benefits associated with air quality, reduction in GhG emissions, and regional economic development. It is important to focus on these co-benefits because public money cannot generally be used to fund a commodity that will primarily benefit a for-profit firm.

[89] https://www.portseattle.org/sites/default/files/2018-05/RMI_Sustainable_Aviation_Innovative_Funding_SAF_2017.pdf

While the cost of SAF may seem high at the onset of these advancements, there are many related economic opportunities associated with this emerging industry, particularly for Washington and neighboring Pacific Northwest states. As the international oil trade continues to demonstrate volatility, as discussed in the associated electric aircraft section, there are benefits to establishing a regional and domestic market for SAF in the Pacific Northwest states. In a state like Washington with many pro-environment leaders there could be opportunities to create policies that incentivize developments that aim to increase supply chain efficiencies for SAF production. A more efficient supply chain results in a lower cost of the product, which promotes an increased use of SAF if the cost is the same or less than traditional jet fuel. The reason for the economic benefits is associated with the large lumber and forest service management industries already in place in Washington, as one of the feedstocks used in the production of ASTM-certified SAF. It is not an uncommon practice for excess or remaining forest biomass to be collected and burned; instead, residual forest product could be processed and used for biofuel stock. Using residual forest matter as a feedstock does not compete with other foresting industries, air pollution is cut by reducing slash pile burning, residue removal prepares the forest floor for replanting, and the new need for the woody biomass collection and conversion creates jobs in rural economics.[90] As SAF demand increases over time, the demand for forest waste feedstocks will likely also increase, bringing more economic opportunities to foresting industries in Washington. Moreover, airlines that promote their usage of SAF could see an increase in passengers, as many users would opt to fly with airlines that are working toward being more environmentally friendly. This is seen with Alaska Airlines in Washington, who receives warm support from users in the state, and across the country, who are attracted to their environmentally friendly principles. Sea-Tac and Alaska Airlines could experience an increase in traffic due to their attractiveness to environmentally conscious consumers.

What if Upstream production costs limit demand for SAF due to high consumer costs?

Could we provide tax incentives or loan guarantees for investments to expand production in Washington?

Similar to SAF production, there are many financial opportunities related to alternative unleaded fuel solutions for piston aircraft. Cost of AvGas is more expensive than Jet A or motor vehicle gas (MoGas), lower supplies of leaded products and more stringent regulations on the distribution of leaded fuels have caused the price of AvGas to rise, further increasing pressure to develop a viable alternative for GA pilots. The limited number of global producers of TEL, an important ingredient in AvGas, is also a factor in rising prices and limited availability with no producers in the U.S. and a few in in the United Kingdom and China.

[90] https://blog.alaskaair.com/alaska-airlines/company-news/alaska-is-the-most-fuel-efficient-airline/

5.4.2.2 Environmental Considerations

Environmental benefits related to SAF usage are tracked on a lifecycle basis. Tracking GhG emission reduction on a lifecycle basis means the benefits are measured in the aggregate, and account for all emissions reductions associated with complete fuel production process as well as aircraft emissions. Using the lifecycle measurement, biomass-derived alternative fuels (from feedstocks) reduce emissions "since biomass-based hydrocarbons absorbed CO_2 from the atmosphere when they grew and the CO_2 emitted during fuel combustion is equal to that absorbed during its growth". A lifecycle analysis comparing bio-based aviation fuel pathways to traditional petroleum-based jet fuel production completed by Argonne National Laboratory showed that reductions in CO_2 from SAF production and use ranged from 41 to 89 percent when compared to traditional jet fuels.[91]

> *A lifecycle analysis comparing bio-based aviation fuel pathways to traditional petroleum-based jet fuel production showed that reductions in CO_2 from SAF production and use ranged from 41 to 89 percent when compared to traditional jet fuels.*

It is important to note that true emissions reductions depend on rate of production and utilization, which are functions of the fuel's commercial viability.[92] SAF is currently most feasible for widespread adoption when it is formulated as a drop-in fuel, which means it is not only meeting ASTM requirements but also easily integrated into existing infrastructure. When formulated as such, the chemical composition of SAF is typically equivalent or close to equivalent to traditional petroleum-based jet fuel. What this means is that the CO_2 from an engine burning SAF could be very comparable to the emissions from an aircraft using petroleum-based jet fuel. For this reason, benefits associated with SAF production and usage are measured on a lifecycle basis to equitably consider their true environmental benefits.

What if Lifecycle CO_2 emissions reduction do not make a positive environmental impact based on current production?

Could we support local SAF production that uses local feedstocks and refineries near areas of greatest demand?

5.4.2.3 Infrastructure Needs

Currently, only forms of drop-in SAF have been ASTM approved, which means there are few infrastructure needs pertaining to changes to fuel farms or aircraft engines. Because drop-in fuel alternatives perform like traditional jet fuels, they are generally supported by existing fuel farms and

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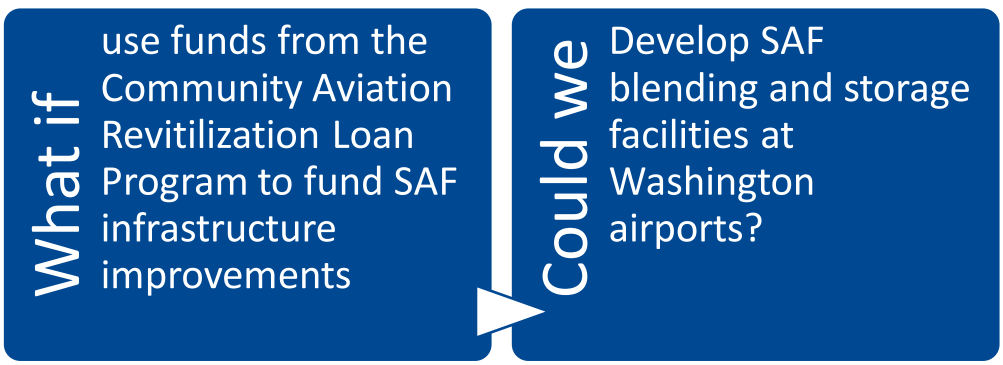
[91] https://www.nap.edu/read/23490/chapter/8#77
[92] https://www.nap.edu/read/23490/chapter/8#77

other fueling apparatuses and are compatible with turbine aircraft (not piston aircraft). Since drop-in SAF can be used with existing fuel systems, airports providing Jet A fuel can smoothly transition into the use of SAF.

> *Because SAF will be developed to be drop-in ready, airports that currently provide Jet A will be able to seamlessly transition to SAF with few or no modifications to existing infrastructure.*

If an airport does need upgrades to their fuel systems to support SAF they could apply to participate in WSDOT's new revolving loan program known as the Community Aviation Revitalization Board (CARB) Loan Program. Generally, a Washington airport cannot receive state funding to build a fuel farm or upgrade fueling infrastructure as these are revenue-generating projects. WSDOT's new revolving loan fund program through CARB is designed to provide loans for revenue-generating projects on airport property. The loan program was established in 2019 and provides $5 million in loan funding for public-use airports with less than 75,000 annual commercial enplanements. The funds can be used for revenue-generating projects that are not eligible under FAA nor existing state grant funding programs. The maximum amount of funding that can be provided per project is $750,000.[93]



While drop-in alternative fuels make it easy for airports, aircraft, and operators to adopt this emerging technology, concerns related to alternative fuel production do remain. Before SAF can become commonplace in the aviation industry, infrastructure and supply chain needs must first be established.

Figure 5.13 summarizes an example of the supply chain for SAF production. This example shows the blending of SAF and conventional jet fuel occurring after production; the blending process can also occur at existing petroleum refineries.[94]

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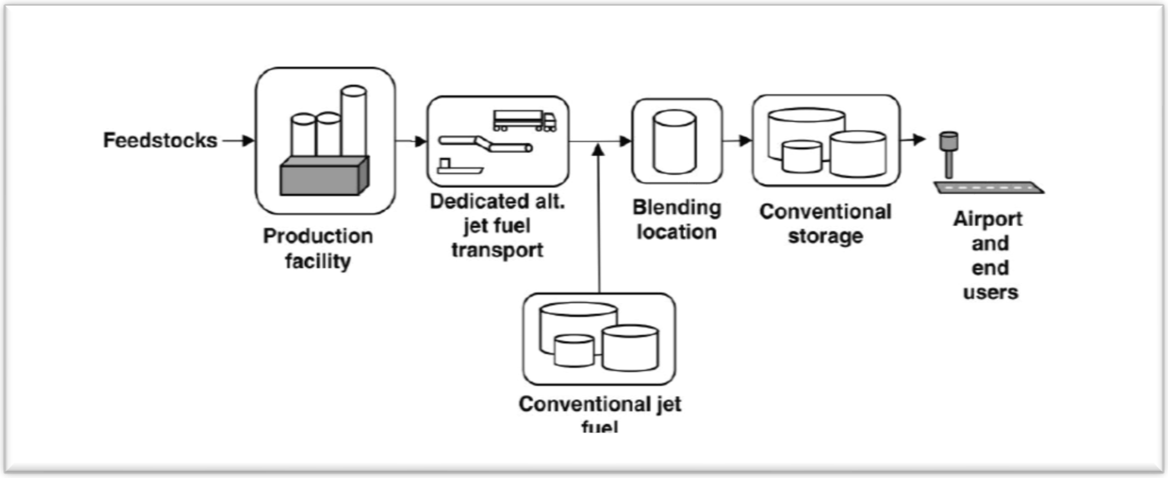
[93] Presentation to the Washington State Community Airports Association (October 2019). "Community Aviation Revitalization Loan Program."
[94] NREL, *An Overview of Aviation Fuel Markets for Biofuels Stakeholders.* July 2014

Figure 5.13. SAF Supply Chain



Source: ACRP 2012 as cited in NREL 2014

The U.S consumes an estimated 20 billion gallons of aviation fuel annually,[95] so it follows that any viable alternative fuel options must be able to meet a high level of demand for production and delivery. In 2017, the "Aviation Biofuels Infrastructure Feasibility Study" was published with an objective to identify sites that could provide Sea-Tac International Airport with up to 50 million gallons of SAF a year through multiple development phases of production, including receipt, blending, storage, and delivery. An aviation biofuel production plant was not considered for this study as it was considered too long-term for the study horizon (i.e., the study focused on short-term supply chain options). Feasible sites were chosen based on construction costs needed for infrastructure, environmental constraints, planning and permitting needs, and other contingencies that factored into final scoring and recommendations.[96] The three sites selected through this study are shown in **Table 5.12**.

Table 5.12. Sites for SAF Infrastructure for Sea-Tac

Site	Ownership	Zoning	Site Suitability
Sea-Tac Airport Fuel Farm	Port of Seattle (leased to Sea-Tac Fuel, LLC)	Aviation operations	– Existing jet fuel use – No rail access – Provides added truck offload capacity – Limited land available
Phillips 66/Olympic Pipeline Renton Terminal	Phillips 66 (one parcel) and Olympic Pipeline (one parcel) (ability to lease tanks and/or property)	Industrial	– Existing jet fuel use – Wetlands on west side of parcels – Rail access would require spur across other properties and wetlands
North-end Refinery	Various refineries	Industrial	– Existing jet fuel use – Existing rail and marine access

Source: "Aviation Biofuels Infrastructure Feasibility Study" Table 2 – Summary of Findings

[95] https://www.thomasnet.com/insights/imt/2012/10/02/world-aviation-industry-tries-to-overcome-green-fuel-hurdles/
[96] https://www.portseattle.org/sites/default/files/2018-03/Aviation_Biofuel_Infrastructure_Report_Condensed.pdf

The Sea-Tac study provides an understanding for the feasibility of creating effective supply chain infrastructure to support SAF usage at that particular airport while also providing guidance on the types of facilities generally needed to support SAF usage at commercial service and GA airports across the state. The study's findings offer a strong indication of the feasibility of SAF implementation in terms of storage and end use, however, major questions remain about production facilities. As a result, the most significant infrastructure needs are not associated with airport development, but instead on the development of local production facilities which retain maximum environmental benefits (i.e., environmental benefits erode as feedstocks are transported nationally or globally). Therefore, an ideal SAF production facility would have access to nearby feedstocks with year-round availability and/or have the capacity to store large quantities of the feedstocks at the production facility.

WSU has taken on the question of developing a regional SAF supply chain in inland Washington using lipids (i.e., oilseeds and FOG). The WSU team is currently evaluating potential regional oilseed production, identifying opportunities for hub-and-spoke-type supply chain, and assessing existing community assets that may facilitate future development.[97] This research project is being conducted via CAAFI in collaboration with the Massachusetts Institute of Technology and FAA Center of Excellence for Alternative Jet Fuels & Environment.[98]

5.4.2.4 Staff and Workforce

Another benefit to the drop-in component of SAF is that the current workforce involved in fueling operations at airports would likely see little disturbance, as those responsible for conventional jet fueling activities could easily transition to SAF operations. Moreover, since many potential feedstocks used in SAF production are associated with agricultural and foresting services, there are opportunities for job growth in these sectors, bolstering rural economic development. The demand for crop production would stimulate the rural economy and could generate additional revenue for local businesses. Moreover, additional transportation-sector jobs associated with crop delivery could generate economic opportunities in the region. Producing and using domestic feedstocks to generate SAF expands domestic energy production. According to a 2017 U.S Department of Energy report, bio-economy activities have directly generated $48 billion in revenue and created 285,000 jobs throughout the U.S.[99] It is anticipated that this sector will continue to grow both domestically and worldwide, with job growth occurring simultaneously.

> *The production of SAF presents new workforce opportunities for rural Washingtonians as demand for feedstocks produced in the state increases with commercial deployment of this emerging technology.*

[97] http://www.caafi.org/focus_areas/state_initiatives.html
[98] https://ascent.aero/participant/washington-state-university/
[99] https://www.energy.gov/sites/prod/files/2017/09/f37/bioeconomy_by_the_numbers_infographic.pdf

As the FAA remains committed to advancing the initiative to find alternative AvGas solutions, it can be expected the workforce involved in the research and development sector will grow or, at minimum, remain constant. It is difficult to project changes to the workforce for AvGas fueling operations without knowing what the alternative fuel could require. If the alternative AvGas requires retrofitting engines, job opportunities in the aircraft maintenance and mechanic sectors could increase.

What if WSDOT leverages a partnership with a local research facility through a higher education institution

Could we pursue research and development efforts for safe AvGas alternatives at Washington universities?

5.4.2.5 Mobility and Access

The ability of pilots and aircraft operators to have access to alternative jet fuel is highly dependent on the optimization of production and development processes. One factor that may increase access to SAF is the centralized nature of aviation operations. Approximately five percent of all airports handle 90 percent of international flights, which means even making SAF fueling available at a relatively small number of airports could prove very effective in reducing the GhG emissions associated with aviation operations.[100] International flights use the most fuel and Sea-Tac provides travel to 28 international destinations, meaning there is great opportunity for emissions reduction using SAF for these international flights. Moreover, Sea-Tac experiences the majority of commercial service and air cargo operations in the state. Sea-Tac is the ninth-busiest airport in the U.S.—handling an estimated 46.8 million passengers (enplaned and deplaned) and 425,860 metric tons of air cargo annually (2017 data). Approximately 11 percent of the airport's 23.3 million enplaned passengers in 2017 were on international non-stop flights to 20 countries around the globe.[101] Coupled with Sea-Tac being so far from East Coast markets, even a partial transition to SAF could make a big difference for flights originating in Washington.

The transition from traditional to alternative fuels may be particularly challenging for rural parts of the state due to new supply chains that would need to be established between producers of the fuels and airports. If rural airports have a difficult time accessing alternative fuels, it could prevent some aircraft from using those airports. This could lead to reduced mobility in areas where this fuel is unavailable, potentially exacerbating any aviation access issues for the state's rural residents and businesses.

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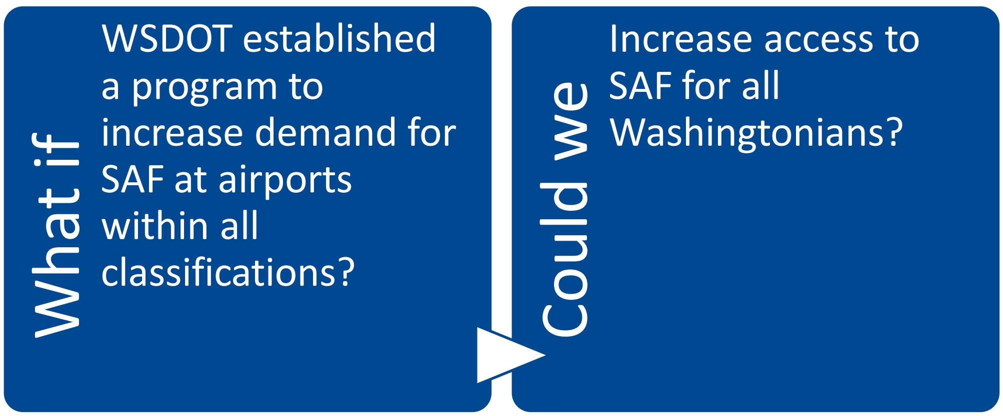
[100] https://www.iea.org/newsroom/news/2019/march/are-aviation-biofuels-ready-for-take-off.html
[101] Community Attributes, Inc. (January 2018). *Sea-Tac International Airport's Economic Impacts*. Available online at https://www.portseattle.org/sites/default/files/2018-02/180131_CAI_sea_tac_airport_economic_impacts.pdf (accessed December 2019).

While there are potentially several barriers impacting large-scale production of SAF, there is an opportunity for increased access by way of smart policy. A supportive policy foundation could alleviate some regulatory barriers and incentivize companies to pursue production facilities, in turn increasing accessibility to SAF in the future. The challenges associated with accessing SAF are currently tied to a lack of production and supply facilities—which may open new opportunities for private investors, research and development companies working in the biomass or feedstock production sectors, agricultural businesses, refineries, and others to optimize the process of producing and suppling these alternative biofuels.



Pilots and passengers who rely on the piston-powered GA fleet are at risk of mobility and access concerns due to potentially decreased access to 100LL fuels over time. With tightening regulations, few manufactures producing TEL, and other factors, the cost of AvGas has risen over time. As costs rise, pilots' and passengers' abilities to access the benefits of piston-powered GA flying will likely decrease. This could be particularly problematic for rural areas, who may rely on these aircraft to access valuable quality of life benefits associated with various types of GA flying. However, the GA community feels confident that leaded fuel will not be removed from the market until there is a feasible alternative in place.

5.4.2.6 Safety

Safety is the most critical factor to any aspect of the aviation industry and considered a top priority for every airport, aircraft, operator, and manufacturer. While developing any alternative fuel, whether it be alternative biofuel for jet aircraft or unleaded alternatives for piston engine aircraft, safety implications are of the upmost importance. Therefore, it is no surprise that the ASTM requirements for SAF standards, published in the ASTM D7566-11, details a lengthy process for getting a SAF product approved for use. Alternative biofuels go through rigorous, exhaustive, and resource-intensive testing programs before meeting ASTM standards. Jet fuels currently approved by ASTM procedures are all drop-in ready, which means there are no major safety concerns for using these fuel alternatives. While there may be some factors limiting an extensive roll out for SAF, factors related to performance and safety are not among them. Moreover, approval procedures for SAF usage are overseen by several civil aviation authorities, aviation industry stakeholders, engine manufacturers, and original equipment manufacturers (OEMs). Beyond that, the world's leading aviation authorities, including the FAA, European Aviation Safety Agency (EASA), and others, have provided guidance for safe SAF usage. [102]

What if WSDOT created a public outreach campaign to educate users and pilots that safety and functionality with SAF is the same as with traditional jet fuel?

Could we Increase the widespread adaption of SAF?

One of the major challenges in transitioning away from unleaded fuels for piston aircraft is related to safety. The lead additive TEL is necessary to have enough octane level in the fuel to prevent engine knocking, which can lead to sudden engine failure. Octane level is not a measure of the energy in the fuel, but rather a measure of the fuel's resistance to detonation; therefore, it is extremely important for AvGas to have adequate octane levels. There are four different ways to measure an octane level, but for reference the Lean Mixture rating is 100 octanes for AvGas. Removing TEL from the fuel reduces the Lean Mixture level to 80, which is not a high enough octane level for safe operations. Alternative AvGas fuels have failed to be a feasible alternative because they are not reaching the necessary octane level to reach the level of safety provided by leaded AvGas. To date, there are no alternative additives that can be used to improve the octane level of AvGas, which means the options for safe fuel alternatives are limited.

If leaded AvGas were to be phased out the only other option for piston aircraft operators would be to replace the engine type. At this time, the complete overhaul of piston engines across the country is not a feasible option to replace the use of AvGas.[103] Recent developments in electric aircraft engines may eventually nullify the need for a non-leaded alternative fuel for piston-powered aircraft. Manufacturers in Washington are already retrofitting small GA aircraft with electric engines, which may prove a more technologically feasible and economical fuel alternative for piston aircraft owners and pilots. Additional information about the emergence of electric aircraft is available in an associated section developed as part of the Washington AEIS.

[102] https://www.ebaa.org/app/uploads/2018/05/14271-BBA-Business-Aviation-Guide-to-SAJF-A4_MAY-2018_PROOF.pdf
[103] https://www.shell.com/business-customers/aviation/aeroshell/knowledge-centre/technical-talk/techart12-30071515.html

5.4.3 Summary of Alternative Aviation Fuel Considerations

Alternative fuel solutions are paramount in tackling the aviation industry's goal of reducing carbon and other GhG emissions. Demand for air transportation for business, recreation, cargo, military, and other needs are not going away; in fact, demand for air travel is on the rise due to globalization and other worldwide trends. Therefore, the industry needs to be proactive about feasible alternative fuel solutions that can still meet current and future demand while decreasing CO_2 emissions. ASTM-certified SAF is already in-use today, but in relatively small quantities. As SAF has yet to reach optimal production levels, there are barriers to widespread commercialization. In particular, the end user price for SAF exceeds that of traditional jet fuel due to high production costs.

> *SAF production has the potential to boost rural economies and reduce GhG emissions which will improve air quality and mitigate the many health and environmental issues associated with global climate change.*

While barriers do exist, the benefits of SAF are great in terms of economic, social, and environmental benefits. SAF production has the potential to boost rural economies across the U.S. through new agricultural opportunities for feedstock production. This could create new jobs for agricultural and timber workers, as well as a new marketplace for materials that had previously been considered "waste". Moreover, the social and environmental benefits of reducing Jet A carbon emissions are seen through increased air quality, reduction in health problems associated with particulate matter from these emissions, and slowing or reducing the potential health and environmental impacts of global climate change. As discussed in **Section 5.1.2.2**, an estimated 22 to 50 percent of travelers have reduced their reliance on air travel due to environmental concerns. The number of environmentally concerned travelers may increase following the COVID-19 outbreak as people experience the air quality improvements associated with reduced fossil fuel-powered travel (by air and ground). SAF offers a viable alternative by providing the advantages of air travel without the resultant emissions. Its marketability to travelers may entice more airlines to use sustainable bio-fuels in their commercial fleets and create the economies of scale necessary to reduce costs. As a result—in addition to workforce development opportunities—SAF may play an important role in maintaining a vibrant and prosperous commercial air service market, particularly in the post-COVID-19 era of air travel. Furthermore, the FAA and EPA are committed to reducing the aviation industry's carbon footprint, so it is likely that SAF usage will continue to increase over time, with the ultimate goal of full commercial adaption.

While advancements in alternative jet fuel solutions are evident, the alternative solutions for leaded AvGas are still in progress, with no alternative unleaded aviation fuel for piston aircraft existing to date. However, the FAA through the PAFI group have made several findings that will be used in a continuing effort to create a drop-in ready unleaded aviation fuel for the piston engine GA community. It is important to continue working to find a feasible fuel alternative for this community to phase out the use of leaded aviation fuel. Similar to SAF discussed above, an AvGas alternative may bring new pilots into aviation, as the environmental and health concerns of leaded fuel may be a deterrent to some sustainably minded potential flyers.

Table 5.13 summarizes the potential economic impacts of alternative aviation fuels in Washington in terms of the key focus areas presented in this paper.

Table 5.13. Summary of Economic Impacts of Alternative Aviation Fuels in Washington

Potential Area of Economic Impact	Potential Type of Economic Impact	Description of Impact
Financial (On- and Off-Airport)	Positive and Negative	Due to limited production and supply facilities, SAF is currently more expensive than conventional aviation fuels. Costs are anticipated to decrease over time as levels of supply and demand shift with widespread commercial adoption. Prices will not experience the same volatility as conventional (i.e., fossil) fuels.
Environmental	Positive	CO_2 emissions are anticipated to decrease an estimated 41 to 89 percent as compared to conventional fuels when analyzed on a lifecycle basis. A lead-free AvGas alternative will be significant better in terms of air quality and human health.
Infrastructure	Neutral	SAFs are anticipated to be formulated to be drop-in ready, requiring no modifications to existing infrastructure. Additional infrastructure may be required during the transition from conventional to alternative fuels for blending. Some airports may provide both conventional fuel and SAF during the transition period before fleet wide adoption to support all aircraft operators.
Staff & Workforce	Positive	Existing support staff are anticipated to provide aircraft fuel services for SAF. New opportunities may be created in rural areas for feedstock production.
Mobility & Access	Neutral	Because SAFs are drop-in ready, existing levels of aviation access and transportation mobility should be maintained across the state.
Safety	Neutral	Alternative aviation fuels undergo the same rigorous ASTM testing procedures as conventional fuel to provide the same level of safety regardless of type.

Source: Kimley-Horn 2019

5.5 Summary

Considering the variety of benefits associated with some of the leading emerging technologies in the industry, the future of aviation is promising, especially in Washington. Each technology offers new opportunities to enhance economic development, vitality, strength, and diversity in the state. Alternative jet fuels and electric aircraft could lead to a reduction in the industry's GhG emissions and contribute to a cleaner and more sustainable transportation sector. This in turn may result in a resurgence of air travel, particularly in the post-COVID-19 recovery era as air travelers feel the effects of improved air quality. Electric aircraft, UAS, and UAM applications have the potential to promote mobility between regions—particularly for connecting rural and urban populations—and decrease traffic congestion in urban centers. This could lead to new business partnerships, improved access to jobs and educational opportunities, and more productive hours as less time is spent in transit. Electric aircraft may enhance intrastate mobility and connect more residents and businesses to markets both within the state and across the globe. Electricity is also cheaper than fossil fuels. Washington enjoys some of the nation's cheapest electricity due inexpensive and abundant hydropower. Costs are generally stable, putting investors and consumers at significantly less risk for unexpected price spikes and drops. These factors could improve access to aviation services and may provide a promising solution to increasing east/west connectivity in Washington. Economic impacts could increase should additional out of state and international travelers visit Washington. On- and off-airport aerospace jobs may also increase if these new technologies are developed, tested, and/or manufactured in the state. Air and landside improvement projects necessary to support additional based aircraft, operations, and travelers could result in temporary construction spending impacts.

While the potential financial impacts of emerging technologies are diverse, there are also several challenges that need to be addressed before full-scale deployment. From a financial perspective, job growth in one sector may result in losses in another. Deliveries conducted by UAV could replace ground-based delivery services and leave an entire segment of the existing workforce without a viable alternative for employment without additional training. Electric-powered vehicles may compete with other electricity consumers, either driving up prices or causing brownouts should the grid be ill-prepared to keep up with new demands. Transmission infrastructure may need to be upgraded, which is neither an inexpensive nor quick process—particularly if lines need to be constructed on or near private or environmentally sensitive areas. Lost fuel revenues could affect current levels of investment into airports, forcing state policymakers, WSDOT Aviation, and airports to work together to find new revenue streams and funding mechanisms to align policy with emerging aviation technologies. Budgets may be particularly stretched should additional maintenance and/or capacity improvements be warranted if operations increase in the state.

These challenges should not be considered obstacles to the integration of new technologies into the existing system. Instead, considering and implementing solutions now—before issues do arise—gives WSDOT Aviation and airports the opportunity to maximize the many benefits associated electric aircraft, UAM, UAV, and alternative aviation fuels. Proactive planning is key to resiliency and leveraging opportunities as they arise instead of struggling to adapt. Each one of these technologies brings with it an exciting new market waiting to be established. As these technologies enter commercial viability, it will be important to consider and develop solutions to mitigate potential challenges related to public support and awareness, high initial investments, underdeveloped or undeveloped infrastructure, supply chains, and integration into the existing airspace system. Despite these challenges, Washington's strong aviation and aerospace manufacturing industry and established technology sector make it well positioned to optimize on opportunities associated with these emerging trends.

> *Washington's strong aviation and aerospace manufacturing industries and established technology sector make it well positioned to optimize opportunities associated with emerging aviation trends.*

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Appendix A. IMPLAN I/O Model

The IMPLAN package consists of an I/O model and a database.[1] The IMPLAN I/O model was used to quantify the impact of continued re-circulation of direct business revenues resulting from on-airport activities (airport operation and airport tenants) and off-airport activities (visitor spending, agriculture-related activity, and production for air cargo). IMPLAN is now the most-widely used I/O economic modeling system in the U.S. It utilizes data from the following sources:

- National Income and Product Accounts (NIPA) from the U.S. Department of Commerce that traces inter-industry technology relationships (also known as I/O structural matrices)
- Countywide employment and income data from the BEA
- Bureau of Labor Statistics (BLS) from the U.S. Department of Labor
- IMPLAN's calculated industry and county-specific estimates of local purchasing rates ("local purchase percentage") which includes coverage of public sector activity and consumer activity as reflected in its "social accounting matrix"[2]

The industry detail for the 2017 IMPLAN package is at the level of 536 industries and is based on BEA categories, which correspond to two to four-digit groups in the North American Industrial Classification System (NAICS).[3] IMPLAN can be used to profile and model regional economies based on zip codes, counties and states in the U.S., and at the national level.

The database provided in the IMPLAN package includes jobs, labor income, value added, and business revenues (also known as output) for each of the 536 industries in a chosen region. When an industry is not present in a region, the line item still is provided but values are reflected as zero. [4]

Using these data, specific missing direct values can be imputed such as when collected data includes jobs but not labor income or business revenues, or when data include business revenues but not jobs or labor income. In these circumstances IMPLAN data can be used to fill in missing values specific to the associated region and airport based on regional averages.[5] Value added is always computed using the IMPLAN model because survey respondents generally are not aware of the value added that their business or activity generate. The use of IMPLAN for attribution or imputation of missing direct values was discussed and described during the study process.

[1] IMPLAN, LLC (formerly the Minnesota IMPLAN Group).
[2] All U.S. I/O models develop local purchasing rates based on annual National Income and Product Account tables produced by the Bureau of Economic Analysis (BEA, a bureau within the U.S. Department of Commerce) and from benchmark industry surveys that are conducted every five years by the BEA
[3] Typically, IMPLAN, and all I/O models and federal and state data bases have at least a 1-2-year lag time to allow for data collection, publication and integration into models. In using the 2017 IMPLAN model, dollars were adjusted to 2018 values.
[4] In this study, "regions" are defined as aggregation of Washington counties in the WSDOT regions, and the state of Washington.
[5] In some cases, a survey could report an industry that is missing in the regional data base (reported with values as zero). In those circumstances state averages can be used.

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Appendix B. Economic Impacts of Washington Airports by Airport

Appendix B of the Washington Aviation Economic Impact Study (AEIS) provides the numerical economic impacts of each Washington airport in the scope of this study in terms of the following:

- Table B.1. Economic Impacts by Type – Direct Economic Impacts
- Table B.2. Economic Impacts by Type – Supplier Sales
- Table B.3. Economic Impacts by Type – Re-spending of Worker Income
- Table B.4. Economic Impacts by Type – Total Economic Impacts of Washington Airports
- Table B.5. Washington Tax Revenues by Type

For additional information about results presented in this appendix as well as definitions of terminology used, please see **Chapter 1. Methodology**. Consolidated statewide results are presented in **Chapter 2. Economic Impacts of Washington Airports**.

Note the economic impacts of Seattle-Tacoma International Airport (Sea-Tac or SEA) were obtained from the "Sea-Tac International Airport Economic Impacts" study (Community Attributes, Inc., January 2018) conducted by the Port of Seattle. As such, while the total economic impacts of Washington airports include Sea-Tac, impacts for Sea-Tac were not independently calculated nor validated as part of the Washington AEIS. Additionally, the Sea-Tac study did not calculate value added as a component of economic impact. As a result, this measure of economic impact cannot be presented at the statewide level in the Washington AEIS.

Table B.1. Economic Impacts by Type – Direct Economic Impacts

Associated City	Airport Name	FAA ID	Direct Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Commercial Service[1]						
Bellingham	Bellingham International	BLI	1,668	$97,685,000	$163,039,000	$269,878,000
East Wenatchee	Pangborn Memorial	EAT	652	$30,623,000	$48,133,000	$148,702,000
Friday Harbor	Friday Harbor	FHR	197	$16,683,000	$31,186,000	$53,015,000
Kenmore	Kenmore Air Harbor Inc.	S60	160	$10,404,000	$14,502,000	$22,532,000
Pasco	Tri-Cities	PSC	1,467	$57,105,000	$98,846,000	$169,002,000
Pullman	Pullman/Moscow Regional	PUW	581	$26,579,000	$41,706,000	$76,050,000
Seattle	Boeing Field/King County International	BFI	7,837	$784,258,000	$896,705,000	$1,553,509,000
Seattle[2]	Sea-Tac International Airport	SEA	87,300	$74,470,000	N/A	$352,827,000
Seattle	Kenmore Air Harbor	W55	214	$9,005,000	$13,121,000	$20,193,000
Spokane	Spokane International (Geiger Field)	GEG	7,605	$316,081,000	$538,046,000	$902,334,000
Walla Walla	Walla Walla Regional	ALW	732	$34,525,000	$67,309,000	$142,265,000
Yakima	Yakima Air Terminal (McAllister Field)	YKM	1,040	$77,311,000	$150,928,000	$360,900,000
GA						
Anacortes	Skyline SPB	21H	5	$525,000	$633,000	$1,027,000
Anacortes	Anacortes	74S	15	$885,000	$1,730,000	$3,739,000
Anatone	Rogersburg State	D69	1	$7,000	$10,000	$17,000
Arlington	Arlington Municipal	AWO	1,194	$91,738,000	$232,883,000	$437,252,000
Auburn	Auburn Municipal	S50	120	$8,614,000	$14,341,000	$24,812,000
Bandera	Bandera State	4W0	1	$17,000	$22,000	$35,000
Battle Ground	Goheen Field	W52	1	$7,000	$10,000	$17,000
Battle Ground	Cedars North Airpark	W58	1	$7,000	$10,000	$17,000
Bellingham	Floathaven SPB	0W7	9	$834,000	$1,396,000	$3,295,000
Bremerton	Bremerton National	PWT	2,263	$170,685,000	$231,949,000	$544,139,000
Brewster	Anderson Field	S97	5	$256,000	$358,000	$677,000

Associated City	Airport Name	FAA ID	Direct Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Burlington	Skagit Regional	BVS	156	$13,952,000	$23,050,000	$40,094,000
Camas	Grove Field	1W1	10	$1,040,000	$1,989,000	$3,685,000
Cashmere	Cashmere-Dryden	8S2	5	$325,000	$541,000	$1,433,000
Chehalis	Chehalis-Centralia	CLS	1,188	$40,664,000	$65,603,000	$105,702,000
Chelan	Lake Chelan	S10	37	$1,055,000	$1,815,000	$4,271,000
Chewelah	Chewelah Municipal	1S9	4	$190,000	$246,000	$459,000
Clayton	Cross Winds	C72	1	$87,000	$103,000	$181,000
Cle Elum	De Vere Field	2W1	3	$188,000	$241,000	$447,000
Cle Elum	Cle Elum Municipal	S93	2	$86,000	$126,000	$228,000
Colfax	Lower Granite State	00W	1	$9,000	$12,000	$21,000
Colfax	Port of Whitman Business Air Center	S94	24	$909,000	$1,541,000	$4,030,000
College Place	Martin Field	S95	5	$349,000	$440,000	$804,000
Colville	Colville Municipal	63S	2	$63,000	$91,000	$160,000
Concrete	Mears Field	3W5	8	$224,000	$398,000	$663,000
Copalis Beach	Copalis State	S16	1	$17,000	$20,000	$36,000
Dalles, OR	Columbia Gorge Regional/The Dalles Municipal	DLS	110	$11,256,000	$21,954,000	$41,405,000
Darrington	Darrington Municipal	1S2	1	$24,000	$34,000	$57,000
Davenport	Davenport Municipal	68S	5	$149,000	$207,000	$397,000
Deer Park	Deer Park Municipal	DEW	64	$1,930,000	$3,210,000	$5,463,000
Easton	Easton State	ESW	1	$17,000	$21,000	$38,000
Eastsound	Orcas Island	ORS	38	$2,805,000	$4,933,000	$8,424,000
Eatonville	Swanson Field	2W3	7	$503,000	$1,087,000	$2,630,000
Electric City	Grand Coulee Dam	3W7	5	$169,000	$242,000	$434,000
Ellensburg	Bowers Field	ELN	121	$6,250,000	$10,520,000	$23,367,000
Elma	Elma Municipal	4W8	7	$357,000	$489,000	$859,000

Associated City	Airport Name	FAA ID	Direct Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Ephrata	Ephrata Municipal	EPH	52	$3,063,000	$4,850,000	$9,272,000
Everett[1]	Snohomish County (Paine Field)	PAE	46,353	$7,036,773,000	$17,022,537,000	$40,732,531,000
Forks	Forks Municipal	S18	3	$73,000	$109,000	$187,000
Forks	Quillayute	UIL	28	$1,757,000	$2,798,000	$4,375,000
Friday Harbor	Friday Harbor SPB	W33	19	$1,931,000	$2,338,000	$3,787,000
Goldendale	Goldendale Municipal	S20	1	$2,000	$4,000	$6,000
Greenwater	Ranger Creek State	21W	1	$19,000	$26,000	$45,000
Hoquiam	Bowerman Field	HQM	47	$1,952,000	$3,107,000	$4,848,000
Ilwaco	Port of Ilwaco	7W1	1	$5,000	$8,000	$13,000
Ione	Ione Municipal	S23	3	$23,000	$35,000	$63,000
Kahlotus	Lower Monumental State	W09	1	$15,000	$18,000	$33,000
Kelso	Southwest Washington Regional	KLS	54	$4,590,000	$9,114,000	$17,096,000
Kent	Norman Grier Field (Crest Airpark)	S36	66	$3,248,000	$4,474,000	$7,046,000
Lakewood	American Lake SPB	W37	1	$3,000	$5,000	$8,000
Langley	Whidbey Airpark	W10	10	$874,000	$1,727,000	$2,952,000
Laurier	Avey Field	69S	1	$4,000	$6,000	$10,000
Leavenworth	Lake Wenatchee State	27W	1	$17,000	$19,000	$32,000
Lester	Lester State	15S	1	$7,000	$9,000	$15,000
Lind	Lind Municipal	0S0	5	$263,000	$272,000	$332,000
Lopez	Lopez Island	S31	7	$336,000	$481,000	$870,000
Lynden	Lynden Municipal Airport - Jansen Field	38W	3	$166,000	$215,000	$343,000
Mansfield	Mansfield	8W3	3	$285,000	$316,000	$2,444,000
Mattawa	Desert Aire	M94	20	$2,236,000	$2,465,000	$4,036,000
Mazama	Lost River	W12	1	$115,000	$127,000	$210,000
Mead	Mead Flying Service	70S	7	$348,000	$464,000	$835,000
Metaline Falls	Sullivan Lake State	09S	1	$20,000	$25,000	$44,000

Associated City	Airport Name	FAA ID	Direct Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Monroe	First Air Field	W16	14	$732,000	$1,009,000	$1,601,000
Morton	Strom Field	39P	5	$292,000	$384,000	$644,000
Moses Lake	Grant County International	MWH	1,359	$109,989,000	$223,907,000	$674,856,000
Moses Lake	Moses Lake Municipal	W20	52	$2,979,000	$4,354,000	$9,689,000
Oak Harbor	A J Eisenberg	OKH	44	$3,213,000	$4,346,000	$7,440,000
Ocean Shores	Ocean Shores Municipal	W04	6	$288,000	$389,000	$724,000
Odessa	Odessa Municipal	43D	7	$414,000	$546,000	$1,040,000
Okanogan	Okanogan Legion	S35	3	$60,000	$80,000	$155,000
Olympia	Hoskins Field	44T	1	$4,000	$5,000	$9,000
Olympia	Olympia Regional	OLM	265	$18,696,000	$30,160,000	$61,388,000
Omak	Omak Municipal	OMK	24	$1,617,000	$2,606,000	$6,277,000
Oroville	Dorothy Scott Municipal	0S7	5	$175,000	$269,000	$433,000
Othello	Othello Municipal	S70	13	$557,000	$632,000	$905,000
Packwood	Packwood	55S	6	$319,000	$432,000	$776,000
Point Roberts	Point Roberts Airpark	1RL	1	$7,000	$11,000	$17,000
Port Angeles	Sekiu	11S	2	$4,000	$5,000	$9,000
Port Angeles	William R Fairchild International	CLM	104	$4,546,000	$7,924,000	$14,870,000
Port Townsend	Jefferson County International	0S9	76	$2,628,000	$4,237,000	$7,680,000
Poulsbo	Port of Poulsbo Marina SPB	83Q	0	$0	$0	$0
Puyallup	Pierce County - Thun Field	PLU	145	$8,109,000	$13,107,000	$26,206,000
Quincy	Quincy Municipal	80T	1	$14,000	$22,000	$36,000
Renton	Renton Municipal	RNT	10,201	$1,587,526,000	$3,842,378,000	$9,292,768,000
Renton	Will Rogers Wiley Post SPB	W36	1	$8,000	$11,000	$18,000
Republic	Ferry County	R49	2	$105,000	$142,000	$282,000
Richland	Richland	RLD	370	$25,579,000	$34,555,000	$63,554,000
Richland	Prosser	S40	178	$4,252,000	$6,305,000	$12,257,000

Associated City	Airport Name	FAA ID	Direct Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Rimrock	Tieton State	4S6	1	$10,000	$13,000	$23,000
Ritzville	Pru Field	33S	3	$216,000	$279,000	$529,000
Roche Harbor	Roche Harbor SPB	W39	6	$641,000	$774,000	$1,256,000
Rochester	R & K Skyranch	8W9	1	$4,000	$6,000	$11,000
Rosalia	Rosalia Municipal	72S	5	$276,000	$368,000	$692,000
Rosario	Rosario SPB	W49	70	$7,323,000	$8,818,000	$14,306,000
Seattle	Seattle Seaplanes SPB	0W0	2	$39,000	$57,000	$89,000
Sequim	Sequim Valley	W28	7	$224,000	$336,000	$583,000
Shelton	Sanderson Field	SHN	439	$23,052,000	$70,952,000	$178,088,000
Silverdale	Apex Airpark	8W5	2	$224,000	$410,000	$951,000
Skykomish	Skykomish State	S88	1	$36,000	$44,000	$71,000
Snohomish	Harvey Field	S43	368	$14,371,000	$27,558,000	$46,143,000
South Bend	Willapa Harbor	2S9	1	$23,000	$29,000	$49,000
Spokane	Felts Field	SFF	264	$15,383,000	$25,405,000	$46,148,000
Stanwood	Camano Island Airfield	13W	7	$667,000	$821,000	$1,291,000
Starbuck	Little Goose Lock and Dam State	16W	1	$12,000	$15,000	$26,000
Stehekin	Stehekin State	6S9	1	$15,000	$18,000	$29,000
Sunnyside	Sunnyside Municipal	1S5	25	$1,221,000	$1,688,000	$3,036,000
Tacoma	Tacoma Narrows	TIW	307	$15,443,000	$32,184,000	$88,525,000
Tekoa	Willard Field	73S	4	$212,000	$278,000	$520,000
Toledo	South Lewis County (Ed Carlson Memorial Field)	TDO	23	$1,404,000	$2,227,000	$3,962,000
Tonasket	Tonasket Municipal	W01	4	$453,000	$500,000	$824,000
Twisp	Twisp Municipal	2S0	2	$46,000	$67,000	$114,000
Vancouver	Pearson Field	VUO	191	$7,802,000	$12,995,000	$23,152,000
Vancouver	Fly For Fun	W56	2	$35,000	$56,000	$93,000

Associated City	Airport Name	FAA ID	Direct Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Vashon Island	Vashon Municipal	2S1	2	$136,000	$183,000	$316,000
Walla Walla	Page	9W2	1	$0	$1,000	$1,000
Warden	Warden	2S4	1	$13,000	$20,000	$33,000
Waterville	Waterville	2S5	11	$623,000	$742,000	$1,291,000
Westport	Westport	14S	6	$400,000	$506,000	$941,000
Wilbur	Wilbur Municipal	2S8	24	$1,108,000	$1,221,000	$1,684,000
Wilson Creek	Wilson Creek	5W1	3	$213,000	$257,000	$467,000
Winthrop	Methow Valley State	S52	37	$2,366,000	$3,459,000	$6,222,000
Woodland	Woodland State	W27	2	$27,000	$39,000	$63,000
Sub Total (Excluding SEA)			88,973	$10,740,711,000	$24,111,467,000	$56,375,293,000
Total (Including SEA)[3]			**176,273**	**$14,391,508,000**	**N/A**	**$67,856,591,000**

Totals may not sum due to rounding. Notes: (1) Snohomish County (Paine Field) began scheduled commercial passenger service in 2019 after the 2018 study year of the Washington AEIA. As such, the airport was analyzed as a GA airport in the Washington AEIS. (2) Impacts of Sea-Tac obtained from the "Sea-Tac International Airport Economic Impacts" study (Community Attributes, Inc., January 2018) conducted by the Port of Seattle. (3) Because value added was not calculated for Sea-Tac, this measure cannot be reported at the statewide level. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Airline Data, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table B.2. Economic Impacts by Type – Supplier Sales

Associated City	Airport Name	FAA ID	Supplier Sales			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Commercial Service						
Bellingham	Bellingham International	BLI	561	$30,466,000	$50,524,000	$99,555,000
East Wenatchee	Pangborn Memorial	EAT	297	$20,524,000	$32,880,000	$58,094,000
Friday Harbor	Friday Harbor	FHR	128	$7,465,000	$11,940,000	$22,890,000
Kenmore	Kenmore Air Harbor Inc.	S60	62	$3,210,000	$5,095,000	$9,266,000
Pasco	Tri-Cities	PSC	300	$18,968,000	$33,026,000	$54,039,000
Pullman	Pullman/Moscow Regional	PUW	141	$9,276,000	$14,919,000	$24,819,000
Seattle	Boeing Field/King County International	BFI	5,193	$253,969,000	$369,201,000	$676,174,000
Seattle[1]	Sea-Tac International Airport	SEA	N/A	$1,251,400,000	N/A	$4,451,800,000
Seattle	Kenmore Air Harbor	W55	48	$2,592,000	$4,167,000	$7,761,000
Spokane	Spokane International (Geiger Field)	GEG	1,716	$110,949,000	$179,136,000	$292,791,000
Walla Walla	Walla Walla Regional	ALW	285	$18,957,000	$30,462,000	$50,808,000
Yakima	Yakima Air Terminal (McAllister Field)	YKM	606	$44,990,000	$68,069,000	$116,227,000
GA						
Anacortes	Skyline SPB	21H	3	$178,000	$254,000	$447,000
Anacortes	Anacortes	74S	6	$335,000	$542,000	$1,082,000
Anatone	Rogersburg State	D69	0	$3,000	$4,000	$7,000
Arlington	Arlington Municipal	AWO	686	$39,930,000	$64,429,000	$123,606,000
Auburn	Auburn Municipal	S50	52	$2,912,000	$4,770,000	$9,663,000
Bandera	Bandera State	4W0	0	$6,000	$8,000	$15,000
Battle Ground	Goheen Field	W52	0	$2,000	$4,000	$6,000
Battle Ground	Cedars North Airpark	W58	0	$2,000	$3,000	$6,000
Bellingham	Floathaven SPB	0W7	6	$332,000	$509,000	$1,021,000
Bremerton	Bremerton National	PWT	982	$70,247,000	$107,539,000	$187,180,000
Brewster	Anderson Field	S97	1	$77,000	$128,000	$214,000

Associated City	Airport Name	FAA ID	Supplier Sales			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Burlington	Skagit Regional	BVS	69	$4,005,000	$6,232,000	$11,870,000
Camas	Grove Field	1W1	6	$415,000	$627,000	$1,085,000
Cashmere	Cashmere-Dryden	8S2	2	$144,000	$233,000	$398,000
Chehalis	Chehalis-Centralia	CLS	181	$11,787,000	$21,622,000	$34,927,000
Chelan	Lake Chelan	S10	6	$432,000	$670,000	$1,144,000
Chewelah	Chewelah Municipal	1S9	1	$65,000	$100,000	$165,000
Clayton	Cross Winds	C72	0	$33,000	$47,000	$76,000
Cle Elum	De Vere Field	2W1	1	$62,000	$93,000	$154,000
Cle Elum	Cle Elum Municipal	S93	0	$26,000	$45,000	$74,000
Colfax	Lower Granite State	00W	0	$4,000	$5,000	$9,000
Colfax	Port of Whitman Business Air Center	S94	12	$798,000	$1,258,000	$2,378,000
College Place	Martin Field	S95	2	$127,000	$188,000	$307,000
Colville	Colville Municipal	63S	0	$23,000	$37,000	$61,000
Concrete	Mears Field	3W5	1	$80,000	$134,000	$275,000
Copalis Beach	Copalis State	S16	0	$7,000	$10,000	$16,000
Dalles, OR	Columbia Gorge Regional/The Dalles Municipal	DLS	67	$4,941,000	$7,507,000	$12,594,000
Darrington	Darrington Municipal	1S2	0	$6,000	$11,000	$21,000
Davenport	Davenport Municipal	68S	1	$48,000	$77,000	$130,000
Deer Park	Deer Park Municipal	DEW	12	$720,000	$1,181,000	$1,937,000
Easton	Easton State	ESW	0	$7,000	$10,000	$15,000
Eastsound	Orcas Island	ORS	21	$1,178,000	$1,882,000	$3,568,000
Eatonville	Swanson Field	2W3	4	$334,000	$521,000	$967,000
Electric City	Grand Coulee Dam	3W7	1	$53,000	$88,000	$146,000
Ellensburg	Bowers Field	ELN	42	$2,917,000	$4,824,000	$8,182,000
Elma	Elma Municipal	4W8	2	$129,000	$203,000	$346,000

Associated City	Airport Name	FAA ID	Supplier Sales			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Ephrata	Ephrata Municipal	EPH	14	$998,000	$1,601,000	$2,635,000
Everett	Snohomish County (Paine Field)	PAE	52,896	$3,418,820,000	$5,350,348,000	$10,720,760,000
Forks	Forks Municipal	S18	0	$25,000	$43,000	$73,000
Forks	Quillayute	UIL	3	$161,000	$287,000	$467,000
Friday Harbor	Friday Harbor SPB	W33	11	$650,000	$932,000	$1,647,000
Goldendale	Goldendale Municipal	S20	0	$1,000	$1,000	$2,000
Greenwater	Ranger Creek State	21W	0	$8,000	$11,000	$19,000
Hoquiam	Bowerman Field	HQM	8	$548,000	$923,000	$1,599,000
Ilwaco	Port of Ilwaco	7W1	0	$2,000	$3,000	$5,000
Ione	Ione Municipal	S23	0	$8,000	$14,000	$23,000
Kahlotus	Lower Monumental State	W09	0	$6,000	$8,000	$13,000
Kelso	Southwest Washington Regional	KLS	27	$2,001,000	$3,094,000	$5,198,000
Kent	Norman Grier Field (Crest Airpark)	S36	19	$925,000	$1,535,000	$2,866,000
Lakewood	American Lake SPB	W37	0	$1,000	$2,000	$3,000
Langley	Whidbey Airpark	W10	6	$349,000	$581,000	$1,231,000
Laurier	Avey Field	69S	0	$1,000	$2,000	$4,000
Leavenworth	Lake Wenatchee State	27W	0	$6,000	$8,000	$13,000
Lester	Lester State	15S	0	$3,000	$4,000	$6,000
Lind	Lind Municipal	0S0	0	$22,000	$36,000	$61,000
Lopez	Lopez Island	S31	2	$112,000	$185,000	$386,000
Lynden	Lynden Municipal Airport - Jansen Field	38W	1	$51,000	$79,000	$144,000
Mansfield	Mansfield	8W3	19	$992,000	$1,503,000	$2,272,000
Mattawa	Desert Aire	M94	11	$733,000	$1,042,000	$1,682,000
Mazama	Lost River	W12	1	$38,000	$54,000	$87,000
Mead	Mead Flying Service	70S	2	$124,000	$192,000	$316,000
Metaline Falls	Sullivan Lake State	09S	0	$7,000	$11,000	$17,000

Associated City	Airport Name	FAA ID	Supplier Sales			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Monroe	First Air Field	W16	4	$205,000	$341,000	$642,000
Morton	Strom Field	39P	1	$91,000	$142,000	$236,000
Moses Lake	Grant County International	MWH	739	$60,242,000	$95,136,000	$167,938,000
Moses Lake	Moses Lake Municipal	W20	18	$1,278,000	$2,005,000	$3,251,000
Oak Harbor	A J Eisenberg	OKH	14	$774,000	$1,292,000	$2,588,000
Ocean Shores	Ocean Shores Municipal	W04	1	$88,000	$142,000	$258,000
Odessa	Odessa Municipal	43D	2	$115,000	$184,000	$314,000
Okanogan	Okanogan Legion	S35	0	$18,000	$29,000	$48,000
Olympia	Hoskins Field	44T	0	$1,000	$2,000	$3,000
Olympia	Olympia Regional	OLM	105	$7,596,000	$11,521,000	$19,989,000
Omak	Omak Municipal	OMK	7	$559,000	$857,000	$1,485,000
Oroville	Dorothy Scott Municipal	0S7	1	$44,000	$75,000	$123,000
Othello	Othello Municipal	S70	1	$79,000	$131,000	$222,000
Packwood	Packwood	55S	1	$91,000	$148,000	$252,000
Point Roberts	Point Roberts Airpark	1RL	0	$2,000	$3,000	$7,000
Port Angeles	Sekiu	11S	0	$1,000	$2,000	$4,000
Port Angeles	William R Fairchild International	CLM	30	$2,108,000	$3,381,000	$5,943,000
Port Townsend	Jefferson County International	0S9	15	$981,000	$1,679,000	$2,870,000
Poulsbo	Port of Poulsbo Marina SPB	83Q	0	$0	$0	$0
Puyallup	Pierce County - Thun Field	PLU	52	$3,684,000	$5,781,000	$10,049,000
Quincy	Quincy Municipal	80T	0	$4,000	$8,000	$13,000
Renton	Renton Municipal	RNT	11,926	$774,251,000	$1,211,441,000	$2,433,822,000
Renton	Will Rogers Wiley Post SPB	W36	0	$2,000	$4,000	$7,000
Republic	Ferry County	R49	0	$32,000	$51,000	$88,000
Richland	Richland	RLD	137	$9,047,000	$13,981,000	$22,907,000
Richland	Prosser	S40	29	$1,856,000	$3,023,000	$5,031,000

Associated City	Airport Name	FAA ID	Supplier Sales			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Rimrock	Tieton State	4S6	0	$4,000	$6,000	$9,000
Ritzville	Pru Field	33S	1	$72,000	$110,000	$183,000
Roche Harbor	Roche Harbor SPB	W39	4	$216,000	$309,000	$546,000
Rochester	R & K Skyranch	8W9	0	$1,000	$2,000	$4,000
Rosalia	Rosalia Municipal	72S	1	$93,000	$144,000	$241,000
Rosario	Rosario SPB	W49	42	$2,481,000	$3,539,000	$6,239,000
Seattle	Seattle Seaplanes SPB	0W0	0	$10,000	$18,000	$35,000
Sequim	Sequim Valley	W28	1	$79,000	$142,000	$238,000
Shelton	Sanderson Field	SHN	302	$23,707,000	$37,553,000	$66,450,000
Silverdale	Apex Airpark	8W5	1	$117,000	$174,000	$308,000
Skykomish	Skykomish State	S88	0	$12,000	$17,000	$31,000
Snohomish	Harvey Field	S43	92	$5,061,000	$8,446,000	$16,972,000
South Bend	Willapa Harbor	2S9	0	$7,000	$11,000	$18,000
Spokane	Felts Field	SFF	85	$5,862,000	$9,079,000	$14,710,000
Stanwood	Camano Island Airfield	13W	3	$192,000	$285,000	$500,000
Starbuck	Little Goose Lock and Dam State	16W	0	$5,000	$7,000	$11,000
Stehekin	Stehekin State	6S9	0	$5,000	$7,000	$12,000
Sunnyside	Sunnyside Municipal	1S5	5	$338,000	$558,000	$939,000
Tacoma	Tacoma Narrows	TIW	221	$15,394,000	$25,944,000	$46,537,000
Tekoa	Willard Field	73S	1	$73,000	$112,000	$185,000
Toledo	South Lewis County (Ed Carlson Memorial Field)	TDO	7	$478,000	$758,000	$1,287,000
Tonasket	Tonasket Municipal	W01	2	$148,000	$211,000	$341,000
Twisp	Twisp Municipal	2S0	0	$15,000	$25,000	$41,000
Vancouver	Pearson Field	VUO	44	$2,845,000	$4,841,000	$7,993,000
Vancouver	Fly For Fun	W56	0	$12,000	$21,000	$34,000

Associated City	Airport Name	FAA ID	Supplier Sales			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Vashon Island	Vashon Municipal	2S1	1	$33,000	$55,000	$112,000
Walla Walla	Page	9W2	0	$0	$0	$0
Warden	Warden	2S4	0	$4,000	$7,000	$12,000
Waterville	Waterville	2S5	2	$140,000	$219,000	$370,000
Westport	Westport	14S	2	$135,000	$206,000	$357,000
Wilbur	Wilbur Municipal	2S8	3	$168,000	$265,000	$441,000
Wilson Creek	Wilson Creek	5W1	1	$66,000	$99,000	$163,000
Winthrop	Methow Valley State	S52	5	$355,000	$567,000	$958,000
Woodland	Woodland State	W27	0	$9,000	$15,000	$25,000
Sub Total (Excluding SEA)			78,435	$5,011,601,000	$7,832,828,000	$15,402,431,000
Total (Including SEA)[2]			**N/A**	**$6,263,009,000**	**N/A**	**$19,854,237,000**

Totals may not sum due to rounding. Notes: (1) The Sea-Tac International Airport Economic Impacts study (Community Attributes, Inc., January 2018) did not report jobs as a metric for supplier sales. (2) Because value added was not calculated for Sea-Tac, this measure cannot be reported at the statewide level. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Airline Data, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table B.3. Economic Impacts by Type – Re-spending of Worker Income

Associated City	Airport Name	FAA ID	Re-spending of Worker Income			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Commercial Service						
Bellingham	Bellingham International	BLI	711	$31,144,000	$57,598,000	$102,002,000
East Wenatchee	Pangborn Memorial	EAT	299	$16,044,000	$28,989,000	$46,969,000
Friday Harbor	Friday Harbor	FHR	146	$6,392,000	$11,819,000	$20,935,000
Kenmore	Kenmore Air Harbor Inc.	S60	67	$3,029,000	$5,602,000	$9,920,000
Pasco	Tri-Cities	PSC	427	$23,054,000	$41,644,000	$67,562,000
Pullman	Pullman/Moscow Regional	PUW	185	$10,033,000	$18,117,000	$29,377,000

Associated City	Airport Name	FAA ID	Re-spending of Worker Income			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Seattle	Boeing Field/King County International	BFI	5,649	$247,363,000	$457,397,000	$810,136,000
Seattle	Sea-Tac International Airport	SEA	41,400	$2,197,300,000	N/A	$6,544,900,000
Seattle	Kenmore Air Harbor	W55	56	$2,546,000	$4,708,000	$8,338,000
Spokane	Spokane International (Geiger Field)	GEG	2,245	$121,663,000	$219,651,000	$356,221,000
Walla Walla	Walla Walla Regional	ALW	286	$15,430,000	$27,877,000	$45,233,000
Yakima	Yakima Air Terminal (McAllister Field)	YKM	720	$38,870,000	$70,202,000	$113,906,000
GA						
Anacortes	Skyline SPB	21H	4	$156,000	$289,000	$511,000
Anacortes	Anacortes	74S	7	$294,000	$543,000	$963,000
Anatone	Rogersburg State	D69	0	$3,000	$5,000	$8,000
Arlington	Arlington Municipal	AWO	740	$32,422,000	$59,954,000	$106,186,000
Auburn	Auburn Municipal	S50	60	$2,645,000	$4,891,000	$8,663,000
Bandera	Bandera State	4W0	0	$5,000	$10,000	$17,000
Battle Ground	Goheen Field	W52	0	$2,000	$4,000	$7,000
Battle Ground	Cedars North Airpark	W58	0	$2,000	$4,000	$7,000
Bellingham	Floathaven SPB	0W7	7	$288,000	$533,000	$945,000
Bremerton	Bremerton National	PWT	1,287	$70,082,000	$126,763,000	$207,145,000
Brewster	Anderson Field	S97	2	$92,000	$166,000	$270,000
Burlington	Skagit Regional	BVS	101	$4,440,000	$8,211,000	$14,543,000
Camas	Grove Field	1W1	7	$358,000	$646,000	$1,052,000
Cashmere	Cashmere-Dryden	8S2	3	$154,000	$279,000	$451,000
Chehalis	Chehalis-Centralia	CLS	288	$15,599,000	$28,168,000	$45,844,000
Chelan	Lake Chelan	S10	8	$418,000	$756,000	$1,224,000
Chewelah	Chewelah Municipal	1S9	1	$69,000	$124,000	$201,000
Clayton	Cross Winds	C72	1	$30,000	$55,000	$89,000
Cle Elum	De Vere Field	2W1	1	$67,000	$120,000	$195,000

Associated City	Airport Name	FAA ID	Re-spending of Worker Income			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Cle Elum	Cle Elum Municipal	S93	1	$31,000	$56,000	$90,000
Colfax	Lower Granite State	00W	0	$3,000	$6,000	$10,000
Colfax	Port of Whitman Business Air Center	S94	9	$499,000	$902,000	$1,462,000
College Place	Martin Field	S95	2	$125,000	$226,000	$366,000
Colville	Colville Municipal	63S	0	$23,000	$41,000	$67,000
Concrete	Mears Field	3W5	2	$70,000	$129,000	$228,000
Copalis Beach	Copalis State	S16	0	$6,000	$11,000	$18,000
Dalles, OR	Columbia Gorge Regional/The Dalles Municipal	DLS	77	$4,164,000	$7,519,000	$12,238,000
Darrington	Darrington Municipal	1S2	0	$7,000	$13,000	$24,000
Davenport	Davenport Municipal	68S	1	$55,000	$100,000	$162,000
Deer Park	Deer Park Municipal	DEW	13	$731,000	$1,320,000	$2,141,000
Easton	Easton State	ESW	0	$6,000	$11,000	$18,000
Eastsound	Orcas Island	ORS	25	$1,073,000	$1,984,000	$3,514,000
Eatonville	Swanson Field	2W3	5	$265,000	$479,000	$782,000
Electric City	Grand Coulee Dam	3W7	1	$59,000	$107,000	$173,000
Ellensburg	Bowers Field	ELN	51	$2,732,000	$4,933,000	$8,005,000
Elma	Elma Municipal	4W8	2	$129,000	$233,000	$381,000
Ephrata	Ephrata Municipal	EPH	21	$1,138,000	$2,057,000	$3,330,000
Everett	Snohomish County (Paine Field)	PAE	58,977	$2,583,888,000	$4,776,601,000	$8,462,004,000
Forks	Forks Municipal	S18	0	$26,000	$47,000	$77,000
Forks	Quillayute	UIL	16	$899,000	$1,625,000	$2,656,000
Friday Harbor	Friday Harbor SPB	W33	13	$573,000	$1,060,000	$1,877,000
Goldendale	Goldendale Municipal	S20	0	$1,000	$1,000	$2,000
Greenwater	Ranger Creek State	21W	0	$7,000	$13,000	$21,000
Hoquiam	Bowerman Field	HQM	13	$689,000	$1,247,000	$2,037,000

Associated City	Airport Name	FAA ID	Re-spending of Worker Income			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Ilwaco	Port of Ilwaco	7W1	0	$2,000	$3,000	$5,000
Ione	Ione Municipal	S23	0	$9,000	$15,000	$25,000
Kahlotus	Lower Monumental State	W09	0	$5,000	$10,000	$15,000
Kelso	Southwest Washington Regional	KLS	31	$1,699,000	$3,069,000	$4,994,000
Kent	Norman Grier Field (Crest Airpark)	S36	22	$943,000	$1,744,000	$3,089,000
Lakewood	American Lake SPB	W37	0	$1,000	$2,000	$3,000
Langley	Whidbey Airpark	W10	6	$281,000	$520,000	$920,000
Laurier	Avey Field	69S	0	$1,000	$2,000	$4,000
Leavenworth	Lake Wenatchee State	27W	0	$5,000	$9,000	$15,000
Lester	Lester State	15S	0	$2,000	$4,000	$7,000
Lind	Lind Municipal	0S0	1	$64,000	$116,000	$188,000
Lopez	Lopez Island	S31	2	$107,000	$197,000	$349,000
Lynden	Lynden Municipal Airport - Jansen Field	38W	1	$49,000	$90,000	$159,000
Mansfield	Mansfield	8W3	6	$332,000	$600,000	$971,000
Mattawa	Desert Aire	M94	12	$667,000	$1,206,000	$1,953,000
Mazama	Lost River	W12	1	$34,000	$62,000	$101,000
Mead	Mead Flying Service	70S	2	$125,000	$226,000	$366,000
Metaline Falls	Sullivan Lake State	09S	0	$7,000	$13,000	$20,000
Monroe	First Air Field	W16	5	$213,000	$394,000	$697,000
Morton	Strom Field	39P	2	$94,000	$170,000	$277,000
Moses Lake	Grant County International	MWH	885	$47,480,000	$85,766,000	$138,942,000
Moses Lake	Moses Lake Municipal	W20	23	$1,231,000	$2,224,000	$3,602,000
Oak Harbor	A J Eisenberg	OKH	22	$957,000	$1,770,000	$3,134,000
Ocean Shores	Ocean Shores Municipal	W04	2	$102,000	$185,000	$303,000
Odessa	Odessa Municipal	43D	3	$148,000	$267,000	$433,000
Okanogan	Okanogan Legion	S35	0	$22,000	$39,000	$63,000

Associated City	Airport Name	FAA ID	Re-spending of Worker Income			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Olympia	Hoskins Field	44T	0	$1,000	$2,000	$4,000
Olympia	Olympia Regional	OLM	153	$8,322,000	$15,050,000	$24,597,000
Omak	Omak Municipal	OMK	13	$699,000	$1,262,000	$2,044,000
Oroville	Dorothy Scott Municipal	0S7	1	$59,000	$107,000	$173,000
Othello	Othello Municipal	S70	3	$154,000	$277,000	$450,000
Packwood	Packwood	55S	2	$107,000	$194,000	$315,000
Point Roberts	Point Roberts Airpark	1RL	0	$2,000	$4,000	$7,000
Port Angeles	Sekiu	11S	0	$1,000	$2,000	$4,000
Port Angeles	William R Fairchild International	CLM	36	$1,966,000	$3,555,000	$5,810,000
Port Townsend	Jefferson County International	0S9	19	$1,032,000	$1,867,000	$3,051,000
Poulsbo	Port of Poulsbo Marina SPB	83Q	0	$0	$0	$0
Puyallup	Pierce County - Thun Field	PLU	61	$3,342,000	$6,045,000	$9,879,000
Quincy	Quincy Municipal	80T	0	$5,000	$9,000	$14,000
Renton	Renton Municipal	RNT	13,343	$584,579,000	$1,080,639,000	$1,914,436,000
Renton	Will Rogers Wiley Post SPB	W36	0	$2,000	$4,000	$8,000
Republic	Ferry County	R49	1	$39,000	$71,000	$115,000
Richland	Richland	RLD	175	$9,456,000	$17,083,000	$27,731,000
Richland	Prosser	S40	31	$1,677,000	$3,029,000	$4,914,000
Rimrock	Tieton State	4S6	0	$4,000	$7,000	$11,000
Ritzville	Pru Field	33S	1	$79,000	$142,000	$230,000
Roche Harbor	Roche Harbor SPB	W39	4	$190,000	$352,000	$623,000
Rochester	R & K Skyranch	8W9	0	$1,000	$3,000	$4,000
Rosalia	Rosalia Municipal	72S	2	$101,000	$182,000	$295,000
Rosario	Rosario SPB	W49	50	$2,175,000	$4,023,000	$7,124,000
Seattle	Seattle Seaplanes SPB	0W0	0	$11,000	$21,000	$37,000
Sequim	Sequim Valley	W28	1	$81,000	$146,000	$238,000

Associated City	Airport Name	FAA ID	Re-spending of Worker Income			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Shelton	Sanderson Field	SHN	273	$14,868,000	$26,889,000	$43,946,000
Silverdale	Apex Airpark	8W5	2	$96,000	$174,000	$284,000
Skykomish	Skykomish State	S88	0	$11,000	$20,000	$35,000
Snohomish	Harvey Field	S43	107	$4,667,000	$8,631,000	$15,285,000
South Bend	Willapa Harbor	2S9	0	$7,000	$13,000	$21,000
Spokane	Felts Field	SFF	113	$6,110,000	$11,030,000	$17,889,000
Stanwood	Camano Island Airfield	13W	4	$193,000	$358,000	$633,000
Starbuck	Little Goose Lock and Dam State	16W	0	$4,000	$8,000	$12,000
Stehekin	Stehekin State	6S9	0	$5,000	$8,000	$13,000
Sunnyside	Sunnyside Municipal	1S5	8	$421,000	$761,000	$1,235,000
Tacoma	Tacoma Narrows	TIW	157	$8,550,000	$15,465,000	$25,272,000
Tekoa	Willard Field	73S	1	$77,000	$139,000	$225,000
Toledo	South Lewis County (Ed Carlson Memorial Field)	TDO	9	$474,000	$856,000	$1,393,000
Tonasket	Tonasket Municipal	W01	3	$136,000	$245,000	$397,000
Twisp	Twisp Municipal	2S0	0	$16,000	$29,000	$46,000
Vancouver	Pearson Field	VUO	55	$2,993,000	$5,405,000	$8,796,000
Vancouver	Fly For Fun	W56	0	$12,000	$22,000	$36,000
Vashon Island	Vashon Municipal	2S1	1	$40,000	$74,000	$131,000
Walla Walla	Page	9W2	0	$0	$0	$0
Warden	Warden	2S4	0	$4,000	$8,000	$13,000
Waterville	Waterville	2S5	4	$197,000	$356,000	$577,000
Westport	Westport	14S	3	$146,000	$264,000	$431,000
Wilbur	Wilbur Municipal	2S8	6	$300,000	$542,000	$879,000
Wilson Creek	Wilson Creek	5W1	1	$70,000	$126,000	$204,000
Winthrop	Methow Valley State	S52	21	$1,132,000	$2,045,000	$3,312,000

Associated City	Airport Name	FAA ID	Re-spending of Worker Income			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Woodland	Woodland State	W27	0	$9,000	$16,000	$26,000
Sub Total (Excluding SEA)			88,232	$3,949,089,000	$7,282,105,000	$12,784,441,000
Total (Including SEA)[1]			**129,627**	**$6,146,396,000**	**N/A**	**$19,329,343,000**

Totals may not sum due to rounding. Notes: (1) Because value added was not calculated for Sea-Tac, this measure cannot be reported at the statewide level. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Airline Data, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table B.4. Economic Impacts by Type – Total Economic Impacts of Washington Airports

Associated City	Airport Name	FAA ID	Total Economic Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Commercial Service						
Bellingham	Bellingham International	BLI	2,940	$159,295,000	$271,160,000	$471,435,000
East Wenatchee	Pangborn Memorial	EAT	1,248	$67,192,000	$110,001,000	$253,765,000
Friday Harbor	Friday Harbor	FHR	471	$30,541,000	$54,945,000	$96,840,000
Kenmore	Kenmore Air Harbor Inc.	S60	289	$16,643,000	$25,199,000	$41,718,000
Pasco	Tri-Cities	PSC	2,194	$99,128,000	$173,516,000	$290,603,000
Pullman	Pullman/Moscow Regional	PUW	907	$45,889,000	$74,743,000	$130,247,000
Seattle	Boeing Field/King County International	BFI	18,679	$1,285,589,000	$1,723,302,000	$3,039,819,000
Seattle	Sea-Tac International Airport	SEA	151,400	$7,099,500,000	N/A	$22,477,900,000
Seattle	Kenmore Air Harbor	W55	318	$14,143,000	$21,996,000	$36,291,000
Spokane	Spokane International (Geiger Field)	GEG	11,566	$548,693,000	$936,832,000	$1,551,346,000
Walla Walla	Walla Walla Regional	ALW	1,304	$68,911,000	$125,648,000	$238,306,000
Yakima	Yakima Air Terminal (McAllister Field)	YKM	2,366	$161,172,000	$289,198,000	$591,034,000
GA						
Anacortes	Skyline SPB	21H	12	$859,000	$1,175,000	$1,985,000
Anacortes	Anacortes	74S	27	$1,514,000	$2,816,000	$5,783,000

Associated City	Airport Name	FAA ID	Total Economic Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Anatone	Rogersburg State	D69	1	$14,000	$19,000	$33,000
Arlington	Arlington Municipal	AWO	2,621	$164,090,000	$357,267,000	$667,044,000
Auburn	Auburn Municipal	S50	232	$14,171,000	$24,002,000	$43,137,000
Bandera	Bandera State	4W0	1	$28,000	$39,000	$66,000
Battle Ground	Goheen Field	W52	1	$11,000	$17,000	$29,000
Battle Ground	Cedars North Airpark	W58	1	$11,000	$17,000	$29,000
Bellingham	Floathaven SPB	0W7	21	$1,455,000	$2,438,000	$5,261,000
Bremerton	Bremerton National	PWT	4,532	$311,014,000	$466,252,000	$938,464,000
Brewster	Anderson Field	S97	8	$426,000	$653,000	$1,161,000
Burlington	Skagit Regional	BVS	326	$22,397,000	$37,494,000	$66,507,000
Camas	Grove Field	1W1	22	$1,814,000	$3,262,000	$5,822,000
Cashmere	Cashmere-Dryden	8S2	10	$623,000	$1,052,000	$2,282,000
Chehalis	Chehalis-Centralia	CLS	1,658	$68,050,000	$115,393,000	$186,473,000
Chelan	Lake Chelan	S10	51	$1,905,000	$3,241,000	$6,639,000
Chewelah	Chewelah Municipal	1S9	5	$324,000	$470,000	$825,000
Clayton	Cross Winds	C72	2	$150,000	$205,000	$346,000
Cle Elum	De Vere Field	2W1	5	$315,000	$454,000	$796,000
Cle Elum	Cle Elum Municipal	S93	3	$144,000	$227,000	$392,000
Colfax	Lower Granite State	00W	1	$17,000	$23,000	$40,000
Colfax	Port of Whitman Business Air Center	S94	45	$2,206,000	$3,701,000	$7,870,000
College Place	Martin Field	S95	10	$600,000	$854,000	$1,477,000
Colville	Colville Municipal	63S	3	$109,000	$170,000	$288,000
Concrete	Mears Field	3W5	11	$374,000	$660,000	$1,166,000
Copalis Beach	Copalis State	S16	1	$29,000	$42,000	$71,000
Dalles, OR	Columbia Gorge Regional/The Dalles Municipal	DLS	254	$20,361,000	$36,980,000	$66,238,000

Associated City	Airport Name	FAA ID	Total Economic Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Darrington	Darrington Municipal	1S2	1	$38,000	$58,000	$101,000
Davenport	Davenport Municipal	68S	7	$252,000	$384,000	$689,000
Deer Park	Deer Park Municipal	DEW	89	$3,381,000	$5,711,000	$9,541,000
Easton	Easton State	ESW	1	$30,000	$41,000	$71,000
Eastsound	Orcas Island	ORS	83	$5,056,000	$8,799,000	$15,506,000
Eatonville	Swanson Field	2W3	16	$1,102,000	$2,087,000	$4,379,000
Electric City	Grand Coulee Dam	3W7	8	$281,000	$437,000	$753,000
Ellensburg	Bowers Field	ELN	214	$11,898,000	$20,277,000	$39,554,000
Elma	Elma Municipal	4W8	11	$615,000	$926,000	$1,585,000
Ephrata	Ephrata Municipal	EPH	88	$5,198,000	$8,508,000	$15,237,000
Everett	Snohomish County (Paine Field)	PAE	158,227	$13,039,480,000	$27,149,486,000	$59,915,294,000
Forks	Forks Municipal	S18	4	$124,000	$198,000	$337,000
Forks	Quillayute	UIL	47	$2,816,000	$4,710,000	$7,498,000
Friday Harbor	Friday Harbor SPB	W33	43	$3,154,000	$4,330,000	$7,312,000
Goldendale	Goldendale Municipal	S20	1	$4,000	$6,000	$11,000
Greenwater	Ranger Creek State	21W	1	$34,000	$50,000	$85,000
Hoquiam	Bowerman Field	HQM	68	$3,189,000	$5,277,000	$8,484,000
Ilwaco	Port of Ilwaco	7W1	1	$8,000	$14,000	$23,000
Ione	Ione Municipal	S23	3	$40,000	$65,000	$111,000
Kahlotus	Lower Monumental State	W09	1	$26,000	$36,000	$61,000
Kelso	Southwest Washington Regional	KLS	113	$8,291,000	$15,277,000	$27,289,000
Kent	Norman Grier Field (Crest Airpark)	S36	106	$5,115,000	$7,754,000	$13,002,000
Lakewood	American Lake SPB	W37	1	$5,000	$8,000	$14,000
Langley	Whidbey Airpark	W10	22	$1,503,000	$2,828,000	$5,103,000
Laurier	Avey Field	69S	1	$6,000	$10,000	$18,000
Leavenworth	Lake Wenatchee State	27W	1	$28,000	$37,000	$60,000

Associated City	Airport Name	FAA ID	Total Economic Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Lester	Lester State	15S	1	$12,000	$17,000	$28,000
Lind	Lind Municipal	0S0	7	$349,000	$423,000	$581,000
Lopez	Lopez Island	S31	11	$554,000	$863,000	$1,605,000
Lynden	Lynden Municipal Airport - Jansen Field	38W	5	$265,000	$384,000	$646,000
Mansfield	Mansfield	8W3	29	$1,610,000	$2,419,000	$5,687,000
Mattawa	Desert Aire	M94	44	$3,636,000	$4,713,000	$7,671,000
Mazama	Lost River	W12	2	$187,000	$243,000	$397,000
Mead	Mead Flying Service	70S	11	$597,000	$882,000	$1,517,000
Metaline Falls	Sullivan Lake State	09S	1	$34,000	$47,000	$81,000
Monroe	First Air Field	W16	23	$1,150,000	$1,744,000	$2,941,000
Morton	Strom Field	39P	8	$476,000	$696,000	$1,157,000
Moses Lake	Grant County International	MWH	2,983	$217,712,000	$404,809,000	$981,736,000
Moses Lake	Moses Lake Municipal	W20	93	$5,488,000	$8,584,000	$16,542,000
Oak Harbor	A J Eisenberg	OKH	80	$4,944,000	$7,407,000	$13,162,000
Ocean Shores	Ocean Shores Municipal	W04	9	$478,000	$716,000	$1,285,000
Odessa	Odessa Municipal	43D	12	$677,000	$997,000	$1,788,000
Okanogan	Okanogan Legion	S35	4	$100,000	$147,000	$266,000
Olympia	Hoskins Field	44T	1	$6,000	$9,000	$16,000
Olympia	Olympia Regional	OLM	523	$34,614,000	$56,730,000	$105,974,000
Omak	Omak Municipal	OMK	45	$2,875,000	$4,724,000	$9,805,000
Oroville	Dorothy Scott Municipal	0S7	7	$278,000	$450,000	$728,000
Othello	Othello Municipal	S70	17	$790,000	$1,040,000	$1,576,000
Packwood	Packwood	55S	10	$517,000	$773,000	$1,344,000
Point Roberts	Point Roberts Airpark	1RL	1	$12,000	$18,000	$31,000
Port Angeles	Sekiu	11S	2	$6,000	$10,000	$17,000
Port Angeles	William R Fairchild International	CLM	171	$8,621,000	$14,860,000	$26,623,000

Associated City	Airport Name	FAA ID	Total Economic Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Port Townsend	Jefferson County International	0S9	110	$4,641,000	$7,784,000	$13,600,000
Poulsbo	Port of Poulsbo Marina SPB	83Q	-	$0	$0	$0
Puyallup	Pierce County - Thun Field	PLU	258	$15,136,000	$24,933,000	$46,133,000
Quincy	Quincy Municipal	80T	1	$23,000	$38,000	$63,000
Renton	Renton Municipal	RNT	35,470	$2,946,356,000	$6,134,458,000	$13,641,026,000
Renton	Will Rogers Wiley Post SPB	W36	1	$12,000	$19,000	$32,000
Republic	Ferry County	R49	3	$176,000	$265,000	$485,000
Richland	Richland	RLD	682	$44,083,000	$65,619,000	$114,192,000
Richland	Prosser	S40	238	$7,785,000	$12,357,000	$22,202,000
Rimrock	Tieton State	4S6	1	$18,000	$25,000	$43,000
Ritzville	Pru Field	33S	6	$367,000	$530,000	$942,000
Roche Harbor	Roche Harbor SPB	W39	14	$1,047,000	$1,436,000	$2,425,000
Rochester	R & K Skyranch	8W9	1	$7,000	$11,000	$19,000
Rosalia	Rosalia Municipal	72S	8	$469,000	$694,000	$1,227,000
Rosario	Rosario SPB	W49	162	$11,979,000	$16,381,000	$27,670,000
Seattle	Seattle Seaplanes SPB	0W0	2	$61,000	$96,000	$161,000
Sequim	Sequim Valley	W28	11	$384,000	$624,000	$1,060,000
Shelton	Sanderson Field	SHN	1,013	$61,628,000	$135,395,000	$288,484,000
Silverdale	Apex Airpark	8W5	5	$437,000	$757,000	$1,543,000
Skykomish	Skykomish State	S88	1	$59,000	$81,000	$136,000
Snohomish	Harvey Field	S43	567	$24,098,000	$44,635,000	$78,401,000
South Bend	Willapa Harbor	2S9	1	$37,000	$54,000	$88,000
Spokane	Felts Field	SFF	462	$27,356,000	$45,515,000	$78,749,000
Stanwood	Camano Island Airfield	13W	15	$1,052,000	$1,464,000	$2,425,000
Starbuck	Little Goose Lock and Dam State	16W	1	$21,000	$29,000	$49,000
Stehekin	Stehekin State	6S9	1	$25,000	$33,000	$53,000

Associated City	Airport Name	FAA ID	Total Economic Impacts			
			Jobs (no.)	Labor Income ($)	Value Added ($)	Business Revenues ($)
Sunnyside	Sunnyside Municipal	1S5	38	$1,981,000	$3,007,000	$5,211,000
Tacoma	Tacoma Narrows	TIW	684	$39,387,000	$73,593,000	$160,333,000
Tekoa	Willard Field	73S	6	$362,000	$530,000	$930,000
Toledo	South Lewis County (Ed Carlson Memorial Field)	TDO	38	$2,356,000	$3,841,000	$6,641,000
Tonasket	Tonasket Municipal	W01	9	$737,000	$957,000	$1,562,000
Twisp	Twisp Municipal	2S0	2	$77,000	$121,000	$202,000
Vancouver	Pearson Field	VUO	290	$13,639,000	$23,241,000	$39,940,000
Vancouver	Fly For Fun	W56	2	$59,000	$99,000	$163,000
Vashon Island	Vashon Municipal	2S1	3	$208,000	$313,000	$559,000
Walla Walla	Page	9W2	1	$1,000	$1,000	$2,000
Warden	Warden	2S4	1	$21,000	$36,000	$58,000
Waterville	Waterville	2S5	17	$960,000	$1,317,000	$2,237,000
Westport	Westport	14S	11	$681,000	$975,000	$1,729,000
Wilbur	Wilbur Municipal	2S8	32	$1,577,000	$2,029,000	$3,005,000
Wilson Creek	Wilson Creek	5W1	5	$348,000	$482,000	$834,000
Winthrop	Methow Valley State	S52	63	$3,853,000	$6,071,000	$10,492,000
Woodland	Woodland State	W27	2	$45,000	$70,000	$114,000
Sub Total (Excluding SEA)			255,640	$19,701,401,000	$39,226,400,000	$84,562,165,000
Total (Including SEA)[3]			**407,042**	**$26,800,918,000**	**N/A**	**$107,040,070,000**

Totals may not sum due to rounding. Notes: (1) Because value added was not calculated for Sea-Tac, this measure cannot be reported at the statewide level. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2020, Dean Runyan, Inc. 2018, Airline Data, Inc. 2018, Community Attributes 2018. Calculations by EBP US 2020 using the 2017 IMPLAN model

Table B.5. Washington Tax Revenues by Type

Associated City	Airport Name	FAA ID	On-Airport			Off-Airport (Visitor Spending)			Total Taxes (On-Airport and Visitor Spending)		
			Local	State	Total	Local	State	Total	Local	State	Total
Commercial Service											
Bellingham	Bellingham International	BLI	$2,713,300	$16,680,120	$19,393,420	$1,340,480	$6,267,790	$7,608,270	$4,053,780	$22,947,910	$27,001,690
East Wenatchee	Pangborn Memorial	EAT	$2,543,520	$15,524,420	$18,067,940	$179,600	$872,240	$1,051,840	$2,723,120	$16,396,660	$19,119,780
Friday Harbor	Friday Harbor	FHR	$1,156,160	$6,164,920	$7,321,080	$66,870	$392,240	$459,110	$1,223,030	$6,557,160	$7,780,190
Kenmore	Kenmore Air Harbor Inc.	S60	$291,500	$1,107,150	$1,398,650	$23,190	$126,160	$149,350	$314,690	$1,233,310	$1,548,000
Pasco	Tri-Cities	PSC	$550,300	$4,515,920	$5,066,220	$1,166,400	$5,395,240	$6,561,640	$1,716,700	$9,911,160	$11,627,860
Pullman	Pullman/Moscow Regional	PUW	$224,860	$1,729,740	$1,954,600	$343,550	$1,743,030	$2,086,580	$568,410	$3,472,770	$4,041,180
Seattle	Boeing Field/King County International	BFI	$8,359,220	$69,736,900	$78,096,120	$934,340	$5,665,070	$6,599,410	$9,293,560	$75,401,970	$84,695,530
Seattle	Sea-Tac International Airport	SEA	N/A	N/A	$45,700,000	N/A	N/A	$190,600,000	N/A	N/A	$236,300,000
Seattle	Kenmore Air Harbor	W55	$137,630	$522,620	$660,250	$47,160	$256,600	$303,760	$184,790	$779,220	$964,010
Spokane	Spokane International (Geiger Field)	GEG	$6,116,780	$34,717,880	$40,834,660	$6,906,350	$30,527,360	$37,433,710	$13,023,130	$65,245,240	$78,268,370
Walla Walla	Walla Walla Regional	ALW	$2,751,740	$14,697,380	$17,449,120	$265,810	$1,289,900	$1,555,710	$3,017,550	$15,987,280	$19,004,830
Yakima	Yakima Air Terminal (McAllister Field)	YKM	$971,380	$9,404,460	$10,375,840	$277,070	$1,412,450	$1,689,520	$1,248,450	$10,816,910	$12,065,360
GA											
Anacortes	Skyline SPB	21H	$16,600	$82,730	$99,330	$0	$0	$0	$16,600	$82,730	$99,330
Anacortes	Anacortes	74S	$260	$14,640	$14,900	$7,380	$40,160	$47,540	$7,640	$54,800	$62,440
Anatone	Rogersburg State	D69	$200	$1,310	$1,510	$20	$110	$130	$220	$1,420	$1,640
Arlington	Arlington Municipal	AWO	$1,897,790	$12,948,730	$14,846,520	$47,930	$254,240	$302,170	$1,945,720	$13,202,970	$15,148,690
Auburn	Auburn Municipal	S50	$33,970	$369,690	$403,660	$71,460	$388,820	$460,280	$105,430	$758,510	$863,940
Bandera	Bandera State	4W0	$660	$2,510	$3,170	$40	$250	$290	$700	$2,760	$3,460
Battle Ground	Goheen Field	W52	$1,190	$6,450	$7,640	$160	$870	$1,030	$1,350	$7,320	$8,670
Battle Ground	Cedars North Airpark	W58	$1,190	$6,450	$7,640	$160	$870	$1,030	$1,350	$7,320	$8,670
Bellingham	Floathaven SPB	0W7	$440	$18,020	$18,460	$70	$390	$460	$510	$18,410	$18,920
Bremerton	Bremerton National	PWT	$615,290	$4,729,020	$5,344,310	$162,890	$864,070	$1,026,960	$778,180	$5,593,090	$6,371,270
Brewster	Anderson Field	S97	$83,150	$415,730	$498,880	$2,970	$16,170	$19,140	$86,120	$431,900	$518,020
Burlington	Skagit Regional	BVS	$181,610	$1,015,680	$1,197,290	$52,450	$278,200	$330,650	$234,060	$1,293,880	$1,527,940
Camas	Grove Field	1W1	$2,200	$29,240	$31,440	$4,020	$21,880	$25,900	$6,220	$51,120	$57,340
Cashmere	Cashmere-Dryden	8S2	$860	$11,540	$12,400	$140	$770	$910	$1,000	$12,310	$13,310
Chehalis	Chehalis-Centralia	CLS	$1,178,540	$7,367,300	$8,545,840	$89,090	$472,560	$561,650	$1,267,630	$7,839,860	$9,107,490
Chelan	Lake Chelan	S10	$19,150	$102,500	$121,650	$1,840	$10,010	$11,850	$20,990	$112,510	$133,500
Chewelah	Chewelah Municipal	1S9	$2,020	$14,680	$16,700	$810	$4,420	$5,230	$2,830	$19,100	$21,930
Clayton	Cross Winds	C72	$2,020	$14,680	$16,700	$0	$0	$0	$2,020	$14,680	$16,700
Cle Elum	De Vere Field	2W1	$2,620	$13,940	$16,560	$210	$1,150	$1,360	$2,830	$15,090	$17,920
Cle Elum	Cle Elum Municipal	S93	$27,890	$120,860	$148,750	$1,460	$7,980	$9,440	$29,350	$128,840	$158,190
Colfax	Lower Granite State	00W	$3,870	$19,620	$23,490	$60	$330	$390	$3,930	$19,950	$23,880
Colfax	Port of Whitman Business Air Center	S94	$36,770	$226,880	$263,650	$170	$950	$1,120	$36,940	$227,830	$264,770
College Place	Martin Field	S95	$8,390	$41,830	$50,220	$1,430	$7,780	$9,210	$9,820	$49,610	$59,430

Associated City	Airport Name	FAA ID	On-Airport			Off-Airport (Visitor Spending)			Total Taxes (On-Airport and Visitor Spending)		
			Local	State	Total	Local	State	Total	Local	State	Total
Colville	Colville Municipal	63S	$480	$3,460	$3,940	$1,780	$9,700	$11,480	$2,260	$13,160	$15,420
Concrete	Mears Field	3W5	$700	$9,930	$10,630	$3,150	$17,120	$20,270	$3,850	$27,050	$30,900
Copalis Beach	Copalis State	S16	$800	$2,770	$3,570	$40	$240	$280	$840	$3,010	$3,850
Dalles, OR	Columbia Gorge Regional/The Dalles Municipal	DLS	$0	$564,750	$564,750	$12,220	$66,520	$78,740	$12,220	$631,270	$643,490
Darrington	Darrington Municipal	1S2	$7,200	$36,010	$43,210	$310	$1,690	$2,000	$7,510	$37,700	$45,210
Davenport	Davenport Municipal	68S	$290	$1,540	$1,830	$1,410	$7,690	$9,100	$1,700	$9,230	$10,930
Deer Park	Deer Park Municipal	DEW	$10,500	$52,350	$62,850	$61,680	$327,180	$388,860	$72,180	$379,530	$451,710
Easton	Easton State	ESW	$520	$2,770	$3,290	$40	$250	$290	$560	$3,020	$3,580
Eastsound	Orcas Island	ORS	$95,540	$476,840	$572,380	$15,810	$86,010	$101,820	$111,350	$562,850	$674,200
Eatonville	Swanson Field	2W3	$230	$25,930	$26,160	$400	$2,170	$2,570	$630	$28,100	$28,730
Electric City	Grand Coulee Dam	3W7	$430	$2,470	$2,900	$3,250	$17,690	$20,940	$3,680	$20,160	$23,840
Ellensburg	Bowers Field	ELN	$4,010	$151,380	$155,390	$61,250	$324,910	$386,160	$65,260	$476,290	$541,550
Elma	Elma Municipal	4W8	$8,490	$29,430	$37,920	$4,880	$26,540	$31,420	$13,370	$55,970	$69,340
Ephrata	Ephrata Municipal	EPH	$13,180	$157,670	$170,850	$24,800	$131,560	$156,360	$37,980	$289,230	$327,210
Everett	Snohomish County (Paine Field)	PAE	$11,712,380	$261,851,150	$273,563,530	$379,800	$2,014,630	$2,394,430	$12,092,180	$263,865,780	$275,957,960
Forks	Forks Municipal	S18	$400	$1,590	$1,990	$2,140	$11,650	$13,790	$2,540	$13,240	$15,780
Forks	Quillayute	UIL	$4,750	$38,680	$43,430	$200	$1,070	$1,270	$4,950	$39,750	$44,700
Friday Harbor	Friday Harbor SPB	W33	$59,760	$297,830	$357,590	$1,810	$9,850	$11,660	$61,570	$307,680	$369,250
Goldendale	Goldendale Municipal	S20	$0	$0	$0	$100	$540	$640	$100	$540	$640
Greenwater	Ranger Creek State	21W	$480	$2,720	$3,200	$180	$1,000	$1,180	$660	$3,720	$4,380
Hoquiam	Bowerman Field	HQM	$6,030	$20,710	$26,740	$45,970	$243,890	$289,860	$52,000	$264,600	$316,600
Ilwaco	Port of Ilwaco	7W1	$10	$70	$80	$160	$890	$1,050	$170	$960	$1,130
Ione	Ione Municipal	S23	$30	$230	$260	$830	$4,540	$5,370	$860	$4,770	$5,630
Kahlotus	Lower Monumental State	W09	$450	$2,400	$2,850	$40	$250	$290	$490	$2,650	$3,140
Kelso	Southwest Washington Regional	KLS	$6,700	$162,040	$168,740	$28,990	$157,760	$186,750	$35,690	$319,800	$355,490
Kent	Norman Grier Field (Crest Airpark)	S36	$43,570	$165,460	$209,030	$79,600	$433,120	$512,720	$123,170	$598,580	$721,750
Lakewood	American Lake SPB	W37	$1,320	$6,140	$7,460	$10	$80	$90	$1,330	$6,220	$7,550
Langley	Whidbey Airpark	W10	$530	$40,430	$40,960	$5,970	$32,510	$38,480	$6,500	$72,940	$79,440
Laurier	Avey Field	69S	$0	$0	$0	$160	$890	$1,050	$160	$890	$1,050
Leavenworth	Lake Wenatchee State	27W	$460	$2,170	$2,630	$90	$480	$570	$550	$2,650	$3,200
Lester	Lester State	15S	$0	$0	$0	$0	$0	$0	$0	$0	$0
Lind	Lind Municipal	0S0	$3,860	$20,470	$24,330	$570	$3,080	$3,650	$4,430	$23,550	$27,980
Lopez	Lopez Island	S31	$2,790	$13,930	$16,720	$2,360	$12,840	$15,200	$5,150	$26,770	$31,920
Lynden	Lynden Municipal Airport - Jansen Field	38W	$2,900	$16,550	$19,450	$2,290	$12,440	$14,730	$5,190	$28,990	$34,180
Mansfield	Mansfield	8W3	$2,530	$50,170	$52,700	$180	$1,000	$1,180	$2,710	$51,170	$53,880
Mattawa	Desert Aire	M94	$57,320	$326,400	$383,720	$270	$1,460	$1,730	$57,590	$327,860	$385,450
Mazama	Lost River	W12	$2,660	$16,320	$18,980	$30	$160	$190	$2,690	$16,480	$19,170
Mead	Mead Flying Service	70S	$5,890	$29,360	$35,250	$4,500	$24,510	$29,010	$10,390	$53,870	$64,260

Associated City	Airport Name	FAA ID	On-Airport			Off-Airport (Visitor Spending)			Total Taxes (On-Airport and Visitor Spending)		
			Local	State	Total	Local	State	Total	Local	State	Total
Metaline Falls	Sullivan Lake State	09S	$390	$2,800	$3,190	$40	$250	$290	$430	$3,050	$3,480
Monroe	First Air Field	W16	$5,390	$33,090	$38,480	$16,420	$89,360	$105,780	$21,810	$122,450	$144,260
Morton	Strom Field	39P	$2,940	$18,020	$20,960	$2,660	$14,490	$17,150	$5,600	$32,510	$38,110
Moses Lake	Grant County International	MWH	$170,050	$4,290,610	$4,460,660	$112,800	$598,340	$711,140	$282,850	$4,888,950	$5,171,800
Moses Lake	Moses Lake Municipal	W20	$74,360	$453,500	$527,860	$510	$2,800	$3,310	$74,870	$456,300	$531,170
Oak Harbor	A J Eisenberg	OKH	$11,160	$135,240	$146,400	$6,970	$37,920	$44,890	$18,130	$173,160	$191,290
Ocean Shores	Ocean Shores Municipal	W04	$1,120	$3,880	$5,000	$170	$920	$1,090	$1,290	$4,800	$6,090
Odessa	Odessa Municipal	43D	$750	$4,000	$4,750	$550	$2,980	$3,530	$1,300	$6,980	$8,280
Okanogan	Okanogan Legion	S35	$150	$890	$1,040	$140	$770	$910	$290	$1,660	$1,950
Olympia	Hoskins Field	44T	$1,320	$6,140	$7,460	$30	$180	$210	$1,350	$6,320	$7,670
Olympia	Olympia Regional	OLM	$27,970	$564,150	$592,120	$111,650	$592,250	$703,900	$139,620	$1,156,400	$1,296,020
Omak	Omak Municipal	OMK	$9,480	$74,380	$83,860	$40	$240	$280	$9,520	$74,620	$84,140
Oroville	Dorothy Scott Municipal	0S7	$260	$3,760	$4,020	$2,700	$14,710	$17,410	$2,960	$18,470	$21,430
Othello	Othello Municipal	S70	$0	$31,970	$31,970	$3,180	$17,310	$20,490	$3,180	$49,280	$52,460
Packwood	Packwood	55S	$170	$1,050	$1,220	$1,830	$9,940	$11,770	$2,000	$10,990	$12,990
Point Roberts	Point Roberts Airpark	1RL	$1,440	$6,680	$8,120	$170	$910	$1,080	$1,610	$7,590	$9,200
Port Angeles	Sekiu	11S	$80	$340	$420	$50	$300	$350	$130	$640	$770
Port Angeles	William R Fairchild International	CLM	$111,800	$504,450	$616,250	$72,270	$383,370	$455,640	$184,070	$887,820	$1,071,890
Port Townsend	Jefferson County International	0S9	$39,830	$138,900	$178,730	$66,280	$360,690	$426,970	$106,110	$499,590	$605,700
Poulsbo	Port of Poulsbo Marina SPB	83Q	$0	$0	$0	$0	$0	$0	$0	$0	$0
Puyallup	Pierce County - Thun Field	PLU	$138,000	$937,630	$1,075,630	$11,250	$59,700	$70,950	$149,250	$997,330	$1,146,580
Quincy	Quincy Municipal	80T	$0	$0	$0	$600	$3,250	$3,850	$600	$3,250	$3,850
Renton	Renton Municipal	RNT	$1,233,690	$48,869,910	$50,103,600	$183,260	$972,120	$1,155,380	$1,416,950	$49,842,030	$51,258,980
Renton	Will Rogers Wiley Post SPB	W36	$2,160	$6,680	$8,840	$180	$990	$1,170	$2,340	$7,670	$10,010
Republic	Ferry County	R49	$41,160	$222,970	$264,130	$150	$830	$980	$41,310	$223,800	$265,110
Richland	Richland	RLD	$384,150	$2,367,640	$2,751,790	$53,130	$281,860	$334,990	$437,280	$2,649,500	$3,086,780
Richland	Prosser	S40	$154,260	$804,820	$959,080	$10,460	$56,930	$67,390	$164,720	$861,750	$1,026,470
Rimrock	Tieton State	4S6	$280	$1,590	$1,870	$40	$250	$290	$320	$1,840	$2,160
Ritzville	Pru Field	33S	$2,760	$14,680	$17,440	$100	$550	$650	$2,860	$15,230	$18,090
Roche Harbor	Roche Harbor SPB	W39	$19,920	$99,280	$119,200	$420	$2,260	$2,680	$20,340	$101,540	$121,880
Rochester	R & K Skyranch	8W9	$1,320	$6,140	$7,460	$60	$330	$390	$1,380	$6,470	$7,850
Rosalia	Rosalia Municipal	72S	$2,390	$14,680	$17,070	$1,830	$9,940	$11,770	$4,220	$24,620	$28,840
Rosario	Rosario SPB	W49	$232,390	$1,158,240	$1,390,630	$370	$2,020	$2,390	$232,760	$1,160,260	$1,393,020
Seattle	Seattle Seaplanes SPB	0W0	$2,160	$6,680	$8,840	$1,360	$7,410	$8,770	$3,520	$14,090	$17,610
Sequim	Sequim Valley	W28	$3,510	$13,990	$17,500	$5,750	$31,280	$37,030	$9,260	$45,270	$54,530
Shelton	Sanderson Field	SHN	$2,685,030	$9,795,020	$12,480,050	$87,750	$465,460	$553,210	$2,772,780	$10,260,480	$13,033,260
Silverdale	Apex Airpark	8W5	$180	$5,000	$5,180	$250	$1,360	$1,610	$430	$6,360	$6,790
Skykomish	Skykomish State	S88	$1,450	$5,520	$6,970	$40	$250	$290	$1,490	$5,770	$7,260

Associated City	Airport Name	FAA ID	On-Airport			Off-Airport (Visitor Spending)			Total Taxes (On-Airport and Visitor Spending)		
			Local	State	Total	Local	State	Total	Local	State	Total
Snohomish	Harvey Field	S43	$141,620	$1,155,150	$1,296,770	$142,190	$754,250	$896,440	$283,810	$1,909,400	$2,193,210
South Bend	Willapa Harbor	2S9	$350	$1,770	$2,120	$160	$890	$1,050	$510	$2,660	$3,170
Spokane	Felts Field	SFF	$162,970	$1,131,120	$1,294,090	$99,260	$526,560	$625,820	$262,230	$1,657,680	$1,919,910
Stanwood	Camano Island Airfield	13W	$16,810	$103,110	$119,920	$330	$1,800	$2,130	$17,140	$104,910	$122,050
Starbuck	Little Goose Lock and Dam State	16W	$400	$1,900	$2,300	$40	$250	$290	$440	$2,150	$2,590
Stehekin	Stehekin State	6S9	$440	$2,070	$2,510	$40	$250	$290	$480	$2,320	$2,800
Sunnyside	Sunnyside Municipal	1S5	$1,260	$7,180	$8,440	$10,640	$57,910	$68,550	$11,900	$65,090	$76,990
Tacoma	Tacoma Narrows	TIW	$239,310	$2,048,830	$2,288,140	$252,990	$1,341,990	$1,594,980	$492,300	$3,390,820	$3,883,120
Tekoa	Willard Field	73S	$2,390	$14,680	$17,070	$1,280	$6,940	$8,220	$3,670	$21,620	$25,290
Toledo	South Lewis County (Ed Carlson Memorial Field)	TDO	$4,650	$35,850	$40,500	$15,580	$84,760	$100,340	$20,230	$120,610	$140,840
Tonasket	Tonasket Municipal	W01	$10,640	$65,280	$75,920	$10	$50	$60	$10,650	$65,330	$75,980
Twisp	Twisp Municipal	2S0	$260	$1,580	$1,840	$1,210	$6,600	$7,810	$1,470	$8,180	$9,650
Vancouver	Pearson Field	VUO	$85,510	$577,420	$662,930	$203,130	$1,077,500	$1,280,630	$288,640	$1,654,920	$1,943,560
Vancouver	Fly For Fun	W56	$1,190	$6,450	$7,640	$1,430	$7,750	$9,180	$2,620	$14,200	$16,820
Vashon Island	Vashon Municipal	2S1	$95,070	$294,250	$389,320	$60	$310	$370	$95,130	$294,560	$389,690
Walla Walla	Page	9W2	$220	$890	$1,110	$0	$0	$0	$220	$890	$1,110
Warden	Warden	2S4	$0	$0	$0	$560	$3,020	$3,580	$560	$3,020	$3,580
Waterville	Waterville	2S5	$4,820	$45,360	$50,180	$110	$620	$730	$4,930	$45,980	$50,910
Westport	Westport	14S	$4,400	$22,320	$26,720	$350	$1,910	$2,260	$4,750	$24,230	$28,980
Wilbur	Wilbur Municipal	2S8	$17,580	$93,300	$110,880	$5,670	$30,840	$36,510	$23,250	$124,140	$147,390
Wilson Creek	Wilson Creek	5W1	$2,870	$16,320	$19,190	$70	$380	$450	$2,940	$16,700	$19,640
Winthrop	Methow Valley State	S52	$1,480	$8,500	$9,980	$1,050	$5,730	$6,780	$2,530	$14,230	$16,760
Woodland	Woodland State	W27	$260	$1,590	$1,850	$720	$3,900	$4,620	$980	$5,490	$6,470
Sub Total (Excluding Sea-Tac)			$48,148,230	$543,196,900	$591,345,130	$14,235,190	$68,246,700	$82,481,890	$62,383,420	$611,443,600	$673,827,020
Total Tax Revenues (Including Sea-Tax)			**$48,148,230**	**$543,196,900**	**$637,045,130**	**$14,235,190**	**$68,246,700**	**$273,081,890**	**$62,383,420**	**$611,443,600**	**$910,127,020**

Totals may not sum due to rounding. Sources: Airport Managers Survey 2019, Airport Tenants/FBO Surveys 2019, Kimley Horn 2019, EBP US 2019 , Washington State Department of Revenue 2019, Community Attributes 2018. Calculations by EBP US 2019

Appendix C. Washington Aviation Economic Impact Calculator

> *The Calculator can be accessed at*
>
> ***http://washair.tredis.net/AirportWashington.aspx.***

Appendix C provides the Washington Aviation Economic Impact Calculator User's Manual (or Calculator). The Calculator enables airport administrators and sponsors, policymakers, and members of public to conduct airport economic impact scenario analyses. This tool can be used to evaluate how changes at a single airport, such as an airport improvement project or policy change, may affect the Washington economy, the regional economy where the airport is located, and the local economy when measuring direct impacts.

The Calculator is designed to assess a variety of alternative scenarios representing:

- Changes in aviation activity including commercial enplanements and general aviation (GA) operations and passengers
- Changes in freight and cargo operations (excluding access and off-airport logistics)
- Inter-airport shifts, such as shifts in operations and passengers, among airports
- Changes in terminal tenants and in-terminal employment
- Changes in airport expenditures, including those for construction, maintenance, and operations

The Calculator is widget embedded in WSDOT's Aviation webpage. The tool serves as an interface between users and the statewide economic input-output (I/O) model used in the 2020 Washington AEIS. It is supported across most internet browsers (i.e., Chrome, Firefox, Microsoft Edge, and Safari). The Washington Aviation Economic Impact Calculator can be accessed at http://washair.tredis.net/AirportWashington.aspx.

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Washington Aviation Economic Impact Calculator

User's Manual

July 2020

Prepared for

Washington State Department of Transportation
Aviation Division
"Innovative leadership in state aeronautics"

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1. Introduction

The Washington State Department of Transportation (WSDOT) Aviation Division published the 2020 Washington Aviation Economic Impact Study (AEIS) to document the 2018 contributions of Washington's public-use airports to the state's economy. The Aviation Economic Impact Calculator was developed to enable airport administrators and sponsors, policymakers, and members of public to estimate an airport's change in regional and statewide impacts based on potential changes in activity at the airport.

This User's Manual describes the various functions of the Aviation Economic Impact Calculator and provides step-by-step instructions to use the web-based tool. This User's Manual is divided into two major sections and a supplementary appendix:

- **Section 2** provides users with a broad overview of the Aviation Economic Impact Calculator, its intended purposes, and uses.
- **Section 3** gives users a comprehensive description and set of instructions for entering scenario data and viewing scenario results in the Aviation Economic Impact Calculator.
- **Appendix A** provides a glossary of terms that are not already defined in Sections 2 and 3.
- **Appendix B** lists the airports included in the scope of the 2020 Washington AEIS by WSDOT Region and county.
- **Appendix C** includes example projects to help users think through the data input changes potentially associated with various types of scenarios.

Users will also see **green call-out boxes** that include key terms and concepts that are defined or further explained throughout this User's Manual. Additional terms and their definitions are included in Appendix A.

2. Overview of the Aviation Economic Impact Calculator

Purposes of the Aviation Economic Impact Calculator

The primary purpose of the Aviation Economic Impact Calculator (also referred to as the Calculator) is to enable airport administrators and sponsors, policymakers, and members of public to conduct airport economic impact scenario analyses. Some examples of these analyses include evaluating how a surge in visitors, an increase in construction spending, or a growth in tenants would affect regional and state economies.

WSDOT's Aviation Economic Impact Calculator is a web-based tool designed for economic assessment of the state's public-use airport system. This tool can be used to evaluate how changes at a single airport, such as an airport improvement project or policy change, may affect the Washington economy, the regional economy where the airport is located, and the local economy when measuring direct impacts. Economic impacts from this tool are presented either statewide or regionally as changes in business revenue (often referred to as sales or economic output), labor income, and jobs are created. The tool also includes baseline results from the 2020 Washington AEIS, which is based on 2018 data. The Calculator estimates both the short-term economic impacts related to capital projects and the long-term economic impacts associated with airport operations and tourism from out of state visitor spending in Washington.

What Can be Assessed with the Calculator?

The Calculator is designed to assess a variety of alternative scenarios representing:

- Changes in aviation activity including commercial enplanements and general aviation (GA) operations and passengers
- Changes in freight and cargo operations (excluding access and off-airport logistics)
- Inter-airport shifts, such as shifts in operations and passengers among airports
- Changes in terminal tenants and in-terminal employment
- Changes in airport expenditures, including those for construction, maintenance, and operations

The Calculator can generate impact reports for an individual airport on either its region or the state as a whole. Users will be able to view and download scenario reports as discussed in **Section 3.5.2**. Reports include estimates of:

- Direct and total impacts (with multiplier impacts) by economic sector[1]
- Changes in overall economic activity as measured by business output and jobs at the state and regional levels

Four Elements of the Calculator

The Calculator has four main elements that are described in Section 3. These elements are listed below, along with the main components that make up each element (labeled as "Sections"). The section labels (e.g., Section A, Section B, etc.) are not displayed in the Calculator; they are only used in this User's Manual as a way to organize and clarify the parts covered in the Calculator.

The four elements include:

1. Homepage: Search for an airport name and choose an airport to be evaluated in the Calculator.
2. Spending: Displays the selected airport's baseline and scenario values for airport and visitor spending inputs.
    - Section A: Airport's Annual Budget and Expenditures
    - Section B: Airport's Commercial Enplanements and Visitors
    - Section C: Airport's General Aviation Operations and Visitors
    - Section D: Visitor Spending (Commercial Service and GA)
3. Employment: Displays the selected airport's baseline and scenario values for airport administration and tenant employment inputs.
    - Section A: On-site Transportation Activities

[1] Terms are defined in Appendix A.

- Section B: On-site Supporting Services
- Section C: On-site Freight Activities
- Section D: On-site Passenger Terminal Activities
- Section E: Other Air Services

4. Results: Displays the selected scenario impacts by region or state.

- Section A: Economic Impacts Summary
- Section B: On-Airport Jobs
- Section C: Temporary Construction Jobs
- Section D: Visitor Spending Jobs

Advisory Note: The economic calculator uses 2018 airport data. This data will remain unchanged until the aviation economic impact study or similar activity is conducted that collects new, in depth economic data. The multipliers in the calculator will be updated annually or as new multiplier data becomes available.

3. Aviation Economic Impact Calculator User's Manual

Overview

The Calculator is a multi-tab widget embedded in WSDOT's Aviation webpage. The tool serves as an interface between users and the statewide economic input-output (I/O) model used in the 2020 Washington AEIS. It is supported across most internet browsers (i.e., Chrome, Firefox, Microsoft Edge, and Safari).

> *The Washington Aviation Economic Impact Calculator can be accessed at http://washair.tredis.net/AirportWashington.aspx.*

Through the Calculator, users are able to project potential changes to an airport's baseline economic impact as estimated by the Washington AEIS. Revised economic impacts reflect user-defined impacts generated by entering different/updated scenarios into the Calculator. Any new inputs will not be saved, nor will new inputs influence the data in the original Washington AEIS. Additionally, when the Calculator is reloaded on their browser, users will be redirected to the Homepage and all new inputs will be automatically deleted, resetting scenario values to baseline values. Any changes to the scenario values can be saved by clicking the red "Save" button. Changes that are saved are only stored within an active session. Once users navigate away from the Calculator—either by hitting the back button on their browser or choosing a new airport—their active session and scenario values will be automatically deleted.

Once users have chosen an airport from the homepage, they will be directed to the first modifiable tab in the calculator: "Spending". On this page, users can also see the other modifiable tab ("Employment") and the "Results" tab, as well as the drop-down list of Washington airports on the top-left corner of the widget. These three tabs are used to move between the three key elements of the Calculator and are further explained in subsequent sections below. Each element is a separate heading, and these headings are further broken into subheadings with details on different components of the element.

It is important to note that there are no buttons within the Calculator widget that will allow users to print the "Spending" and "Employment" screens (i.e., the scenario inputs changed by the user). In both tabs, the easiest option to capture all of the information is to copy and paste the content into a Microsoft Word document using the following steps:

1. For the Employment tab only, click on "Expand All" so all modifiable fields are shown (all modifiable fields are always shown in the Spending tab).
2. Click on the empty white space to the left of the "Save" button.
3. Drag the curser to the bottom of the page and release once all content is selected.
4. Copy the content by right-clicking and selecting "Copy" or using the system shortcut for copy: CTRL + C for Windows users and Command + C for Macintosh users.
5. Open a Microsoft Word document and paste the content. Users should right-click and choose "Keep Source Formatting" under Paste Options. The system shortcut for paste is CTRL + V for Windows uses and Command + V for Macintosh users

Users can also use a print screen option for the Spending tab. However, it is important to note that these options will only capture content on the screen as shown. Content that is below the current screen view (normally accessed by scrolling down) will not be captured. The general options to print a snapshot of the screen are using Print Screen button, using the Snipping Tool, or printing to PDF as follows:

- The system shortcut for the Print Screen option is Ctrl + P for Window users and Command + P for Macintosh users.
- The system shortcut for the Snipping Tool option is Windows icon + Shift + S for Window users and Shift + Command + 4 for Macintosh users.
- To print to PDF, right-click the screen and choose "Print". Depending on the browser, users then chose "Save to PDF" in the Destination drop-down menu or chose "Adobe PDF" in the Select Printer box. Users then click "Print" or "Save" (again depending on the browser), and the screenshot can be saved to the computer for later reference.

These printing options will only print or save the current screen view and ignore any hidden tables (unless the table view option has been expanded and elements of the hidden table are shown on the screen). **It is recommended that users maintain records of what they change to generate new results.**

Users will also see key terms that are defined or further explained in **green call-out boxes** throughout the User's Manual. Additional related terms and their definitions are in Appendix A.

Calculator Homepage

3.1.1 Navigating the Aviation Economic Impact Calculator Homepage

Purpose: Allows users to select a specific airport to review and edit inputs.

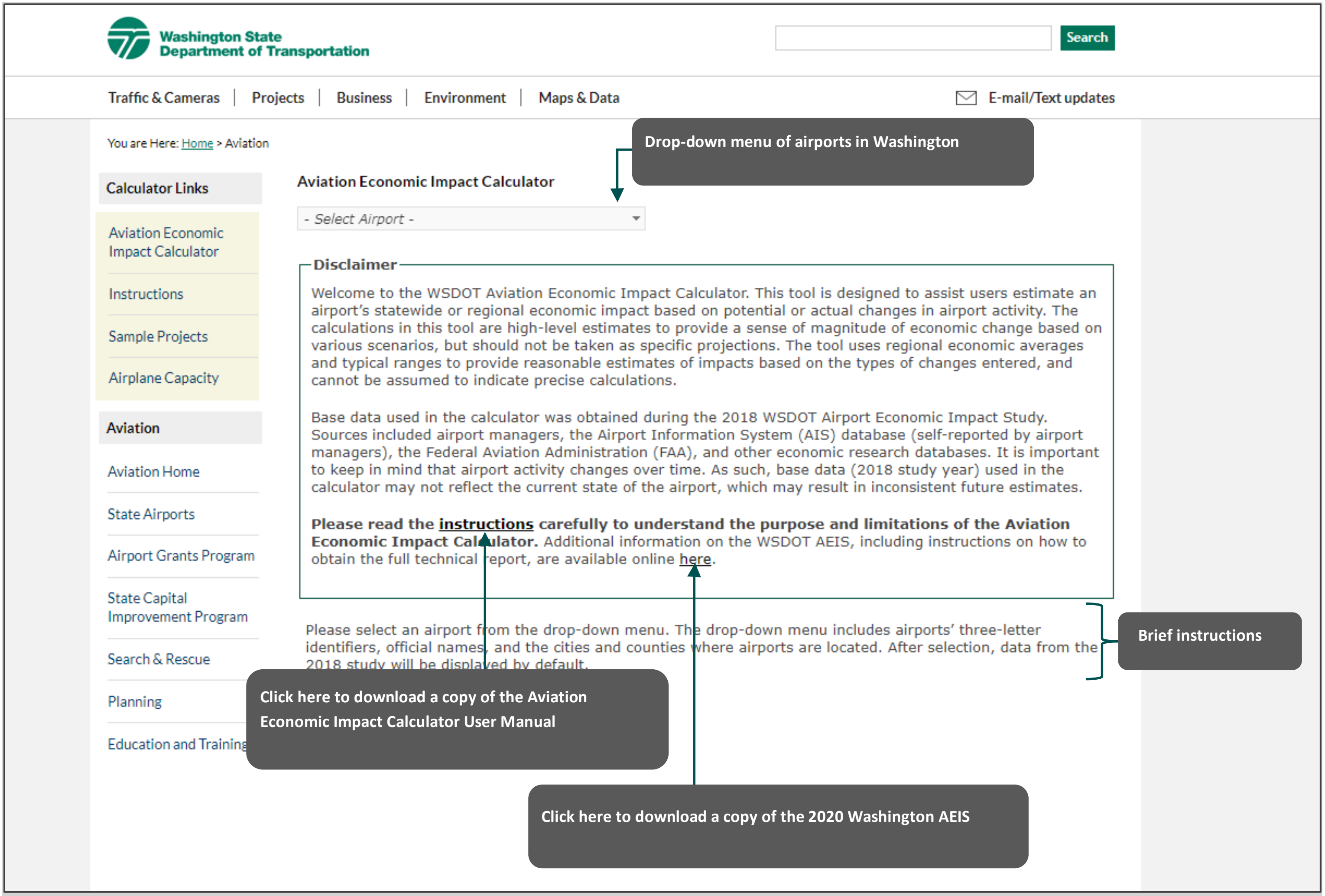
User Input: Select an airport to view by clicking on the drop-down menu and navigating to the desired airport. Once an airport has been selected, the page will direct users to the Calculator.

Description: As shown on **Figure 1**, the first page that users will see when accessing the Aviation Economic Impact Calculator widget includes:

- An airport selection drop-down menu on the top-left corner of the page. The drop-down menu includes airports' three-letter identifiers, official names, and the associated cities and counties where located. The airports are listed in alphabetical order by airport name (not code).
- A disclaimer statement about the capabilities of the tool. Within this disclaimer statement, users can also download this User's Manual by clicking on the instructions hyperlink and accessing the WSDOT Aviation AEIS website by clicking on the "here" hyperlink.
- Brief instructions on choosing an airport from the airport selection drop-down menu.

Users can only view one airport at a time and will be redirected to the selected airport's tabs once they have made a selection. Modifiable tabs are Spending and Employment, which include columns that display baseline values and scenario inputs (see **Sections 3.3** and **3.4** for details). Baseline values reflect the airport's data from the Washington AEIS. Scenario inputs is where users can add different values that reflect changes in airport activity. The Results tab is where users can see how their scenario values impact the airport's regional or state economic impacts (see **Section 3.5**).

Figure 1. Washington Aviation Economic Impact Calculator Homepage



Source: EBP US 2020

Spending Tab

3.1.2 Overview of Using the Spending Tab

This tab displays baseline on-airport activity and visitor spending inputs and enables users to modify these inputs to run an updated annual economic impact for the selected airport (i.e., their scenario). The screen is divided into four sections (as shown in Figure 2):

- Section A is used to enter capital and operational budgets and expenditures.
- Sections B and C are used to describe and enter scenario values for the commercial service and GA operations (respectively) at the selected airport.
- Section D is used to describe the visitor spending from travelers who depart the state using commercial service aviation and GA.

This is the first modifiable tab that users see once they choose an airport to evaluate. For each of the three sections on the page, there are two columns: Baseline and Scenario. The baseline values on this page are fixed; users can modify scenario values to build new input values into their scenario report (initially set to the baseline numbers as the default).

When the Washington AEIS was completed, airports may not have had baseline values in some categories. For instance, many airports do not support commercial service visitors and therefore show values of zero under Baseline in the commercial visitor and visitor spending sections.

Users can modify scenario values in this tab as further described below. Once an input has been changed, the save button will turn orange to prompt users to save their work. **Users must click "Save" on the top right to preserve their changes and make sure they are included in the calculation when changing to the Results tab.** Once users hit "Save", the inputs that have been modified will be highlighted in red text so that they can be easily identified (as shown in **Figure 2**). The "Save" button will turn back to a maroon color to let users know that the changes they made have been saved.

HOW ARE THE ELEMENTS WITHIN THE SPENDING TAB DEFINED?

Airport Capital Annual Budget: This is the budget towards the airport's facility and infrastructure.

Airport Operational Annual Budget: This is the budget towards personnel costs and annual facility operating costs.

Other On-Airport Capital Expenditures: This is any additional expenditures made, such as by tenants, to improve or expand the airport's facilities and infrastructure.

Commercial: This group consists of estimated visiting passengers arriving by commercial passenger service.

Enplanements: The number of revenue-paying passengers boarding an aircraft.

Percent Visitors: Percent of visitors who use the airport to travel to Washington from out of state or international locations.

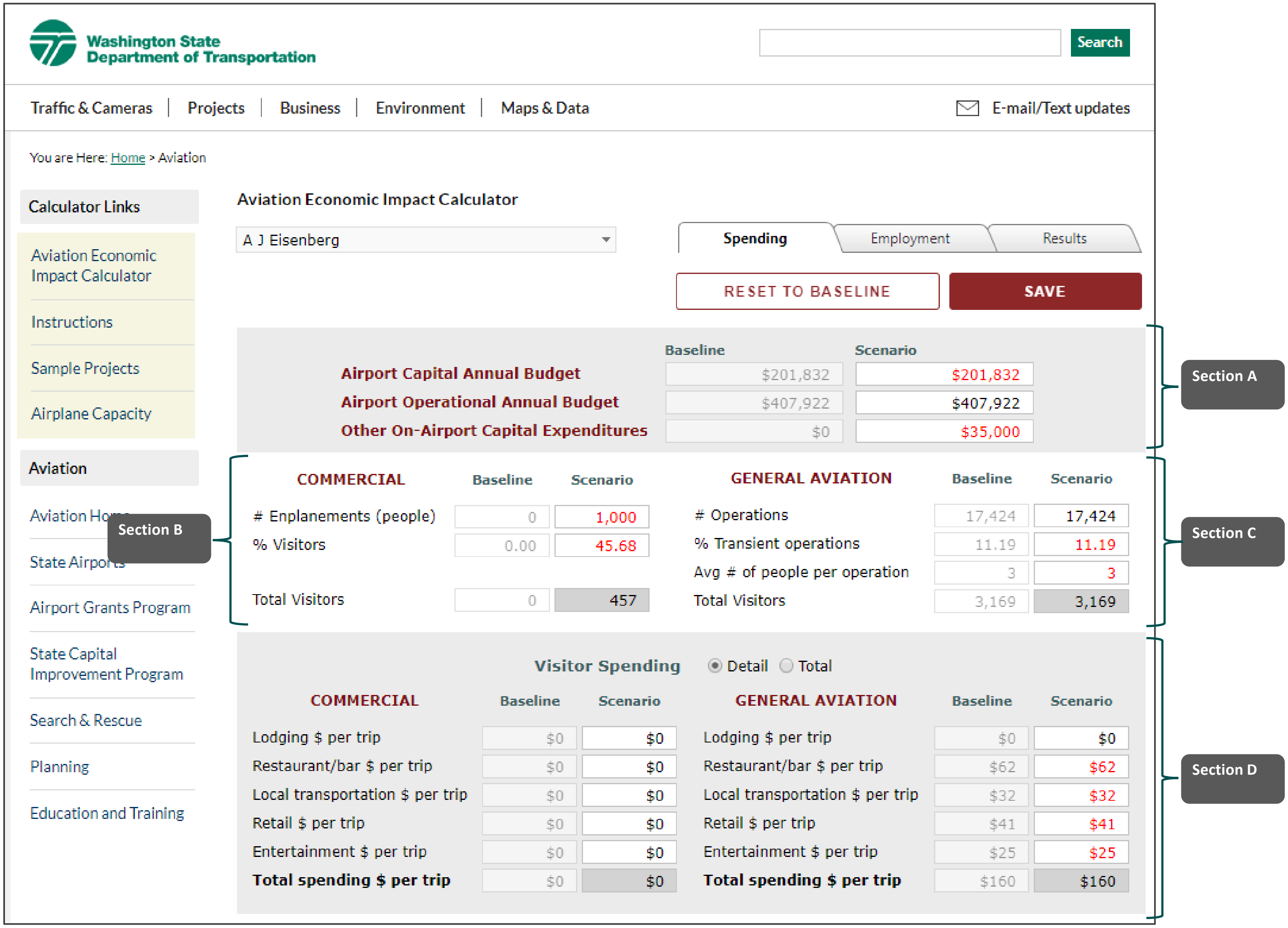
General Aviation (GA): This group consists of estimated passengers arriving by GA.

Transient Operations: GA flights that bring out of state or international visitors to Washington.

In addition, once changes have been saved, there is an option to reset all inputs that have been changed back to the baseline values by clicking on the "Reset to Baseline" button on the top right next to "Save". Once values have been reset to baseline, inputs previously highlighted in red will return to baseline values and will turn back to black. **The "Reset to Baseline" button will reset all values on this page for the selected airport, but it will not impact any saved or unsaved changes in the other modifiable tabs.**

Users will also see a drop-down menu of airports, located at the top left corner of the tab, that will allow users to evaluate another airport. When users navigate to another airport, changes made to existing airports will not be lost within an active session if changes are saved.

Figure 2. Spending Tab



Source: EBP US 2020

3.1.3 Section A: Airport Annual Budget and Expenditures

Purpose: To allow users to change the airport annual budget and capital expenditure baseline values to their scenario values for the selected airport.

User Input: Users can change the dollar values of their selected airport's capital annual budget, operational annual budget, and other on-airport capital expenditures, as applicable, by entering new values in the Scenario column boxes for each category. Once one or a combination of these categories are updated, users should click "Save" to preserve their work.

Description: This section displays the options that users have to change their selected airport's capital annual budget, operational annual budget, and/or other on-airport capital expenditures, based on the scenario under evaluation. The scenario values should be entered in the Scenario column. Changes can be saved or reset to baseline values following the instructions in **Section 3.2.1**.

3.1.4 Section B: Commercial Enplanements and Visitors

Purpose: To allow users to change the number of visitors from the selected airport's baseline values to the user's scenario values.

User Input: Users can update values in their scenario for their selected airport's number of commercial enplanements and the percentage of enplanements that are out of state or international visitors, as applicable. The "Total Visitors" box will calculate the actual number of total commercial visitors based on the enplanements and percentage visitors entered. Once one or a combination of these categories are updated, users should click "Save" to preserve their work.

Description: This section displays the options that users have to change the number of commercial visitors from the airport's baseline values in terms of number of commercial enplanements and percentage of visitors. The number of annual enplanements should be entered as a whole number. For example, 10.75 people would be entered as "11." The percentage of enplanements that are visitors can be entered as a number in decimal form (e.g., 10.75%)

Each time users make a change to either of these inputs, "Total Visitors" will be automatically updated and shown. The updated "Total Visitors" value is generated by multiplying the total number of enplanements (people) by the percentage of visitors**. Users cannot update the "Total Visitors" row; the only way users can update this row is by updating the "# Enplanements" or "% Visitors" row.** Changes can be saved or reset to baseline values following the instructions in **Section 3.2.1**.

3.1.5 Section C: GA Operations and Visitors

Purpose: To allow users to change the number of GA operations, percentage of transient operations, and average number of people per operation for the selected airport.

User Input: Users can update values in the scenario column for the selected airport's GA activity including number of operations, percentage of transient operations (aircraft originating from/departing for destination outside of Washington state), and average number of people per operation. The "Total Visitors" box will calculate the actual number of aviation visitors generated based on the number of operations, percent transient operations, and average number of people per operation. Once one or a combination of these categories are updated, users should click "Save" to preserve their work.

Description: This section displays the options that users have to change the number of GA visitors who rely on their airport from the baseline values. **While the "# Operations" simply represents the total number of GA operations in the selected airport, the "% Transient Operations" represents the percent of GA flights that bring out of state or international visitors to Washington.**

Users can modify the baseline values for their scenario analysis by inputting new values in the scenario column. The "# Operations" and "Avg # of people per operation" rows should be entered as a whole number. For example, 10.75 people would be entered as "11". The percentage of transient operations can be entered as a number in decimal form (e.g., 10.75 percent). Changes should be saved or can be reset to baseline values following the instructions in **Section 3.2.1**.

Each time users make changes to the editable rows, such as "# Operations," "% Transient operations," or "Avg # of people per operation," "Total Visitors" will be automatically be updated. Users cannot update the "Total Visitors" row; the only way users can update this row is by updating the GA editable rows. The updated "Total Visitors" value is generated using the following equation:

*Total Visitors = (# Operations) * (50%) * (% of Transient operations) * (Average # of people per operation)*

Note: An operation represents take-offs and landings. The number of operations at an airport is multiplied by 50 percent to account for the fact that each trip includes two operations, but passengers should only be counted once during their visit to Washington.

3.1.6 Section D: Visitor Spending

Purpose: To allow users to change baseline visitor spending dollar amounts for commercial and GA visitors to scenario values.

User Input: Users can update visitor spending for their scenario in terms of total dollars per trip in the following categories:

- Lodging
- Restaurant and bar
- Local transportation
- Retail
- Entertainment

All values are entered as an average per trip dollar amount. Users can update commercial and GA spending separately for each category if the "Detail" radio button is selected. The "Total spending $ per trip" box will be updated to the sum of all spending by category. If the spending by category is unknown, users also have the option to update only the "Total Spending $ per trip" if the "Total" radio button is selected. This option distributes a certain percentage of the total towards the various spending categories according to the statewide analysis. Once one or a combination of these categories are updated, users should click "Save" to preserve their work.

Description: This section displays the options that users have to update commercial and GA visitor spending inputs for their scenario in terms of dollars spent per visitor. Users can either enter specific spending by category, if available, or a total per-visitor spending value that is automatically allocated to the different spending categories based on the 2018 baseline distribution of expenditures for the selected airport. These two options are available by toggling between the "Detail" and "Total" radio buttons.

When the "Detail" radio button is selected, users can change dollar values attributed to the different spending categories, and the sum of all spending categories will be totaled in the "Total spending $ per trip" row. The five spending categories are:

- Lodging $ per trip: Visitor spending on hotels and motels (including casinos, short-term rentals, and other accommodations).
- Restaurant/bar $ per trip: Visitor spending on full-service and limited-service restaurants, as well as other food and drinking places.
- Local transportation $ per trip: Visitor spending on ground transportation including taxis, Transportation Network Companies (TNCs) (e.g., Uber and Lyft), public transportation, and other transportation services. **Note that on-airport car rentals should not be entered here but assumed car rentals off-airport should be included.** On-airport car rentals are captured in airport tenant activity and can be modified in the employment tab under On-site Transportation Activities" (see **Section 3.4.2** for more details).
- Retail $ per trip: Visitor spending on retail establishments, such as stores that sell electronics and appliances, food and beverage, health and personal care items, clothing, general merchandise, sporting goods, musical instruments, and books.
- Entertainment $ per trip: Visitor spending on movies, shows, sporting events, amusements, museum admissions and other similar activities.

Alternatively, when the "Total" radio button is selected, the five spending categories are locked (highlighted in gray) and the only editable box is "Total spending $ per trip" in the scenario column. Users can change the values in the scenario column for either commercial spending per trip, GA spending per trip, or both. The Calculator will then automatically distribute shares of the total spending (reflected in 2018 $USD) among the five spending categories described above.

Total spending across categories is distributed separately for "Commercial" and "General Aviation" visitor spending. How that total spending $ per trip is distributed among the five spending categories is shown in **Table 1**. If users previously edited spending in individual categories while in the "Detail" setting, changes will not be maintained if a new total spending amount is entered while in the "Total" setting.

Table 1. Total Per Trip Spending Distribution by Category

Spending Category ($ per trip)	Commercial	GA
Lodging	48%	30%
Restaurant/bar	29%	34%
Local transportation	3%	11%

Spending Category ($ per trip)	Commercial	GA
Retail	15%	13%
Entertainment	5%	12%
Total spending	100%	100%

Source: EBP US 2020

Any changes to the scenario values should be saved or be reset to baseline values following the instructions in **Section 3.2.1** before continuing to a different tab.

Employment Tab

3.1.7 Overview of Using the Employment Tab

The Employment tab is where users can view the baseline number and modify scenario inputs for on-site jobs (based on headcount) for the following groups:

- On-site Transportation Activities
- On-site Supporting Services
- On-site Freight Activities
- On-site Passenger Terminal Activities
- Other Air Services
- Miscellaneous Activities

Definitions for on-site jobs and these specific categories are available in the **call-out box** on the following page. Users navigate to this tab by clicking on the Employment tab at the top of the Calculator widget once an airport has been selected. The page includes a black header bar for each of the groups. Below each header is a table with a list of specific activities within that group, and columns for each the Baseline and Scenario numbers, as shown in **Figure 3**.

At the top left of the tab, users have the option to "Expand All" to show all job activities for all six groups, or "Collapse All" to hide all of the tables under the group headers. Alternatively, users can choose to expand any of the groups by directly clicking on the black header/title bar labeled with the chosen group's name and "(Show Details)". Individual tables can also be hidden by clicking on the black header/title bar of choice where it now says "(Hide Details)" next to the group's name. If users want to see a short description of each of the employment groups, they can hover over the black header/title bars and a pop-up comment box will appear next to the title bar explaining the group. The first five employment groups pertain specifically to aviation-related activities, while the "miscellaneous" group contains other non-aviation-related activities commonly occurring at Washington airports.

Similar to the Spending tab, each table on this tab includes a column with baseline numbers and a scenario column where numbers can be entered for the user's scenario analysis. The baseline column shows the results of each data field from the Washington AEIS and cannot be changed. The right "Employment" column reflects the number of jobs to be evaluated as part of the scenario analysis.

After making any changes on this screen, the "Save" button will change to orange to indicate inputs need to be saved. Users must click Save before moving on. After changes have been saved, any scenario numbers that differ from the Baseline number will be red, and the "Reset to Baseline" button will appear next to the "Save" button. To undo any saved changes and reset all jobs numbers to the baseline numbers, users should click the "Reset to Baseline" button.

The drop-down menu of airports located at the top left of the tab allows users to evaluate a different airport. When users navigate to another airport, changes made to existing airports will not be lost within an active session if changes are saved.

DEFINITIONS: ON-SITE JOBS AND EMPLOYMENT GROUPS

On-site Jobs: In this context, "jobs" refers to the sum of full- and part-time workers. Each part-time employee counts as a full head, rather than calculating full-time equivalent hours (commonly referred to as a "headcount"). Jobs include wage and salaried employees as well as proprietors.

On-site Transportation Activities: Employment for terminal, on-site transit, car rental, and other transportation activities.

On-site Supporting Services: Employment for on-site building maintenance, parking, and safety services.

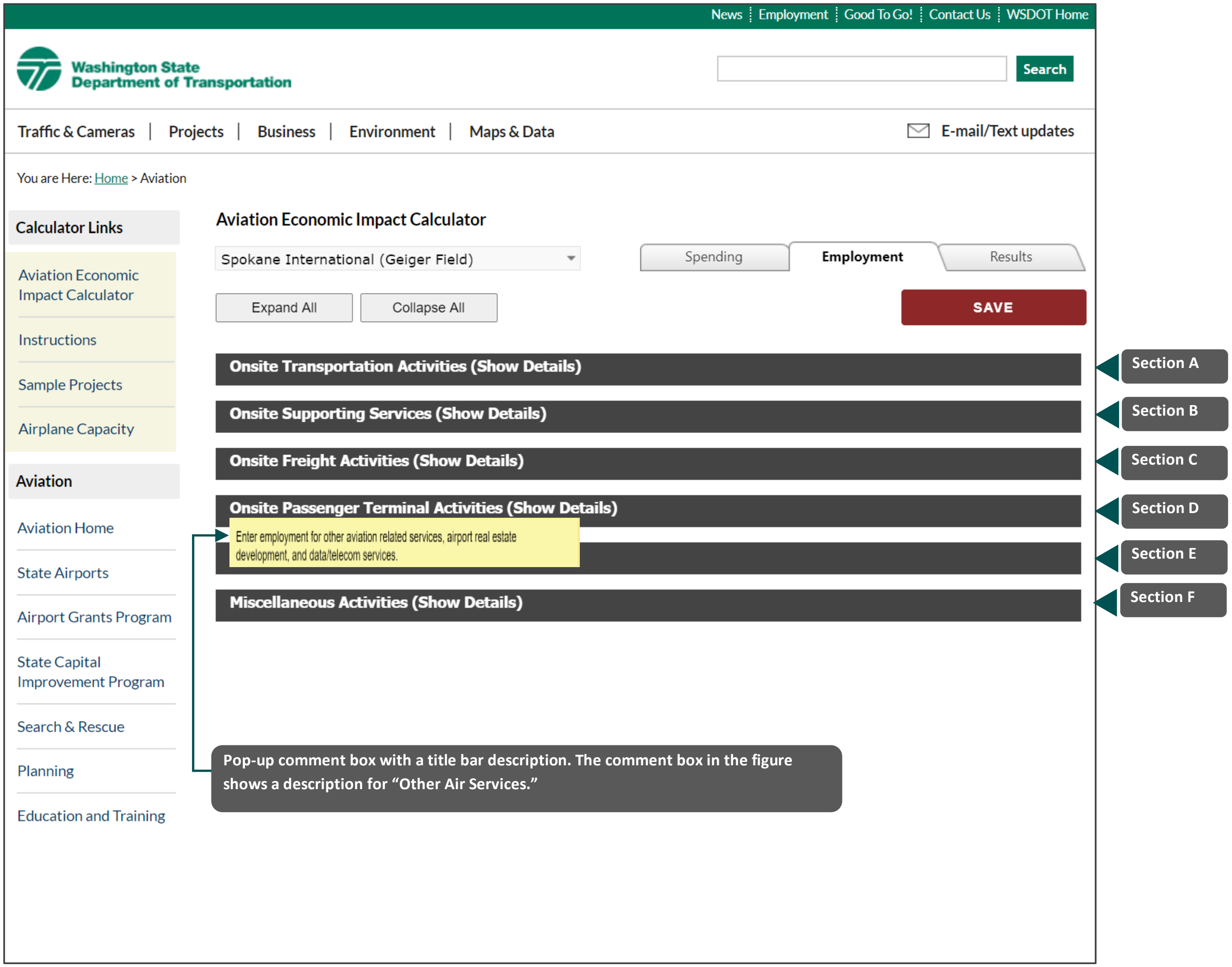
On-site Freight Activities: Employment for on-site freight cargo, warehousing, & postal services.

On-site Passenger Terminal Activities: Employment for on-site retail, restaurant, and entertainment services.

Other Air Services: Employment for on-site air services, such as news/traffic reporting, real estate, and property development, etc.

Miscellaneous Activities: Various types of non-aviation-related industries commonly found at Washington's airports. Examples include agriculture, construction, healthcare, marinas, and non-aviation-related government agencies.

Figure 3. Employment Tab



Source: EBP US 2020

3.1.8 Section A: On-site Transportation Activities

Purpose: To allow users to change the number of employees related to on-site transportation activities.

User Input: Users can change the number of employees in job activities relating to on-site transportation activities. Once scenario values have been updated under Employment, users need to click "Save" to preserve their work.

Description: This section displays the baseline numbers for jobs in on-site transportation services activities, and users can update the values used for the scenario analysis. The baseline jobs for each activity are shown in the second column of the table, and the scenario values can be edited in the third column labeled "Employment". After making changes, users should either "Save" their changes or "Reset to Baseline Values," using the respective options on the top-right corner of the widget.

The different types of activities within on-site transportation services are as follows:

- Airline Companies: Aviation carriers with scheduled passenger and/or cargo service
- Airport Terminal Facilities & Administration: Jobs associated with the upkeep, maintenance, and operation of the airport terminal as well as airport management/operators. This row may also include jobs associated with hangar rental, parking services, baggage and cargo handling, and runway cleaning/maintenance services.
- Car Rental: Automotive rental service companies that are located on-site
- Charter Services other than Fixed Based Operator (FBO): On-airport charter flight companies, which might include pilot, crew, aircraft maintenance, company administration, and other jobs.
- FBO: On-airport FBOs, which generally includes services such as fueling, hangar rental, tie-down and parking maintenance, aircraft repair, flight instruction, and other related services.
- On-site Transportation Activities:
  - Non-Aviation Vehicle Repair and Maintenance, including repair and maintenance of on-airport ground transportation vehicles
  - Taxi/Limo, including ride-hailing/TNC activities
- Rental of Aviation Equipment: On-airport aircraft rental services
- Repair of Aviation Equipment: Aircraft maintenance and repair service jobs, including testing services (does not include jobs associated with FBOs and charter services)
- Sale of Aviation Equipment: Aircraft dealers' services

3.1.9 Section B: On-site Supporting Services

Purpose: To allow users to change the number of employees relating to on-site supporting services.

User Input: Users can change the number of employees in job activities relating to on-site supporting activities. Once scenario values have been updated under "Employment," users need to click "Save" to preserve their work.

Description: This section displays the baseline numbers for jobs in on-site supporting services activities, and users can update the values used for the scenario analysis. The baseline jobs for each activity are shown in the Baseline column of the table, and the scenario inputs can be edited in the Employment column. Users should either "Save" their changes or "Reset to Baseline Values," using the respective options on the top-right corner of the widget.

The different activities within On-site Supporting Services are:

- Aerial Firefighting: Use of aircraft to combat wildfires
- Aviation Training and Education: Flight school instruction, education and training, and other educational flight-related activities
- Building Maintenance: Maintenance and repair on on-airport buildings
- Federal Government (non-military): Federal agencies, such as the Federal Aviation Administration (FAA), Customs and Border Protection (CPB), Immigration and Customs Enforcement (ICE), the Drug Enforcement Administration (DEA), and the Federal Bureau of Investigation (FBI). This may also include other agencies such as the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS), but it does not include the Transportation Security Administration (TSA) and other Department of Homeland Security (DHS) agencies.
- Military National Guard: Federal and state Air National Guard personnel
- On-site Supporting Services:
    - Consultants (contracted on-airport staff effectively functioning as employees)
    - Hospitals
    - Hotels
    - Labor & Civic Organizations
    - Legal Services
- Parking: Airport parking services
- Public Safety (Police, Fire): Airport police, fire, and other state and local public safety personnel
- Security/TSA: Federal agencies such as the TSA and other security-oriented positions within DHS

3.1.10 Section C: On-site Freight Services

Purpose: To allow users to change the number of employees relating to on-site freight activities.

User Input: Users can adjust the number of employees in job activities relating to on-site freight activities. Once scenario values have been updated under Employment, users need to click "Save" to preserve their work.

Description: This section displays the baseline numbers for jobs in on-site freight activities, and users can update the scenario input values. For each activity in the table, baseline jobs are shown in the left column, and scenario jobs can be edited in the right column under Employment. Users should either "Save" their changes or "Reset to Baseline Values", using the respective options on the top-right corner of the widget.

The different activities are that are within on-site freight services are as follows:

- Cargo Consolidators & Air Couriers: Integrated air cargo carriers (e.g., FedEx, UPS, and DHL), freight forwarders, express delivery, and other courier services.
- Postal Service: United States Postal Service activities
- Trucking Companies: Freight trucking companies located on-airport or serving airport logistics via through the fence arrangements
- Warehouse & Distribution: On-airport or through-the-fence activities associated with warehousing, logistics, distribution, and shipping and receiving services (including scheduling) on-airport or serving airport logistics via through the fence arrangements

3.1.11 Section D: On-site Passenger Terminal Activities

Purpose: To allow users to change the number of employees relating to on-site passenger terminal activities.

User Input: Users can change the number of employees in job activities relating to on-site passenger terminal activities. Once scenario values have been updated under "Employment," users need to click "Save" to preserve their work.

Description: This section displays the baseline numbers for jobs in on-site passenger terminal activities. Users can also update the inputs for these activities used for the scenario analysis. The baseline jobs for each activity are shown in the Baseline column of the table, while the scenario inputs can be edited in the Employment column. Users should either "Save" their changes or "Reset to Baseline Values" using the respective options on the top-right corner of the widget.

The different activities within On-site Passenger Terminal Activities are:

- On-site Passenger Services: Activities associated with currency exchange, banking, and other personal care services
- On-site Retail: Retail stores in sectors such as electronics, health and personal care, clothing, sporting goods, and general merchandise stores, or other
- On-site Passenger Terminal Activities – Entertainment: On-airport entertainment services such as museums. Note that restaurant, bar, and catering services are counted separately.
- On-site Restaurants/Bars/Catering: Restaurants, other food/drinking establishments, and catering services.

3.1.12 Section E: Other Air Services

Purpose: To allow users to change the number of employees relating to other air services, such as aerial applicators and supply, medical evaluation, news/traffic reporting, and weather reporting and forecasting.

User Input: Users can change the number of employees in job activities relating to other air services. Once scenario values have been updated under "Employment," users need to click "Save" to preserve their work.

Description: This section displays the baseline numbers for jobs in other air services activities, and users can update the values used for analysis. For each activity row, baseline jobs are shown, and the inputs for analysis can be edited in the Employment column of the table. Users should either "Save" their changes or "Reset to Baseline Values" using the respective options on the top-right corner of the widget.

The different activities within other air services include the following:

- Aerial Applicators and Supply: Crop dusting and other agricultural applications
- Medical Evacuation: Air ambulance services or other medical transport activities
- News/Traffic Reporting: Radio and television broadcasting services that rely on aviation
- Other Air Services: The number of jobs associated with the following activities:
  - Data/hosting
  - Telecom
  - On-airport real estate and property development
  - Skydiving
- Sightseeing: Scenic and sightseeing transportation services
- Weather: Meteorological and other weather forecasting and reporting services.

3.1.13 Section F: Miscellaneous Activities

Purpose: To allow users to change the number of employees relating to miscellaneous on-airport activities that do not fall into sections A – E. These include agricultural services (but not aerial applicators), education institutions (but not flight training), and various types of businesses and organizations that are located on an airport, but that are not specifically identified in one of the earlier sections.

User Input: Users can change the number of employees in job activities relating to miscellaneous activities. Once scenario values have been updated under "Employment," users need to click "Save" to preserve their work.

Description: This section displays the baseline numbers for jobs in fifteen categories of miscellaneous activities, and users can update the values used for analysis. For each activity row, baseline jobs are shown, and the inputs for analysis can be edited in the Employment column of the table. Users should either "Save" their changes or "Reset to Baseline Values" using the respective options on the top-right corner of the widget. Miscellaneous activities include the following:

- Agriculture/Agricultural Support Services/Livestock/Farming
- Construction/Restoration/Construction Support Services/Remodeling
- Educational Institutions/High Schools/Colleges/Universities/Departments
- Energy Services/Energy Utilities
- Healthcare/Health Services/Wellness Services
- Marinas, Shipbuilding, and Repairs
- Misc. Commercial Trade & Services
- Misc. Manufacturing

- Misc. Media, Content Production, & Publishing
- Misc. Organizations & Associations
- Misc. Professional Services
- Misc. Services
- Misc. Software & Computer Services
- Misc. Transportation or Services
- State/Local Government Agencies/Departments

Results Tab

3.1.14 Overview of Using the Results Tab

This part of the Calculator will show the economic impact results for a scenario analysis based on the inputs provided in the Spending and Employment tabs. All reports produced in this tab are available as data tables and can be exported as Microsoft Excel files (specifically as a Microsoft Excel 97-2003 Worksheet).

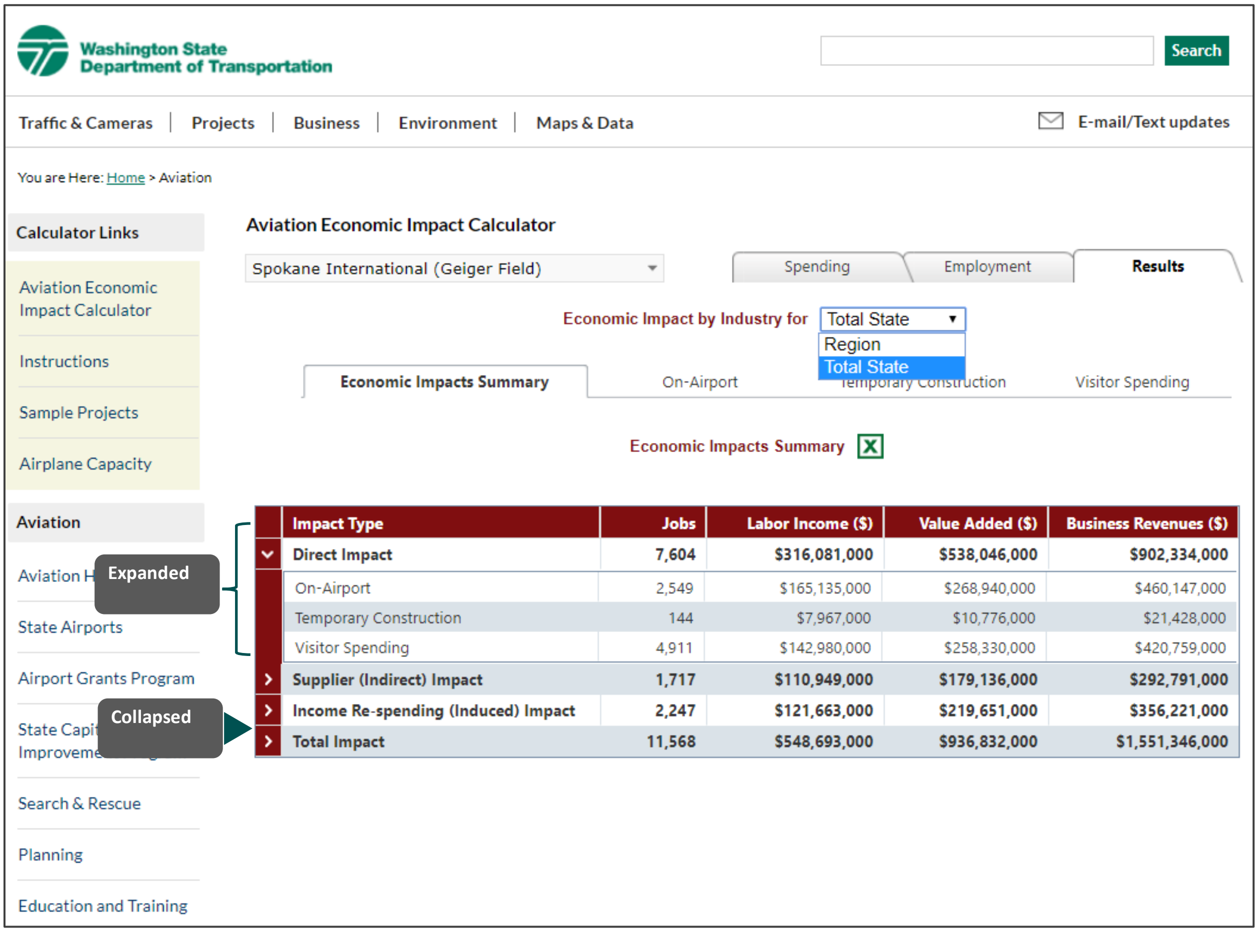
By clicking on the Results tab, users will be redirected to the Economic Impacts Summary section where they will see a summary of the economic impact analysis results for the selected airport. The information shown on this page can be disaggregated by expanding "Direct Impact", "Supplier (Indirect) Impact", "Income Re-spending (Induced) Impact," and "Total Impact" within the Economic Impacts Summary table (see **Figure 4**) to show the effects on each of the three impact types for On-Airport, Temporary Construction, and Visitor Spending activities.

Users can also view the economic impact of their scenario by total state or region. Additionally, if users would like to revise any scenario inputs after running a scenario report, they can navigate back to either the Spending tab or the Employment tab, make the desired revision, click "Save," and then return to the Results tab page regenerate their report.

WHAT IS THE DIFFERENCE BETWEEN TOTAL STATE AND REGION?

Users have the option to toggle between Total State and Region within the Results tab. If users want to see the cumulative impacts of their scenario for the whole state of Washington, they should click on Total State. If users just want to see the impact of their scenario to the WSDOT transportation region that their selected airport is in, they should choose Region.

Figure 4. Economic Impact Summary Tab



Impact Type	Jobs	Labor Income ($)	Value Added ($)	Business Revenues ($)
Direct Impact	7,604	$316,081,000	$538,046,000	$902,334,000
On-Airport	2,549	$165,135,000	$268,940,000	$460,147,000
Temporary Construction	144	$7,967,000	$10,776,000	$21,428,000
Visitor Spending	4,911	$142,980,000	$258,330,000	$420,759,000
Supplier (Indirect) Impact	1,717	$110,949,000	$179,136,000	$292,791,000
Income Re-spending (Induced) Impact	2,247	$121,663,000	$219,651,000	$356,221,000
Total Impact	11,568	$548,693,000	$936,832,000	$1,551,346,000

Source: EBP US 2020

At the top-left side of the Results tab, users will see a drop-down menu of airports. This drop-down menu is visible throughout this tab and among the subtabs so users can quickly evaluate another airport after they have viewed their results for their current selected airport.

3.1.15 Viewing and Downloading Scenario Reports

Purpose: To allow users to view and download scenario reports by the selected airport.

User Input: Users can view different scenario report results for different geographical levels (total state or region). The results are presented as tables, and also sometimes as pie charts and bar charts (as described below).

Description: Once users have modified the Spending and Employment tabs, they can then view their scenario analysis results using the Results tab. At the top-left side of the Results tab, users will see a drop-down menu of airports. Under the drop-down menu titled, "Economic Impact by Industry for," users can analyze their scenario results by two geographical levels: total state and region. The values in the scenario report will change according to the geography selected.

Below the "Economic Impact by Industry for" drop-down menu, users will find four summary tabs. Users can navigate between the tabs by clicking on the tab names. Within each summary tab, users will find tables and charts summarizing the results of the scenario analysis run by the Calculator. The four summary tabs that users will see are:

- Economic Impact Summary
- On-Airport Jobs
- Temporary Construction Jobs
- Visitor Spending Jobs

KEY DEFINITIONS USED IN THE RESULTS TAB

On-Airport: Employment and activity at the airport (both working directly for the airport and tenants). These activities broadly include airside activities, terminal services to passengers (including concessions), air-related services by government agencies (such as TSA), construction, airport administration, and all on-airport tenants with employees working on airport property.

Temporary Construction: Employment and activity due specifically to capital-investment projects conducted by airport administration and tenants.

Visitor Spending: Off-airport spending by visitors who depart via the airport.

Total State: The entire state of Washington.

Region: The WSDOT transportation region in which the selected airport is located. Additional information about WSDOT transportation regions is available in the Introduction of the Washington AEIS Technical Report.

Users are also able to export the results of each particular tab as a Microsoft Excel 1997-2003 file by clicking on the green Excel icon next to the table name in the center of the page just below the tabs. **Users are also able to view the summaries as pie charts and bar charts under the On-Airport Jobs, Temporary Construction Jobs, and Visitor Spending Jobs subtabs.** Detailed descriptions of the four summary sub-tabs are provided below.

The Calculator does not have an option for users to directly export the pie and bar charts. If users want to print these charts, one option is to print a snapshot using the Print Screen button. The system shortcut for the Print Screen option is Ctrl + P for Window users and Command + P for Macintosh users. Users can also use the Snipping tool. The system shortcut for the Snipping tool option is Windows icon + Shift + S for Window users and Shift + Command + 4 for Macintosh users. Users operating Microsoft Edge or Explorer can also right-click on the image, click "Save picture as" (select .png as the file type), and then save the image to their computer. The saved image can then be inserted into another compatible software program such as Microsoft Word or PowerPoint. Users operating Google Chrome can save as a PDF by right-clicking on the image, choosing "Print," selecting "Save as PDF" under the Destination drop-down list, and clicking "Save." PDFs must be exported to an image file (such as .jpg or .png) prior to being inserted in a Microsoft Word or PowerPoint file. This can be done using a PDF to image converter application (such as Adobe Acrobat Pro) or the Snipping tool described above. Free PDF to image converter applications are also readily available online.

3.1.16 Section A: Economic Impact Summary Sub-tab

Purpose: To allow users to view and download the Economic Impacts Summary for the selected airport.

User Input: Users can view a summary of the selected airport's economic impact results presented as a table.

Description: The table shown in this sub-tab summarizes the overall economic impact of the selected airport(s), shown as four types of impacts:

- Direct Impact: Direct impact represent the economic impact of on-airport and visitor-related activities and temporary construction on the Washington economy
- Supplier (Indirect) Impact: Supplier sales impact is generated from the purchases of goods and services made by airport-based businesses, on-airport public sector agencies, and businesses in the state's hospitality industries. These purchases are effectively business sales earned by supplier companies located across the state or in the airport's region.
- Income Re-spending (Induced) Impact: The income re-spending impact is derived from direct and supplier businesses that hire additional workers to meet the demand for airport and visitor services. Payroll earned by workers in businesses that benefit from direct or supplier business revenues leads to further spending by households. Additional business revenues, payroll, and jobs are supported as this income re-spending circulates within Washington or within a specific region.
- Total Impact: Total economic impacts represent the sum of direct, supplier sales, and income re-spending impacts.

An image of this tab is shown in Figure 4 above.

The default Economic Impact Summary sub-tab screen is a table that provides the four types of impacts in terms of:

- Jobs
- Labor Income ($)
- Value Added ($): Synonymous with contributions to Gross Regional Product, Gross State Product, or Gross Domestic Product
- Business Revenues ($): Often referred to as sales or output

Additionally, users can view a breakdown of the four impact types by clicking on the ">" in the red bar next to the impact rows. The breakdown will include values for one or a combination of On-Airport, Temporary Construction, and Visitor Spending.

The values shown in the On-Airport, Temporary Construction, and Visitor Spending rows will match the values in each of the disaggregated summary sub-tabs of the same name. In some cases, the numbers may be slightly different due to rounding.

3.1.17 Section B: On-Airport Jobs (Sub-tab)

Purpose: To allow users to view and download the job impacts of their scenario from on-airport activities.

User Input: Users can view a summary of the economic impact of the selected airport's scenario on jobs from on-airport activities, which are presented as either a table (i.e., "data"), pie, or chart.

Description: As shown in **Figure 5**, the On-Airports sub-tab shows the total jobs by sector as classified by the North American Industry Classification System (NAICS) codes. These jobs stem from employment and activity at the airport (both working directly for the airport and for tenants). This information is generated based on the values users input on the Employment tab. The NAICS sectors that are included in the table are:

- Agricultural & Extraction (NAICS codes 111-115, 211-213)
- Utilities (NAICS code 221)
- Construction (NAICS code 230)
- Manufacturing (NAICS codes 311-339)
- Wholesale Trade (NAICS code 420)
- Retail Trade (NAICS codes 441-454)
- Transportation (NAICS codes 481-488)
- Postal & Warehousing (NAICS codes 491-493)
- Media and Information (NAICS codes 511-519)
- Financial Activities (NAICS codes 521-525, 531-533)
- Professional & Business Services (NAICS codes 541, 551, 561-562)
- Education & Health Services (NAICS codes 611, 621-624)
- Other Services (NAICS codes 711-713, 721-722, 811-814)
- Government (NAICS code 920)

Users can view the On-Airport jobs data in three ways: as a data table (Data), as a pie chart (Pie), or as a bar chart (Chart). To change the data view, users can click on the drop-down menu above the sub-tabs to the left of the "Economic Impact by Industry for" menu. To see how results of On-Airport compare to Temporary Construction and Visitor Spending, users can navigate to the "Economic Impacts Summary" sub-tab.

The Data view presents the information as a data table. From this view, users can evaluate the direct and multiplier impacts of each job sector. These direct and multiplier impacts are broken out in the columns of the table and include:

- Direct impact (on-airport, temporary construction, and visitor spending)
- Supplier Sales (multiplier impact)
- Income Re-spending (multiplier impact)
- Total

These direct and multiplier impacts are further explained under the Economic Impact Summary subsection of this User's Manual (see **Section 3.5.3**). Users can export the data table as a Microsoft Excel 1997-2003 file by clicking on the green Excel icon located above the table.

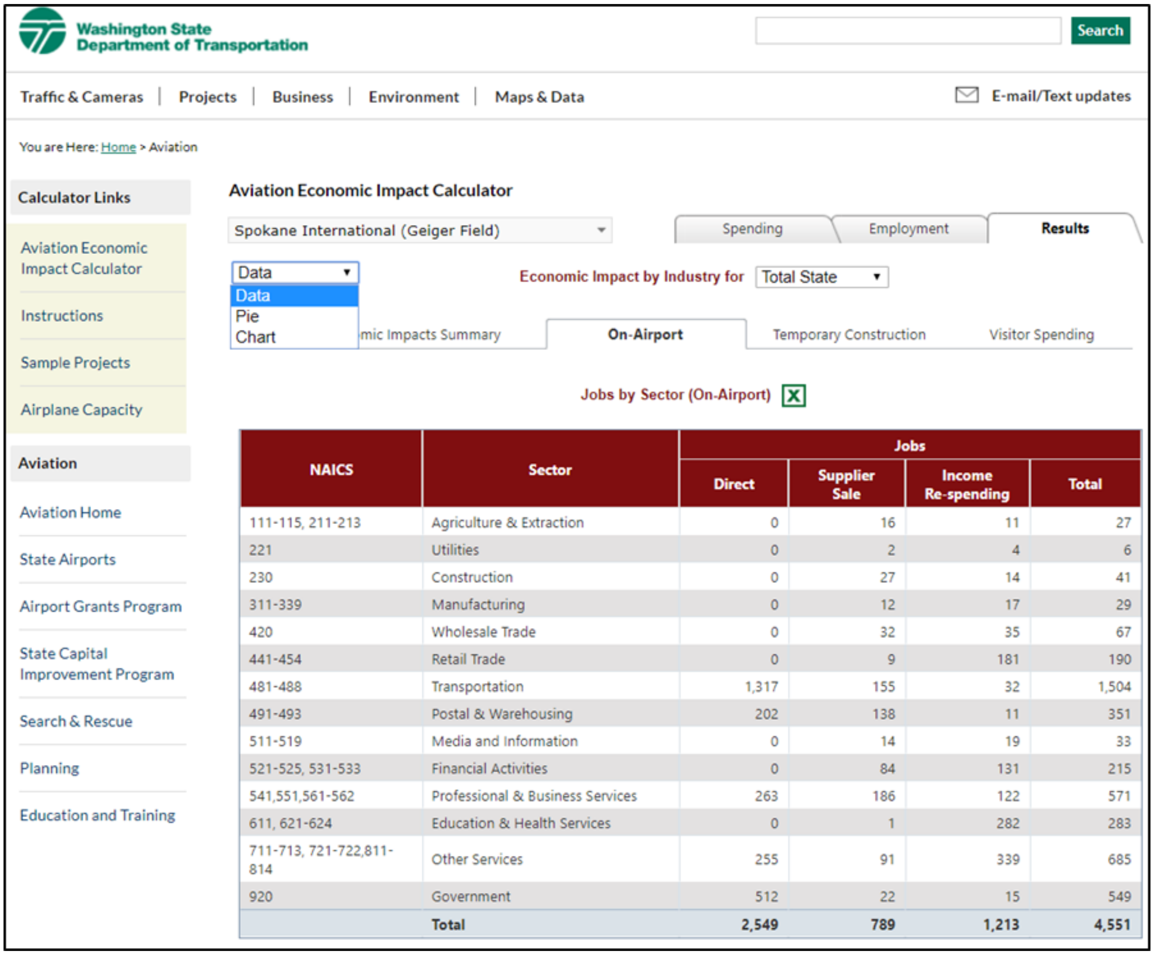
The Pie view shows a pie chart with the total impact numbers and percent of total impact for each sector. Users can see the values associated with any sector by hovering over that piece of the chart or the associated label. Sectors that result in less than one percent in the analysis will be grouped into a "Rest of Sectors" category. The Chart view displays the same data as a bar graph with the total impact numbers for each sector, categorized in terms of the following impact types:

- Direct (blue bar)
- Indirect (i.e., Supplier Impact, green bar)
- Induced (i.e., Income Re-spending Impact, yellow bar)

Users can see the number of jobs associated with any sector by hovering over that piece of the Chart.

If users want to print either the Data, Pie, or Chart within this sub-tab, a general option is to print a snapshot of the screen with the Print Screen button. The system shortcut for the Print Screen option is Ctrl + P for Window users and Command + P for Macintosh users. Users can also use the Snipping tool. The system shortcut for the Snipping tool option is Windows icon + Shift + S for Window users and Shift + Command + 4 for Macintosh users.

Figure 5. On-Airport Jobs Tab - Data View



NAICS	Sector	Jobs			
		Direct	Supplier Sale	Income Re-spending	Total
111-115, 211-213	Agriculture & Extraction	0	16	11	27
221	Utilities	0	2	4	6
230	Construction	0	27	14	41
311-339	Manufacturing	0	12	17	29
420	Wholesale Trade	0	32	35	67
441-454	Retail Trade	0	9	181	190
481-488	Transportation	1,317	155	32	1,504
491-493	Postal & Warehousing	202	138	11	351
511-519	Media and Information	0	14	19	33
521-525, 531-533	Financial Activities	0	84	131	215
541,551,561-562	Professional & Business Services	263	186	122	571
611, 621-624	Education & Health Services	0	1	282	283
711-713, 721-722,811-814	Other Services	255	91	339	685
920	Government	512	22	15	549
	Total	**2,549**	**789**	**1,213**	**4,551**

Source: EBP US 2020

3.1.18 Section C: Temporary Construction Jobs Sub-tab

Purpose: To allow users to view and download the economic impact of the selected airport's scenario on jobs from temporary construction activities.

User Input: Users can view a summary of the economic impact of the selected airport's scenario on jobs from temporary construction activities, which are presented as either a table (i.e., "data"), pie, or chart.

Description: As shown in **Figure 6**, the Temporary Construction sub-tab summarizes the effects of temporary construction spending in the same 14 NAICS job sectors used on the On-Airport Jobs sub-tab. These effects are generated by changes to the Airport Capital Budget and Other On-Airport Capital Expenditures entered on the Spending tab. To see how results of Temporary Construction compare to On-Airport and Visitor Spending, users can navigate to the "Economic Impacts Summary" sub-tab.

Users have the option to view the Temporary Construction jobs data in three ways: Data, Pie, and Chart. To change the data view, users can click on the drop-down menu above the sub-tabs to the left of the "Economic Impact by Industry for" menu. In the Data view, users can evaluate the direct, multiplier, and total impacts of each job sector. Direct and multiplier impacts are briefly explained under the Economic

Impact Summary subsection of this User's Manual (see **Section 3.5.3**). Users can export the data as a Microsoft Excel 1997-2003 file by clicking on the green Excel icon located above the table.

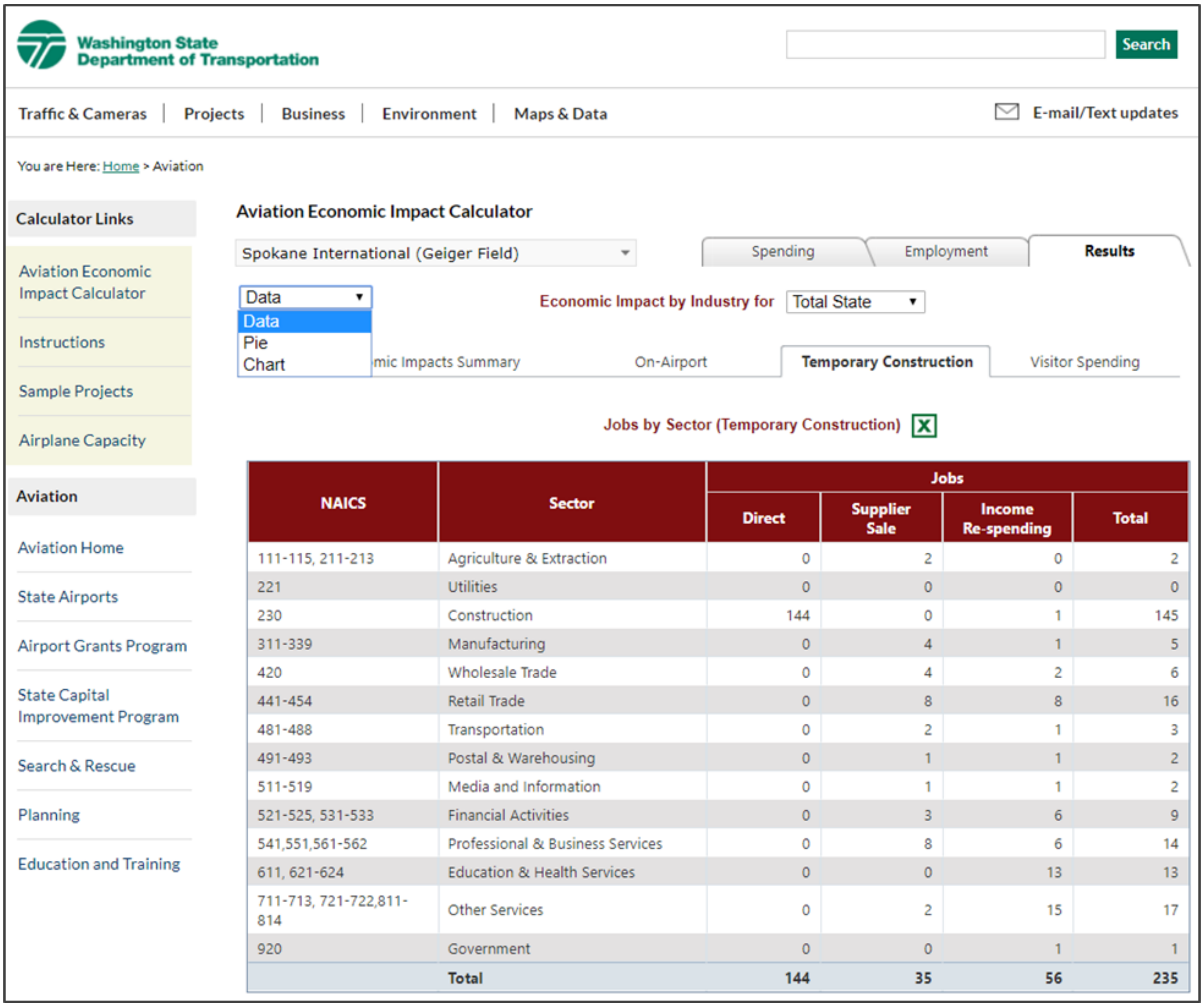
The Pie view shows a pie chart with the total impact numbers and percent of total impact for each sector. Users can see the values associated with any sector by hovering over that piece of the chart or the associated label. Sectors that result in less than one percent job impact will be grouped into a "Rest of Sectors" category. The Chart view displays the same data as a bar graph with the total impact numbers for each sector, categorized as either of the following three impacts:

- Direct (blue bar)
- Indirect (i.e., Supplier Impact, green bar)
- Induced (i.e., Income Re-spending Impact, yellow bar)

Users can see the number of jobs associated with any sector by hovering over that piece of the Chart.

If users want to print these charts, a general option is to print a snapshot of the screen with the Print Screen button. The system shortcut for the Print Screen option is Ctrl + P for Window users and Command + P for Macintosh users. Users can also use the Snipping tool. The system shortcut for the Snipping tool option is Windows icon + Shift + S for Window users and Shift + Command + 4 for Macintosh users.

Figure 6. Temporary Construction Jobs Tab - Data View



NAICS	Sector	Jobs			
		Direct	Supplier Sale	Income Re-spending	Total
111-115, 211-213	Agriculture & Extraction	0	2	0	2
221	Utilities	0	0	0	0
230	Construction	144	0	1	145
311-339	Manufacturing	0	4	1	5
420	Wholesale Trade	0	4	2	6
441-454	Retail Trade	0	8	8	16
481-488	Transportation	0	2	1	3
491-493	Postal & Warehousing	0	1	1	2
511-519	Media and Information	0	1	1	2
521-525, 531-533	Financial Activities	0	3	6	9
541,551,561-562	Professional & Business Services	0	8	6	14
611, 621-624	Education & Health Services	0	0	13	13
711-713, 721-722,811-814	Other Services	0	2	15	17
920	Government	0	0	1	1
	Total	**144**	**35**	**56**	**235**

Source: EBP US 2020

3.1.19 Section D: Visitor Spending Jobs Sub-tab

Purpose: To allow users to view and download the economic impact of the selected airport's scenario on jobs from visitor spending activities.

User Input: Users can view a summary of the economic impact of the selected airport's scenario on jobs from visitor spending activities, which are presented as either a table (i.e., "data"), pie, or chart.

Description: As shown in **Figure 7**, the Visitor Spending sub-tab summarizes the effect of visitor spending on 14 NAICS job sectors identified in the On-Airport Jobs sub-tab. Users can evaluate the direct and multiplier impacts of each job sector; these direct and multiplier impacts include Direct impact (on-airport, temporary construction, and visitor spending), Supplier Sale (multiplier impact), and Income Re-spending (multiplier impact). To see how results of Visitor Spending compare to On-Airport and Temporary Construction, users can navigate to the "Economic Impacts Summary" sub-tab.

Users have the option to view the results in Visitor Spending in three ways: Data, Pie, and Chart. To change the data view, users can click on the drop-down menu above the sub-tabs to the left of the "Economic Impact by Industry for" menu. In Data view, users can evaluate the direct, multiplier, and total impacts of each job sector.

Direct, multiplier, and total impacts are briefly explained under the Economic Impact Summary subsection in this User's Manual (see **Section 3.5.3**). Users can export the data as a Microsoft Excel 1997-2003 file by clicking on the green Excel icon located above the table.

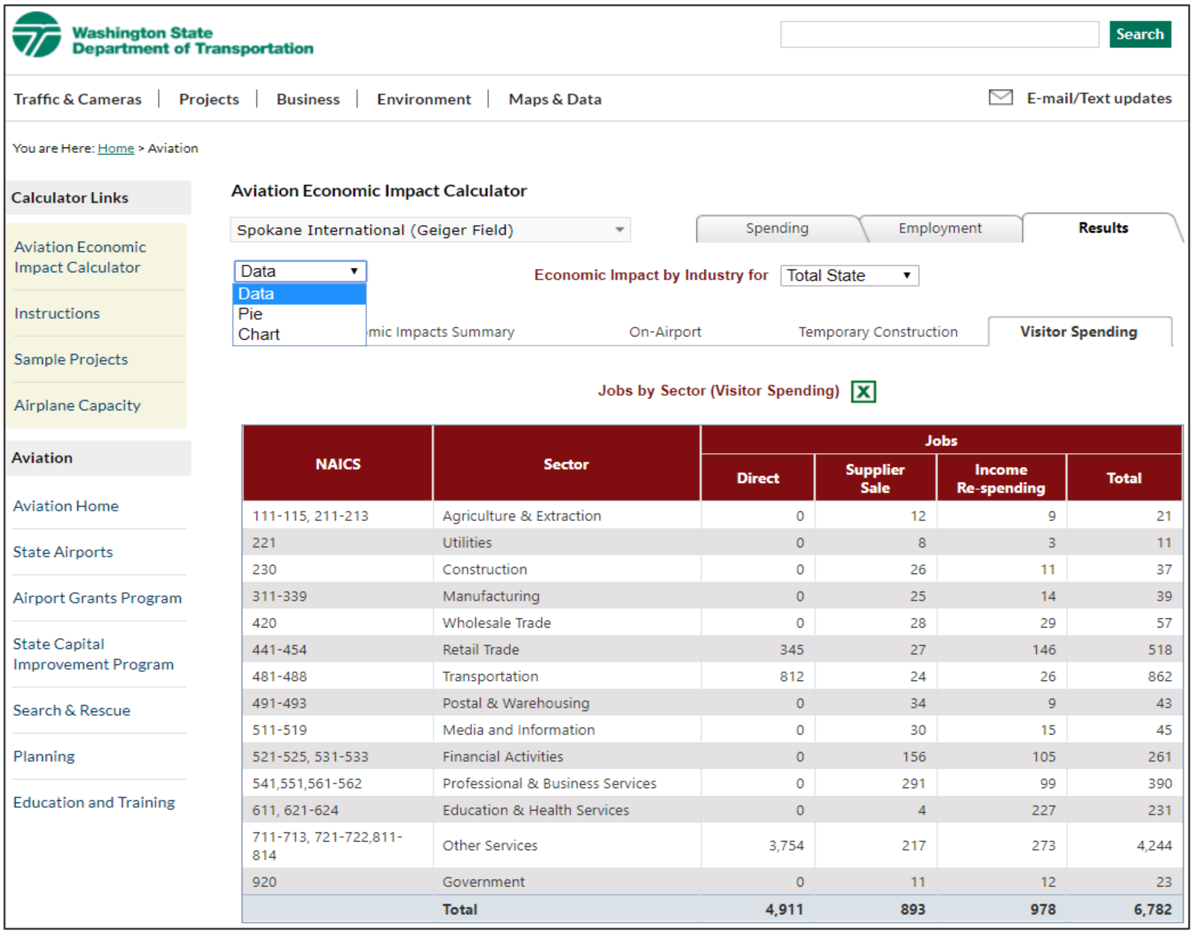
Users have the option to view the Visitor Spending jobs data as a Pie or Chart in addition to Data view. To change the view, users can click on the drop-down menu above the sub-tabs to the left of the "Economic Impact by Industry for" menu. The Pie view shows a pie chart with the total impact numbers and percent of total impact for each sector. Users can see the values associated with any sector by hovering over that piece of the chart or the associated label. Sectors with less than one percent impact will be grouped into a "Rest of Sectors" category. The Chart view displays the same data as a bar graph with the total impact numbers categorized as either:

- Direct (blue bar)
- Indirect (i.e., Supplier Impact, green bar)
- Induced (i.e., Income Re-spending Impact, yellow bar)

Users can see the number of jobs associated with any sector by hovering over that piece of the Chart.

If users want to print these charts, a general option is to print a snapshot of the screen with the Print Screen button. The system shortcut for the Print Screen option is Ctrl + P for Window users and Command + P for Macintosh users. Users can also use the Snipping tool. The system shortcut for the Snipping tool option is Windows icon + Shift + S for Window users and Shift + Command + 4 for Macintosh users. Users operating Microsoft Edge or Explorer can also right-click on the image, click "Save picture as" (select .png as the file type), and then save the image to their computer. The saved image can then be inserted into another compatible software program such as Microsoft Word or PowerPoint. Users operating Google Chrome can save as a PDF by right-clicking on the image, choosing "Print," selecting "Save as PDF" under the Destination drop-down list, and clicking "Save." PDFs must be exported to an image file (such as .jpg or .png) prior to being inserted in a Microsoft Word or PowerPoint file. This can be done using a PDF to image converter application (such as Adobe Acrobat Pro) or the Snipping tool described above. Free PDF to image converter applications are also readily available online.

Figure 7. Visitor Spending Jobs Tab - Data View



NAICS	Sector	Jobs			
		Direct	Supplier Sale	Income Re-spending	Total
111-115, 211-213	Agriculture & Extraction	0	12	9	21
221	Utilities	0	8	3	11
230	Construction	0	26	11	37
311-339	Manufacturing	0	25	14	39
420	Wholesale Trade	0	28	29	57
441-454	Retail Trade	345	27	146	518
481-488	Transportation	812	24	26	862
491-493	Postal & Warehousing	0	34	9	43
511-519	Media and Information	0	30	15	45
521-525, 531-533	Financial Activities	0	156	105	261
541,551,561-562	Professional & Business Services	0	291	99	390
611, 621-624	Education & Health Services	0	4	227	231
711-713, 721-722,811-814	Other Services	3,754	217	273	4,244
920	Government	0	11	12	23
	Total	**4,911**	**893**	**978**	**6,782**

Source: EBP US 2020

Appendix A: Glossary of Terms

The following terms are used throughout the Aviation Economic Impact Calculator:

- **Direct Impact:** Direct impact, also known as direct effects, take place in the industry immediately affected, whether it is on- or off-airport. These impacts are a result of on-airport activities, spending by airport visitors off-airport, and the production of air cargo.
- **Income Re-spending (Induced Impacts):** Income re-spending (induced impacts) measures the effects of the changes in household income representing the effects from the spending of wages earned by workers of directly and indirectly affected industries.
- **Multiplier Impact:** Multiplier impacts are made up of indirect and induced impacts, which are labeled as "supplier sales" and "income re-spending" to carry intuitive descriptions of the two streams of effects. These are the impacts of income circulating the regional or statewide economies from new consumer expenditures.
- **North American Industrial Classification System (NAICS):** NAICS is the means used by federal statistical agencies to classify business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. NAICS is organized by sectors and each sector is numbered. The specificity of a sector is analogous to the number of "digits" represented by that sector, with more digits representing more specificity. For example, sector 48-49 (considered a two-digit sector) is "Transportation and Warehousing"; sector 481 (three digits) is "Air Transportation"; and sector 4811 (four digits) is "Scheduled Passenger Transportation".
- **Supplier Sales (Indirect Impacts):** Supplier sales (indirect impacts) measure the purchase of supplies and services needed to produce directly supplied products and services.
- **Total Impacts:** Total impacts are the summation of direct and multiplier (supplier sales and income re-spending) impacts.
- **Visitor Spending:** Defined as off-airport spending by out of state and international visitors who arrive by air to Washington. Typical spending categories are retail purchases, food and drink, entertainment, lodging, and off-airport transportation. Spending by visitors on these items are counted as direct impacts, which then trigger additional impacts from supplier sales and income re-spending.

Appendix B: Airport Lists

Table B.1 lists the counties the compose each of the six WSDOT transportation regions. **Table B.2** list the airports in the scope of the 2020 Washington AEIS by WSDOT transportation region and associated city.

B.1 Counties by WSDOT Region

Table B.1 provides the counties the comprise each of WSDOT's six transportation regions.

Table B.1. Counties by WSDOT Region

Region No.	Region Name	Counties
1	Eastern	Adams, Ferry, Lincoln, Pend Oreille, Spokane, Stevens, Whitman
2	North Central	Chelan, Douglas, Grant, Okanogan
3	Northwest	Island, King, San Juan, Skagit, Snohomish, Whatcom
4	Olympic	Clallam, Grays Harbor, Jefferson, Kitsap, Mason, Pierce, Thurston
5	South Central	Asotin, Benton, Columbia, Franklin, Garfield, Kittitas, Walla Walla, Yakima
6	Southwest	Aahkiakum, Clark, Cowlitz, Klickitat, Lewis, Pacific, Skamania

Source: WSDOT Aviation 2019

B.2 Washington Airports by WSDOT Region and Associated City

Table B.2 provides a list of Washington airports by WSDOT transportation region and associated city.

Table B.2. Washington Airports by WSDOT Region and Associated City

Region	Associated City	Airport Name	FAA ID
Eastern	Chewelah	Chewelah Municipal	1S9
	Clayton	Cross Winds	C72
	Colfax	Lower Granite State	00W
	Colfax	Port of Whitman Business Air Center	S94
	Colville	Colville Municipal	63S
	Davenport	Davenport Municipal	68S
	Deer Park	Deer Park Municipal	DEW
	Ione	Ione Municipal	S23
	Laurier	Avey Field	69S
	Lind	Lind Municipal	0S0
	Mead	Mead Flying Service	70S
	Metaline Falls	Sullivan Lake State	09S
	Odessa	Odessa Municipal	43D
	Othello	Othello Municipal	S70
	Pullman	Pullman/Moscow Regional	PUW
	Republic	Ferry County	R49
	Ritzville	Pru Field	33S
	Rosalia	Rosalia Municipal	72S

Region	Associated City	Airport Name	FAA ID
	Spokane	Spokane International (Geiger Field)	GEG
	Spokane	Felts Field	SFF
	Tekoa	Willard Field	73S
	Wilbur	Wilbur Municipal	2S8
North Central	Brewster	Anderson Field	S97
	Cashmere	Cashmere-Dryden	8S2
	Chelan	Lake Chelan	S10
	East Wenatchee	Pangborn Memorial	EAT
	Electric City	Grand Coulee Dam	3W7
	Ephrata	Ephrata Municipal	EPH
	Leavenworth	Lake Wenatchee State	27W
	Mansfield	Mansfield	8W3
	Mattawa	Desert Aire	M94
	Mazama	Lost River	W12
	Moses Lake	Grant County International	MWH
	Moses Lake	Moses Lake Municipal	W20
	Okanogan	Okanogan Legion	S35
	Omak	Omak Municipal	OMK
	Oroville	Dorothy Scott Municipal	0S7
	Quincy	Quincy Municipal	80T
	Stehekin	Stehekin State	6S9
	Tonasket	Tonasket Municipal	W01
	Twisp	Twisp Municipal	2S0
	Warden	Warden	2S4
	Waterville	Waterville	2S5
	Wilson Creek	Wilson Creek	5W1
	Winthrop	Methow Valley State	S52
Northwest	Everett	Snohomish County (Paine Field)	PAE
	Friday Harbor	Friday Harbor	FHR
	Friday Harbor	Friday Harbor SPB	W33
	Kenmore	Kenmore Air Harbor Inc.	S60
	Rosario	Rosario SPB	W49
	Seattle	Kenmore Air Harbor	W55
	Snohomish	Harvey Field	S43
	Anacortes	Skyline SPB	21H
	Anacortes	Anacortes	74S
	Arlington	Arlington Municipal	AWO
	Auburn	Auburn Municipal	S50
	Bandera	Bandera State	4W0
	Bellingham	Floathaven SPB	0W7

Region	Associated City	Airport Name	FAA ID
	Bellingham	Bellingham International	BLI
	Burlington	Skagit Regional	BVS
	Concrete	Mears Field	3W5
	Darrington	Darrington Municipal	1S2
	Eastsound	Orcas Island	ORS
	Kent	Norman Grier Field (Crest Airpark)	S36
	Langley	Whidbey Airpark	W10
	Lester	Lester State	15S
	Lopez	Lopez Island	S31
	Lynden	Lynden Municipal Airport - Jansen Field	38W
	Monroe	First Air Field	W16
	Oak Harbor	A J Eisenberg	OKH
	Point Roberts	Point Roberts Airpark	1RL
	Renton	Renton Municipal	RNT
	Renton	Will Rogers Wiley Post SPB	W36
	Roche Harbor	Roche Harbor SPB	W39
	Seattle	Seattle Seaplanes SPB	0W0
	Seattle	Boeing Field/King County International	BFI
	Skykomish	Skykomish State	S88
	Stanwood	Camano Island Airfield	13W
	Vashon Island	Vashon Municipal	2S1
Olympic	Bremerton	Bremerton National	PWT
	Copalis Beach	Copalis State	S16
	Eatonville	Swanson Field	2W3
	Elma	Elma Municipal	4W8
	Forks	Forks Municipal	S18
	Forks	Quillayute	UIL
	Greenwater	Ranger Creek State	21W
	Hoquiam	Bowerman Field	HQM
	Lakewood	American Lake SPB	W37
	Ocean Shores	Ocean Shores Municipal	W04
	Olympia	Hoskins Field	44T
	Olympia	Olympia Regional	OLM
	Port Angeles	Sekiu	11S
	Port Angeles	William R Fairchild International	CLM
	Port Townsend	Jefferson County International	0S9
	Poulsbo	Port of Poulsbo Marina SPB	83Q
	Puyallup	Pierce County - Thun Field	PLU
	Rochester	R & K Skyranch	8W9
	Sequim	Sequim Valley	W28

Region	Associated City	Airport Name	FAA ID
	Shelton	Sanderson Field	SHN
	Silverdale	Apex Airpark	8W5
	Tacoma	Tacoma Narrows	TIW
	Westport	Westport	14S
South Central	Walla Walla	Walla Walla Regional	ALW
	Anatone	Rogersburg State	D69
	Cle Elum	De Vere Field	2W1
	Cle Elum	Cle Elum Municipal	S93
	College Place	Martin Field	S95
	Easton	Easton State	ESW
	Ellensburg	Bowers Field	ELN
	Kahlotus	Lower Monumental State	W09
	Pasco	Tri-Cities	PSC
	Richland	Richland	RLD
	Richland	Prosser	S40
	Rimrock	Tieton State	4S6
	Starbuck	Little Goose Lock and Dam State	16W
	Sunnyside	Sunnyside Municipal	1S5
	Walla Walla	Page	9W2
	Yakima	Yakima Air Terminal (McAllister Field)	YKM
Southwest	Battle Ground	Goheen Field	W52
	Battle Ground	Cedars North Airpark	W58
	Camas	Grove Field	1W1
	Chehalis	Chehalis-Centralia	CLS
	Dalles, OR	Columbia Gorge Regional/The Dalles Municipal	DLS
	Goldendale	Goldendale Municipal	S20
	Ilwaco	Port of Ilwaco	7W1
	Kelso	Southwest Washington Regional	KLS
	Morton	Strom Field	39P
	Packwood	Packwood	55S
	South Bend	Willapa Harbor	2S9
	Toledo	South Lewis County (Ed Carlson Memorial Field)	TDO
	Vancouver	Pearson Field	VUO
	Vancouver	Fly For Fun	W56
	Woodland	Woodland State	W27

Source: WSDOT Aviation 2019

Appendix C: Example Scenarios

This appendix provides examples of how to enter several sample projects that users could evaluate using the Aviation Economic Impact Calculator. These examples are designed to give users a better idea of the type of scenarios that can be evaluated, as well as the type of inputs that may be affected by various types of scenarios. The examples do not represent a specific planned project or airport goal.

The first section includes an overview of potential implications associated with each type of project that should be considered when developing scenario inputs. **Table C.1** provides example scenario inputs for four types of projects that may be evaluated by the Aviation Economic Impact Calculator.

C.1 Landing Page

Select the airport to be evaluated using the drop-down list.

C.2 Spending Tab

This section includes potential areas of change to reflect the scenario associated with the first modifiable tab: "Spending".

C.2.1 Capital Annual Budget

To modify this section, users should consider if the project would require or have an associated capital expenditure. Note the 2020 Washington AEIS estimated each airport's "average" annual capital expenditure using three years of data (2016 through 2018). The temporary impacts of a specific project can be estimated by inputting the total capital cost, even if that expenditure was made over multiple years. Users can also evaluate the potential economic impacts of a higher average annual expenditure (reflecting average spending over multiple years). Data input into this section should include capital money from local, state, federal, and other sources. Capital investment made by tenants can be input here or in "Other On-airport Capital Expenditures" (expenditures should not be duplicated in both sections).

C.2.2 Operational Annual Budget

This section assesses the scenario's potential impacts to the airport's annual operating budget (note baseline figures reflect 2018 expenditures as reported by during the data collection phase of the 2020 Washington AEIS). This could reflect operating funds provided by the airport sponsor as well as revenue impacts generated by income sources such as:

- Commercial (i.e., business) land leases and rents
- T-hangar lease agreements
- Private hangar land leases
- Agricultural land lease
- Terminal concession rents
- Fuel flowage fees
- Landing and ramp fees

In this section, it is important for users to carefully consider all the implications of a proposed project. The construction of a hangar, for example, may result in revenues generated by lease agreements as well as fuel flowage fees due to a higher number of aircraft based at the facility. The user will have to generate the potential revenue impacts.

C.2.3 Other On-airport Capital Expenditures

Users can enter capital expenditures made by non-government sources, such as tenant improvement projects. A new flight training school, for example, may convert an existing on-airport building to classrooms for ground school or choose to build a new facility. An FBO may complete a pavement improvement project to the apron adjacent to its facility. Also consider that tenant improvements often result in additional associated airport revenues that should be reflected in the "Operational Annual Budget" section above. *These capital expenditures can also be input into the "Airport Capital Annual Budget" box above.*

C.2.4 Airport Operations: Commercial and General Aviation [GA]

For this section, users must consider how this proposed change may impact the number of out of state and international visitors using the airport. For commercial service and GA airports, users should consider if this proposed change could affect:

- Type of aircraft using the facility
- Frequency of operations
- Out of state or international destinations served

Essentially, the user needs to consider how the project may impact the number and/or percent of total non-local passengers and pilots (i.e., visitors) relying on the airport. For example, a runway lengthening project may allow larger and more demanding aircraft to operate. These aircraft generally have longer ranges, which could increase the percent of transient (i.e., out of state/international) operations. Additionally, the average number of people per operation could increase.

For commercial service airports, users need to consider how the change could affect the airport's number of enplanements (revenue-paying passengers boarding an aircraft). If an airline adds one flight per day destined for an out of state airport using an aircraft with 70 seats, this would increase the number of enplanements and potentially the percent of visitors utilizing the facility.

C.2.5 Visitor Spending

In the section above ("Airport Operations"), users are asked to estimate the number of non-local visitors annually relying on the airport. In this section, users are asked to estimate the amount of money each visitor spends during their trip to Washington. The visitor spending section allows users to adjust the "baseline" spending profiles developed as part of the 2020 Washington AEIS. This section should be changed if the user has an indication of the purpose of visitors' trips, as well as the activities they may engage in while in the state. As described in detail in **Section 3.1.6**, users can either provide the total expenditure using the "Total" radio button or spending by sector using the "Detail" radio button.

Business travelers drawn to a specific city for a conference at a newly constructed convention center and hotel may spend a higher amount than baseline on lodging, less on local transportation (since he or she is unlikely to travel beyond the convention center/hotel during a work conference), and more on entertainment (reflective of average conference fees). Note spending profiles reflect total visitor spending per trip and not daily totals.

C.3 Employment Tab

The employment tab provides users with the ability to modify the number of on-airport workers occurring as a result of the scenario under evaluation. Users should carefully consider how a proposed change may impact the support and services provided to aircraft, their pilots, and passengers. This may include additional workers required to support an increase in operations, services to pilots and passengers, or air cargo activities. An airport may choose to update this section with changes in tenant and/or airport administration employment to maintain the accuracy of the airport's economic impact over time.

C.4 Results Tab

The results of the scenario changes made by the users are reflected in the Results tab. There are no modifiable fields in this section.

Table C.1. Aviation Economic Impact Calculator Scenarios

	Landing Page	Spending Tab					Employment Tab
Scenario	Airport	Capital Annual Budget	Operational Annual Budget	Other On-airport Capital Expenditures	Airport Operations (CS/GA)	Visitor Spending	On-airport Business Activity (Employment)
Construct a new T-hangar (+12 units rented to recreational pilots)	Select airport using drop-down menu	+$750,000 (construction cost)	+$50,000 (lease fees and fuel sales)	No change	+8,000 GA operations; No change to % transient operations	+$50/visitor	+1 airport employee
New flight school locating at the airport (3 aircraft conducing 4 one-hour training flights/day with 6 touch and go ops)		No change	+$20,000 (lease fees and fuel sales)	+$25,000 (tenant improvements)	+30,000 GA operations; No change to % transient operations	No change	+3 flight instructors, +1 aircraft mechanic, +2 business administrators
Runway extension (+441 feet)		$3,450,000 (construction cost)	+$15,000 (fuel sales)	No change	+1,000 GA operations; +5% transient operations	No change	+1 FBO employee
Increased commercial passenger enplanements (addition of one CS flight/day from Salt Lake City)		No change	+$50,000 (fees collected from concessionaires, parking, and fuel sales)	No change	+21,000 enplanements; +8% visitors	+$75/visitor	+1 airport administrator, +1 airline staff member, +1 rental car employee, +1 TSA agent, +2 restaurant staff

Source: EBP US 2020

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