APPENDIX B:

EXISTING AND FUTURE DEMAND FORECASTING RESULTS OF INTERCITY PASSENGER RAIL AND FREIGHT RAIL TRANSPORTATION

This appendix is intended to provide an overview of demand forecasting methdology and present detailed forecast results for Amtrak Cascades intercity passenger rail service and freight rail transportation. This appendix supplements the Amtrak Cascades system-level ridership forecast in Chapter 4 by providing forecast results disaggreated at station and region levels. This appendix also supplements the statewide freight rail demand forecast in Chapter 3 by presenting freight rail commodity flow forecast by trade types, freight rail tonnage and train volume forecast at corridor level.

1.0 Existing and future demand of Amtrak Cascades intercity rail service

This section starts with an overview of ridership forecast modeling methdology and assumptions, followed by 2018 Amtrak Cascades station ridership and 2040 projections under various growth scenarios by metropolitan/regional transportation planning organizations (MPO/RTPO) and by Oregon and British Columbia.

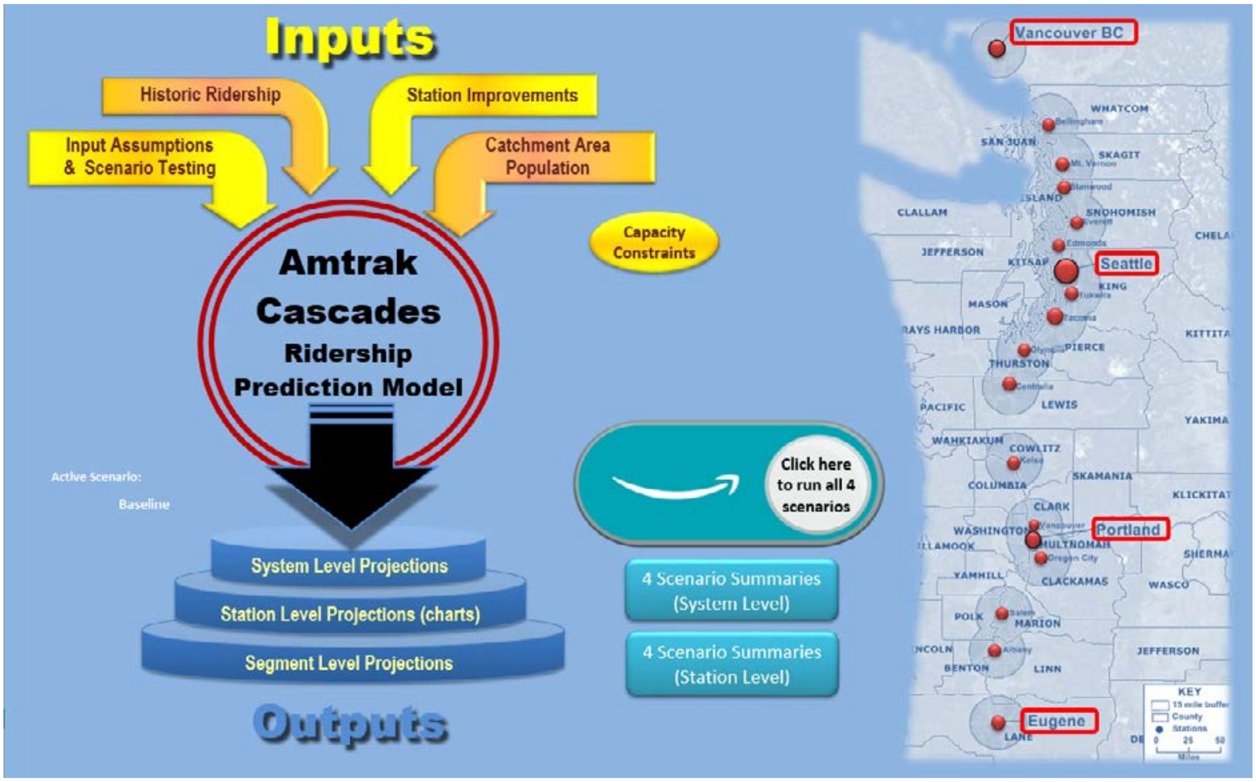
1.1 Modeling Assumption and Methodology

The Amtrak Cascades ridership forecast model is a spreadsheet based linear multiple regression model which predicts annual ridership at station level first, and then sums up station level ridership to create the system ridership for the entire Cascades Corridor from Vancouver, BC to Eugene, Oregon. The model uses the following key variables as inputs:

- Service levels: number of daily train trips and travel times by three segments (Vancouver BC to Seattle, Seattle to Portland, and Portland to Eugene)
- On-time performance: annual on-time performance by Washington segment (Vancouver BC to Portland) and Oregon segment (Portland to Eugene)
- Station catchment area population: the population[1] within a 30-minute driving distance of each station

This forecasting model applies a traditional demand analysis approach and mostly uses supply side factors as inputs, focusing on improvements in the supply or quality of Amtrak Cascades service, and the potential ridership implications of improvements. The modeling approach does not examine the impact of modal competition between intercity rail and other travel modes on ridership.

Exhibit 1-1: Amtrak Cascades ridership forecast model



The forecast model uses historical observed data from 1996 through 2018 to estimate model coefficients, and produces annual riderhsip projections for various scenarios between 2019 and 2040. Four growth scenarios were established to forecast future ridership under various service alternatives, ranging from no improvement to a full set of service enhancements. These scenarios were developed in consultation with ODOT to ensure consistency with its plans for future service between Portland and Eugene. The service level assumptions for Seattle to Portland service under high growth scenario are aligned with the assumptions adopted in WSDOT's previous rail planning efforts — such as the 2006 Long Range Plan, 2014 State Rail Plan, and 2017 Fleet Management Plan — to ensure consistency.

Exhibit 1-2 shows the current service level in base year 2018 and detailed service level assumptions in future year 2040 by each scenario. The baseline scenario assumes maintaining status quo and no improvements beyond what is currently programmed. The low growth assumes a small increase in reliability, service frequency, and minor reduction in travel time. Moderate growth assumes moderate service enhancement by adding additional trips and reducing travel time across the corridor. The highest growth assumes the most aggressive set of service improvements, with significant reduction in travel time, much more frequent service, longer trains, and much higher reliability. These scenarios reflect past planning efforts by WSDOT and ODOT. Implementation of these scenarios would require consultation, planning, and agreements with host railroads on developing service goals and identifying specific actions needed to achieve those service goals.

Exhibit 1-2: Need title

Scenarios	Frequency and Travel Time by Segments (in hours and minutes)			Reliability	Train Capacity (seats)
	Vancouver BC to Seattle	Seattle to Portland	Portland to Eugene		
2018 Base year	2 daily round trips in 4h 5m	4 daily round trips in 3h 30m	2 daily round trips in 2h 35m	56%	268
Baseline scenario 2040	2 daily round trips in 4h	6 daily round trips in 3h 20m	2 daily round trips in 2h 35m	88%	268
Low growth scenario 2040	2 daily round trips in 4h	8 daily round trips in 3h 10m	2 daily round trips in 2h 35m	90%	300
Moderate growth scenario 2040	3 daily round trips in 3h 50m	8 daily round trips in 3h 10m	4 daily round trips in 2h 25m	90%	300
High growth scenario 2040	4 daily round trips in 2h 37m	13 daily round trips in 2h 30m	6 daily round trips in 2h 20m	95%	300

1.2 Cascades existing and future ridership forecast results by station and region

Exhibit 1-3 shows the Amtrak Cascades 2018 ridership and forecasted 2040 ridership under various growth scenarios by stations and MPO/RTPO/neighboring state or province. Exhibit 1-4 shows station ridership growth by percentage from 2018 to 2040.

In 2018, a total of 802,000 riders traveled on Amtrak Cascades, with 33% of riders getting on/off stations in Oregon state, 10% in British Columbia, and the remaining 57% getting on/off in Washington state.

System-level ridership is forecasted to range from 1.28 million passengers in 2040 for the baseline scenario to over 2.5 million for the high growth scenario, representing a range of 60% to 214% growth over 2018 ridership. The percent growth of station-level ridership varies due to differences in service assumptions including trip frequency and travel time, reliablity and varying population growth across different regions, which are key driving factors affecting pasenger rail demand.

Exhibit 1-3: Amtrak Cascades existing and future ridership forecast by station and various scenarios

MPO/RTPO/ neighboring state	Station Name	2018 Base Year	2040 Baseline	2040 Low Growth	2040 Moderate Growth	2040 High Growth
Oregon	Eugene	24,600	35,400	35,700	58,900	82,700
	Albany	9,900	14,500	14,600	24,000	33,800
	Salem	20,200	29,200	29,400	48,600	68,300
	Oregon City	6,000	9,300	9,300	15,400	21,700
	Portland	205,700	308,200	348,600	477,100	717,000
Southwest Washington Regional Transportation Council (RTC)	Vancouver, WA	38,400	61,100	75,800	75,800	113,500
Cowlitz-Wahkiakum Council of Governments (CWCOG)	Kelso/ Longview	13,400	21,000	26,100	26,100	39,000
	Centralia	10,800	18,900	23,400	23,400	35,000
Thurston Regional Planning Council (TRPC)	Olympia/ Lacey	26,700	42,500	52,700	52,700	78,900
Puget Sound Regional Council (PSRC)	Tacoma	41,700	71,600	88,900	88,900	133,000
	Tukwila	16,400	26,000	32,300	32,300	48,300
	Seattle	249,500	400,900	475,200	491,900	705,700
	Edmonds	10,800	15,100	15,200	20,400	27,700
	Everett	11,000	15,300	15,300	20,600	27,900
	Stanwood	2,600	3,400	3,400	4,500	6,200
Skagit Council of Governments (SCOG)	Mt. Vernon	8,600	11,900	12,000	16,100	21,800
Whatcom Council of Governments (WCOG)	Bellingham	25,500	33,200	33,200	44,800	60,700
British Columbia	Vancouver, BC	79,900	164,100	164,900	189,800	296,800
Total		**801,700**	**1,281,600**	**1,456,000**	**1,711,300**	**2,518,000**

Exhibit 1-4: Amtrak Cascades station ridership growth by percentage under various scenarios

MPO/RTPO/ neighboring state	Station Name	Percentage share of 2018 total ridership	Percentage change from 2018 to 2040 ridership			
			Baseline Growth	Low Growth	Moderate Growth	High Growth
Oregon	Eugene	3.1%	44%	45%	139%	236%
	Albany	1.2%	46%	47%	142%	241%
	Salem	2.5%	45%	46%	141%	238%
	Oregon City	0.7%	55%	55%	157%	262%
	Portland	25.7%	50%	69%	132%	249%
Southwest Washington Regional Transportation Council (RTC)	Vancouver, WA	4.8%	59%	97%	97%	196%
Cowlitz-Wahkiakum Council of Governments (CWCOG)	Kelso/ Longview	1.7%	57%	95%	95%	191%
	Centralia	1.3%	75%	117%	117%	224%
Thurston Regional Planning Council (TRPC)	Olympia/ Lacey	3.3%	59%	97%	97%	196%
Puget Sound Regional Council (PSRC)	Tacoma	5.2%	72%	113%	113%	219%
	Tukwila	2.0%	59%	97%	97%	195%
	Seattle	31.1%	61%	90%	97%	183%
	Edmonds	1.3%	40%	41%	89%	156%
	Everett	1.4%	39%	39%	87%	154%
	Stanwood	0.3%	31%	31%	73%	138%
Skagit Council of Governments (SCOG)	Mt. Vernon	1.1%	38%	40%	87%	153%
Whatcom Council of Governments (WCOG)	Bellingham	3.2%	30%	30%	76%	138%
British Columbia	Vancouver, BC	10.0%	105%	106%	138%	271%
Total		**100.0%**	**60%**	**82%**	**113%**	**214%**

Exhibits B-5 through B-10 show the 2018 and 2040 projected Amtrak Cascades station ridership for six MPO/RTPOs in Washington state, which are direclty served by Amtrak Cascades intercity rail service. The station ridership represents the average number of annual riders getting on at a station and riders getting off at the same station, which is calculated as the sum of ons and offs divided by two.

Exhibit 1-5: Amtrak Cascades ridership by stations, 2018 and 2040 scenarios – RTC

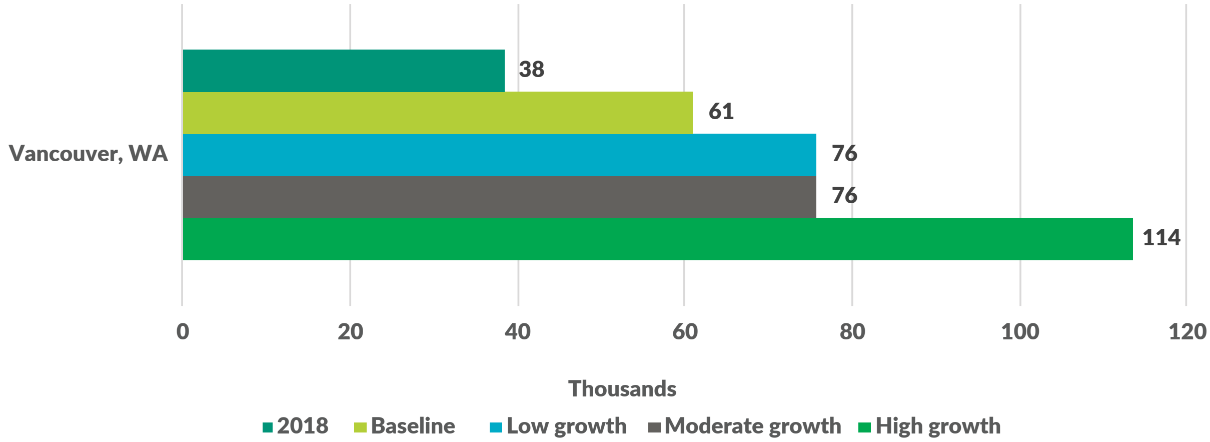


Exhibit 1-6: Amtrak Cascades ridership by stations, 2018 and 2040 scenarios – CWCOG

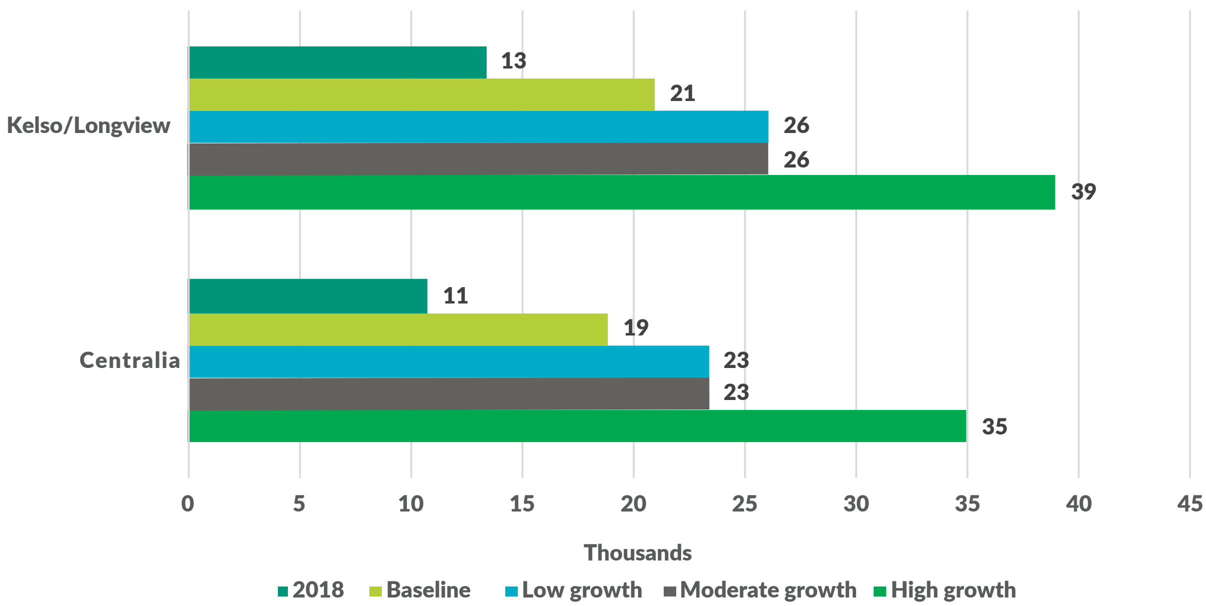


Exhibit 1-7: Amtrak Cascades ridership by stations, 2018 and 2040 scenarios – TRPC

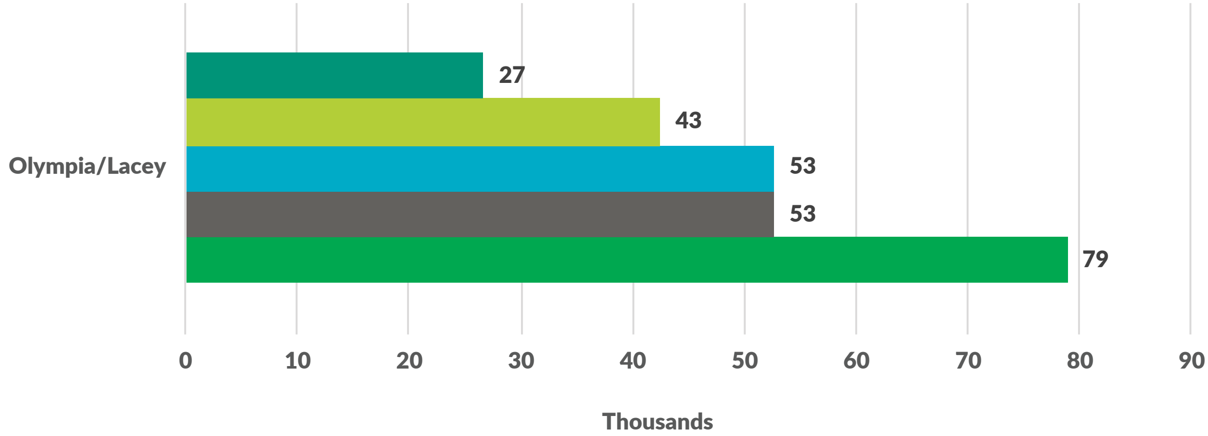


Exhibit 1-8: Amtrak Cascades ridership by station, 2018 and 2040 scenarios – PSRC

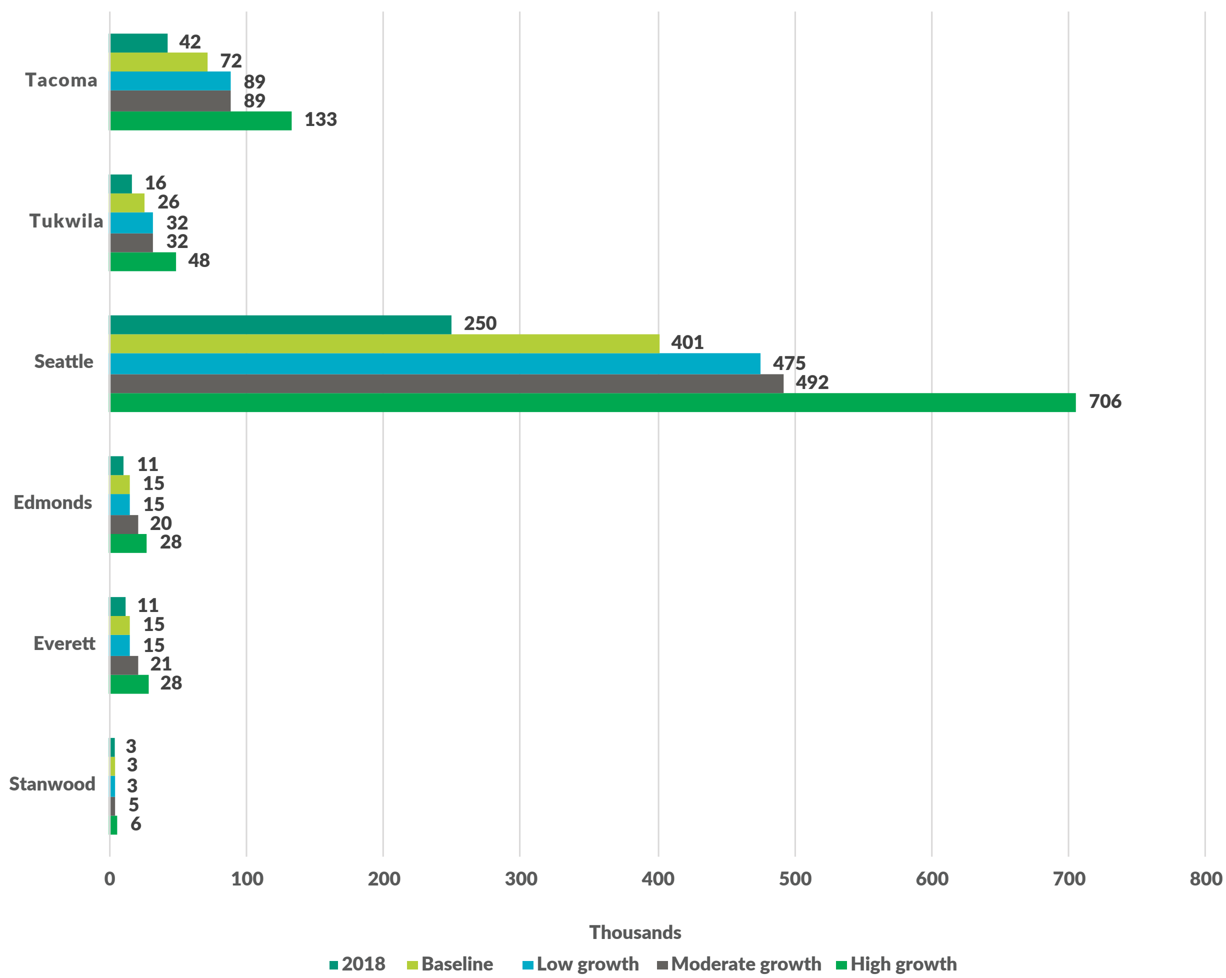


Exhibit 1-9: Amtrak Cascades ridership by stations, 2018 and 2040 scenarios – SCOG

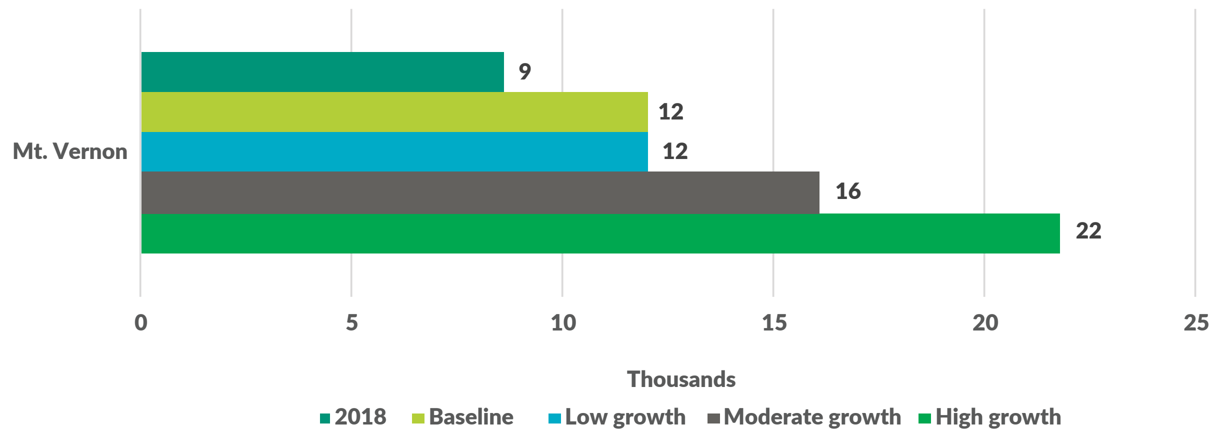
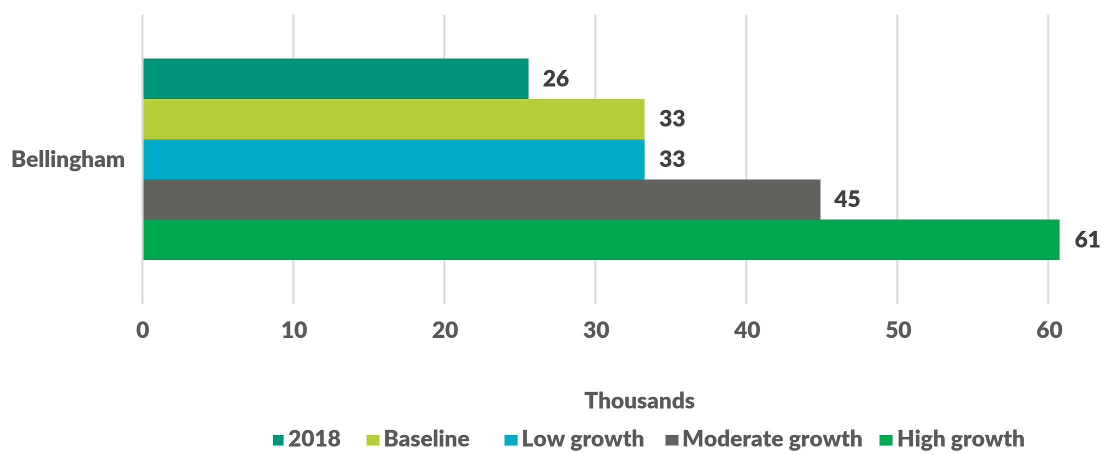


Exhibit 1-10: Amtrak Cascades ridership by stations, 2018 and 2040 scenarios – WCOG



2.0 Freight rail commodity flow and train volumes

Private railroads typically do not release network-level data on train volumes, so an analysis of commodities carried by rail within the state provides a basis for analysis of present and future rail demand. This demand directly influences the type of freight service and level of investment that the railroads will undertake. For the state, anticipated patterns of freight flows and demand for intercity travel will affect multimodal transportation policy and investment strategy to address the mobility needs of the state's residents and shipping public.

This section starts with an overview of freight rail modeling data sources and methodology. It then presents freight rail commodity flow and train volumes for base year 2016 and future year 2040 under various growth scenarios.

2.1 Data sources and methodology

The primary data sources utilized to develop the freight rail forecast are the Surface Transportation Board's 2016 Carload Waybill data, FHWA Freight Analysis Framework (FAF) version 4 forecast, Regional Economic Models, Inc. (REMI) model for Washington state forecast, and Oak Ridge National Laboratory rail network. Additional key inputs include 2016 freight train counts provided by the railroads and rail import and export volume data from the largest Washington ports.

The 2016 base year modeling framework includes three modules:

- Enhance the raw Waybill origin-destination flow database by identifying and adjusting Washington port-related flows, North American Free Trade Agreement (NAFTA) related flows, and other flows on Washington's rail system
- Assign enhanced Waybill OD flows to the rail network by identifying station locations of origin, destination and interchange, and using TransCAD software to conduct an all-or-nothing assignment of freight rail tonnages
- Convert link level annual tonnage flow outputs to average daily train volumes

Extensive quality checks were performed to ensure correctness and consistency of the results with source data. Freight rail volumes were adjusted based on rail import and export data from major ports and freight train volume results were calibrated with 2016 freight rail train counts provided by railroads.

Please note that the metric used in the freight rail forecast is the commodity lading weight, consistent with the metric used by federal data sources such as FHWA and Surface Transportation Board. BNSF uses a different metric -- gross ton miles -- to measure rail shipments on its network, which is based on the gross weight (including equipment tare weight) and shipment distance. Due to data availability, the freight demand forecast analysis adopts the net weight metric for analysis and reporting, which should not be directly compared to the railroad's gross ton mile metric.

The 2040 moderate freight rail flow forecast was developed using a two-step approach:

- Link FAF4 growth rates by commodity, modes, origin, and destination to 2016 waybill freight rail flows (enhanced database from the base year modeling results) to develop interim 2040 moderate growth freight rail flow forecast. Due to the fact that the growth rates in the FAF4 database over the period 2012-2020 showed high variability, the annualized growth rates over 2020-2040 were used and extrapolated to 2016 for developing the 2040 forecast.
- Adjust FAF4 growth rates based on comparison with REMI economic forecasts for Washington and apply the adjustment factors to the interim 2040 moderate growth freight rail flow database by commodity and direction to develop the final moderate growth forecast.

In order to effectively plan for the rapidly changing environment and better address uncertainties in the driving factors of freight and economic growth, two alternative scenarios, low growth scenario and high growth scenario, were also developed to supplement the moderate growth forecast scenario. Exhibit 2-1 provides an overview of the three scenarios. Scenario planning analysis was performed to establish alternative future scenarios using information on trends and evolving practices for key industries using the rail system in Washington, and Economic and international trade trends that could significantly change the status quo. Alternative growth rates were developed and applied to 2016 base year freight rail flow to forecast 2040 freight rail demand for low growth and high growth scenarios.

Exhibit 2-1: Freight rail demand forecast scenarios

Low growth scenario	Moderate growth scenario	High growth scenario
• Driven by a significant decline in export volumes and the resulting cumulative effects • Assumes that tariffs imposed by the U.S. and other nations have a substantial, lasting effect on international trade and suppress export activity • Assumes high potential negative effects on agricultural imports/ exports and international containerized trade, and declined energy exports	• Driven by growth in industries requiring long-haul movement of heavy commodities • Assumes no long-term effects from tariff and trade tensions • Based on FHWA's FAF 4[2] growth rates and long-term macroeconomic forecasts derived from REMI model[3]	• Driven by robust growth in export volumes • Assumes that tariffs imposed by the U.S. and other nations have little to no effect on international trade volumes and/or are removed with minimal or no lingering effects • Assumes high potential growth in energy exports caused by proposed bulk shipment facilities for coal and oil, • and robust potential growth in international containerized trade and agricultural imports and exports

The future scenarios do not consider the potential effects of Columbia River System Operations EIS[4] process on future freight rail demand because no definitive data is currently available. CRSO EIS development is a five-year federal process to develop a range of reasonable alternatives for long-term river system operations. Nothing has been decided yet and the subsequent results of EIS decisions are unknown at this point.

2 FHWA Freight Analysis Framework version 4.4.1 forecast: https://ops.fhwa.dot.gov/freight/freight_analysis/faf/
3 Economic forecasts including population and gross domestic product from WSDOT purchased REMI economic model.

2.2 Freight rail commodity flow

This section analyzes the top commodities moved by rail in 2016 and those expected to be moved in 2040. It is important to understand which industries are dependent on rail and which will continue to be in the future. Exhibit 2-2 and 2-3 present the top rail commodities by tonnage in 2016 and their 2040 projections in tons for the low growth scenario, moderate growth scenario, and high growth scenario. Exhibit 2-4 shows 2016 and 2040 share of statewide tonnage by rail commodity, and Exhibit 2-6 shows the percentage change from 2016 to 2040 for those commodity groups.

When measured in weight, cereal grains and agricultural products are expected to stay as the top commodities moved by rail in the state, regardless of the forecast scenario.

Under the low growth scenario and the moderate growth scenario, coal shipments are expected to decline by half, as inbound shipments to Washington state to the Centralia Power Plant and through shipments to Portland General Electric are expected to cease within the next decade. What coal volumes remain are modest exports through Washington ports, as well as US-produced coal going to Canada for export. Under the high growth scenario, coal and crude petroleum are projected to grow 375% and 97% by 2040 respectively, as it is assumed that new high-capacity facilities for crude oil export and at least one facility for coal exports will be constructed and operating at full capacity by 2040.

Rounding out the top four commodities in 2016 is mixed freight, a category for which the specific commodity is not identified. This commodity class is handled almost entirely in intermodal service. In 2016, 10.6 million tons of mixed freight were handled in intermodal service. Most intermodal traffic, including containerized imports and exports, moves as mixed freight, accounting for 58%of all intermodal traffic on a tonnage basis. On an overall tonnage basis, mixed freight accounted for 9% of all traffic, while all intermodal traffic accounted for 15%. Mixed freight is expected to grow through 2040 under all three scenarios, displaying particular sensitivity to trade policy.

Exhibit 2-2: 2016 and 2040 forecasted rail flows in Washington by commodities

Commodity	2016 Rail Tonnage (millions)	2040 Low Scenario Rail Tonnage (millions)	2040 Moderate Scenario Rail Tonnage (millions)	2040 High Scenario Rail Tonnage (millions)
Cereal grains	26.0	17.3	57.1	71.7
Other ag prods.	16.9	11.5	50.5	63.3
Coal	11.9	5.7	5.7	56.7
Mixed freight	10.7	10.9	14.6	22.7
Wood products	9.2	7.1	15.8	15.9
Crude Petroleum Oil	7.5	7.7	7.7	14.7
Animal feed	5.9	5.8	9.9	11.8
Petroleum and Coal Products	4.6	4.5	4.5	5.5
Waste/scrap	4.5	6.1	6.6	7.9
Fertilizers	3.5	3.0	5.2	6.5
Other	21.5	30.9	38.7	44.8
Total	**122.0**	**110.4**	**216.2**	**321.4**

Exhibit 2-3: Top rail commodities by tonnage, 2016 and forecasted 2040 scenarios

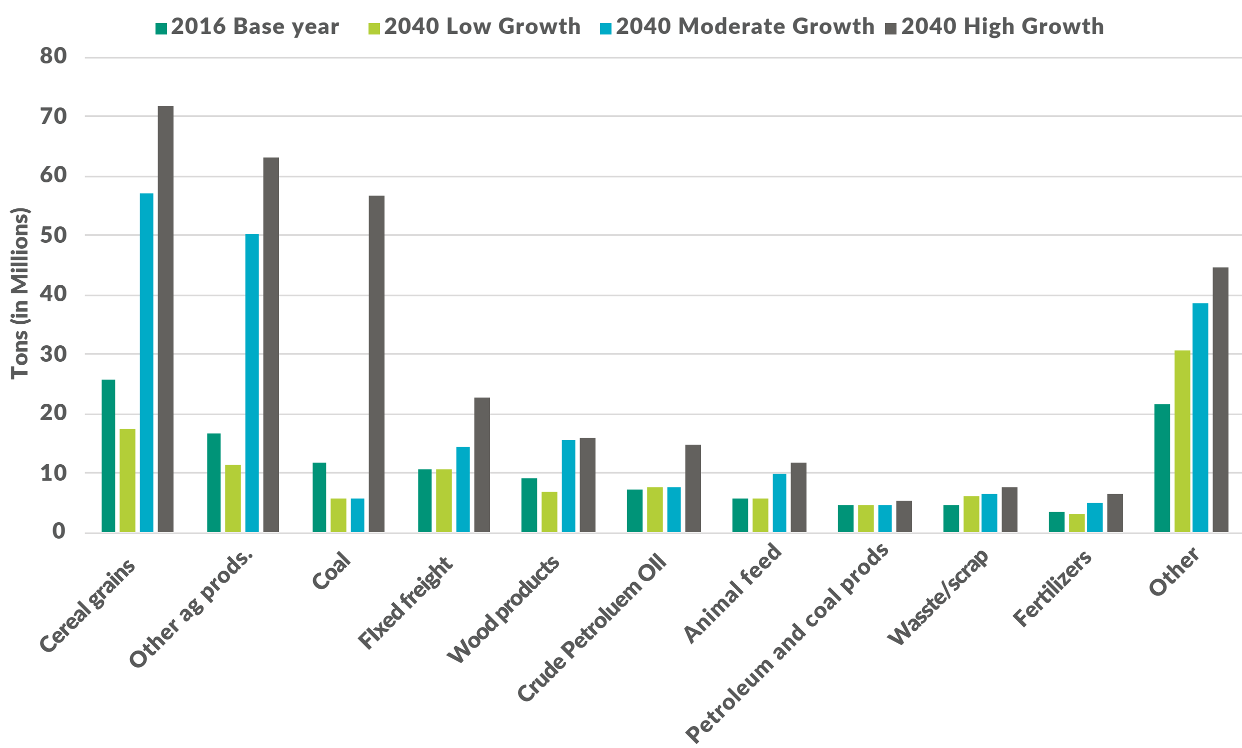


Exhibit 2-4: 2016 and 2040 share of statewide tonnage by commodity and scenarios

Commodity	2016 Base year	2040 Low Scenario	2040 Moderate Scenario	2040 High Scenario
Cereal grains	21%	16%	26%	22%
Other ag prods.	14%	10%	23%	20%
Coal	10%	5%	3%	18%
Mixed freight	9%	10%	7%	7%
Wood products	8%	6%	7%	5%
Crude Petroleum Oil	6%	7%	4%	5%
Animal feed	5%	5%	5%	4%
Petroleum and Coal Products	4%	4%	2%	2%
Waste/scrap	4%	6%	3%	2%
Fertilizers	3%	3%	2%	2%
Other	18%	28%	18%	14%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 2-5: Freight rail flow change from 2016 to 2040 by commodities and growth scenarios

Commodity	2040 Low Scenario	2040 Moderate Scenario	2040 High Scenario
Cereal grains	-33%	120%	176%
Other ag prods.	-32%	199%	275%
Coal	-52%	-52%	375%
Mixed freight	2%	37%	113%
Wood products	-23%	71%	72%
Crude Petroleum Oil	2%	2%	97%
Animal feed	-1%	68%	101%
Petroleum and Coal Products	-1%	-1%	20%
Waste/scrap	35%	47%	74%
Fertilizers	-13%	51%	87%
Other	44%	80%	109%
Total	**-10%**	**77%**	**163%**

A breakdown of 2016 and 2040 freight rail traffic into Port and NAFTA related imports and exports, domestic, and through flow is shown in exhibit 2-6. Exhibit 2-7 through 2-10 provide more details for total import, total export and domestic flow by commodities. These exhibits reveal that the significant changes are largely influenced by bulk commodity exports from Washington ports. Most other types of movements see similar volumes across each scenario, although all types of international movements decrease in the Low Growth scenario. In particular, these exports from Washington ports are anticipated to see a 38% reduction in traffic from over 39 million tons to just over 24.5 million tons, accounting for the majority of the decrease in international traffic.

Exhibit 2-6: Annual rail flows in Washington by trade type, 2016 and 2040 scenarios

Movement Type	2016 Rail Tonnage (millions)	2040 Low Scenario Rail Tonnage (millions)	2040 Moderate Scenario Rail Tonnage (millions)	2040 High Scenario Rail Tonnage (millions)
Domestic	48.9	55.9	57.4	62.5
WA Ports Import [a]	7.5	7.1	11.1	18.8
NAFTA U.S. Import [b]	17.2	14.7	32.5	37.5
WA Ports Export [c]	39.3	24.5	105.8	190.2
NAFTA U.S. Export [d]	8.5	7.5	8.7	11.5
NAFTA Through [e]	0.7	0.7	0.7	0.8
Total	**122.0**	**110.4**	**216.2**	**321.4**

Source: 2016 Enhanced Carload Waybill Sample, FAF4 Forecast with Adjustments.

a. Washington Ports import consists of traffic originating outside of the NAFTA countries that is handled through a Washington port with final destination anywhere in the US.
b. Imports to Canada and Mexico from WA Ports (after importing) are included under WA Ports Import; these are not considered as NAFTA U.S. Export.
c. Washington port exports consists of traffic originating anywhere in the US, including Washington, and exported from a Washington port.
d. Exports from Canada and Mexico to WA Ports (for exporting) are included under WA Ports Export; these are not considered as NAFTA U.S. Import.
e. A limited amount of Canada-Mexico trade partner flows pass through Washington.

Exhibit 2-7: Top commodities in Washington by rail tonnage, split by import, export, and domestic, 2016

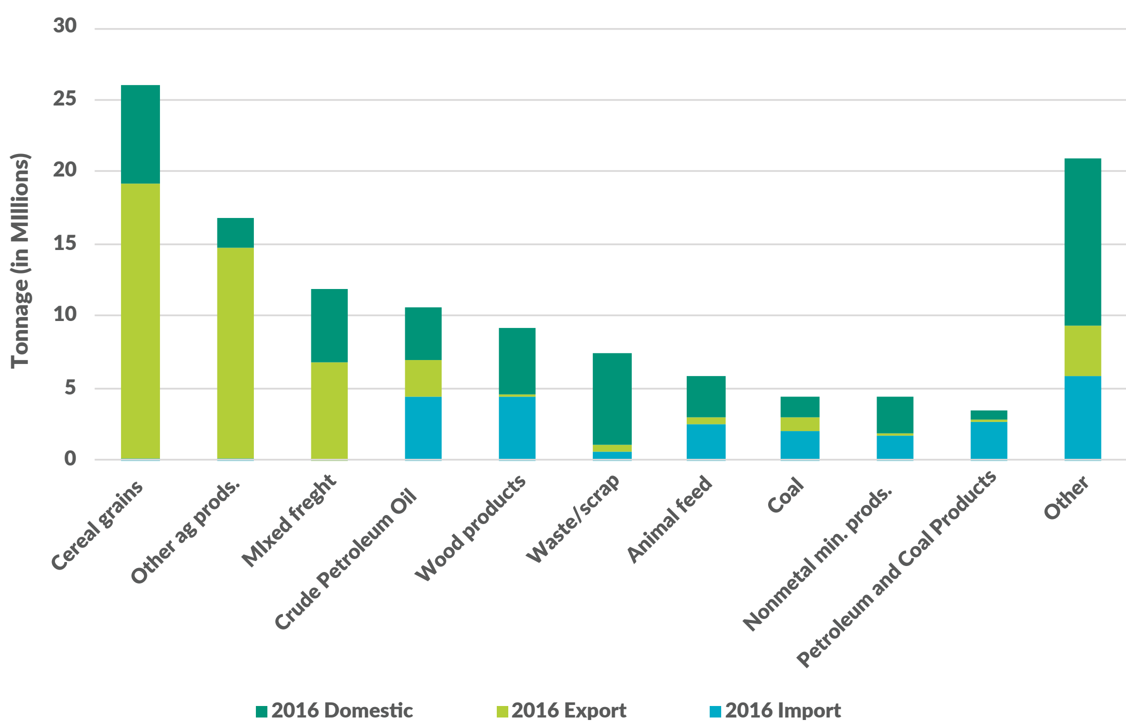


Exhibit 2-8: Top commodities in Washington by rail tonnage, split by import, export, and domestic, 2040 Growth Scenario

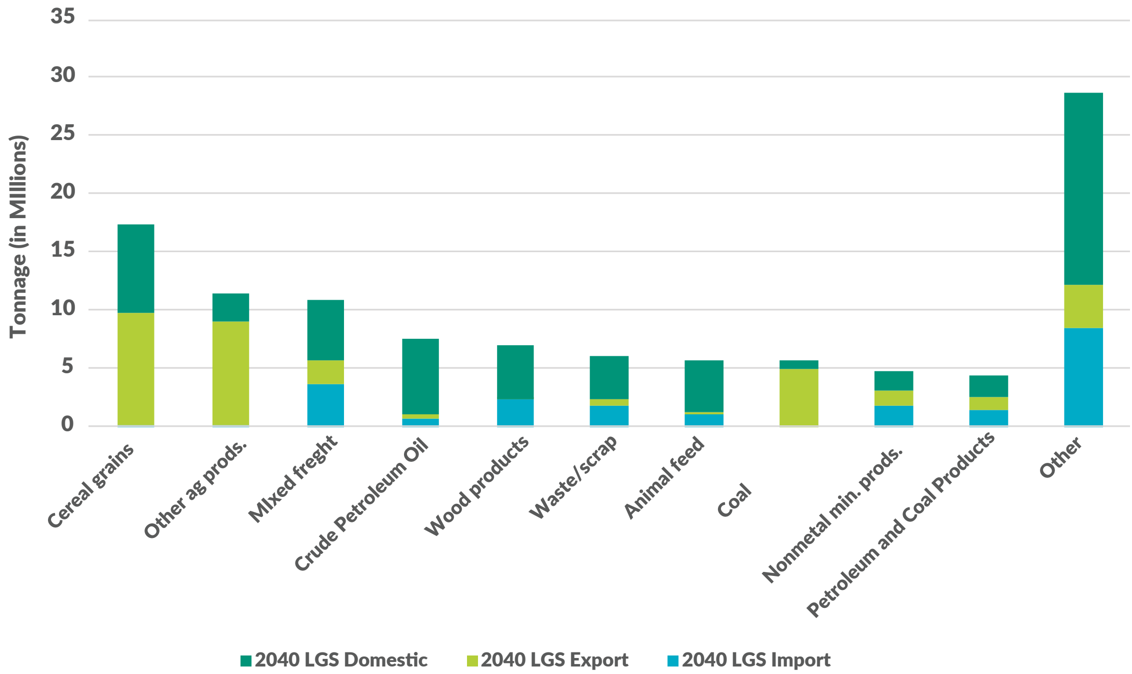


Exhibit 2-9: Top commodities in Washington by rail tonnage, split by import, export, and domestic, 2040 Moderate Scenario

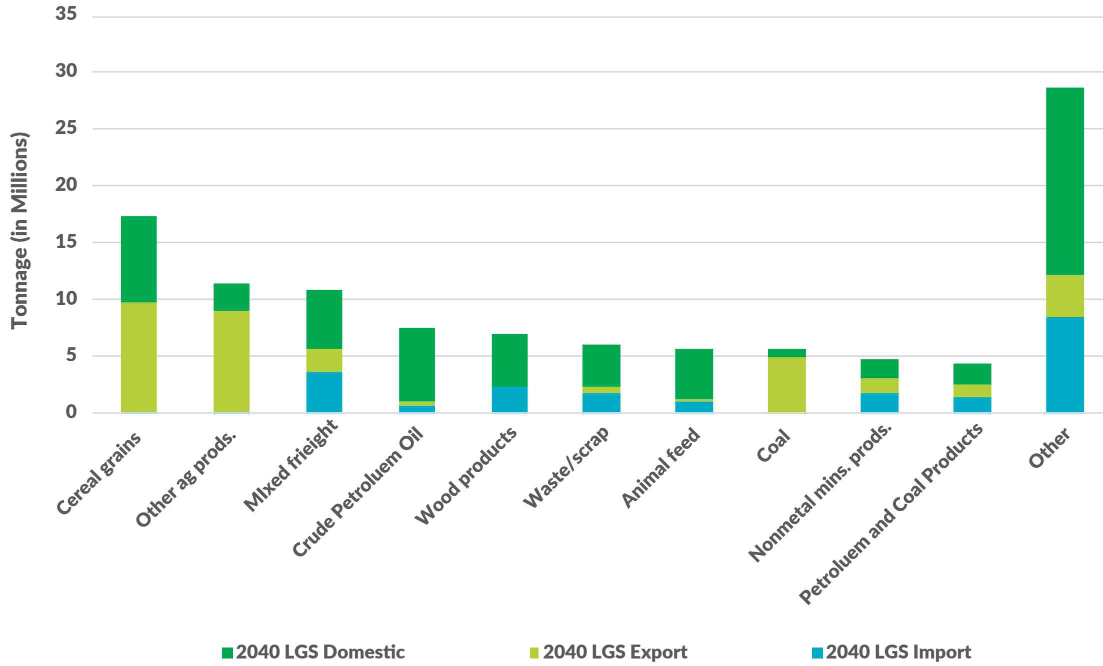
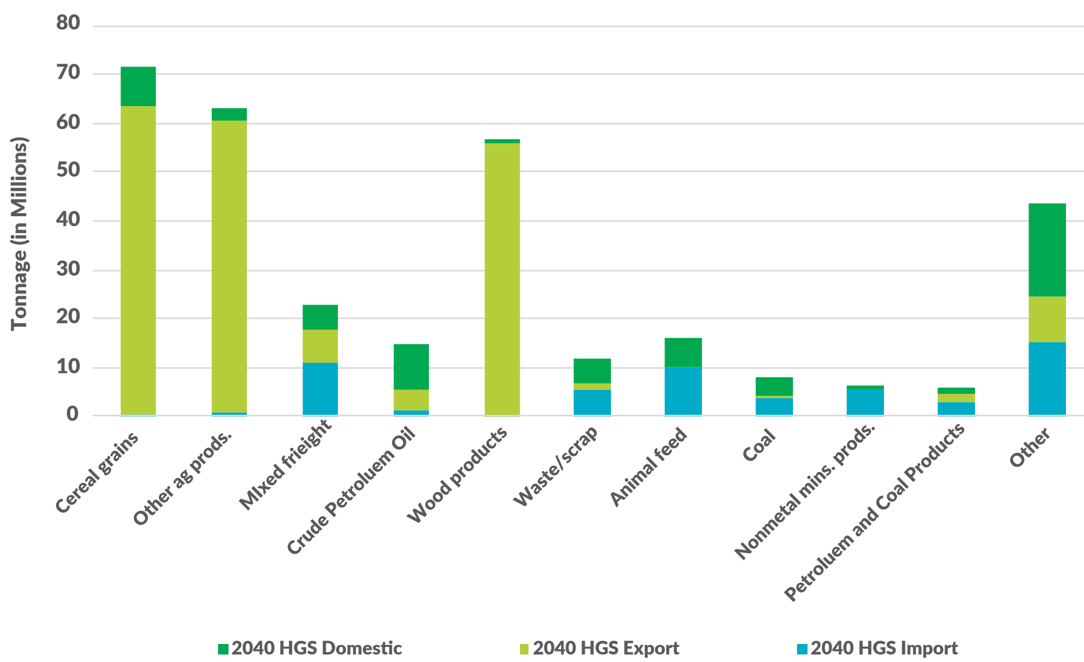


Exhibit 2-10: Top commodities in Washington by rail tonnage, split by import, export, and domestic, 2040 High Growth Scenario



2.3 Freight rail tonnage and train volumes by corridor

This section provides freight rail tonnage and freight train volume forecasts for the 2016 base year, and three scenarios of low growth, moderate growth, and high growth. Train volumes are expressed in average trains per day and were estimated using the network assignment and train volume estimation approach which is explained in the subsection below.

Network assignment and train volume estimation

The modeling approach used for assigning freight rail tonnage to corridors and estimating train volumes included two steps based on available data:

Network assignment - assigning enhanced waybill origin-destination commodity flow data to the rail network by identifying origin, destination, and interchange station locations. This step generates annual tonnages by commodity and rail service type for each section of the rail network in the state.

Train volume estimation - converting annual tonnage flow outputs calculated during the network assignment step into average daily train volumes. This conversion was conducted based on average payload factors (tons per car or unit),[5] estimated number of rail car units per train,[6] future productivity assumptions (described below), and empty train return ratios.[7] First, the payload factors by commodity and service type were used to turn annual tonnage into annual loaded car volume. Then loaded car volume was converted to train volumes for each section of the rail network. Train volumes were calculated by applying operational parameters including the number of cars or units per train and empty train return ratios by service types. Future productivity gains in terms of car per train was considered when estimating train volume for future years.

Future productivity assumptions

To estimate the future number of freight trains, several forms of productivity gains in train operations were assumed to occur. These include: (1) continued increase in load limits for rail cars; (2) continued refinement of car designs to optimally use the available clearance envelope; and (3) lengthening of trains. In this analysis, only the productivity gain effect of increases in load limits for rail cars was considered due to the lack of sufficient data to predict future productivity gains resulted from the other two drivers. It was assumed that load limit would increase from 286,000-pounds to 315,000-pounds, the benefits of which would accrue to bulk and general merchandise type rail cars. Tons per car assumptions for bulk and general merchandise rail cars in 2016 were increased by a factor of 1.128[8]. For all other rail car types, no productivity gain was assumed.

2016 base year estimates

Exhibits 2-11 and 2-12 show the 2016 freight tonnage and daily train volumes. The 2016 base year analysis results were calibrated based on freight train count data provided by BNSF.

2040 Low growth forecasts

The effects on daily train volumes from the low growth scenario are shown in Exhibit 2-13. With the change in train volumes being almost non-existent under the low growth scenario, significantly fewer freight trains would be operated across the network as a result of the productivity gains previously discussed. Thus, 44 trains would use BNSF's longstanding bottleneck between Spokane and Sandpoint, Idaho, while the traffic on the corridor between Tacoma and Vancouver, WA, would decline to 28 trains from the 35 trains operated in 2016. Exhibit 2-17 summarizes the daily freight train totals by railroad corridor.

2040 Moderate growth forecasts

Exhibit 2-14 and 2-15 show the moderate growth forecasted annual tonnage flow and average daily train volumes on Washington's rail system in 2040.

By 2040 the rail line east of Spokane used by BNSF and Union Pacific, where the state's east-west rail corridors converge, is projected to carry over 90 daily trains. More than 65 daily freight trains are projected to move on the rail line between Longview and Vancouver, and 84 total daily freight trains along the Columbia River route east of Vancouver. Up to 58 daily freight trains are projected to move along the I-5 corridor in the Seattle-Tacoma area. Exhibit 2-17 summarizes the daily freight train totals by railroad corridor.

2040 High growth forecasts

The effects on daily train volumes from the high growth scenario are shown in Exhibit 2-16. With the high growth scenario, existing bottlenecks would worsen, and new ones would arise. East of Spokane, BNSF's main line is projected to handle 102 trains daily, while the I-5 Corridor between Tacoma and Vancouver increases to 102 trains, BNSF's corridor subdivision along the Columbia River between Vancouver, WA, and Pasco would increase to 88 trains, and Stevens Pass, between Everett and Spokane would increase to 34 trains. In all of these instances, these traffic volumes could only be handled with substantial investments by the host railroads. Exhibit 2-17 summarizes the daily freight train totals by railroad corridor.

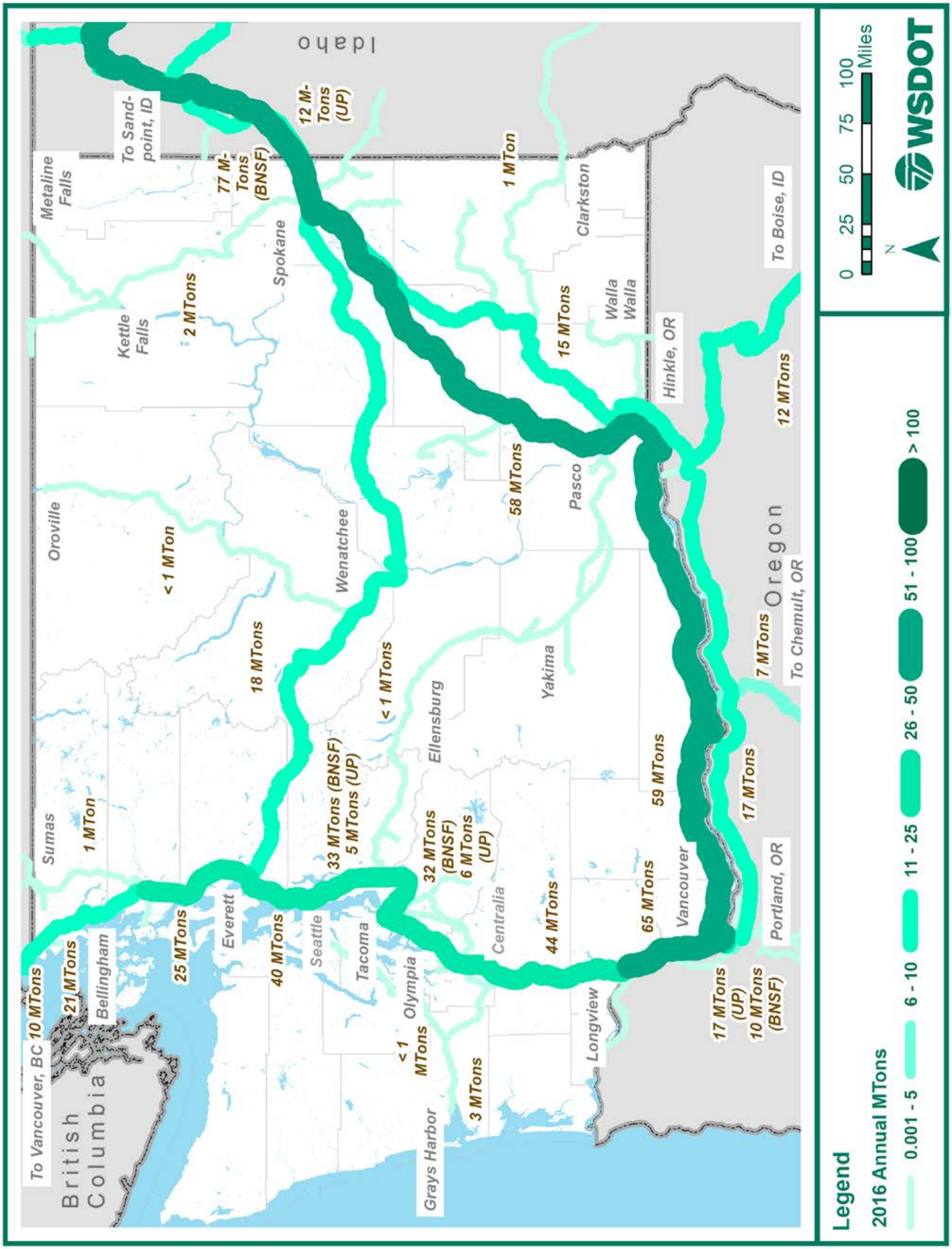
Combined freight and passenger rail capacity analysis

A rail system capacity analysis was also performed by combining the freight rail demand and passenger rail demand forecasts developed for low, moderate and high growth scenarios to examine how the forecasted rail traffic growth would affect the performance of the existing rail network in Washington state if no additional capacity or operational improvements were made to the network. The general approach used for the high-level capacity analysis includes identifying the rail network's essential physical attributes including number of tracks and signal system types, calculating the existing practical capacity of each mainline segment based on those attributes, and comparing the current and projected train volumes from demand forecast results against practical capacity for each mainline segment. The results of the analysis are expressed by level of service and can be found in Chapter 5.

In reality, the Class I railroads (BNSF and Union Pacific) and other infrastructure owners will likely address key capacity issues as they emerge. Therefore, the 2040 capacity assessment is intended to illustrate the magnitude of future rail traffic anticipated for the rail system in Washington. It underscores the need for continued planning and action to address capacity and mobility concerns throughout the system. Neither BNSF nor Union Pacific have validated or endorsed the capacity analysis.

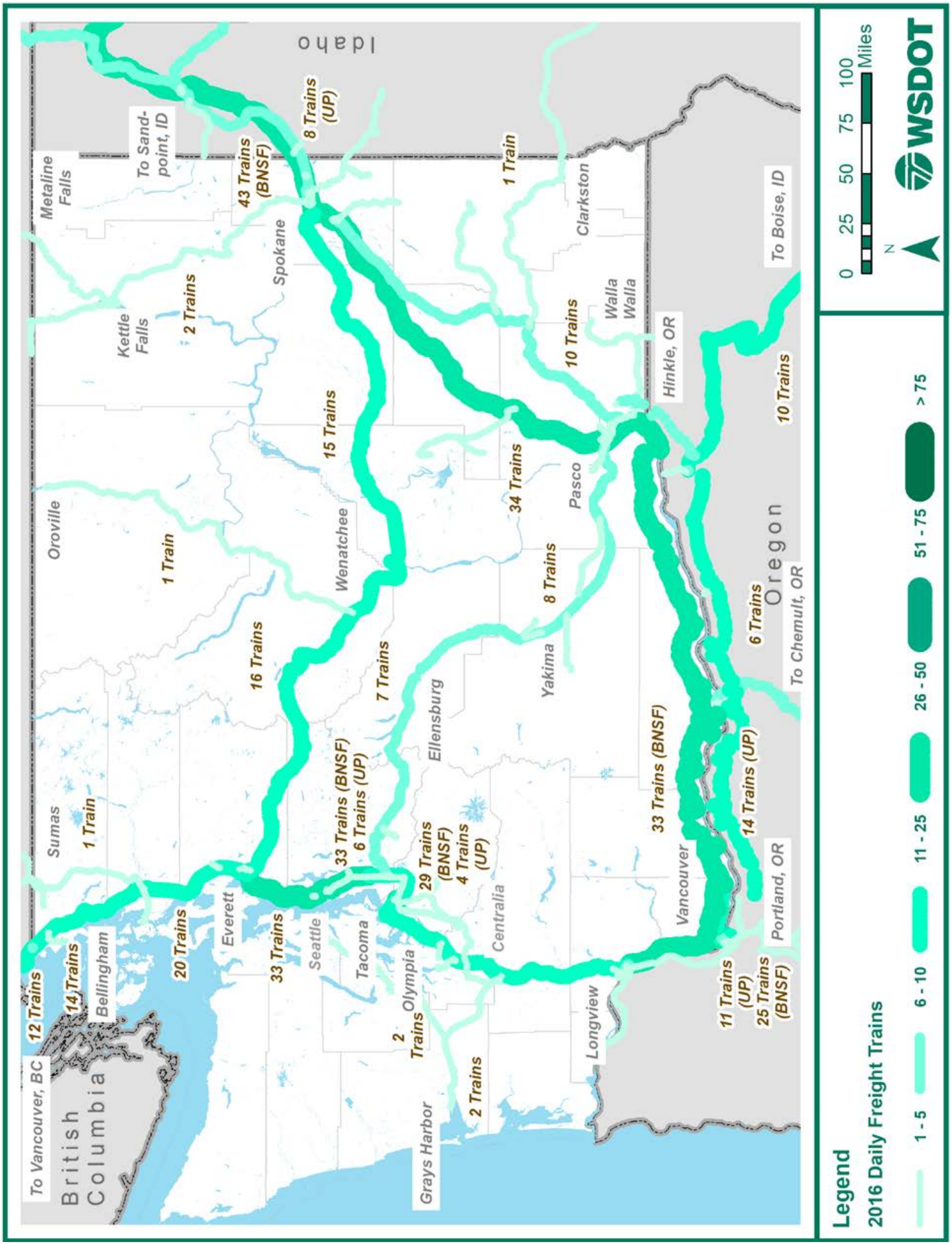
This analysis represents just one perspective on how freight rail volumes will change over time and was developed to serve the needs of Washington State Rail Plan. It is different from the rail capacity analysis completed in 2017 Marine Cargo Forecast, which used different data sources, modeling approach, assumptions, and future forecast scenarios.

Exhibit 2-11: Base year annual rail tonnage flows in Washington, 2016



Source: WSDOT's 2016 Enhanced Waybill Sample and Freight Rail Modeling.

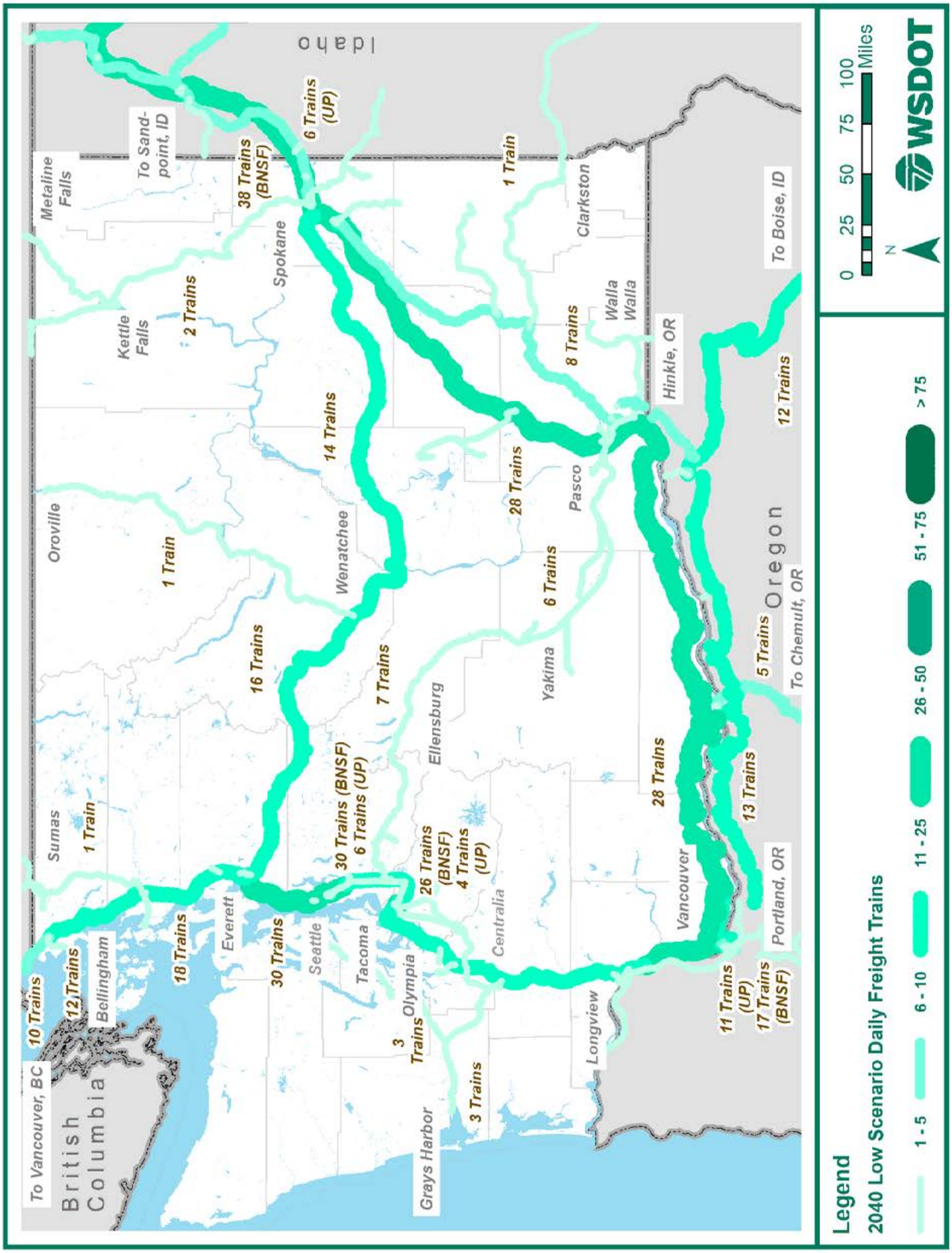
Exhibit 2-12: Base year average daily freight train volumes in Washington, 2016



Source: WSDOT's 2016 Enhanced Waybill Sample and Freight Rail Modeling.

Note: The train volumes shown in the map are rounded up values to the nearest even number to account for forward and return moves.

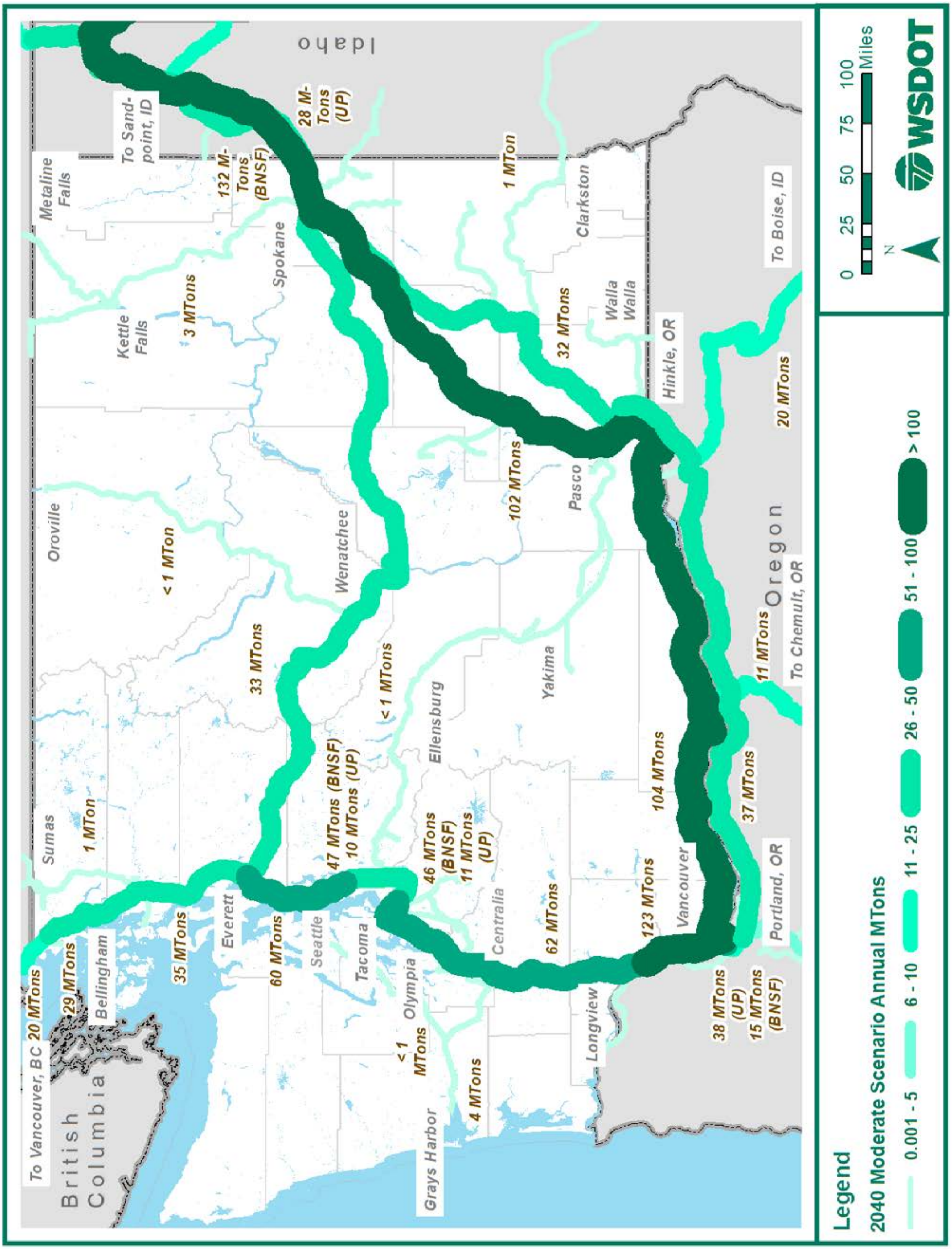
Exhibit 2-13: Exhibit 2-13 Low growth scenario forecasted year average daily freight train volumes in Washington, 2040



Source: WSDOT's 2040 Forecasted Enhanced Waybill Sample and Freight Rail Modeling.

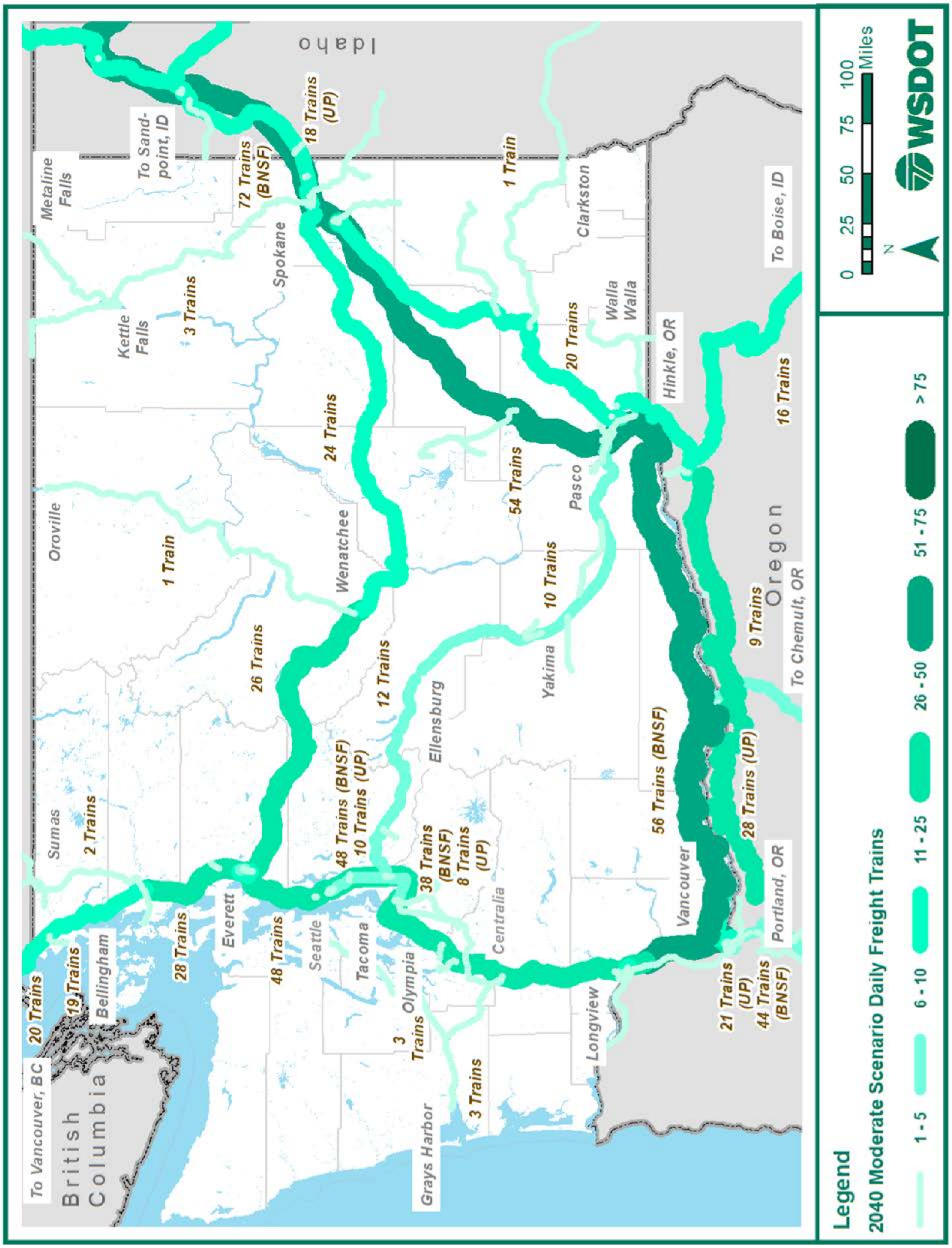
Note: The train volumes shown in the map are rounded up values to the nearest even number to account for forward and return moves.

Exhibit 2-14: Moderate growth scenario forecast annual rail tonnage flows in Washington, 2040



Source: WSDOT's 2040 Forecasted Enhanced Waybill Sample and Freight Rail Modeling.

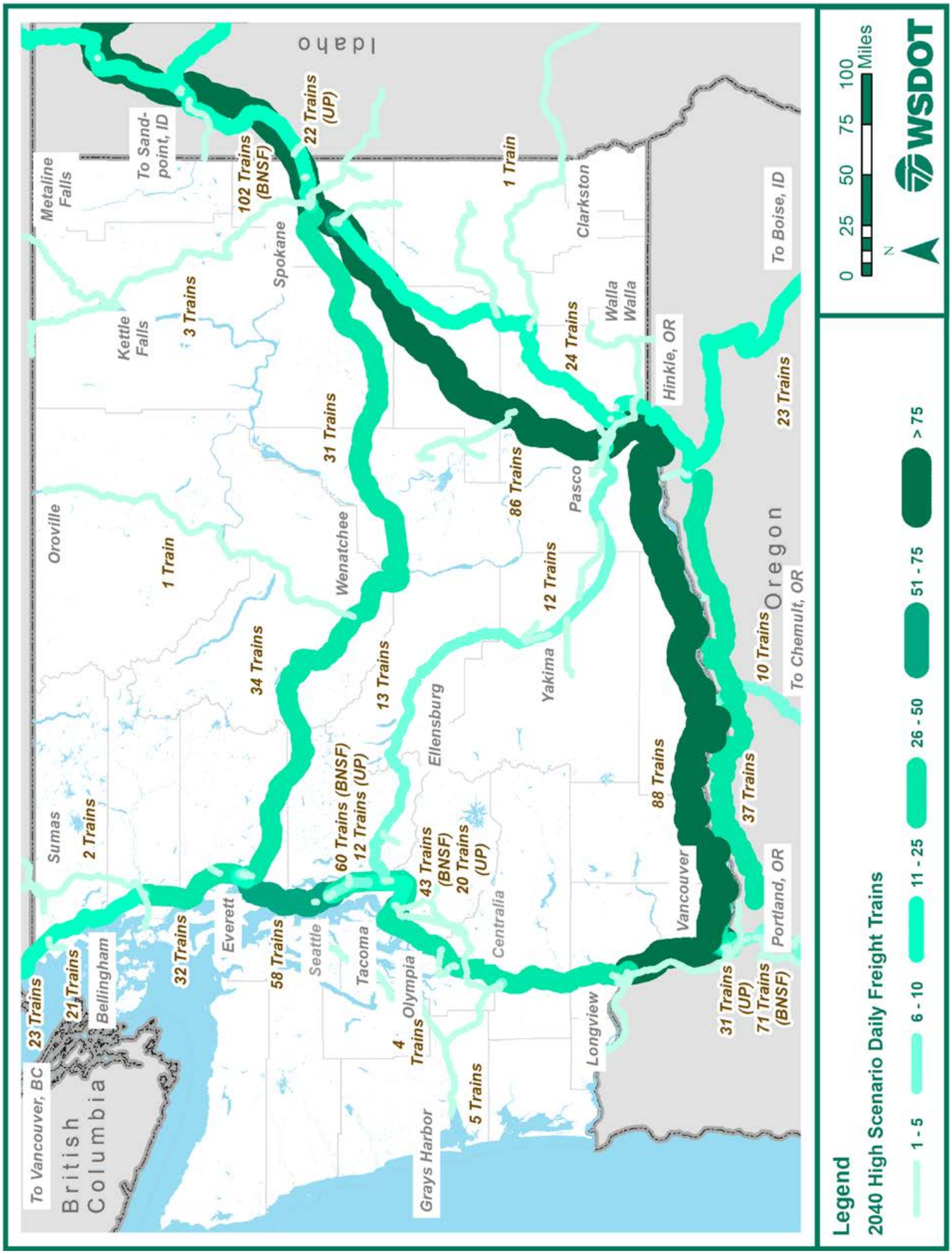
Exhibit 2-15: Moderate growth scenario forecasted year average daily freight train volumes in Washington, 2040



Source: WSDOT's 2040 Forecasted Enhanced Waybill Sample and Freight Rail Modeling.

Note: The train volumes shown in the map are rounded up values to the nearest even number to account for forward and return moves.

Exhibit 2-16: High growth scenario forecasted year average daily freight train volumes in Washington, 2040



Source: WSDOT's 2040 Forecasted Enhanced Waybill Sample and Freight Rail Modeling.

Note: The train volumes shown in the map are rounded up values to the nearest even number to account for forward and return moves

Exhibit 2-17: Estimated daily freight trains by railway subdivision, 2016 and 2040 scenarios

Corridor	2016	2040 Low Growth Scenario	2040 Moderate Growth Scenario	2040 High Growth Scenario
Auburn - Pasco	8	6	10	12
Everett-Vancouver, BC, Canada	20	18	28	32
Hinkle, ID-Lakeside	10	8	20	24
Pasco-Lakeside	34	28	54	86
Vancouver-Pasco	34	28	56	88
Seattle-Tacoma (BNSF)	34	31	48	60
Seattle-Tacoma (UP)	6	6	10	12
Tacoma-Vancouver (BNSF/UP Shared Use Segment)	35	28	65	102
Seattle-Everett	34	30	48	58
Everett-Spokane	17	16	26	34
Lakeside - Spokane (BNSF/UP Shared Use Segment)	44	38	72	102
Spokane-Sandpoint, ID (BNSF)	44	38	72	102
Spokane-Sandpoint, ID (UP)	8	6	18	22
Portland, OR-Vancouver (BNSF/UP Shared Use Segment)	22	22	36	46
Fallbridge-Chemult, OR	6	6	8	8
Other Rail (Non-Class I)	65	54	110	161

Source: WSDOT's 2016 and 2040 Forecasted Enhanced Waybill Sample and Freight Rail Modeling