Freight Origin and Destination Study for Washington State Trucking: Characteristics and Trends

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Abstract

This paper reports on an extensive study of the origin, destination and other characteristics of trucks in the state of Washington conducted in 2003-2004, presenting findings and comparison to a similar study done in the state in 1994-1995. Over 24,000 interviews at 28 locations, over four seasons, were conducted in the survey, providing a comprehensive overview of freight movements in the state. This allowed in depth comparisons to the movements revealed in the earlier study when 28,000 truckers at the same 28 locations were interviewed.

The paper will present the methodology of these surveys, surveys that to the authors' knowledge are the first and only ones done in the nation that provided this intimate and detailed information on a statewide basis. Particular attention will be paid to the data management techniques utilized in this massive data base, since much of it is incorporated into a GIS Framework and modeling framework.

Information types produced in the surveys include the carrier, truck type, unloaded truck weight, payload weight, commodity type, and the facility types at the origin and destinations. Detailed information on the highways and routes used by the drivers was also collected as an aid in identifying the major and minor freight corridors in and through Washington.

Examples of sub analyses that have been done will be presented, along with determination of policy issues of congestion, mobility and investment needs that can be examined with these data sets. Comparison of intra state movement to out of state destination and origins provides interesting policy implications to funding at the state or Federal level. A short list of examples of recent data usage requests by the WSDOT, cities, ports, railroads and consulting firms will indicate how these data add value to the planning and investment decisions by private and public decision makers.

Overview

An estimated 21.6 million truck trips occur on state highways in Washington each year, with the value of cargo carried being approximately $550 billion (1997 dollars). Approximately 11.6 million trips originate in Western Washington, with 2.9 million originating in Eastern Washington and 7.1 million coming from out of state. Almost 70 percent of all truck trips originating in Eastern Washington were loaded, while approximately 65 percent of trips from Western Washington carried cargo. Out of state trip origins had the highest percentage of loaded trucks at almost 80 percent. Average cargo weight per truck was highest in Eastern Washington at just over 20 tons. Cargo weights were lowest in Western Washington with an average of approximately 16.5 tons, while trucks originating out of state carried an average 17.5 tons. Significant differences were found in the estimated cargo values of shipments being carried. Shipments originating in Eastern Washington had the lowest value per ton at approximately $1,900, with Western Washington shipments and those from out of state having approximate values of $3,200 and $3,500 respectively. The disparities in average cargo weight and in value per ton are noted by the observation that truck trips originating in Eastern Washington are more likely to be carrying agricultural and forest products than trips originating in Western Washington or out of state. Shipments originating in Western Washington and out of state are more likely to carry intermediate and finished manufactured goods and consumer products. These items are often lighter and of higher value per ton than the agricultural and forest products which are common trip generators in Eastern Washington.

Truck trips originating in Eastern Washington are divided almost equally between Eastern Washington and Western Washington destinations, with most shipments (39 percent) destined to deliver out of state. Western Washington is in marked contrast to Eastern Washington, with over half of all shipments originating in Western Washington terminating within the region. Only 12 percent of Western Washington shipments have a destination in Eastern Washington, with the remainder shipping out of state. Forty percent of all trucks coming from outside Washington deliver in Western Washington, while almost one-third are passing through Washington with destinations to other states or provinces.

Eastern Washington Truck Movements

Businesses and industries in Spokane, Yakima and Wenatchee account for the largest number of freight truck origins in Eastern Washington, with almost 38 percent of all trips originating in these three communities. On average, over 3,500 trucks depart from these locations on a daily basis. Spokane County alone generates over 20 percent of all truck trips coming from the region. While Spokane is the major Eastern regional consumption market and industrial production center, cities such as Yakima, Wenatchee, Pasco and Moses Lake are important regional centers for agricultural production, processing and distribution.

Western Washington cities are frequent destinations for truck trips originating in the Eastern region. Almost 1,200 trucks leave Eastern Washington each day for destinations in Seattle and Tacoma. Kent and Vancouver are also frequent destinations for East region shipments. Spokane is the second most frequent destination after Seattle, with almost 570 shipments per day. About one-third of all truck trips originating in Eastern Washington are destined to terminate out of state. Of these, the most frequent state of destination is Oregon with over 1,400 per day.

Agricultural and forest products are the largest generators of truck trips in Eastern Washington. Commodity classifications for agricultural products, prepared foodstuffs, feed and fertilizers account for 56 percent of all cargo tons originating in the region. Forest products such as lumber, pulp and newsprint and paperboard account for an additional 17 percent. These same commodities account for 34 percent and 4.5 percent of the total value of cargo, respectively. Goods with the highest value that shipped from Eastern Washington were machinery, mixed freight, motorized vehicles and parts and electron and office

equipment. These goods represent approximately 9 percent of the total cargo tonnage generated in Eastern Washington, but almost 38 percent of the total value of cargo shipped.

Western Washington Truck Movements

The Puget Sound area is the largest generator of truck trips in Western Washington and in the state. Ports, industries and businesses in the area create over 75 percent of trips originating in Western Washington. Seattle generates over 6,000 truck trips each day, while Tacoma contributes an additional 5,700. Other large trip generating cities are Kent, Everett, Auburn, Bellingham and Olympia. Together the above cities generate over 53 percent of all truck trips originating in Western Washington. Major generating cities outside of the Puget Sound area are Vancouver, Aberdeen and Chehalis, which together account for approximately 4.5 percent of all trips originating in the Western region.

Over half of all truck trips originating in Western Washington are destined to terminate at cities within the region, with Tacoma and Seattle the most frequently cited locations. Portland, Oregon is the third most popular destination after Tacoma and Seattle, with over 2,300 trips estimated per day. Eastern Washington is the least cited destination for trips originating in Western Washington with only 12 percent of the total generated truck trips. Spokane is the primary city receiving such shipments at an average of almost 480 trucks per day. An estimated 31 percent of all trips originating in the West terminate outside the state. Oregon receives over 5,000 trucks per day, with British Columbia and California receiving over 1,900 and 1,700 respectively.

The cargo content of shipments originating in Western Washington is more varied than those from Eastern Washington reflecting the more diversified economy in the Western region. While wood and lumber products represent the major portion of cargo tonnage at approximately two-thirds of the average total tonnage, significant tonnage of mixed freight (consumer goods) and industrial goods are also shipped on a daily basis from locations in Western Washington. By value, the most important items shipping from Western Washington origins are high-value products such as electronics, finished manufactured goods and equipment. Electronic and office equipment accounts for almost 50 percent of the total cargo value in transit from Western regional locations.

Out of State Origin Movements

An estimated 22,700 trucks originating outside of the state travel on Washington highways every day. Of these, 35 percent of the truck trips have reported origins in Oregon. Trucks originating in British Columbia and California represent 16 and 15 percent of the total out of state origins, respectively. Portland, Oregon is the primary generator of out of state truck trips with over 3,250 trucks entering Washington per day. Vancouver, British Columbia is the next largest out of state origin, averaging over 750 trucks per day moving south across the border. Other British Columbia cities in the Vancouver area such as Surrey, Delta and Richmond also generate significant numbers of southbound freight-truck traffic. Hermiston, Oregon also generates a large number of trucks on a daily basis, mostly moving into Eastern Washington. Just over 50 percent of all truck trips originating outside the state are destined to terminate in Western Washington, with Seattle, Tacoma and Kent the most frequent destinations. Spokane is the most frequent destination for trips terminating in Eastern Washington, followed by Yakima and Pasco. Over 7,400 trucks that have origins outside Washington are passing through to other states or Canadian provinces.

Freight trips originating out of state represent the largest share of total cargo value moving on Washington state highways at an estimated $264 billion per year. Out of state trucks also account for the majority of the total cargo tonnage, with over 210 million tons shipped each year on Washington roadways. Agricultural and food products, forest products and mineral products are the primary commodity cargo

content on these shipments. Gasoline and refined aviation fuel is another significant commodity with out of state origins, reflecting movements from Canadian refineries to demand markets in Washington.

Truck Movements on Major Freight Corridors

A primary goal of this origin and destination survey is to provide data for the analysis of freight movements on the state highway transportation network. Analyses of the various freight corridors, their freight traffic volumes, the direction of the freight flows and the locations of traffic generators or terminal points are critical in determining current and future transport needs in Washington. An important component of these analyses is the commodity cargo content of the trucks on Washington highways. For example, trucks carrying agricultural or forest products are, on average, the most heavily laden transport vehicles on the road, which will have a greater impact on roadways in Eastern Washington and the Olympic Peninsula than in the Puget Sound region. Commodities have been grouped into 41 classifications conforming to the SCTG code for a shipment as identified in the site interviews. This study examines commodity movements along five major transport corridors in Washington: summary results are noted below.

Trucks carrying loads of mixed freight, usually consumer goods, are the most common on Washington highways, comprising over 8 percent of total statewide truck trips. This level is consistent across all of the major corridors, except US 97, reflecting the smaller and more dispersed population in the region served by this highway. Agricultural products such as grains, livestock, animal feeds, fertilizers, prepared and milled foods and other goods make up almost 15 percent of the truck trips in the state, followed by forest products and paper which contributes over 11 percent of the total truck volume.

Results for the I-5, I-82, I-90 and US 395 corridors are remarkably consistent, with only a few commodity classes significantly different for one or more of the highways. For example, US 395 has 6.7 percent of trucks on the road carrying prepared foodstuffs, while I-5 has less than 3.5 percent and I-82 and I-90 have approximately 5 percent each. Another exception category is wood products with most corridors at 6 to 7 percent of total truck trips, and I-82 with just over 4 percent. This can be explained by I-82 serving the Yakima valley and lower Columbia Basin region, which is primarily an unforested, agricultural production region.

While the other highway corridors are consistent in the commodity mix of trucks on the road, US 97 exhibits the greatest variation and concentration in cargo content. Over 25 percent of truck trips moving on US 97 are carrying agricultural products, while the statewide average is 15 percent. Shipments of lumber and wood products are also higher than on other state highways. US 97 also has significantly lower numbers of trucks carrying finished industrial products, machinery and mixed freight.

Cargo Weight, Trailer Type and Axle Count of Freight Trucks

Assessment of the cargo tonnage moving on state highways is crucial in determining the locations of likely infrastructure maintenance and the need for improvements to the existing infrastructure network. Cargo weight is closely correlated with cargo content; agricultural products, fertilizers, forestry products and minerals are some of the heaviest commodities transported on Washington highways. Each of these products has a mean tonnage per truck in excess of 20 tons. The freight corridors also have varying average cargo tonnage, with trucks traveling on US 97 having the greatest average weight at 22 tons per vehicle and I-5 and I-82 having the lowest average weights at 20 tons per vehicle, respectively.

Other determinants of road use and wear can be derived from analysis of commodities being carried in multiple trailer trucks and by larger tractor-trailer rigs. Over one-in-five of the truck trips carrying cereal grains, fertilizers, wood products, stone and coal or petroleum products have truck trips utilizing multiple trailers. These commodities are also more likely to be carried by tractors and trailers with 5 or more

axles. As an example, over 98 percent of trips carrying cereal grains are carried in vehicles with 5 or more axles and almost 97 percent of trucks carrying logs and lumber are likewise configured.

Structure of the paper

The present study presents the results of an extensive origin and destination survey of truck drivers carrying freight on highways in Washington. Over 24,000 interviews were conducted in 2002 and 2003 providing a comprehensive overview of freight movements in the state. A brief summary of the methods and procedures is provided in Section 1 of this report.

Section 2 details the major truck movements in Washington by geographic region of trip origin. Section 3 provides an analysis of the major Washington freight corridors and the freight vehicles carrying cargo. This section also extends the analysis to include implications for current and future transportation infrastructure and future commodity flows on Washington roadways. A final section summarizes the survey results and gives an assessment of the overall system efficiency of freight flows within and through the state.

Section 1: Methodology

Data Collection Methods and Issues

The SFTA origin and destination survey was designed to provide a statistically reliable and comprehensive database of freight truck movements on highways in the state of Washington. A varied set of truck trip and shipment characteristics were determined and incorporated into the survey. Examples of such information include the carrier, truck type, unloaded truck weight, payload weight, commodity type, and the origin and destination facility type(s). Detailed information on the highways and routes used by the drivers was also collected as an aid in identifying the major and minor freight corridors in and through Washington.

Twenty-seven interview sites at permanent weigh stations and ports of entry were utilized to implement the driver survey. Of the sites selected, twenty-six matched the survey locations used in the 1993-1994 EWITS study.

Data was collected during a four-week period in each season (Spring (April 2002), Summer (July 2002), Fall (October 2002), Winter (January 2003)). This was done in order to allow seasonal traffic flow comparisons to be made. Data collection was made on a Wednesday of each week in order eliminate unusual flow patterns associated with the beginning and end of the week. Wherever possible, data collection at each site was obtained over a 24-hour period to gain a comprehensive freight movement profile for each location.

Approximately 24,000 driver interviews were collected (roughly 6,000 per season) to complete the origin and destination survey. Additionally, estimates of the number and direction of non-sampled trucks were made during the interview periods. These counts were then used to construct weighted estimates of total truck volumes at each location by season. The results presented in this study are derived from these weighted truck trip estimates.

Data Management

There are three possible sources of error that can be attributed to on-site data collection issues. Systemic problems arise from poorly worded questions, incorrect interview procedures and/or problems stemming from sub-optimal site selection. Data problems may come from drivers who provide inaccurate information in response to the survey questions. Finally, interview personnel may fill out the survey

incorrectly, providing inaccurate data regarding vehicle information or driver responses.

Errors stemming from improper data collection technique were minimized through a constant monitoring of the survey and data entry personnel. On-site monitoring allowed specific problems to be immediately addressed with the interviewer. Problems identified during data entry were addressed during the following survey season.

Data entry personnel performed accuracy checks on each questionnaire as it was entered into the database. They checked individual answers for consistency and being logical. Each highlighted route was verified that it corresponded to the origin and destination points provided within the survey. Origin and destination points were checked to make sure that the origin was before the weigh station and the destination was beyond the weigh station. Some drivers on round trip routes would incorrectly provide information about a trip segment that may have occurred earlier in the day and was not actually their current trip segment. Once it was determined that the answers on a survey were logically consistent, the questionnaire would then be entered.

Data Analysis and Modeling

The data collected in the origin and destination survey has a wide variety of applications and potential users. An overview of these applications and users is listed below in Table 1.1.

The data obtained in the driver interviews was entered into a MS Access database in table format. Additional information from various sources was systematically added to the database in order to provide greater depth of analysis. Also, Geographical Information Systems (GIS) data for place names, cities and other locations was obtained from the WSDOT GeoData Distribution website (**http://www.wsdot.wa.gov/mapsdata/geodatacatalog/default.htm**). The survey data was geo-coded using the ArcInfo program from ESRI.

The use of the MS Access platform also allows for the incorporation of database information from such sources as the US Census Bureau, the USDOT Bureau of Transportation Statistics and other federal, state and local transportation databases. Linkage of these various databases was and is accomplished by the use of the Standard Classification of Transported Goods (SCTG) code. This code was identified using information obtained during the driver interview about the primary commodity content of the cargo being transported. This information is critical to identifying commodity flows and volumes moving on state highways.

Geo-coding of the data allows for the spatial analysis of transportation movements throughout the state. The origin and destinations survey data may then be related to other database information using common geographical properties such as origin and destination cities or highways. This allows the survey data to be linked to other information such as population, zoning, political units or other socio-economic features. The maps used in this report rely upon these relationships and were made using ArcInfo/ArcMap software tools.

Section 2: Freight Truck Movements on Washington Highways

Overview

The efficient movement of goods within and through Washington is vital to the continued economic vitality of the state and the region. It is estimated that 21.6 million long-haul truck trips move on state highways each year (see Table 2.1 below) carrying approximately $549 billion worth of cargo. With trade being central to economic growth and labor income in the state, the operation and maintenance of the transportation infrastructure in the state is of critical importance.

Table 1.1: Potential Applications for Freight Truck Origin and Destination Data

Corridor Planning

- Identify highway corridors most critical to key industries
- Pinpoint major freight truck generators for specific corridors
- Document routes most widely utilized for national and international trade
- Provide base data to project freight truck traffic growth and decline for specific corridors
- Provide base data to estimate the economic value of specific commodities shipped on specific corridors
- MPO model validation

Intermodal Systems Planning

- Delineate essential highway linked to rail, air, deep water and river ports
- Evaluate intermodal systems most critical to key industries and international competitiveness
- Geographic proximity of intermodal facilities relative to origins and destinations of trucks utilizing those facilities

Survey and Study Development Methodology

- Provide methodological support for other O-D studies
- Define data needs for questionnaire design in other freight studies
- Development of freight data collection techniques

Source: SFTA Freight Truck Origin and Destination Study

Almost 375 million tons of cargo is transported on freight trucks in the state of Washington each year. Most of the cargo weight is attributed to trucks traveling from out of state origins. Approximately 80 percent of out of state freight vehicles are carrying cargo, while 65 to 70 percent of trucks originating in state have loads. This is due to the fact that empty backhauls are not economical over the longer distances typical of interstate or international freight hauls.

Table 2.1: Region of Origin, Tonnage and Economic Value of Cargo Transported Each Year on Washington Highways

Region of Trip Origin	Number of Empty Trucks	Number of Trucks with Cargo	Total Cargo Weight (Million Tons)	Total Cargo Value (Million Dollars)
Eastern WA	**918,822**	**1,996,489**	**40.6**	**50,004**
Western WA	**4,116,279**	**7,502,108**	**123.6**	**234,850**
Out of State	**1,403,889**	**5,687,852**	**210.4**	**264,081**
All Trucks	**6,438,990**	**15,186,449**	**374.6**	**548,935**

Source: SFTA Freight Truck Origin and Destination Study

Cargo tonnage is the largest for shipments originating in Eastern Washington, averaging slightly over 20 tons per truck. However, the value of the cargo shipping from locations in the Eastern region was the lowest, averaging less than $2,000 per ton. Shipments from Western Washington had the lowest average tonnage, at approximately 16 tons per truckload, but an average cargo value of over $3,000 per ton hauled. Trucks coming from origins out of state had the second highest average cargo weights at approximately 18 tons per truck trip and the highest average cargo value at $3,500 per ton. This reflects the relation between cargo value and modal choice over long distances.

Long-haul over-the-road truck trips are more economical if the cargo value of the shipment is higher, such as consumer and electronic goods, or lightweight, high-value manufacturing or industrial goods.

There are also substantial differences in the destinations of truck trips originating from the three regional categories. Truck trips coming from the Eastern region of the state are most likely to have terminal points

outside of Washington, with an almost equal number traveling to Western Washington or staying within the region (Table 2.2). In contrast, the majority of trips originating in the west remain in-region, with an additional 35 percent traveling out of state. Only 12 percent of all truck trips originating in Western Washington have an intended destination in Eastern Washington. The destination split for truck trips coming from out of state origins is more balanced, with 40 percent terminating in Western Washington and approximately 31 percent passing through to destinations in other states of provinces.

Figure 2.1: Regional Classification of Washington Counties

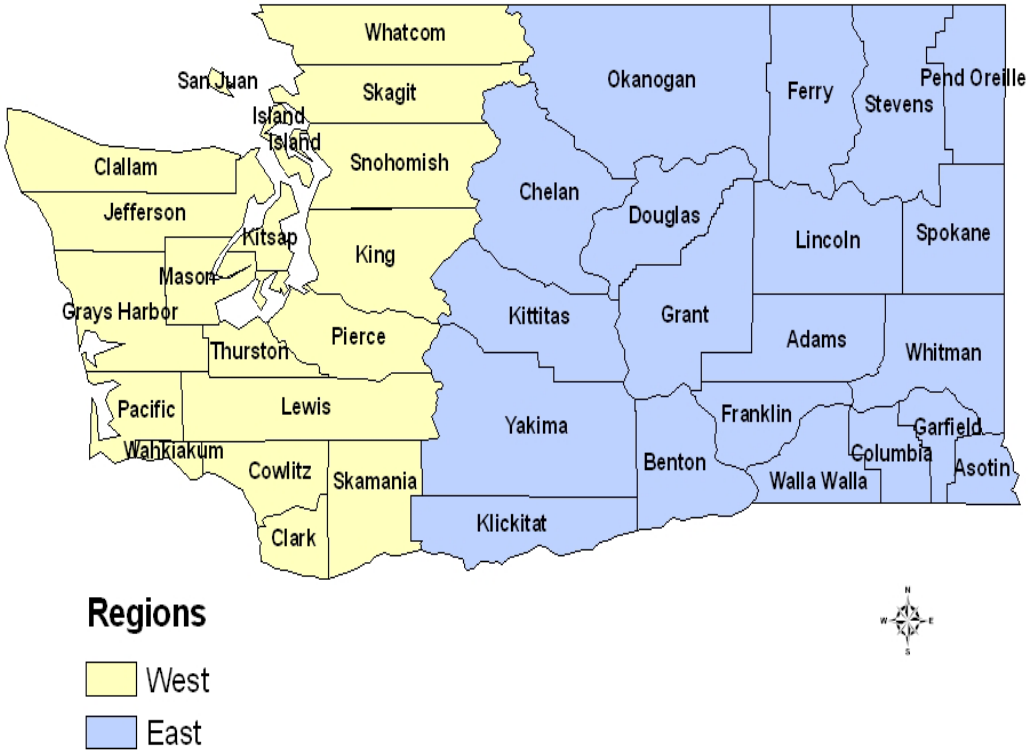


Table 2.2: Region of Trip Destination for Major Origin Regions

Region of Trip Origin	Eastern WA Destinations	Western WA Destinations	Out of State Destinations	All Destinations
Eastern WA	**29%**	**32%**	**39%**	**100%**
Western WA	**12%**	**53%**	**35%**	**100%**
Out of State	**29%**	**40%**	**31%**	

Source: SFTA Freight Truck Origin and Destination Study

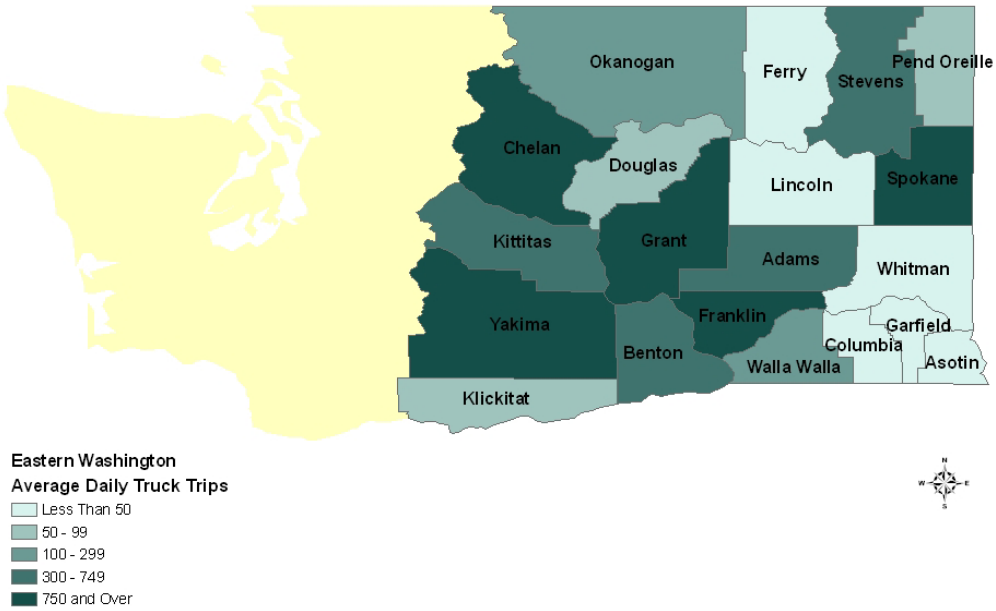
Characteristic Profile of Truck Trips Originating in Eastern Washington

A brief overview of the trip generation statistics by county is presented in Figure 2.2. Businesses and industries in Spokane, Yakima, Grant and Chelan counties are the largest trip generators in the eastern region. On an average day, over 1,000 truck trips originate in these counties. Spokane County alone contributes approximately 1,900 truck trips to the freight traffic moving on state highways. Several other counties, such as Franklin, Benton and Kittitas generate an average of over 500 truck trips each day.

The city of Spokane is the most frequent origin for truck trips originating in the eastern region of Washington. Approximately 1,800 truck trips are generated each day from Spokane businesses and industry, representing almost one-fifth of the entire volume of truck trips originating in Eastern

Washington per day. Yakima and Wenatchee are also major trip originators, with over 800 truck trips beginning daily, on average, in those cities. Other major origin cities in Eastern Washington are Pasco, Moses Lake, Ellensburg, Othello and Kennewick. These cities are the regional centers for the processing and distribution of agricultural commodities produced throughout the counties of the east.

Figure 2.2: Comparison of Average Daily Truck Trips Originating in Eastern Washington Counties



Source: SFTA Freight Truck Origin and Destination Study

As noted in Table 2.2 above, the destinations for truck trips originating in Eastern Washington are most likely to ship out of state, with roughly equal numbers of trucks terminating in either the eastern part of the state, or in the west. Truck trips terminating out of state were most frequently destined for Oregon. Seattle and Spokane were the two most frequent in-state destinations, followed by Tacoma in the west, and Pasco and Yakima in the east. For trucks hauling loads out of state, Portland, Oregon and Hermiston, Oregon were the most frequent destinations, with approximately 300 truck trips moving to each city per day. It should be noted that future hauls to Hermiston might decrease due to the recent closure of a major potato processing plant in that city.

For truck trips originating in Eastern Washington, King County is the most frequent destination (Figure 2.3). Large numbers of truck trips also are destined for Pierce County in the west. Almost all of the truck trips moving from the eastern region to the west are intended to terminate at locations in King or Pierce. Truck trips staying with the east most often are destined for Spokane County, which averages over 600 terminating truck trips per day. Yakima, Franklin and Grant counties receive over 350 trucks each day from other Eastern Washington locations.

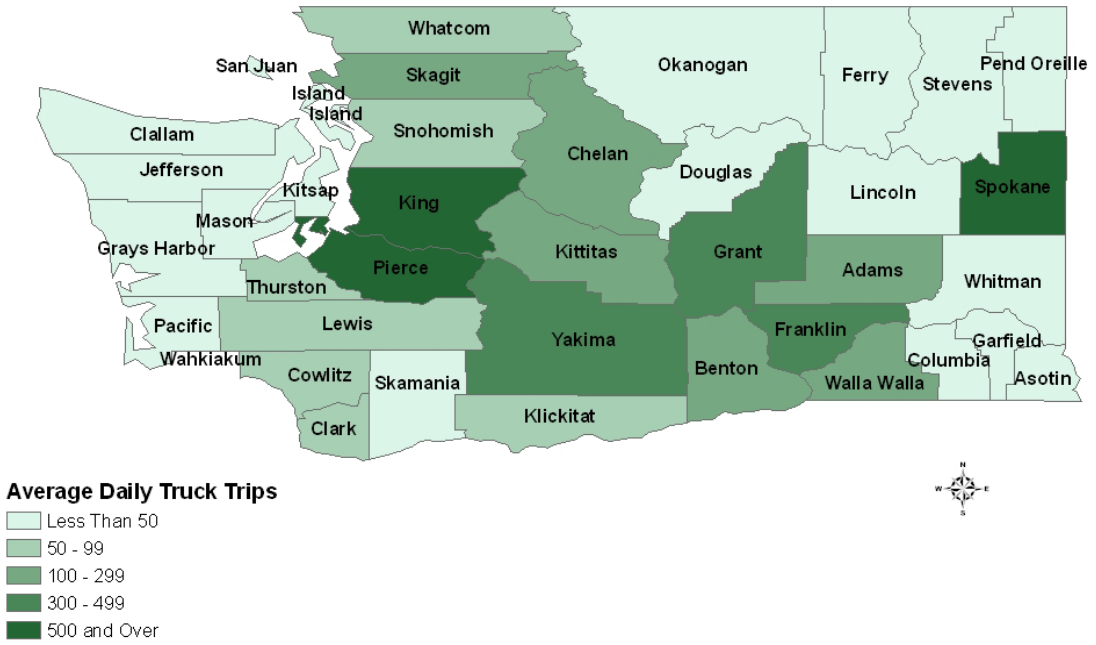
Approximately two truck trips in five originating in Eastern Washington are carrying freight to destinations outside the state. Over 1,400 trucks have loads delivering in the state of Oregon per day, and over 400 trucks haul freight to California. British Columbia and Idaho are also frequent destinations, with each receiving over 300 trucks from Eastern Washington per day.

Cargo Value and Tonnage of Freight Shipped from Eastern Washington

Cargo content in Eastern Washington is dominated by agricultural products, whether grains, fresh fruits

and vegetables, or processed foods and oils. Wood products also make up a significant portion of the goods being hauled from eastern region origins. Agricultural and forest goods, both raw and processed, represent over 60 percent of the average daily tonnage originating in Eastern Washington locations. However, these same goods represent only 35 percent of the average daily value of cargo being generated in the east. Machinery, motor vehicles, electronic and office equipment and industrial goods such as plastics and rubber account for over 35 percent of the average daily total value of cargo, but only 5.5 percent of the average daily total cargo tonnage.

Figure 2.3: Overview of In-State Destinations by County for Truck Trips Originating in Eastern Washington



Source: SFTA Freight Truck Origin and Destination Study

Additional detail of tonnage and value by county is provided in Table 2.3. Freight trips originating in Columbia County have the highest average value per truckload of eastern region origins at almost $84,000. The commodity most frequently cited during the driver interviews for Columbia County was fish, however the large value of the shipments was primarily due to movements of high-value farming equipment through the county. The heaviest truckloads originate in Pend Oreille and Ferry counties, representing the large number of trucks carrying of high-weight goods such as logs, wood chips, raw lumber and pulp. The value of trucks originating in Pend Oreille County is considerably higher (averaging approximately $36,000 per truck trip) than those coming from Ferry County (averaging just over $12,500 per trip) due to the larger number of trucks carrying cargo classified as processed paper or newsprint.

Klickitat County has some of the smallest and lowest valued loads originating in Eastern Washington. While this is certainly related to the relatively low population of the county, geography likely plays a greater role; Klickitat County has the longest span of Columbia River frontage of all Washington counties. As a result, many of the major commodities produced in Klickitat County such as logs and fresh vegetables move short distances to the river and then to ports downstream.

Type of Facility at Place of Origin and Destination

In order to enhance our understanding of the facilities generating truck trips in the state and the destinations receiving such shipments, freight truck drivers were asked to describe the type of facility where they picked up the load and the type of facility at the intended destination. Summary results for facility type origins are found in Table 2.4 and results for facility type destinations are found in Table 2.5.

In Eastern Washington, over half of all freight trip origins are at warehouses and distribution centers or factories. An additional 14 percent originate at freight truck terminals and 12 percent come directly from farms. Of note, 14 percent of the truck drivers could not identify the origin facility type, or the facility was listed as "other." This may reflect the practice of driver/tractor switching, where long-haul trailers are dropped at roadside locations by one driver-and-rig and picked up by another driver-and-rig for final delivery. There is very little intermodal trip origination from non-truck to truck. Origins at rail, marine and air terminals represent slightly over 1 percent of all freight truck origins in Eastern Washington.

Characteristic Profile of Truck Trips Originating in Western Washington

The region of Western Washington is the dominant trip-generating region of the state. The breakdown of average daily truck trips by county is presented in Figure 2.4. Within this region, King, Pierce and Snohomish counties are the largest contributors of freight trips. King County alone produces an average of over 11,000 daily truck trips, while Pierce produces approximately 6,000 trips per day. Businesses and industries in Snohomish County generate over 3,000 freight trucks hauling goods each day. Altogether, communities in Western Washington produce approximately 47,000 truck trips each day.

The cities of Seattle and Tacoma produce the majority of these trips, accounting for almost one-third of the total trip origination in Western Washington. With large-scale, deep-water ports located in both cities, as well as their associated logistics hubs and distribution centers, they are the primary generators of freight traffic in the western region. Over 6,000 trucks depart Seattle daily for other destinations, joined by over 5,770 trucks from Tacoma.

Other Puget Sound communities that contribute large numbers of freight hauls to state highways are Kent, Everett, Auburn, Bellingham and Olympia. Cities such as Vancouver, Aberdeen and Chehalis are major trip generators from Western Washington that are outside the Puget Sound area. Twenty cities account for almost 73 percent of the total freight originations in the western region.

The cities of Seattle and Tacoma are also the primary destinations for truck trips originating in the west. Portland, Oregon and Kent are also major terminal points for trucks hauling freight from Western Washington. A majority of the truck trips generated in the region come from and are destined to deliver within the Puget Sound area, especially King, Pierce and Snohomish counties. Figure 2.5 provides a breakdown of the major destinations for shipments originating in Western Washington by county.

Over 10,000 trucks ship from Western Washington to out of state destinations on a daily basis (Table 2.4). This represents 35 percent of the total number of truck trips generated each day in the western region. Of these truck trips, most are destined for locations in Oregon, British Columbia and California. As mentioned above, Portland, Oregon was the most frequently cited out of state city destination for truck trips originating in the region according to the results of the driver survey.

The commodity mix of goods hauled from origins in Western Washington is more diversified than that of Eastern Washington. Logs, lumber and wood products comprise the largest component of the cargo weight transported on Washington highways from the western region at approximately 30 percent of the total cargo weight, followed by mixed or unknown freight at 20 percent. However, the forestry products account for only 6.4 percent of the total value of cargo shipped from the region. The unknown and mixed

freight, mostly consisting of consumer goods, accounts for about 13 percent of the total cargo value per day.

Table 2.3: Comparison of Average Volume and Value of Cargo Shipped from Eastern Washington Counties

Origin County	Avg. Tons Per Truck	E. WA Rank	Avg. Value Per Truck	E. WA Rank	Major Commodities
Adams	21.1	3	30,641	9	Wheat, potatoes, apples
Asotin	16.5	15	14,855	15	Peas, lumber, paper
Benton	17.2	11	32,398	8	Corn, peas, fertilizer, potatoes
Chelan	14.5	19	29,613	10	Wood chips, logs, apples
Columbia	17	13	83,925	1	Fish
Douglas	17.8	10	34,375	6	Concrete, construction equipment, fruit
Ferry	22	2	12,555	18	Wood chips, lumber
Franklin	17.9	9	38,845	4	Potatoes, hay, farm equipment
Garfield	N/A	20	N/A	20	N/A
Grant	19.25	6	25,727	12	Fertilizer, hay, frozen vegetables
Kittitas	18	8	34,281	7	Hay, fertilizer, potatoes, miscellaneous
Klickitat	14.5	18	7,959	19	Logs/lumber, produce, equipment
Lincoln	20.25	5	14,475	16	Grains, livestock
Okanogan	20.8	4	25,333	13	Logs/lumber, apples, fertilizer
Pend Oreille	24.75	1	35,934	5	Logs/lumber, newsprint/paper
Spokane	16.75	14	39,282	3	Fuel/gasoline, peas, grains, miscellaneous
Stevens	17.2	12	49,725	2	Logs/lumber, livestock, sand/gravel/stone
Walla Walla	18.25	7	21,583	14	Wheat, processed meat, fruits and vegetables
Whitman	14.7	17	12,600	17	Wheat, barley, hay
Yakima	16.4	16	27,326	11	Wine, fertilizer, hay, fruits and vegetables

Note: There was no survey data for shipments originating in Garfield County.
Source: SFTA Freight Truck Origin and Destination Study

Table 2.4: Type of Facility at Place of Origin for Truck Trips Originating in Eastern Washington

Type of Facility	Avg. Daily Number of Trips	% of All Trips
Unknown/Other	1,324	14.17%
Truck Terminal	1,304	13.96%
Rail Terminal	68	0.73%
Marine Terminal	25	0.27%
Air Terminal	16	0.17%
Factory	1,450	15.52%
Warehouse/Distribution Center	3,585	38.36%
Farm	1,103	11.81%
Point of Sale/Consumption	468	5.01%

Source: SFTA Freight Truck Origin and Destination Study

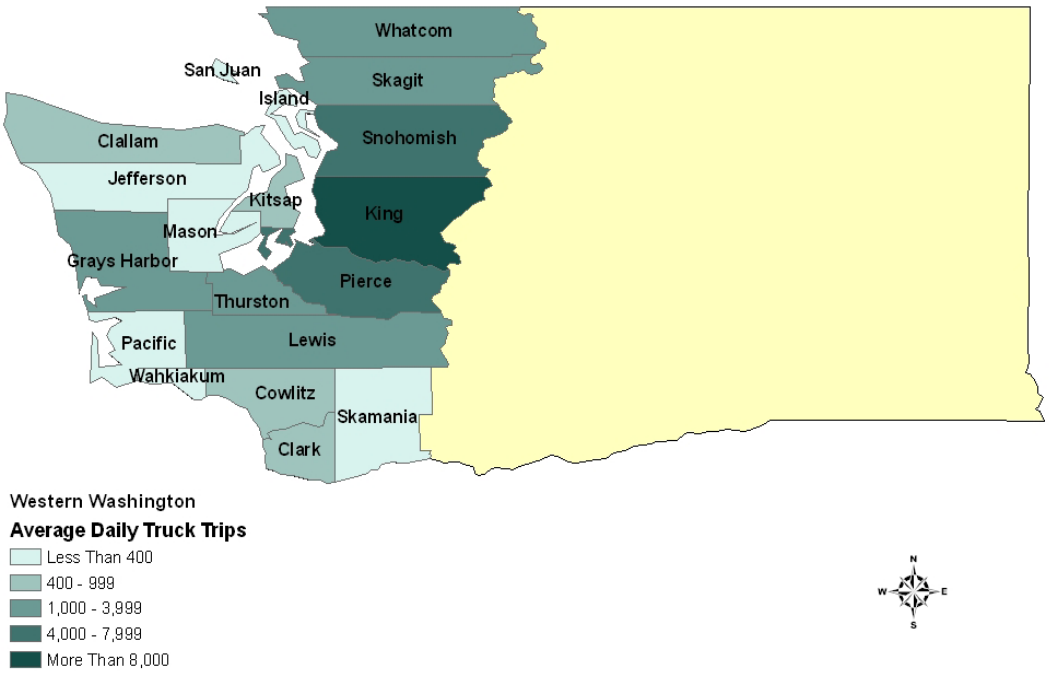
The most dramatic contrast between weight and value in the region is with electronic and office equipment. This commodity segment, which includes personal computers, copiers, telecom equipment and computer software, represents only 1.42 percent of the total weight shipping each day from Western Washington, but 19.75 percent of the total value of cargo shipping each day.

Table 2.5: Type of Facility at Place of Destination for Truck Trips Originating in Eastern Washington

Type of Facility	Avg. Daily Number of Trips	% of All Trips
Unknown/Other	1,451	15.53%
Truck Terminal	1,079	11.55%
Rail Terminal	125	1.34%
Marine Terminal	563	6.02%
Air Terminal	44	0.47%
Factory	1,165	12.47%
Warehouse/Distribution Center	3,371	36.08%
Farm	605	6.47%
Point of Sale/Consumption	939	10.05%

Source: SFTA Freight Truck Origin and Destination Study

Figure 2.4: Comparison of Average Daily Truck Trips Originating in Western Washington Counties



Source: SFTA Freight Truck Origin and Destination Study

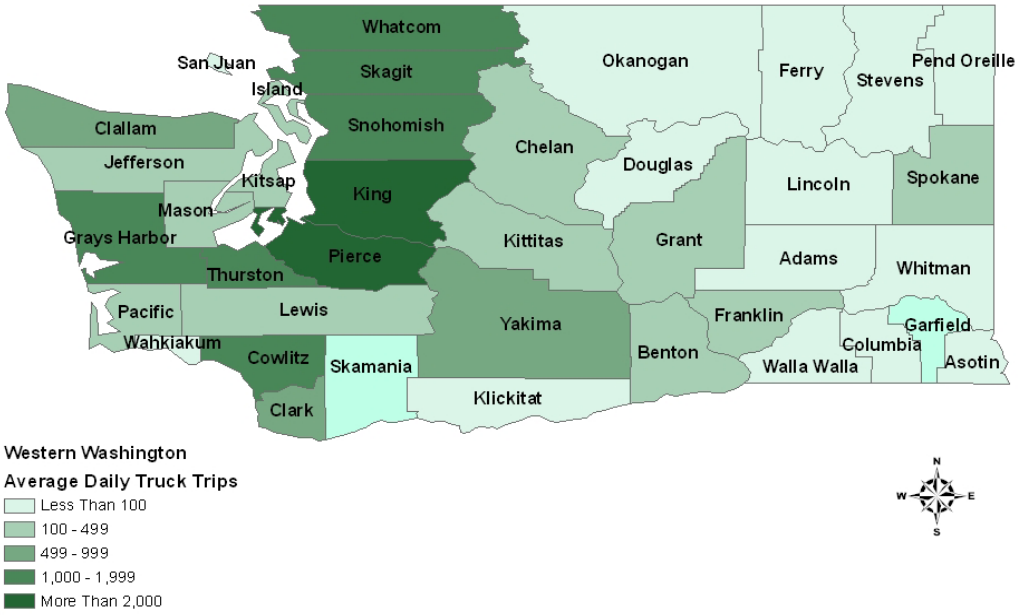
Table 2.5 provides a county-by-county comparison of the average tonnage and average value per truck trip originating in Western Washington. Those counties such as Pacific, Skamania and Mason that are producing and shipping forestry products have some of the highest average tonnages but also, some of the lowest average cargo values. In contrast, Pierce and King Counties rank 12th and 13th in average daily cargo weight, but 2nd and 1st, respectively in average daily cargo value.

Type of Facility at Place of Origin and Destination

Almost 60 percent of the daily freight volume generated in the west region begins at a factory or

warehouse/distribution center; as destination points, factories and distribution centers attract approximately 56 percent of all freight trips terminating in the region. Underscoring the different economic bases between Eastern and Western Washington, the importance of agriculture as a trip originator or destination in the western region is significantly less than that of the eastern region.

Figure 2.5: Overview of In-State Destinations by County for Truck Trips Originating in Western Washington



Source: SFTA Freight Truck Origin and Destination Study

Table 2.4: Most Frequent Out-of-State Destinations for Truck Trips Originating in Western Washington

Destination State/Province	Avg Number of Daily Truck Trips
Oregon	5,064
British Columbia	1,907
California	1,735
Idaho	449
Utah	206
Montana	159
Texas	153
Nevada	127
Other Western States/Provinces	462
States/Provinces East of the Mississippi	657

Source: SFTA Freight Truck Origin and Destination Study

On the other hand, there are more freight trips involved in intermodal transportation (defined as freight origins at marine, rail or air terminals) of products in Western Washington than in the eastern region. Approximately 9 percent of the average daily freight trip traffic in the west originates at an intermodal facility; most of this traffic comes from the deep-water marine ports of the Puget Sound region and their attendant intermodal rail facilities. These results reinforce the important role of the ports, and their accompanying industrial infrastructure, in generating and attracting freight movements throughout Western Washington and the Pacific Northwest.

Table 2.5: Comparison of Average Volume and Value of Cargo Shipped from Western Washington Counties

Origin County	Avg. Tons Per Truck	W. WA Rank	Avg. Value Per Truck	W. WA Rank	Major Commodities
Clallam	7.8	15	14,232	12	Logs, lumber, paper
Clark	12.2	7	36,071	3	Logs, lumber, paper
Cowlitz	14.6	6	18,178	10	Logs, animal feed
Grays Harbor	14.8	5	19,025	9	Logs, lumber, paper
Island	7.1	16	23,155	8	Milk, pipe
Jefferson	9.9	11	10,169	15	Logs, lumber, paper
King	9.1	13	45,054	1	Food products, steel, logs, automobiles
Kitsap	5.8	17	12,664	13	Logs, lumber
Lewis	15.6	4	14,680	11	Logs, lumber, pulp
Mason	16.5	3	12,608	14	Logs, lumber, fuel
Pacific	19.0	2	9,549	16	Logs, lumber
Pierce	9.8	12	44,225	2	Food products, household goods, logs
San Juan	N/A	18	N/A	18	
Skagit	11.7	9	25,948	7	Lumber, potatoes, fuel
Skamania	31.6	1	3,999	17	Logs, wood products
Snohomish	8.9	14	34,684	4	Logs, lumber, asphalt
Thurston	11.7	8	31,176	5	Logs, wood products
Wahkiakum	N/A	19	N/A	19	
Whatcom	11.3	10	29,775	6	Lumber, paper, aluminum, cement

Note: There was no survey data for shipments originating in San Juan and Wahkiakum Counties.
Source: SFTA Freight Truck Origin and Destination Study

Characteristic Profile of Truck Trips Originating Outside of Washington

Most Frequent Origins

On average, over 22,700 trucks enter the state of Washington from origins outside of the state, from states on the East Coast, various Canadian provinces and some from Mexico. During the interview portion of this study, drivers indicated origins from 47 different states, including Alaska, the District of Columbia, 8 Canadian provinces and Mexico. Over one-third of all trucks entering Washington originate in the state of Oregon (Table 2.6). British Columbia and California are also major trip generators, with each contributing over 3,000 trucks per day to freight traffic in Washington.

Portland, Oregon is the most frequent city of origin for trucks coming from out of state. Daily, more than 3,200 truck trips enter Washington having originated in Portland. The Vancouver, British Columbia metropolitan region also produces large numbers or truck trips entering Washington from the north. Approximately 2,400 trucks cross the border from these Canadian locations each day. Hermiston, Oregon is also a major origination point for trucks coming from out of state, particularly in Eastern Washington. As noted previously in the section on Eastern Washington freight patterns, much of this traffic was associated with potato processing. Due to the closure of major processing plant in Hermiston, the continuation of these levels of trip generation is questionable.

Most Frequent Destinations

Over half of the shipments with out of state origins are destined to deliver within the Western Washington region, while only 16 percent terminate in Eastern Washington. A significant number of the out of state

trucks are "pass-through;" these are trucks coming from out of state origins that have ultimate delivery destinations that are also out of state. Much of this traffic is comprised of international flows between businesses in Canada, especially British Columbia, and U.S. firms located in Oregon and California.

Table 2.6: Major Out-of-State Trip Origins for Trucks Traveling on Washington Highways

Origin State/Province	Avg Daily Truck Trips	% of Total Out-of-State Trip Origins
Oregon	8,023	35%
British Columbia	3,728	16%
California	3,427	15%
Idaho	1,481	7%
Montana	797	4%
Alberta	381	3%
Utah	370	2%
Wisconsin	275	1%
Minnesota	257	1%
Other Western States	1,662	8%
Eastern States	1,683	8%
Total Out of State	22,726	100%

Source: SFTA Freight Truck Origin and Destination Study

Freight truck trips originating outside of Washington have widely dispersed destinations within the various regions and cities of the state. Seattle, Tacoma, Spokane and Kent are the most likely destinations, with each receiving more than 1,000 trucks from out of state each day.

Spokane is the primary destination for out-of-state freight shipping to Eastern Washington. Cities such as Yakima, Pasco and Kennewick were also cited as frequent terminal points within the eastern region. Freight moving into Eastern Washington usually enters the state from the south via I-82 near the Tri-Cities, or from the east along I-90 from Idaho into Spokane. Figure 2.6 provides an illustration of the average daily volumes of freight trips from outside of the state received by each Washington county.

Freight passing through Washington is usually destined for locations in Oregon or British Columbia. Trips terminating in Portland were cited most frequently in the driver interviews, followed by Vancouver, British Columbia. Both of these cities receive over 800 trucks per day that have traveled through the state of Washington. Cities comprising the metropolitan area of Vancouver, British Columbia also attract large numbers of freight trips from out of state origins. Northbound volumes are significantly larger than any other geographical location, representing over one-third of the total pass-through freight truck trips.

In Western Washington, most out-of-state trucks enter the state via the I-5 corridor; shipments from British Columbia typically cross the border at Blaine, while shipments from the south usually cross the Columbia River from Portland, Oregon to Vancouver.

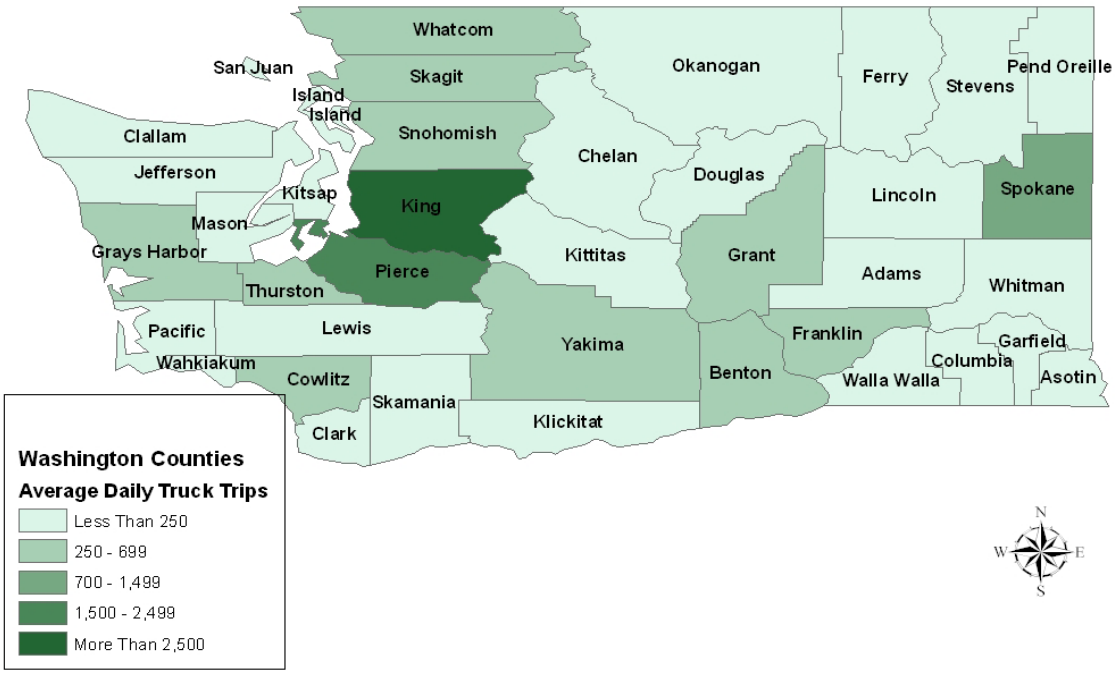
Cargo Value and Tonnage of Freight Shipped from Origins Outside Washington State

Trucks delivering to Eastern Washington carry more products classified as agricultural goods or inputs as a percentage of total freight than trucks delivering in Western Washington. However, there is a higher percentage of trucks carrying timber and forest products to locations in the western region (approximately 16 percent) than to the east (about 11.6 percent). There are more deliveries of industrial and mechanical goods from out of state origins to destinations in Western Washington, while more raw materials and commodity goods are delivered to Eastern Washington.

Freight that is passing through the state is highly concentrated. Most of the cargo weight being

transported through the state is from timber and forestry products traveling south from British Columbia to processing sites in Oregon, or it is the movement of seasonal fresh fruits and vegetables moving to and from distribution points in Canada, Oregon, California and other states. This freight traffic is generally of low-to-moderate value, traveling over relatively short inter-state distances within the Pacific Northwest.

Figure 2.6: Overview of Destinations Within Washington State for Truck Trips Originating Outside of the State



Source: SFTA Freight Truck Origin and Destination Study

The economic value of cargo of shipments from out of state, expressed in dollar terms, is significantly higher to destinations in Western Washington. This is due to the larger market for consumer goods (mixed freight), office and electronic equipment, technical instruments and machinery. On an average day, cargo valued at approximately $525 million is delivered to destinations in Western Washington from outside the state; Eastern Washington receives about $112 million each day. The value of cargo traveling through state is also highly concentrated. High-value goods such as machinery, electronic and office equipment, transportation equipment, motor vehicles and manufactured goods comprise almost half of the value of all goods shipping through the state.

Type of Facility at Place of Origin and Destination

Facility types at origin and destination points for freight shipments coming from outside of Washington are detailed in Tables 2.7 and 2.8. Over 60 percent of freight trucks traveling across the state line began at factories or warehouses. A significant number of trucks began at truck terminals or were classified as unknown. Less than 3 percent of all freight trucks began their trips at intermodal facilities (rail, marine or air terminals) outside of the state.

Factories and distribution centers were also the most frequently cited destinations for trucks traveling from out of state. As expected, deliveries to points of sale or consumption are also numerous, accounting for almost 12 percent of the total terminal points.

Table 2.7: Type of Facility at Place of Origin for Truck Trips Originating Outside of Washington

Type of Facility	Avg. Daily Number of Trips	% of All Trips
Unknown/Other	2,967	13.1%
Truck Terminal	3,692	16.3%
Rail Terminal	289	1.3%
Marine Terminal	268	1.2%
Air Terminal	101	0.4%
Factory	5,763	25.4%
Warehouse/Distribution Center	8,125	35.8%
Farm	808	3.6%
Point of Sale/Consumption	687	2.9%

Source: SFTA Freight Truck Origin and Destination Study

Table 2.8: Type of Facility at Place of Destination for Truck Trips Originating Outside of Washington

Type of Facility	Avg. Daily Number of Trips	% of All Trips
Unknown/Other	3,761	16.5%
Truck Terminal	2,333	10.3%
Rail Terminal	174	0.8%
Marine Terminal	659	2.9%
Air Terminal	134	0.6%
Factory	3,025	13.3%
Warehouse/Distribution Center	9,443	41.6%
Farm	517	2.3%
Point of Sale/Consumption	2,655	11.7%

Source: SFTA Freight Truck Origin and Destination Study

Section 3: Analysis of Commodity Content on Major Washington Freight Corridors

This section provides analysis of commodity flows along five major freight corridors in Washington State (I-5, I-82, I-90, US 97 and US 395). Each of these corridors is a primary component of the intra-state freight transportation network. Moreover, major entry points for goods traveling from outside of Washington are located on these highways. As can be expected, substantial differences do exist between the cargo mixes found on each major highway. However, significant similarities also can be found, perhaps indicating increasing diversity and dispersion in the economic base of Washington, and the importance of Washington's freight transportation network to the efficient flow of diverse products internationally, nationally, throughout the Pacific Northwest and locally within Washington State. The highlights for each major corridor are noted below.

Interstate 5

Interstate 5 is the workhorse of Washington's freight transportation system. This highway passes through the primary concentration of population and industry within Washington state, is in very close proximity to the two largest deep-water marine ports in the state (and two of the largest on the US Pacific coast), and is the primary roadway for goods flowing south from Canada, or north from Oregon and California into the state. I-5 is also a major corridor utilized by the communities involved in the timber and forest products industries on the Olympic Peninsula.

Due to the large population centers situated along Interstate 5, mixed freight and truckloads classified as unknown (assumed to be primarily mixed consumer commodities) comprise the largest percentage of freight trucks on the highway. As noted above, timber and forest products are a major component of I-5

freight traffic, accounting for almost 20 percent of the truck volume on the highway. Industrial inputs and finished goods are also large generators of freight truck traffic along the I-5 corridor.

Interstate 82

Interstate 82 is the primary transportation route for the agricultural industry in south-central Washington State. Almost one-third of the freight trucks on Interstate 82 carry agricultural products, either in raw or processed form. I-82 carries raw fruits and vegetables from regional farms in Washington and Oregon to processors and wholesalers in both states. This interstate movement of agricultural commodities is the leading generator of freight traffic all along this corridor. Additional freight traffic is generated by the distribution of consumer products to the communities of south-central Washington and by the transportation of machinery and equipment utilized in agricultural production and processing.

Interstate 90

Interstate 90 is the second most important freight corridor in Washington and covers the greatest geographical extent. The highway serves to integrate the agricultural producers of Eastern Washington with the manufacturing and port facilities in the west. Approximately 28 percent of the freight traffic on the I-90 corridor is comprised of agricultural products. An additional 19 percent of the truck traffic is carrying industrial inputs and finished goods along I-90. Most of this traffic moves from the east to the west and the ports in Seattle and Tacoma, but the Spokane area also attracts large numbers of such freight flows.

US 97

This freight corridor is a major north-south route for agricultural producers east of the Cascades. One-quarter of all freight trucks on US 97 are carrying agricultural products, more than any other freight corridor in Washington State. US 97 is the primary freight corridor for apples and other fruits produced in the state. Large numbers of forest products moving south from British Columbia and from northern Washington also move along US 97. Such shipments represent approximately 14 percent of all trucks on the highway. As a result of the small and widely dispersed population in the regions served by US 97, mixed and unknown freight (assumed to be mostly consumer commodities) comprise a smaller percentage of total freight volume than on any other major freight corridor.

US 395 North of Spokane

The portion of US 395 north of Spokane is the shortest major freight corridor analyzed in this study, with the lowest freight truck volumes. However, this highway provides a vital link for movements of timber and forestry products from Canada, the Idaho Panhandle and northeastern Washington. The highway also carries other basic materials such as base metals, sands, gravel and stone from these same regions. A more specific analysis of the directional movements of freight along US 395 is forthcoming and will be part of the SFTA Research Report series.

Mean Cargo Tonnage by Commodity

Information and analysis of the total freight cargo tonnage moving along state highways is important when assessing current and future infrastructure needs and investment priorities. For example, roadways that have frequent movement of heavy vehicles will experience faster-than-normal deterioration than highways that have infrequent truck movements or lighter average payload weights. Highways that have frequent truck movements and heavier average payload weights may require more frequent repairs or special infrastructure to support such traffic. Cargo content is a primary component of the expectations of

average cargo payload weights.

During the roadside interviews conducted for this study, drivers were asked to provide information regarding the commodity they were carrying and the average payload weight on their vehicle. Freight trucks carrying agricultural and forest products have the highest mean cargo tonnage on Washington highways. Stone, sand, petroleum and coal also have high average tonnage per truckload. High-value goods such as precision instruments, electronic and office equipment, pharmaceuticals and consumer goods have some of the lowest mean cargo tonnage on freight trucks.

Freight corridors that have large numbers of heavy trucks moving along their highways are more likely to experience roadway surface and subsurface deterioration. Since heavier average payload weights are associated with agriculture, timber and other basic commodities, highways serving as major freight corridors for producers and processors of these goods do have higher mean payloads than other major freight corridors. US 97 and US 395 have the highest mean cargo weights, reflecting the large numbers of trucks carrying agricultural and timber products on those roadways. The lowest mean cargo weights are found on I-5 and I-82, where high-value, low-weight goods such as consumer commodities, electronics and processed agricultural products are more common payloads.

Analysis and Implications of Multiple Trailer Configurations on Key Freight Corridors in Washington State

Freight trucks carrying agricultural and forestry products have the highest percentage of multiple-trailer and large-length configurations. Almost 42 percent of all freight trucks carrying cereal grains have multiple trailers, with almost all of the trucks carrying cereals having configurations of 5 or more axles. While only 7 percent of trucks carrying logs and wood in the rough use multiple trailers, over 73 percent have configurations of 5 or more axles, usually carrying newly felled timbers and logs of pole length to and from lumber mills around the state. Trucks carrying finished goods and consumer products typically utilize multiple trailers less than 10 percent of the time.

On average, just over 11 percent of all freight vehicles surveyed have a multiple trailer configuration, with most of these trucks on US 97 and US 395. Trucks configured with more than 5 axles (the standard tractor-trailer rig configuration) account for over 30 percent of all vehicles carrying freight in Washington State. Again, the majority of trucks so configured are found on US 97 and US 395, which are the primary generators of shipments of timber and forest products, and basic materials such as sand, gravel and quarried stone.

Section 4: Implications of Future Growth in Freight Volumes and the Efficient Movement of Freight Cargo in Washington State

Implications of Future Growth

Freight volumes traveling by truck in Washington State have increased consistently and substantially over the last 10 years. The implementation of NAFTA, increased globalization, modernization of ports, and the general growth of economic activity in the United States resulted in substantial increases in freight traffic within the state. For example, the volume of freight in-bound to the Central Puget Sound area comprising King, Pierce, Snohomish and Thurston counties experienced over 200 percent growth between 1994 and 2003. Overall, freight truck volumes in Washington State as a whole were up over 150 percent between 1994 and 2003.

In a recent paper, Resor and Blaze note that during the period 1990-2000, truck tonnage grew by 6.9 percent annually. Also, total freight traffic (for all modes) is estimated to grow 57% in the next 16 years.

Due to capacity limitations in rail and waterborne infrastructure, most of this volume will be placed on the nation's highway transportation network.[1] As a result, average expectations of growth in freight truck volumes will be approximately 8 percent per year. If the entire expected increase in total freight volumes is transported on the highway network via truck, growth may be as high as 10 percent per year. From these growth estimates, forecasts for high, average and low growth scenarios have been constructed. The high-growth scenario will assume 10 percent annual growth; the average-growth scenario a rate of 5 percent, and the low-growth estimate will be based on a 3 percent rate of growth. The estimated results for each scenario are illustrated below in Chart 4.1.

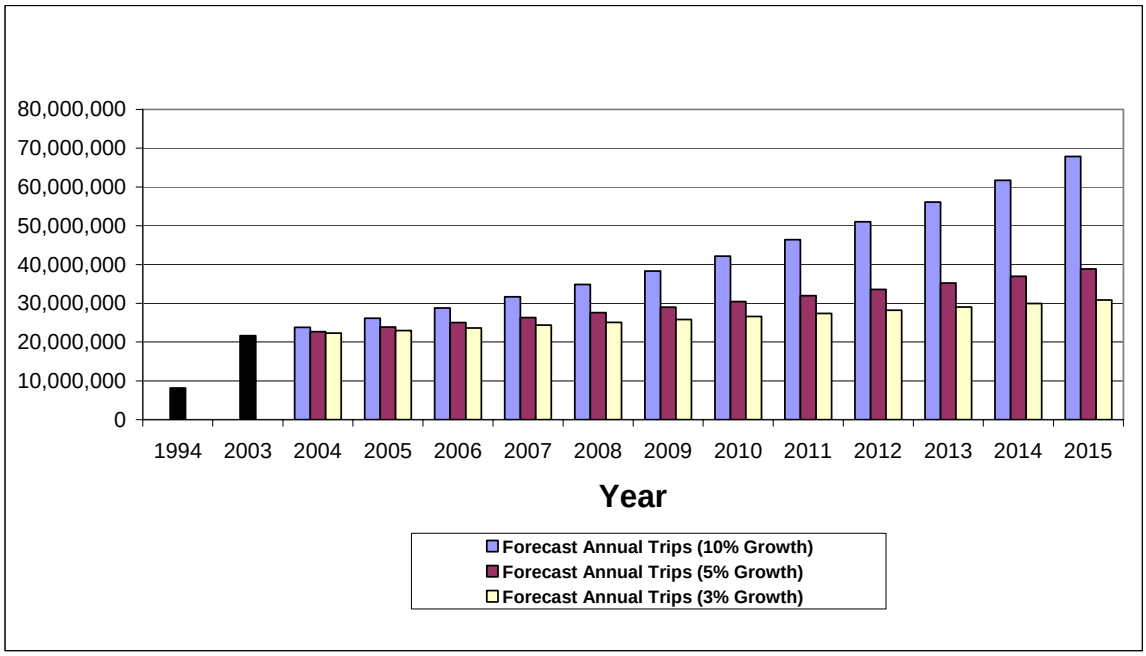
Summary and Conclusions

This report offers both a summary and general analysis of the results of the 2003 statewide origin and destination survey. The information compiled in these surveys provides a detailed profile of freight truck movements within and through the state of Washington.

Effective and efficient integration of Washington's highways into the regional, national and international traffic network is critical to the state's economic vitality. Between 35 and 40 percent of all freight traffic originating in Washington ships to locations outside of the state, while almost one-third of the freight traffic on state roadways originates outside Washington. In fact, there are more interstate and international freight movements in Washington than freight shipments between the Eastern and Western regions of the state.

Intermodal access is of great importance for freight trucks traveling in Washington State. With two major deep-water ports within the state and the river port system of the Columbia-Snake River Basin, Washington is a major attractor of freight shipments moving over water. Flexible and efficient transportation networks that address mobility issues related to port activities are vital to the continued attraction of business in these facilities.

Chart 4.1: Comparison of Forecast Annual Growth in Freight Truck Trips



[1] Resor, Randolph R. and James R. Blaze, "Short Haul Rail Intermodal: Can It Compete With Truck?", a paper presented to the Transportation Research Board, January 2004.